

## Final Report

# Educating healthcare professionals about Australian mushrooms

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**Delivery partner:**

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**Project code:**

MU17002

**Project:**

Educating healthcare professionals about Australian mushrooms (MU17002)

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## Summary

This 3-year project (2019-21) 'MU17002: Educating Healthcare professionals about Australian Mushrooms', was a key strategy of the Mushroom 2017-2021 Strategic Investment Plan key outcome to 'Achieve the bold and ambitious target of domestic consumption of 4 kilograms per person of mushrooms by 2021'. Targeting Australian healthcare professionals (HCPs), it aimed to educate on the nutrition, health and culinary properties of Australian mushrooms (*Agaricus bisporus*) and elevate their profile so that Australian mushrooms became an active recommendation to clients.

The project was strategically developed and executed across four key pillars; Strategic planning & evaluation, Scientific Research, Resource development and Communication & Education. Some of the key outputs included the completion of a world-first systematic literature review (SLR) on *Agaricus bisporus* and its bioactive compounds and health outcomes in human studies, which was accepted for publication in a top-ranking international journal, *The Journal of Nutritional Biochemistry*. The review formed the bases for the development of eight HCP resources including scientific brochures and videos, fact sheets, a recipe booklet, an educational animation and a client-focused brochure. There was the establishment of an online resource hub and along with the development of an engaged HCP database, an engaging communication plan executed via eighteen EDMs, targeted social media and third-party organisation activations. Education was at the core of this project with the development and execution of nine educational activities including GP trade media articles, webinars, conference seminars and an expert roundtable event. The project was monitored and evaluated via three audience sentiment research (ASR) surveys conducted at baseline, at 18 months and at project end.

The project was overwhelmingly successful at meeting all intermediate and end-of-project outcomes. As a result of the project, HCP knowledge of nutrition, health and culinary benefits of mushrooms increased along with HCP's own personal consumption and recommendation to clients. Specifically:

- 97.6% of the respondents were able to specify at least one nutritional property, an increase from 90.6% at baseline. At project end only 2.4% could not select a nutritional property, a huge drop from 2019 (9.4%). Across the board there were between 2.1%-19.7% increase on knowledge of all health benefits. Only 5.4% could not select a health benefit, almost a 50% drop from baseline.
- The number of HCP what reported that were very familiar with the health and nutrition properties of mushrooms doubled over the project to 57.2% and 50.6%, respectively; while those reported they were not familiar halved.
- At project end most HCPs (80%) reported they recommend mushrooms to their clients compared to just under half (47.7%) at baseline. HCPs who recommend mushrooms 'always' or 'often' jumped from only a fifth of HCPs to nearly 1 in 2.

This project clearly demonstrated that the nutrition and health benefits of mushrooms are an important driver to consumption, hence validating efforts to drive awareness of these with HCPs, as a valuable strategy to unlocking and driving industry growth. While this project has started to make an important and successful first step into educating and influencing this important stakeholder influencer group, it is recommended that further investment be continued. Success in any behaviour change lies in consistent and long-term focused investment. Further investment will maximize the current return on investment and help secure mushrooms a rightful place of greater prominence on the 'healthy plate'.

It is recommended that future investment should have both a short-, medium- and long-term strategic approach. In the short to medium term, maintaining top of mind awareness with the established highly engaged HCP database is paramount, with the opportunity to drive further penetration of the communication messages to reach more HCPs (including targeting other sub-groups such as fitness professionals) and those who work in organisations that have their own nutrition and health promotion strategies (i.e., Osteoporosis Australia, Diabetes Australia, etc.). Additionally, while the number of HCPs recommending mushrooms has increased significantly, the main reason some HCPs to not recommend mushrooms was because they do not think about them specifically. Further investment can help close these gaps. Medium to longer term strategies include investment in human clinical research on

mushroom bioactives such beta glucan, and human health outcomes including clinical trials to show how mushrooms can increase vitamin D in at risk groups. This will be important to further build the necessary evidence base to support mushroom's legitimacy and advocacy to achieve greater recognition of mushrooms in Australian Dietary Guidelines.

## Keywords

<Healthcare professional; Mushrooms; Education; Health; Nutrition

## Introduction

Growth and sustainability for the mushroom industry is reliant on driving consumption. As part of the Hort Innovation Mushroom 2017-2021 Strategic Investment Plan (SIP), a key ambition is to *'Achieve the bold and ambitious target of domestic consumption of 4 kilograms per person of mushrooms by 2021'* (Outcome 1). One of the key strategies to achieving this included the investment of the industry's national R&D levy funds into educating healthcare professionals (HCPs) about mushrooms and promoting their consumption.

This project, MU17002: Educating Healthcare professionals about Australian Mushrooms, a key initiative in this endeavour, commenced in January 2019 and ran over 3 years. It was the second project for the Australian mushroom industry focused on educating health professionals (the first being Project MU14000). MU17002 aimed to provide credible, impactful, evidence-based messages to elevate the profile of mushrooms among HCPs so they become an active recommendation to clients and ultimately support the achievement of Mushroom SIP outcome 1.

Fungi are neither an animal nor a plant and belong to their own biologically separate kingdom. The most consumed edible fungi, mushrooms, contain a unique package of micronutrients, as well as other bioactive and flavor compounds, and a growing evidence base of health benefits. Despite their unique nutrition and health benefits, they are often grouped and viewed together from a cultural and culinary viewpoint with vegetables in dietary recommendations. As such, there has been limited awareness of mushroom's unique nutrition and health offering with HCPs, leading to them not being top of mind or actively recommended as a unique, health promoting food.

The end of project key outcomes for the project were to:

1. Increase HCP knowledge about the nutrition and health benefits of mushrooms.
2. Empower HCPs to recommend clients to include mushrooms in their diet.

Key intermediate outcomes that were set for the project included:

- Create uplift in sentiment around mushroom perceptions and health benefits
- Increase understanding amongst HCPs to increase confidence in communicating mushroom benefits
- Move mushrooms from being seen as just another vegetable, to a must-have inclusion in a healthy diet
- Build a database of HCPs so Hort Innovation can continue to communicate beyond 3-year project
- Improve information distribution
- Develop key messages for HCP and consumer audiences
- Educate HCPs on mushroom benefits in an engaging way
- Create visuals aligned in overall look and feel that are easy to digest

## Methodology

The project targeted Australian HCPs with the primary target of General Practitioners (GPs), Dietitians, Nutritionists & Naturopaths. It was strategically developed and executed across 4 key pillars; Strategic planning & evaluation, Scientific Research, Resource development and Education & Communication. The project was conducted with a continuous improvement mindset with modifications to the project implemented based on learnings from activations, research insights and/or in response to external impacts such as COVID-19.

The project was managed by Nutrition Research Australia (NRAUS) and History will be Kind (HWBK). NRAUS was the main point of contact and responsible for the general services. Both NRAUS and HWBK contributed to project strategy development and shared project management with NRAUS leading scientific research, messaging content, communication design direction, reporting requirements and client liaison and HWBK leading the ASR, finalised communication design and graphics, and the communication plan and execution.

### Strategic planning & evaluation

The initial phase of the project involved finalization of key project planning elements in conjunction with Hort Innovation including the project risk register, program logic, and monitoring and evaluation plan.

Communication to HIA on project progress including outputs and outcomes were provided 6 monthly through benchmarking reports.

As part of the monitoring and evaluation plan, and to help inform strategy and evaluate the effectiveness of the communications plan, a detailed ASR survey was designed. The ASR was planned strategically throughout the project; project start (June - July 2019), 18-month point (Sep - Oct 2020) and project end (October 2021). It sought to help establish current and changing attitudes, knowledge and propensity to act of health professionals with regards to Australian mushrooms over time.

The baseline ASR served to provide a benchmark of HCP knowledge, attitudes and behaviour around mushrooms, with the ASR at project end to allow for a comparison and assessment of project effectiveness, insights and learnings. The mid-way ASR provided an indication of project effectiveness and supported the continuous improvement mindset of the project team to take any learnings and adapt strategies if needed.

The ASR consisted of a detailed questionnaire designed to extract both qualitative and quantitative data from the responses. Each question was crafted around a core objective to ensure information collected was robust to help inform and guide the overall approach. The survey captured:

- knowledge levels of the nutritional properties and health benefits of mushrooms,
- the value placed on mushrooms for their nutritional and health properties,
- perception around mushrooms and opinions of mushrooms in diet relating to health,
- behaviour around recommending mushrooms.

Each person who participated in the research was incentivised through a chance to win a gift voucher mechanic.

### Scientific Research

In year 1, a systematic search of the literature was undertaken to provide credible science that could be translated into impactful messaging and that could be utilised in education and communication activations including support for marketing, and HCP presentations, websites and developed resources.

Firstly, to identify the best approach and the most up-to-date literature on mushrooms and health, an initial research scope was conducted. The scope searched scientific databases for studies on edible mushrooms (excluding extract) and health outcomes. The purpose of the scope was to identify the current research and determine the best approach for a commissioned SLR.

From this report, a decision was made in conjunction with Hort Innovation for the SLR to determine



bioactive composition of *Agaricus bisporus* and their effect on all health outcomes in humans. A SLR was then undertaken with over 5000 titles and abstracts investigated for inclusion. When completed, the SLR was developed into a manuscript which was published in the Journal of Nutritional Biochemistry.

The NRAUS NUTRITIONiQ database update service was set up to stay abreast of any new science published once the review was completed (from June, 2019 to project end) using the same search parameter as the systematic review. Automated monthly searches were conducted of scientific databases for any new papers matching the search strategy of the review. This service ensured that the comprehensive research database of mushroom bioactives and human studies, stayed current during the project and to ensure continuity of the project once it ends (if funds are available). The literature of interest was identified, and any relevant updates were provided to Hort Innovation. It was also used to help support communications and messaging throughout the campaign.

### **Resource development**

Throughout the 3 years, collateral was developed as the key mechanism to educate HCPs and increase their knowledge and understanding on the nutrition, health and culinary properties of mushrooms. Along with specific resources to improve HCP knowledge, collateral was developed to support the dissemination of this knowledge to their clients. Different types were developed to help support engagement and interest including brochures, fact sheets, recipe booklets and an animation. Strategically developed over the 3 years, the collateral served as new 'news' to maintain interest and an ongoing conversation with the core owned HCP database.

### **Communication & Education**

A **database** was initially established at start of project that combined contacts from both NRAUS and Australian Mushrooms. The database served as the project's central core target audience with a key objective and outcome to continuously build the database throughout the project. A database growth strategy was developed to continue to build the network during the 3-year period. This was designed to be achieved through specific planned activations that included incentive campaigns within 3<sup>rd</sup> party education activities, leveraging professional association newsletter communications including the Australasian Society of Lifestyle Medicine's (ASLM) the Nutrition Society of Australia (NSA), and the Royal Australian College of General Practitioners (RACGP), recruiting HCPs attending our own educational events and dedicated social media lead generation mechanics.

A **key messaging** dossier ('Dr Flavs Fun Facts') was developed based on the SLR and broader scientific research. The document was utilised when providing scientific and technical advice to stakeholders including Australian Mushrooms website content development and informing content to support the Australian Mushrooms marketing, and project resources, communications and educational activities.

An **ongoing periodic communication** program was developed and executed throughout the 3 years. Based on the evaluation of activations including ASR findings, external environmental influences, planned resource development and educational events, the project strategy was reviewed yearly, and the plan strategically adjusted accordingly. This ensured the content maximised the planned outcome delivery and allowed content to exploit any relevant market trends/insights operating at the time to amplify impact. The communication plan included regular EDMs to the database along with targeted digital activations utilising social media and relevant third-party channels. For growers, periodic communication to keep them informed on the project progress and milestones was planned, developed and executed in conjunction with HIA via 2 x yearly articles in the Australian Mushrooms Journal and yearly presentation.

An **educational activity plan** of events including relevant HCP conferences, webinars and a roundtable event was originally planned at project start with ambition to target all key HCP targets (i.e., GPs, dietitians, nutritionists, and naturopaths). Specific events were modified throughout the project in response to external impacts (COVID-19) and review of mid-way ASR results. COVID-19 disrupted conferences in 2019-20 leading to some being completely cancelled such as Australian Society of Lifestyle Medicine or moved online such as Dietitian Connection.

## Outputs

See **Table 1** for summary of outputs.

### **STRATEGIC PLANNING**

#### **MS 102 PROGRAM LOGIC AND MONITORING AND EVALUATION PLAN**

A program logic and evaluation plan was developed and can be found [here](#). This was devised in line with Hort Innovation guidelines to ensure all activity, outputs and outcomes were clearly mapped out at the start of the campaign.

**Date conducted:** January 2019

#### **MS 103 PROJECT RISK REGISTER**

The [risk register](#) was developed to ensure the team had identified any possible risks and provided a way to best mitigate these in advance.

**Date conducted:** January 2019

#### **MS104 COMMS SET UP & ACTIVITY PLANNING**

To ensure project alignment from the outset, a context collaboration session was undertaken to delve into six fundamental aspects of the project (business context, objectives, ways of working, project approach, risks and KPIs). This session was hosted by HWBK and all core team members were in attendance, including key stakeholders from the consumer agency, Bite Communication.

**Date conducted:** December 2018

**Table 1:** Project MU17002 Outputs Summary

^Outputs developed as **additional outputs** to those agreed in the original budget and project plan.

Strategic Pillar	Year 1	Year 2	Year 3
<b>Strategic Planning</b>  <b>&amp;</b>  <b>Evaluation</b>	MS102 Program logic and monitoring evaluation plan MS103 Project Risk Register MS104 Comms set up & Activity Planning		
	MS109 Benchmarking report MS115 Benchmarking report MS105 Audience Sentiment Research 1 (ASR1)	MS118 Benchmarking report MS126 Benchmarking report MS121 Audience Sentiment Research 2 (ASR2)	MS127 Benchmarking report MS129 Audience Sentiment Research 3 (ASR3) MS130 End-of-campaign report
<b>Scientific Research</b>	MS108 Systematic Literature Scope report <b>Additional scope report &amp; Next Steps^</b> MS111 SLR & key points report	MS113 SLR Manuscript for publication	
<b>Resources</b>	MS112 HCP Vitamin D brochure	MS117 HCP SLR findings brochure <b>SLR video^</b> <b>Vitamin D &amp; Mushroom animation^</b> <b>Recipe booklet^    Mushroom &amp; Vegetable Factsheet^</b>	MS120 Expert White Paper Report on Fungi foods MS124 Vitamin D client-focused resource
<b>Communication</b>  <b>&amp;</b>  <b>Educational activations</b>	MS107 6 x EDMs MS107 Mushroom Journal article x 2 (Aug & Nov) MS107 SIAP Presentation <b>Database &amp; Mushroom Hub^</b>	MS107 6 x EDMs MS107 Mushroom Journal article x 2 (Aug & Dec) MS107 Media release MS107 STUDIO 10 National Mushroom Day	MS107 6 x EDMs MS107 Mushroom Journal article x2 (Aug & Dec) MS107 Applied Hort Growers Presentation
	<b>Medical Journal of Australia Article^</b> MS114 GPCE Conference presentation MS116 GP targeted webinar	MS106 Key Messaging ('Dr Flav's Fun Facts') Dossier for communication MS106 Australian Mushrooms website content development MS122 Expert Roundtable Meeting	MS125 Australian Doctor Publication Article MS119 Dietitian targeted seminar presentation MS128 Naturopath targeted webinar

## **EVALUATION**

### **MS 109/115/118/126/127 PROJECT BENCHMARKING REPORTS: (Appendix 1)**

Five 6-monthly reports were completed across the project to keep stakeholders informed of project progress, outputs and outcomes.

**Submitted:** June 2019, December 2019, June 2020, December 2020, June 2021, December 2021

### **HCP INSIGHTS RESEARCH**

A quantitative ASR survey was undertaken with HCPs three times throughout the project; baseline (ASR 1), mid-way (ASR 2) and project end (ASR 3).

### **MS105 BENCHMARK AUDIENCE SENTIMENT RESEARCH 1 (Appendix 2)**

The first in a series of three ASR reports established baseline attitudes and knowledge of health professionals with regards to mushrooms.



**Date conducted:** August 2019

**Target audience:** Health Care Professionals from owned EDM and social media recruitment.

**Completed responses:** 225

(Appendix 3)

A repeat survey to the baseline research conducted midway through the project to measure impact of the program through comparison to baseline data and gather insights to tailor the project activations in second half of project.



**Date conducted:** November 2020

**Target audience:** Health Care Professionals from owned EDM and social media recruitment.

**Completed responses:** 195

**MS129 AUDIENCE SENTIMENT RESEARCH 3** (Appendix 4 )

The third and final survey conducted at project end to measure the success of the program through comparison to baseline data to evaluate the impact of the program and gather project insights and learnings.



**Date conducted:** September/October 2021

**Target audience:** Health Care Professionals from owned EDM and social media recruitment.

**Completed responses:** 166

## RESEARCH

### MS108 SYSTEMATIC LITERATURE REVIEW SCOPE REPORT: (Appendix 5 )

A systematic scoping review of the literature detailing the existing available research was undertaken alongside a recommendation to determine the best approach for the commissioned SLR.

**Date sent:** March 2019

**Target audience:** Hort Innovation Australia

### SYSTEMATIC LITERATURE REVIEW ADDITIONAL SCOPE: (Appendix 6)

An additional scope conducted to determine the proportion of human research studies on *Agaricus bisporus* versus the other edible mushrooms as an alternative option to understand if most of the science was applicable to Australian Mushrooms (*A. bisporus*) or only to the other mushrooms.

**Date sent:** April 2019

**Target audience:** Hort Innovation Australia

### SYSTEMATIC LITERATURE REVIEW NEXT STEPS: (Appendix 7)

A final recommendation for the SLR to be on the health effects of *Agaricus bisporus* mushrooms in humans including its flavonoid and glucan properties.

**Date sent:** September 2019

**Target audience:** Hort Innovation Australia

### 9 DOCUMENT (Appendix 8)

SLR on the health effects of *Agaricus bisporus* mushrooms in humans including its flavonoid and glucan properties was completed and key points documented created.

**Date sent:** March 2020

**Target audience:** Hort Innovation Australia

### MS113 SYSTEMATIC LITERATURE REVIEW MANUSCRIPT (Appendix 9)

A comprehensive and world-first SLR on *Agaricus Bisporus*, consisting of 68 research articles was developed into a manuscript and was accepted for publication in *The Journal of Nutritional Biochemistry*.



**Date sent:** 24<sup>th</sup> February 2020

**Date accepted for publication:** 8<sup>th</sup> June 2020

**Date open access approved:** 7<sup>th</sup> August

**Impact factor:** 4.490 putting it in top 7% of nutrition journals (most journals have an impact factor of less than 2.0)

**AGARICUS BISPORUS RESEARCH DATABASE:** ([Link](#))

A database of all 500+ research papers on the nutrient and health properties of *Agaricus bisporus* mushrooms.

We applied the NRAUS NUTRITIONiQ database update service to this project to capitalise on the vast amount of research we obtained as part of the SLR process (~500 studies). This service ensured that the [research database](#) stayed current during the course of this project and can be applied beyond year three if funds are available. We have set up an automated research publication alert for the search strategy utilised in the SLR and are collating papers across the databases that are relevant as new research is published. This service allows updates to the database to be streamlined, and for any internal or external communications to be based on the latest science, while providing insights for R&D.

An average of 53.4 titles and abstracts were screened each month (range, 10-109 titles and abstracts). Since the SLR was conducted in June 2019, the NUTRITIONiQ database update service has screened a total of 1,172 records. Of those papers, almost 30% were excluded based on publication prior to 2019, and being duplicate articles already screened. The remaining papers were primarily reporting on industrial management of mushrooms (e.g., wet bubble disease, compost composition), or were relating to mushrooms other than *Agaricus bisporus*.

During that time, no new papers that met the inclusion criteria of the systematic review were identified. One new paper reporting dietary modelling was identified, and an alert summarising the paper was sent to Hort Innovation.

**Date:** Service ran from June 2019 to end of campaign (December 2021).

**Number of research records screened:** 1,172

**RESOURCE DEVELOPMENT**

**MS112 GP VITAMIN D BROCHURE (Appendix 10)**

A bespoke branded four-page A4 brochure, printed on 100% recyclable paper, was developed that brought to life the key findings of the research in bite sized digestible pieces of information for HCPs to share with clients.

**Date:** November 2019.

**Target audience:** General Practitioners

**WHEN IT COMES TO VITAMIN D, TWO SOURCES ARE BEST:**  
A whole food, lifestyle approach to addressing vitamin D deficiency

*"Did you know that Australians spend over \$25M a year on vitamin D supplements, yet 1 in 4 are vitamin D deficient? It is my pleasure to plant with you for the future, from a perspective of research, maintaining the importance of diet as a leading source of vitamin D."*

FROM FRUITFUL, INC. VITAMIN D, MUSHROOMS, AND LIFE. ©2019 FRUITFUL RESEARCH AUSTRALIA

**UNDERSTANDING THE PROBLEM IN AUSTRALIA**

23% have 20-29 IU/mL  
Almost 1 in 4 Australians are vitamin D deficient! Results in impaired bone health.

43% have 25-50 IU/mL or <15 IU/mL  
2 in 5 Australians are vitamin D insufficient! May increase the risk of other disease outcomes.

Vitamin D deficiency is also a public health problem worldwide.

Watch the free Vitamin D webinar: [www.fruitful.com.au/vitamin-d-2019](https://www.fruitful.com.au/vitamin-d-2019)

**FACTORS THAT INCREASE DEFICIENCY RISK**

**NON-MODIFIABLE**  
Age, Genetics, Darker skin, Low latitude, Low sun exposure, Low body fat

**MODIFIABLE**  
Low Vitamin D intake, Low calcium intake, Low physical activity, Lack of Vitamin D supplements, Limited outdoor activities, Limited sun exposure

**DID YOU KNOW?**  
Vitamin D receptors are in nearly every tissue and thousands of binding sites on our genome, controlling over 200 genes, and are thus implicated in many other diseases beyond bone health!

**SUN EXPOSURE GUIDELINES**  
In winter, the recommended time increases substantially.  
Minimum 10-15 min  
Winter Sun 7:30 AM - 3:30 PM

**CURRENT VITAMIN D GUIDELINES**  
RACGP guidelines recommend one source for address vitamin D deficiency: sun exposure or supplement?

0-30 IU/mL (Deficient)  
30-49 IU/mL (Insufficient)  
50-125 IU/mL (Sufficient)

There are few opportunities in Australia to obtain the equivalent of 1000 IU of Vitamin D from natural sources (such as mushrooms).

RACGP guidelines for 20-29 IU/mL deficiency are ineffective in winter in Australia!

**DIETARY INTAKES ARE ALSO BELOW TARGETS**

2-3 µg (20-30 IU)  
4-6 µg (40-60 IU)  
8-10 µg (80-100 IU)

Missing, which is a significant concern as it is a leading cause of vitamin D deficit!

**THERE ARE FEW GOOD SOURCES OF VITAMIN D**

Source	Vitamin D (IU)
Salmon	243
Fortified milk	12.5
Fortified margarine	9.4
Fortified cereal	8.8
Egg	4.8
Fortified soy milk	3.4
Fortified orange juice	2.2
Fortified bread	1.8
Fortified pasta	1.2
Fortified flour	0.4
Fortified oil	0.4
Fortified salt	0.4
Fortified yeast	0.4
Fortified sugar	0.4
Fortified vinegar	0.4
Fortified honey	0.4
Fortified butter	0.4
Fortified margarine	0.4
Fortified shortening	0.4
Fortified lard	0.4
Fortified tallow	0.4
Fortified ghee	0.4
Fortified oil	0.4
Fortified fat	0.4
Fortified protein	0.4
Fortified powder	0.4
Fortified granules	0.4
Fortified crystals	0.4
Fortified tablets	0.4
Fortified capsules	0.4
Fortified lozenges	0.4
Fortified chewing gum	0.4
Fortified candy	0.4
Fortified lollipop	0.4
Fortified ice cream	0.4
Fortified yogurt	0.4
Fortified kefir	0.4
Fortified cheese	0.4
Fortified butter	0.4
Fortified margarine	0.4
Fortified shortening	0.4
Fortified lard	0.4
Fortified tallow	0.4
Fortified ghee	0.4
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Fortified ghee	0.4
Fortified oil	0.4
Fortified fat	0.4
Fortified protein	0.4
Fortified powder	0.4
Fortified granules	0.4
Fortified crystals	0.4
Fortified tablets	0.4
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**VITAMIN D ANIMATION** (Link [here](#))

A 2-minute animation was an add-on to the scheduled activities agreed at the start of the campaign. It utilised graphics developed in year 1 GP webinar and created to capture the key research on mushrooms and vitamin D, with practical tips on consuming UV-exposed mushrooms to increase vitamin D intake.

**Date:** April 2020

**Target audience:** HCPs

**Reach:** 93,035 people (KPI: 20k)



**SLR VIDEO** (Link [here](#))

To help share the SLR research from a different perspective to the published manuscript and accompanying SLR brochure, a 90 second video was created as another additional add on.

**Date sent:** September 2020

**Target audience:** HCPs

**Reach:** 34,128 people (KPI: 20k)

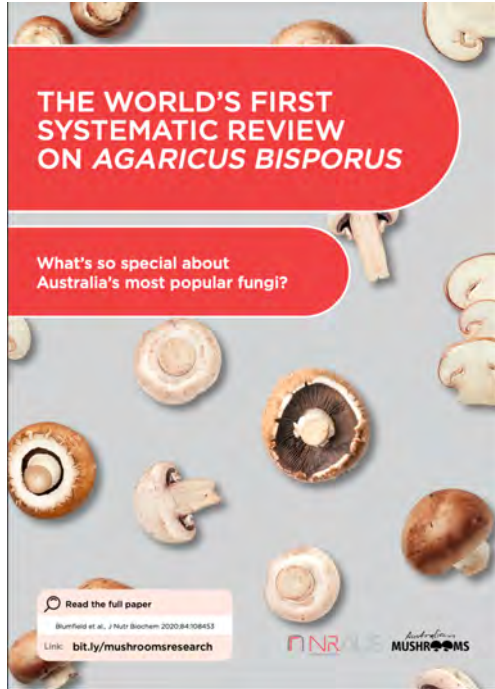


MS117 SLR BROCHURE (Appendix 11)

The key messages from the SLR were re-designed and brought to life in an 8-page brochure for HCPs

Date: July 2020

Target audience: HCPs



**What are the key bioactives in Agaricus bisporus?**

	<b>A</b> ANTIOXIDANTS	<b>B</b> BETA-GLUCANS	<b>C</b> CHITIN	<b>D</b> VITAMIN D	<b>E</b> ERGOTHIONEINE
<b>What is it?</b>	An array of antioxidants usually reported as flavonoids and polyphenols, including catechin, myricetin, quercetin & kaempferol <sup>[2]</sup> . Mushrooms are one of the few non-plant foods that contain antioxidants.	A soluble fibre, commonly found in oats, that has cholesterol lowering properties <sup>[3]</sup> .	A unique prebiotic polysaccharide that makes up the cell wall of fungi – it's like cellulose in plants <sup>[1]</sup> . It's not found in any other foods, except for insects and yeasts.	The sunshine vitamin. Mushrooms naturally contain vitamin D2, with levels increased up to 10 times after the surface of the mushroom is exposed to UVB light (i.e. sunlight) <sup>[10]</sup> .	An antioxidant that can only be made by some fungi and bacteria <sup>[11]</sup> . Mushrooms are the largest dietary source.
<b>How much?</b>	<p>Kaempferol in Agaricus bisporus vs. Strawberries (/100g wet weight)</p>	<p>Beta-glucans in Agaricus bisporus vs. Oats (/100g dry weight)</p>	<p>Chitin in Agaricus bisporus vs. Edible Insects (/100g wet weight)<sup>[9]</sup></p>	<p>Vitamin D equivalents in UV-exposed Agaricus bisporus vs. Raw Eggs (/100g wet weight)<sup>[11]</sup></p>	<p>Ergothioneine in Agaricus bisporus vs. Tempeh (/100g dry weight)</p>
<b>How to maintain in cooking?</b>	Cook for a shorter amount of time <sup>[2, 4]</sup> .	Not affected by cooking <sup>[3]</sup> .	Increases with cooking, regardless of whether the mushroom was fresh, frozen or canned <sup>[9]</sup> .	Using UV-exposed mushrooms, squeeze some lemon juice in the pan, cook at lower temperatures and for shorter times <sup>[10]</sup> .	Cook for a shorter amount of time <sup>[2, 4]</sup> .
<b>WHICH TYPE IS BEST?</b>	<p>+ More vitamin D<sup>[10]</sup>      + More ergothioneine<sup>[11]</sup></p> Portobello                  White Button		<p><b>WHICH PART IS BEST?</b></p> <p>28% more antioxidants in the cap (vs the stem)<sup>[12, 13]</sup></p> <p>40% more beta-glucans in the stem (vs the cap)<sup>[14]</sup></p>		
	<p><b>FUN-gI FACT</b> The stem is a valuable source of bioactives. Don't waste it!</p>				

**RECIPE BOOKLET & FACT SHEET (APPENDIX 12)**

In partnership with Simplot, a 16-page recipe booklet and factsheet were developed as resources for HCPs to use with their clients and was launched at the Dietitian Unite event.

**Date sent:** May 2021

**Target audience:** Dietitians & other HCPs

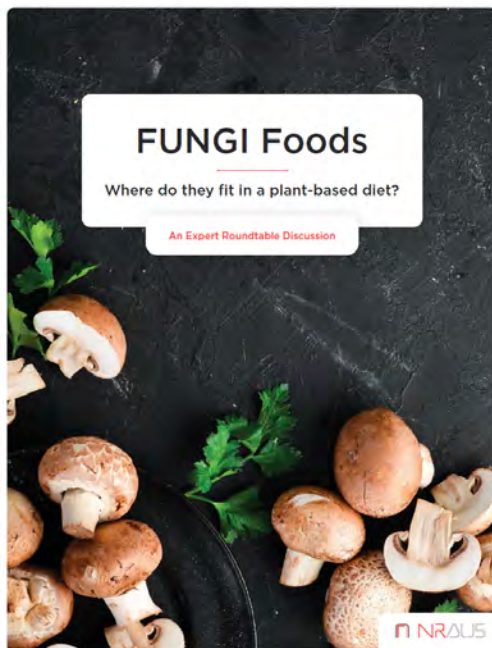


**MS120 ROUNDTABLE WHITE PAPER REPORT (Appendix 13)**

A 22-page white paper to summarise the main themes and key messages from an NRAUS hosted expert roundtable event held virtually on 25<sup>th</sup> November 2020 was developed. The report was used to communicate the findings from the event and offer evidenced-based insights on mushrooms for the consideration of HCPs and policy makers.

**Date:** July 2021

**Target audience:** Dietitians (Secondary: other HCPs)



**MS124 HCP CLIENT BROCHURE VITAMIN D (Appendix 14)**


A 2-page client focused Vitamin D brochure was developed. It was designed to help HCP educate clients on the prevalence of vitamin D deficiency, why we need vitamin D, where we can get it from and showcase common edible mushrooms as the ultimate source of vitamin D to support immunity.

**Date sent:** August 2021

**Target audience:** HCPs


## ARE YOU DEFICIENT IN VITAMIN D?

Nearly 1 in 4 Australians are.<sup>1</sup>




### Why do I need vitamin D?

You may have heard that vitamin D helps your body absorb calcium and supports healthy bones and muscles.<sup>2</sup> But did you know that vitamin D also plays an integral role in ensuring your immune system is healthy?<sup>2\*</sup>




**IMMUNITY**



**MUSCLES & BONES**


### Where do I get it from?

Called the 'sunshine vitamin', vitamin D is produced in your skin when exposed to sunlight. Some foods and supplements are also sources of vitamin D.




**SUN**

- ✔ Vitamin D is produced in your skin when exposed to sunlight.
- ✘ Can be challenging to get enough sun exposure during winter and adhere to sun smart guidelines in summer.




**FOOD**

- ✔ Natural source of vitamin D and provide other essential nutrients.
- ✘ Few foods are a good source of vitamin D.



**VIT D SUPPLEMENTS**

- ✔ Can provide 100% of your daily vitamin D needs.
- ✘ Can be an added cost and typically provide few other nutrients.



**DID YOU KNOW?**  
Australians are getting less than they need from food!

Average intake	Dietary needs <sup>4</sup>
2-3 µg	0 - 50 years
5 µg	51 - 70 years
10 µg	71+ years

## SUN-EXPOSED MUSHROOMS

A stand out source of vitamin D to support immunity.\*


Mushrooms are one of the only non-animal sources of vitamin D, with one serve providing at least 20% of daily dietary needs.<sup>5</sup> Like humans, clever mushrooms produce vitamin D on sunlight exposure.

Placing just 3 Cup or 5 Button mushrooms in the sun for about 15 minutes can provide over 100% of daily vitamin D needs!<sup>6</sup>

**FOOD SOURCES OF VITAMIN D**


Food Source	Vitamin D (µg)	Units Vitamin D µg equivalent per serve <sup>7</sup>
Fortified margarine	0.4 µg	
Fortified breakfast cereal	2.5 µg	
Mushrooms	3.4 µg	
Eggs	4.8 µg	
Salmon	5.4 µg	
UV-exposed mushrooms	24.1 µg	

### Tan your mushrooms, not your skin!




**STEP 1: PREPARE**

Choose one serve which is equal to 1 portobello, 8 cup mushrooms or 5 button mushrooms. Use the whole mushroom as there are different nutrients in the stem compared to the caps!<sup>8</sup>



**STEP 2: TAN**

Put them in the sun for just 15 minutes, and you can increase vitamin D content to 100% of your daily needs! They retain their vitamin D in the fridge for up to 6 days.<sup>9</sup>




**STEP 3: COOK**

Cook on low heat and add some lemon juice to help preserve vitamin D content.<sup>10</sup>

### Much more than vitamin D

- ✔ VEGAN AND VEGETARIAN
- ✔ PROVIDES B VITAMINS
- ✔ GLUTEN FREE



- ✔ LOW IN KILOJOULES
- ✔ ADDS FLAVOUR TO MEALS
- ✔ LOW IN SODIUM

For recipes and more facts: [australianmushrooms.com.au](http://australianmushrooms.com.au)

**Hort Innovation MUSHROOM FUND** This project has been funded by Hort Innovation, using the Mushroom Fund research and development levy and contributions from the Australian Government. Hort Innovation is the grower-owned, not-for-profit research and development corporation for Australian horticulture.

**REFERENCES**

1. 2019-20 Australian Health Survey.

2. Howland D T. Australia New Zealand Food Standards Code, 2010.

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6. Phillips J. Austr Food J. 2015; 52:16.

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9. Saunders J. J. Hort Innovation. 2017; 16:1-3.

10. Luby, P. Hort Innovation. 2017; 16:1-3.

11. Hort Innovation. 2017; 16:1-3.

\*As part of a healthy and caring you.

20

**COMMUNICATION**

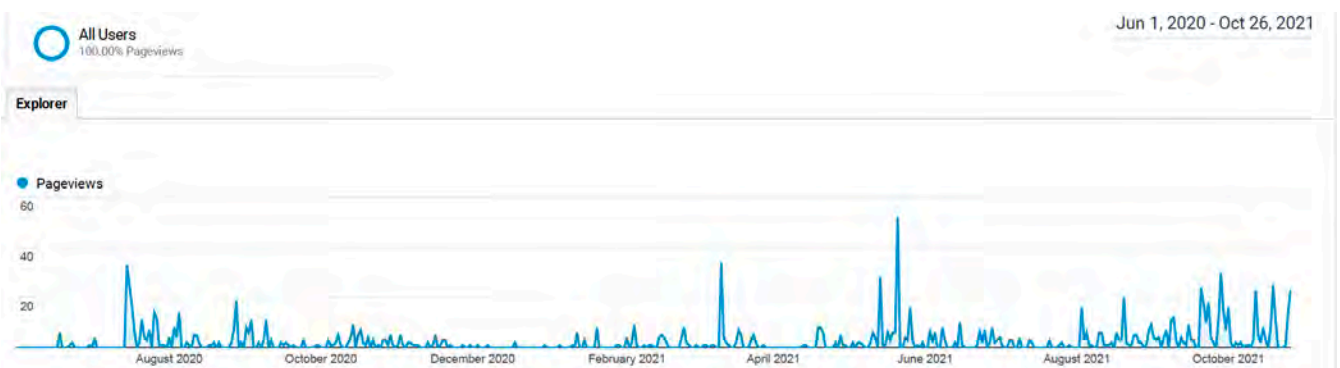
**DATABASE**

A database of 1925 healthcare professionals was established by project end.

**RESOURCE HUB**

A landing page on the NRAUS website was created to house all the mushroom resources in one place, so HCPs have timeless access to the resources. It was called the [‘Mushroom Hub’](#) and first went live on the 2nd July 2020. It houses all the collateral that has been developed throughout the project. Activity at the website was solid over the campaign period reflecting the strong and engaging communication plan.

**Page views: 1284**



**MS106 KEY MESSAGING (‘DR FLAV’S FUN FACTS’) DOSSIER** (Appendix 15)

An internal reference document outlining key facts from the research was developed to support messaging for the Australian Mushrooms marketing, and the HCP resources, education and communications. It was also utilised by Hort Innovation agencies to help support development of consumer and HCP marketing campaigns. It included 48 research insights to help stimulate communication messages, or ‘fun facts’, with the provision that final substantiation was still required to be assessed by NRAUS on final application when used by external agencies.

**Date:** March 2020

**Audience:** Agency partners for HCP and Consumer messaging

**Dr Flav’s Fun Facts** – examples included in the owned EDM

**Dr Flav’s Fun Facts**

**#1**  
**A true whole food**  
While the 'cap' of mushrooms is a richer source of antioxidants, its stem contains more of the soluble fibre beta-glucan.

**Putting the one in ergothiONEine**  
Mushrooms contain more ergothioneine - a unique sulphur-containing antioxidant - than any other food.

**Devoted to vitamin D**  
The vitamin D content of dried mushrooms is still 50% of its original value after 18 months.

### MS107 ELECTRONIC DIRECT MARKETING (EDM) ACTIVATIONS

#### EDM- NRAUS DATABASE WELCOME: (Appendix 16)

A welcome email, introducing respondents to the Australian Mushrooms newsletter was distributed to the NRAUS database.



**Date sent:** 26 June 2019

**Target audience:** NRAUS HCP database

**Reach:** 1292

**Open rate:** 27.6% (Industry average:20-25%)

#### EDM- BASELINE SENTIMENT RESEARCH INVITATION: (Appendix 16)

An EDM was developed to recruit HCPs to complete the baseline ASR and ensure a robust and qualified audience was reached from the outset.



**Date sent:** 8 July 2019

**Target audience:** Australian Mushrooms & NRAUS HCP database

**Reach:** 1317

**Open rate:** 27.6% (Industry average:20-25%)

**EDM - BASELINE AUDIENCE SENTIMENT RESEARCH REMINDER (Appendix 16)**

A reminder EDM for the ASR.



**Date sent:** 26 June 2019

**Target audience:** Project database

**Reach:** 1201

**Open rate:** 27.6% (Industry average:20-25%)

**EDM - PRE-WEBINAR: (Appendix 16)**

An EDM developed in line with the content of the GP targeted webinar, ‘When it comes to vitamin D, two sources are best: a new way to address vitamin D deficiency’, including Dr Flav’s Fun Facts, to encourage our audience to register for the webinar.



**Date sent:** 18 October 2019

**Target audience:** Project database

**Reach:** 1301

**Open rate:** 24.8% (Industry average:20-25%)

**EDM - POST-WEBINAR: (Appendix 16)**

To further bolster reach and engagement for the GP targeted webinar, ‘When it comes to vitamin D, two sources are best: a new way to address vitamin D deficiency’, two post-event EDMs were developed and distributed via the database. One e-newsletter was directed specifically towards those who missed the session, while the other was targeted towards webinar attendees.



**Date:** 20 November 2019

**Target audience:** Project database

**Reach:** 1221

**Open rate:** 22.6% (Industry average:20-25%)



**EDM - YEAR 1 IN REVIEW** (Appendix 17)

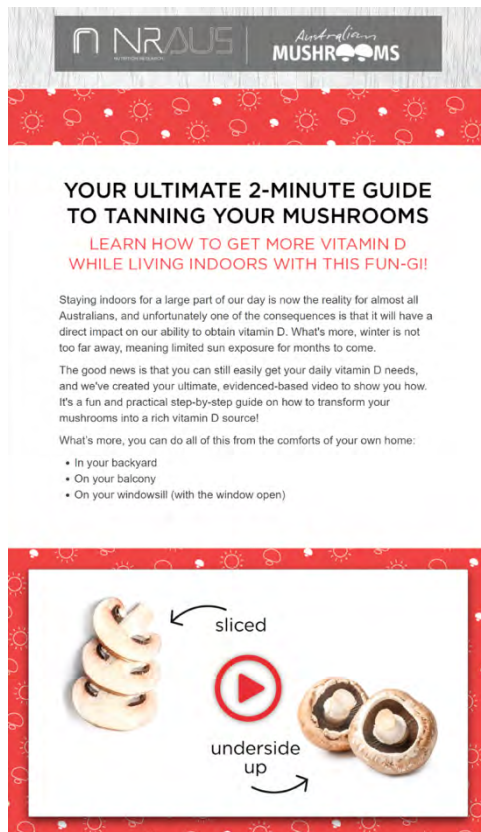
The EDM provided a summary of the research insights and resources completed in 2019. It included key research insights, the mushrooms and vitamin D brochure, a link to the webinar presentation, a link to the MJA Insight article, an update on the SLR, and brief insights from HCPs on what they know about mushrooms.



**Date sent:** 4<sup>th</sup> February 2020  
**Target audience:** HCP database  
**Reach:** 1372  
**Open rate:** 36% (Industry average: 20-25%)

**EDM - VITAMIN D ANIMATION** (Appendix 17)

An EDM created to communicate the 2-minute animation on vitamin D and mushrooms to HCPs.



**Date sent:** 9<sup>th</sup> April 2020  
**Target audience:** HCP database  
**Reach:** 1325  
**Open rate:** 33% (Industry average: 20-25%)

### EDM - SLR BROCHURE AND MANUSCRIPT (Appendix 17)

The SLR brochure and manuscript EDM created to drive awareness of the newly published, world first SLR manuscript and accompanying SLR brochure.



**Date sent:** 26<sup>th</sup> July 2020

**Target audience:** HCP database

**Reach:** 1317

**Open rate:** 33% (Industry average: 20-25%)

**JUST PUBLISHED:  
THE WORLD'S FIRST SYSTEMATIC  
REVIEW ON *AGARICUS BISPORUS***

**WHAT'S SO SPECIAL ABOUT  
AUSTRALIA'S MOST POPULAR FUNGI?**

Dear ,

You probably know that mushrooms are not your typical vegetable. Being a fungi, mushrooms are not classified as a vegetable at all, and have nutritional properties similar to whole grains, animal foods and nuts, too.

But what you may not know is the science behind a mushroom's unique nutritional and health properties. Indeed, there has never been a systematic review published on the world's most popular mushroom, *Agaricus bisporus* - which includes the flat, swiss brown, cup, white button and portobello mushroom varieties.

It's our pleasure to share with you this newly published world-first systematic review, hot off the press!

### EDM - SLR VIDEO (Appendix 17)

An EDM created to drive awareness and share the innovative and exciting research insights in the SLR from a different perspective than the manuscript and accompanying brochure.



**Date sent:** 1<sup>st</sup> September 2020

**Target audience:** HCP database

**Reach:** 1285

**Open rate:** 28.5% (Industry average: 20-25%)

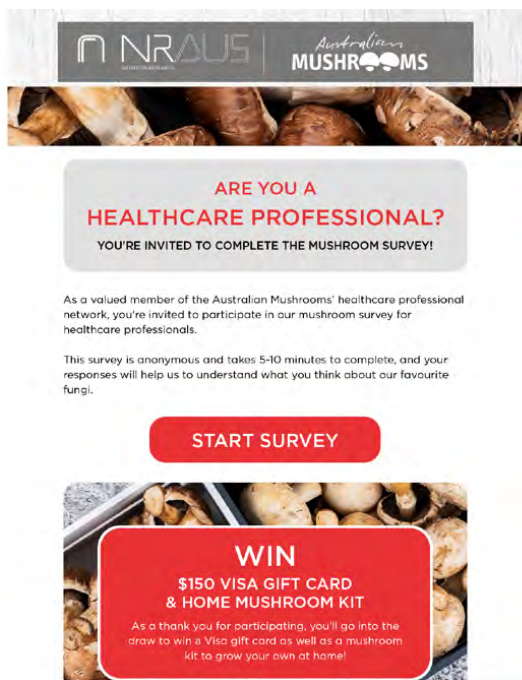
Dear <insert name>.

You might have seen the recent systematic review on Australia's most popular mushroom, which explores its bioactive properties and health effects in humans. But what do the researchers have to say about it?



### EDM - ASR SURVEY INVITE (Appendix 17)

An EDM created to promote the second ASR survey. This included a link to the survey, promotion of the prize and three fun facts on mushrooms.



**Date sent:** 5<sup>th</sup> October 2020

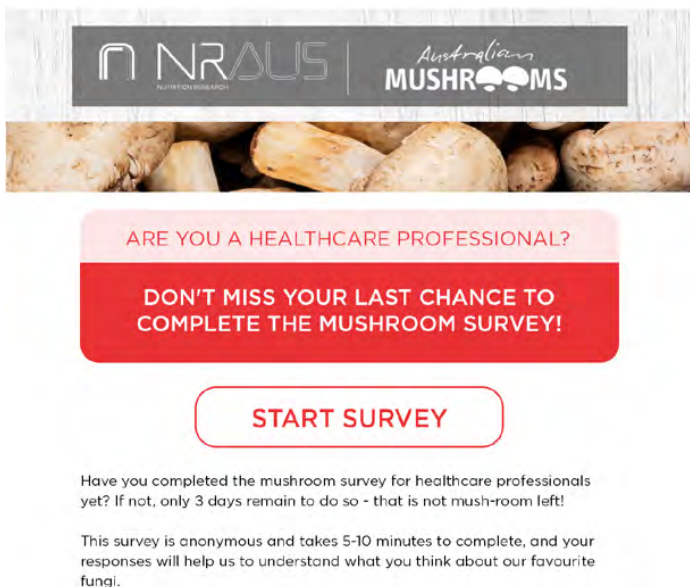
**Target audience:** HCP database

**Reach:** 1271

**Open rate:** 33% (Industry average: 20-25%)

### EDM - ASR SURVEY REMINDER (Appendix 17)

A reminder EDM to complete the Audience Sentiment Research survey was completed. This included a link to the survey and three fun facts on mushrooms.



**Date sent:** 20<sup>th</sup> October 2020

**Target audience:** HCP database

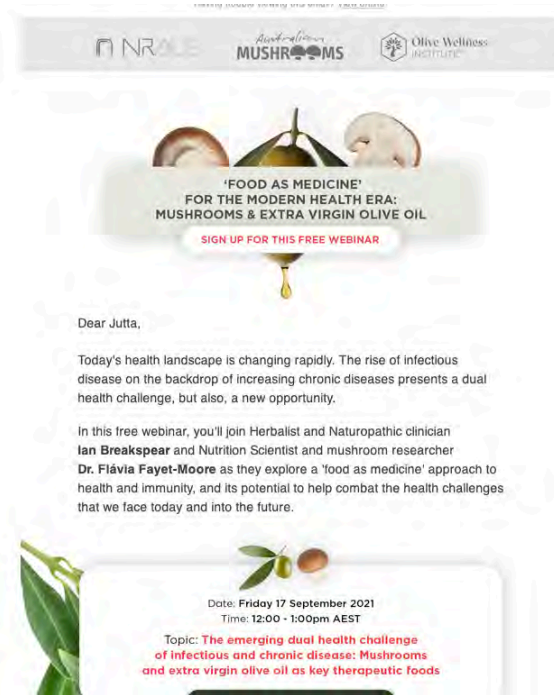
**Reach:** 1261

**Open rate:** 30.5% (Industry average: 20-25%)



**EDM - WEBINAR INVITE (Appendix 18)**

An EDM developed in collaboration with the Olive Wellness Institute (OWI) to promote the Naturopath targeted webinar, ‘Food as medicine for the modern health era: Mushrooms and Extra Virgin Olive Oil. It was distributed via both the Australian Mushrooms and Olive Wellness Institute HCP databases.



**Date sent:** 26<sup>th</sup> August 2021

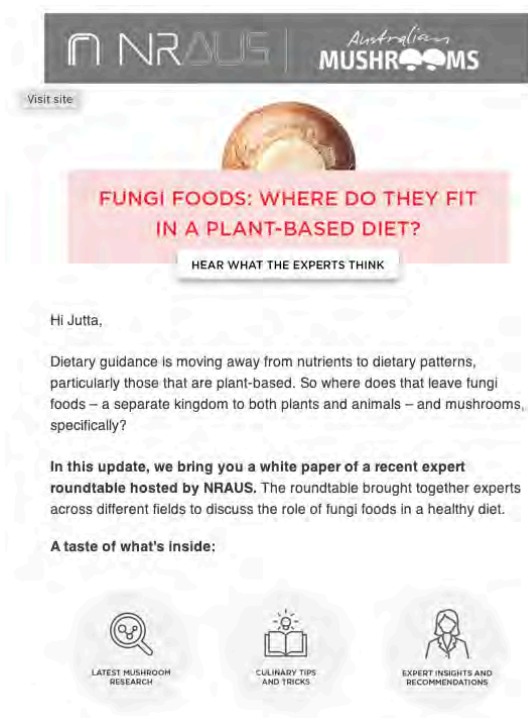
**Target audience:** Australian Mushroom and OWI HCP database

**Reach:** 7014

**Open rate:** 33.8% (Industry average: 20-25%)

**EDM - WHITE PAPER & CONSUMER BROCHURE (Appendix 18)**

An EDM created to drive awareness of the newly released white paper report on “The role of fungi foods in a plant-based diet” from the expert roundtable event in conjunction with the newly developed Vitamin D client focused resource for HCP to utilise in practice.



**Date sent:** 20<sup>th</sup> August 2021

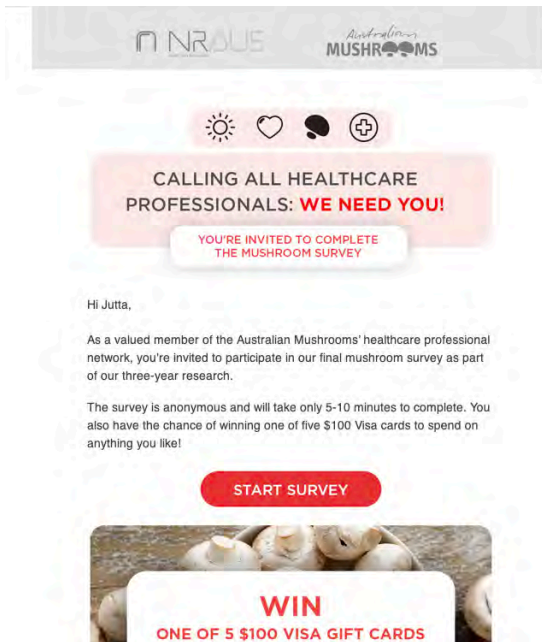
**Target audience:** Australian Mushrooms HCP database

**Reach:** 1437

**Open rate:** 37.4% (Industry average: 20-25%)

### EDM - ASR SURVEY 3 INVITE (Appendix 18)

An EDM created to promote the final ASR survey. It included a link to the survey, promotion of the prize and three fun facts on mushrooms.



**Date sent:** 28<sup>th</sup> September 2021

**Target audience:** Australian Mushroom HCP database

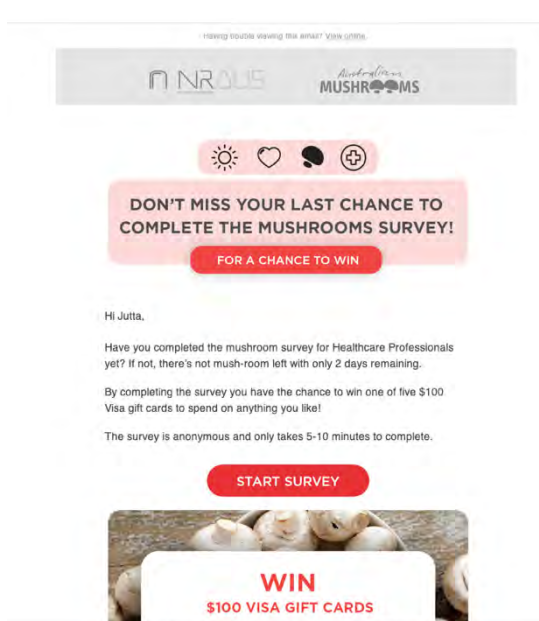
**Reach:** 1903

**Open rate:** 37.4% (Industry average: 20-25%)

### EDM - ASR SURVEY 3 REMINDER

(Appendix 18)

A reminder EDM to recruit for the final ASR survey. This included a link to the survey and three fun facts on mushrooms.



**Date sent:** 19<sup>th</sup> October 2021

**Target audience:** Australian Mushroom HCP database

**Reach:** 1925

**Open rate:** 34.4% (Industry average: 20-25%)

**EDM - END OF CAMPAIGN (Appendix 18)**

An end of campaign EDM created to showcase the key collateral produced over the past 3 years under a single-minded topical message relating to vitamin D. It served as a great reminder and convenient reference for HCPs already in the database, plus drove awareness of the collateral available to the new audience accrued in 2021 who had not seen previous communication.



**Date sent:** 23<sup>rd</sup> November 2021

**Target audience:** Australian Mushroom HCP database

**Reach:** 1897

**Open rate:** 34% (Industry average: 20-25%)

Hi Jutta,

**Vitamin D is a hot topic in nutrition** with almost 2 in 3 Australian adults insufficient or deficient<sup>1,2</sup>. Important for immunity, emerging evidence has also shown that lower vitamin D levels are linked with increased risk and severity of COVID-19 infection<sup>3</sup>.

The impact of diet for vitamin D is often forgotten, with few foods being rich sources. Most adults are unlikely to meet 100% of their dietary vitamin D needs through food alone<sup>4</sup> and risk increases as we reduce our animal food intake.

**The Vitamin D standout: mushrooms exposed to UV-light**

Remarkably, just 3 cup or 5 button mushrooms exposed to UV-light can provide more than 100% of daily vitamin D needs<sup>5</sup>. And research has shown that mushrooms are as effective as vitamin D supplements at increasing vitamin D levels, especially among those who are deficient<sup>5,6</sup>.

**Your comprehensive resources in the one place**

We have put together for you a range of resources, including a research paper, brochures, webinars, and a video, all with a focus on vitamin D and

## MS106 TECHNICAL AND SCIENTIFIC SUPPORT FOR AUSTRALIAN MUSHROOM CAMPAIGN

### INTERVIEW WITH DR FLAVIA FAYET-MOORE

Flavia was contacted by Aaron Darc, Communications Manager- Strategic Co-Investment Content while attending the Nutrition Society of Australia conference to provide a brief, impromptu interview on the project as project leader. The interview was uploaded to Australian Mushrooms' consumer media outlets (Facebook, LinkedIn):

> Vimeo can be accessed [here](#).

**Date conducted:** Dec 2018

**Audience:** Hort Innovation Australia

### AUSTRALIAN MUSHROOMS WEBSITE CONTENT (Appendix 19)

An assessment of all nutritional claims made on the Australian Mushrooms website, with alternative claims, references and copy editing provided.

**Date sent:** 8<sup>th</sup> April 2020

**Audience:** Hort Innovation Australia

### AUSTRALIAN MUSHROOMS MEDIA RELEASE (Appendix 20)

An Australian Mushroom Media Release titled 'New research shows everyday mushroom can be as effective as vitamin D supplements'.

**Date:** 17<sup>th</sup> September 2020

### NATIONAL MUSHROOM DAY

On National Mushroom Day (15<sup>th</sup> October), Dr Flavia Fayet-Moore alongside Chef Matt Donovan talked about the nutrition benefits of mushrooms on Studio 10, an Australian morning talk show on Network 10. This event was supported by the Australian Mushroom Grower's Association, and the research insights unveiled from this project were used to draft the key messages and script for the interview. A copy of the television segment, can be viewed at the following website ([Link](#))



**Date:** 15<sup>th</sup> October 2020

**Audience:** Studio 10 Audiences

**Reach:** 60,000



**MS107 INDUSTRY UPDATE**

**Australian Mushroom Journal**

Regular articles were developed in conjunction with Chris Rowley at HIA to keep growers informed of project progress and milestones

**Date sent:** May 2019, September 2019, April 2020, September 2020, June 2021, December 2021



**STRATEGIC INVESTMENT ADVISORY PANEL (SIAP) PRESENTATION (Appendix 21)**

A presentation was developed for the SIAP meeting to inform key stakeholders on the project progress with Dr. Flavia Fayet-Moore presenting this update in Sydney.

**Date event:** December 2019



**APPLIED HORT PRESENTATION** (Appendix 22)

Dr Flavia Fayet-Moore delivered a presentation to the Australian mushroom growers as part of a webinar series. The presentation was titled, 'Mushrooms for healthy diets: What's new?'. This presentation was supported and organised by Applied Horticulture.

**Date event:** May 2021

**No attendee registered:** 40



## MS107 COMMUNICATION DISTRIBUTION ACTIVITY

### BASELINE SENTIMENT RESEARCH

A static asset was created and communicated via a targeted campaign on Facebook promoting the survey to GP's, physicians, nutritionists and dietitians was developed for a non-public paid social campaign via the Australian Mushrooms Facebook page.

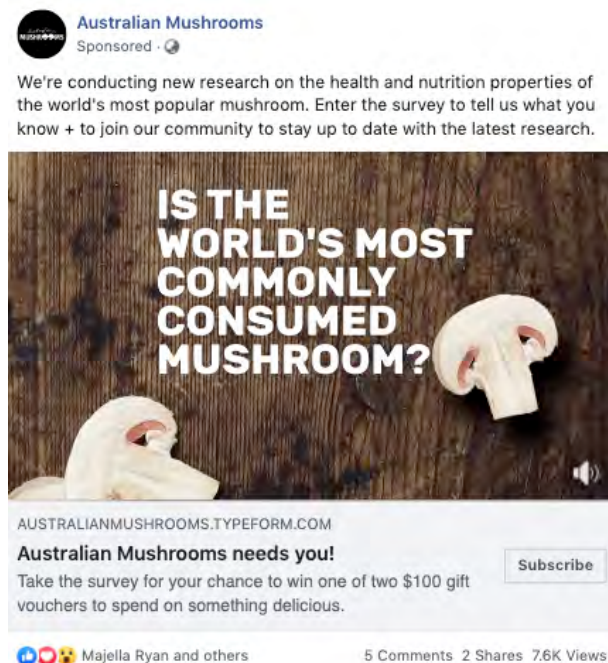
**Date live:** July 2019

**Target audience:** HCPs

**Reach:** 17,500

**CTR:** 1.46%

**Registered to survey:** 88



### VITAMIN D WEBINAR – 2 SOURCES BEST

Bespoke static and GIF adverts were created and leveraged across high-reaching social platforms including Facebook, Instagram and LinkedIn and backed by three leading industry organisations: RACPG, The ASLM and The Medical Republic.

**Date live:** October 2019

**Target audience:** HCPs

#### Social Campaign:

Static and GIF assets were created to support the promotion of the webinar via NRAUS social channels including facebook and LinkedIn.

**AD ONE**



**AD TWO**



**LinkedIn:** 16 visits, 1 registration

**Facebook:** 1032 visits, 10 registrations

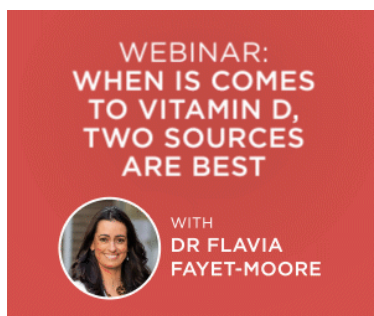
**The Medical Republic**

Static and GIF assets were created to support the promotion of the webinar to The Medical Republic 21,000 GP database via EDMs.

**Unique impressions:** 3,027

**Click through rate:** 0.33%

**GIF advert– 2 x Transitions**



**Medical Republic static advert**



## RACPG

Two adverts were designed for the RAGCP website, as well as a leader board GIF and static posts.

**Impressions:** 37,000 impressions,

**Clicks to website:** 76 individual visits

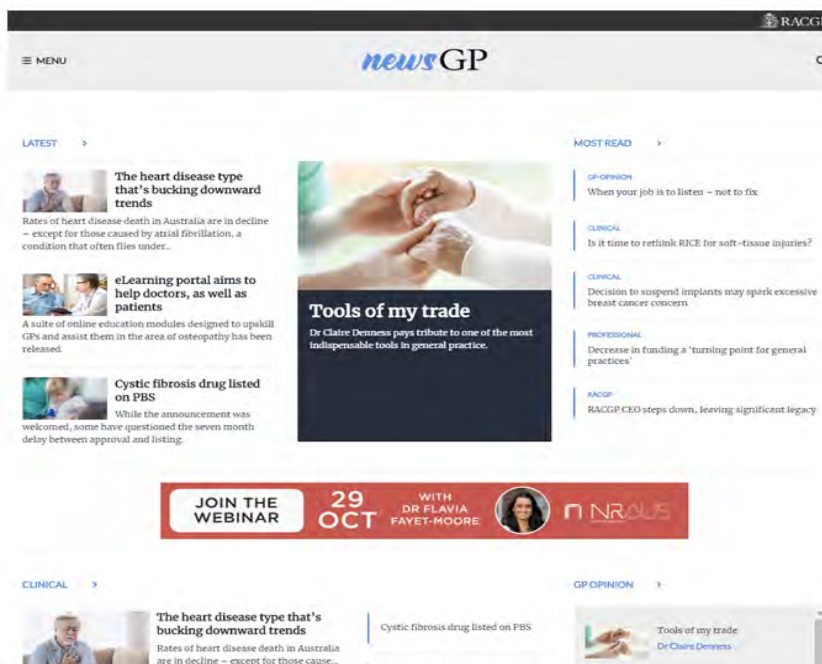
**Registrations:** 10 registrations.



## RACPG Leader board static



## RACPG Advert in situ– RAGCP Website



**The Australasian Society of Lifestyle Medicine (ASLM) advert**

Existing assets were utilised for advertisement within ASLM EDM newsletter.

**Reach:** 8,500 contacts,

**Clicks to website:** 33

**Registrations:** 5 registrations



**NROUS** | Australian MUSHROOMS

**WEBINAR:**  
WHEN IT COMES  
TO VITAMIN D,  
TWO SOURCES ARE BEST

**Upcoming webinar**  
**Nutrition Research Australia and**  
**Australian Mushrooms**  
29 October | 12:30pm-1:30pm AEDT

Nutrition scientist Dr Flávia Fayet-Moore, and GP Dr Jill Gamberg, will explore new ways to improve the vitamin D status of Australians. [Register.](#)

**GPCE SEMINAR: VITAMIN D DECODED**

The sessions were advertised on the GPCE website and to their database of 1100 delegates registered for the GPCE. A 90 x 130 cm full colour advert was designed for the GPCE event guide, handed out to all attendees upon entry to the show.

**Date live:** November 2019

**Target audience:** GPs

**Reach:** 1100

**GPCE**  
GENERAL PRACTICE CONFERENCE & EXHIBITION

22-24 May 2020 Sydney  
25-26 July 2020 Perth  
11-13 Sept 2020 Brisbane  
13-15 Nov 2020 Melbourne

25 YEARS

DELEGATE NAME  
EXHIBITOR ZONE

HOME ABOUT SYDNEY PERTH BRISBANE MELBOURNE EXHIBIT OR SPONSOR REGISTER NOW

Home / Melbourne / Conference / Sessions by Topic / Speakers / Contributor Profile

Print Send to a Friend Share

**DR FLAVIA FAYET-MOORE**  
Bio  
PhD, MNutrDiet, APD, RNutr

Dr Fayet-Moore is the CEO of Nutrition Research Australia, where she leads a team of highly skilled researchers to conduct end-to-end nutrition and communications projects. She is a Registered Nutritionist, Accredited Practising Dietitian, Honorary Associate of the University of Sydney, and the first dietitian in Australia to be board certified in Lifestyle Medicine.

Conference Sessions

**Vitamin D decoded - how can we best address vitamin D deficiency in our patients?**  
16 Nov 2019, 10:15 AM - 11:15 AM, GPCE Melbourne  
Australia has one of the highest rates of skin cancer, and almost 1 in 4 Australians have vitamin D deficiency. This session will explore emerging lifestyle med...

**Vitamin D decoded - how can we best address vitamin D deficiency in our patients?**  
17 Nov 2019, 10:15 AM - 11:15 AM, GPCE Melbourne  
Australia has one of the highest rates of skin cancer, and almost 1 in 4 Australians have vitamin D deficiency. This session will explore emerging lifestyle med...

**SUBSCRIBE FOR UPDATES**  
First Name  
Last Name  
Email  
State: NSW  
Ten plus 0?  
Subscribe

**NRAUS**  
NUTRITION RESEARCH

End to End Nutrition Research & Communication

**Vitamin D decoded:  
how can we best address  
Vitamin D deficiency in  
our patients?**

**Dr Flavia Fayet-Moore, CEO**  
Saturday & Sunday  
10:15am - 11:15am

**SUBSCRIBE**  
TO NRAUS FOR THE LATEST  
RESEARCH UPDATES

Australia has one of the highest rates of skin cancer, and almost 1 in 4 Australians have vitamin D deficiency. Scan the QR code above and subscribe to stay up to date with current research projects.

www.nraus.com | © Copyright 2019 Nutrition Research Australia Pty Ltd.





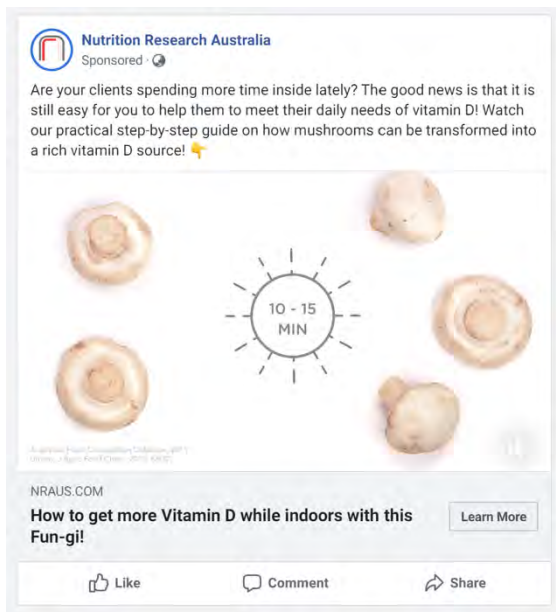
**VITAMIN D ANIMATION**

The animation was supported with Facebook video placement using a dark campaign (i.e. only seen by target audiences) and the video uploaded to the Nutrition Research Australia (NRAUS) website.

**Date Live:** March 2020

**Total reach:** 93,035 (KPI: 20K)

The total Facebook engagements were 100 likes, 19 comments, 23 post saves and 71 post shares.



**Facebook Ad**

**NRAUS Blog Page**



Your Ultimate 2 mins Guide to Tanning your Mushrooms

Learn how to get more Vitamin D while living indoors with this Fun-gi!

Feel like you're stuck indoors? This is now the reality for almost all of us, and unfortunately one of the consequences is that it will have a direct impact on our ability to obtain vitamin D. What's more, winter is not too far away, meaning limited sun exposure for months to come. The good news is that you can still easily get your daily vitamin D needs, and we've created your ultimate, evidenced-based video to show you how. It's a fun and practical step-by-step guide on how to transform your mushrooms into a rich vitamin D source!

What's more, you can do all of this from the comforts of your own home:

- In your backyard
- On your balcony
- On your windowsill (with the window open)



By NRAUS | April 2nd, 2020 | Uncategorized | 0 Comments

Share This Story, Choose Your Platform!

**SLR VIDEO**

The SLR video was promoted to HCPs through a targeted social media strategy. The spend was primarily via Facebook, with some small LinkedIn advertising that was turned off after 5 days to optimise the better performing Facebook campaign with the remaining budget.

**Date Live:** September 2020

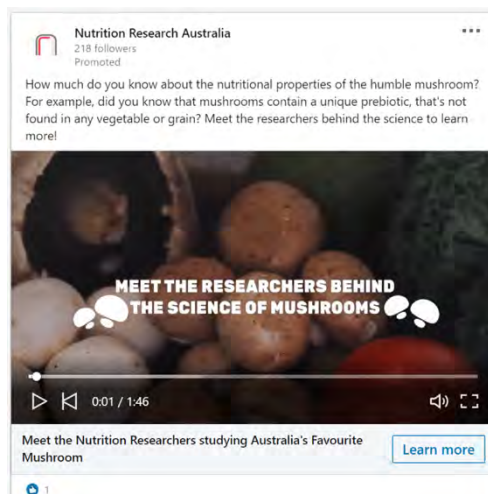
**Total reach:** 34,128 people (KPI: 20k)

**CTR (Link Click-Through-Rate):** Facebook 2.41% (Industry standard 1%; Mushroom campaign average 2.31%).  
LinkedIn: 0.43% (Industry standard 3 – 5%)

**Facebook Ad**



**LinkedIn Ad**



## WHITE PAPER REPORT

The white paper was communicated primarily to dietitians through advertisement through Dietitian Connection (DC) e-Newsletter and Instagram plus a targeted social campaign on LinkedIn that aimed to drive HCPs to resource hub.

**Date Live:** October 2021

**Total reach:** LinkedIn 27,848 (KPI:20K), DC 11,688

**Open rate:** LinkedIn N/A DC 3832 (33% KPI:37%)

**Total clicks:** LinkedIn 163 (KPI:15-30) DC 440 (11% KPI:11%)

**Nutrition Research Australia**  
421 followers  
Promoted

Neither plant nor animal, where does that leave fungi foods - our third food kingdom? This white paper covers the health and culinary role of fungi foods, and specifically mushrooms, from a recent expert roundtable event. Download your FREE copy now.

**FUNGI FOODS  
WHERE DO THEY FIT  
IN A PLANT-BASED DIET?**

Free White Paper - Fungi Foods: Where do they fit in a plant-based diet? [Download](#)

Like Comment Share

### Where do fungi foods fit in a plant-based diet?

Dietary guidance is **moving away from nutrients to dietary patterns**, particularly those that are **plant-based** - but where does that leave fungi foods like mushrooms?

Nutrition Research Australia (NRAUS) have developed a white paper based on a recent expert roundtable that brought together experts across different fields to discuss **the role of fungi foods in a healthy diet**.

A taste of what's inside:

- ✓ Latest mushroom research
- ✓ Culinary tips and tricks
- ✓ Expert insights and recommendations

**FUNGI FOODS  
WHERE DO THEY FIT  
IN A PLANT-BASED DIET?**

Discover what experts had to say about the role of fungi foods in a healthy diet, in this expert white paper report.

NRAUS **Supporting MUSHROOMS** Hort Innovation **INSPIRE**

[Download the paper here](#)

### HCP DIGITAL ACTIVATION

A lead generation HCP targeted social media campaign was developed via LinkedIn to drive awareness and distribution of the client focused vitamin D brochure and in doing recruit HCPs to the owned database. The brochure was also communicated to HCPs via partner digital advertising including Think GP, which included posts across Facebook, twitter, LinkedIn and banner ads on their website and advertising in Australian Society of Lifestyle Medicine (ASLM) e-newsletter.

**Date sent:** September 2021

**Target audience:** HCPs

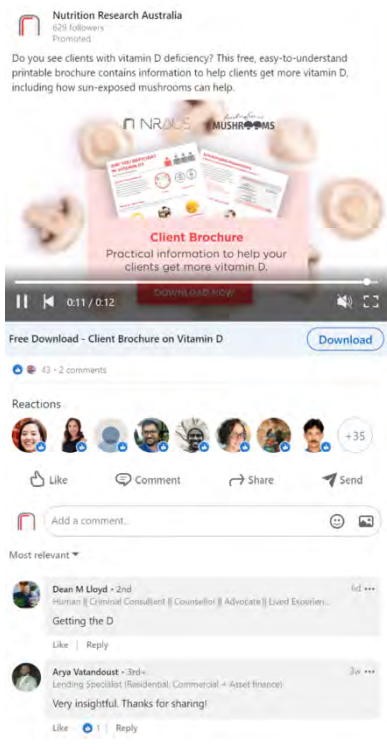
**Reach:** LinkedIn 101,402 (KPI:30K)

Think GP 33,736 (KPI:30K)

**Open rate:** LinkedIn N/A

Think GP 12% (KPI: 37%)

**Total leads:** LinkedIn 139 (KPI:30-60)



September 20 - 24 is Headache and Migraine Awareness week, which provides an opportunity to learn more about the difference between the two, what triggers them, how to manage them and how to seek help. Learn more about migraines by registering for our on-demand webinar below.

### FOOD AS MEDICINE WEBINAR

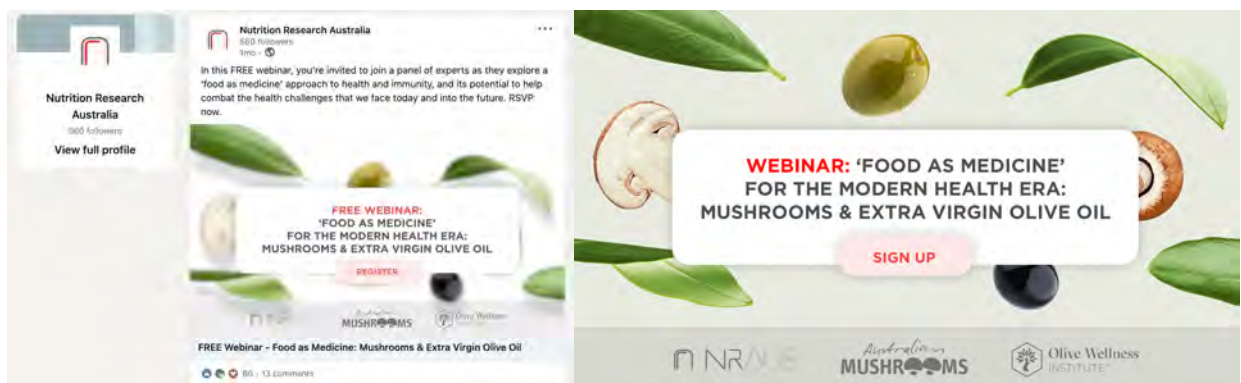
Recruitment to webinar was supported by targeted HCP social media campaign via LinkedIn along with third party advertisement via professional associations including the Australian Natural Therapist Association (ANTA), Naturopath and Herbalist Association Australia (NHAA), Australian Society of Lifestyle Medicine (ASLM) and Australian Mushroom Growers Association (AMGA).

**Date sent:** September 2021

**Target audience:** HCPs

**Total impressions:** LinkedIn 92,270 (KPI: 30K)

**Registrations:** 500 registrations (KPI: 60-70)



### Healthcare Professional Webinar


'Food as Medicine' for the modern health era - Mushrooms & Extra Virgin Olive Oil. In this free webinar for healthcare professionals, you'll join Herbalist and Naturopathic Clinician Ian Breakspear and Nutrition Scientist and mushroom researcher Dr Flavia Fayet-Moore as they explore a 'food as medicine' approach to health and immunity, and its potential to help combat the health challenges that we face today and into the future.

**Date:** Friday 17 September 2021

**Time:** 12:00-1:00pm AEST

**Register here:** [WEBINAR: Food as Medicine for the modern health era - Mushrooms & Olive Oil](#)

**Register for the Webinar**



**'Food as Medicine' for the modern health era – Mushrooms & Extra Virgin Olive Oil**

Today's health landscape is changing rapidly. The rise of infectious disease on the backdrop of increasing chronic diseases presents a dual health challenge, but also, a new opportunity.

In this free webinar, you'll join Herbalist and Neurotoxicologist, Clinician **Ian Breakspear** and Nutrition Scientist and mushroom researcher **Dr Flavia Fayet Moore** as they explore a 'food as medicine' approach to health and immunity, and its potential to help combat the health challenges that we face today and into the future.

**When:** Friday 17 September 2021  
**Time:** 12:00pm - 1:00pm AEST  
[Register here](#)

### Food as medicine in the modern health Era : mushrooms and extra virgin olive oil

From Friday 17 September 2021 from 12pm to 1pm AEST

**Webinar**

**Presented by:** Ian Breakspear / Dr Flavia Fayet Moore / Catherine Itsiopoulos  
**Organiser:** NRAUS and Olive Wellness Institute  
**When:** Friday 17 September from 12pm to 1pm AEST  
**Cost:** Free  
**Duration:** 60 minutes

Today's health landscape is changing rapidly. The rise of infectious disease on the backdrop of increasing chronic diseases presents a dual health challenge, but also, a new opportunity.

In this free webinar, you'll join Herbalist and Neurotoxicologist, Clinician **Ian Breakspear** and Nutrition Scientist and mushroom researcher **Dr Flavia Fayet Moore** as they explore a 'food as medicine' approach to health and immunity, and its potential to help combat the health challenges that we face today and into the future.

**Topic:** The emerging dual health challenges of infectious and chronic diseases: **Mushrooms and Extra Virgin Olive Oil as key therapeutic foods.**

Hosted by Professor **Catherine Itsiopoulos**, Executive Dean, School of Health and Biomedical Sciences, at RMIT University, and a standing international leader in Mediterranean diet.

This webinar is a collaboration between **Australian Mushrooms** and **The Olive Wellness Institute**.

In this webinar you'll learn about:

- The dual health challenges of today: chronic and infectious diseases
- Key nutrients for immunity, including why Vitamin D is getting a lot of attention right now
- New research on common edible mushrooms and their connection to vitamin D
- Latest research on extra virgin olive oil including its immune supporting actions.

[Register here](#)

## Upcoming events

- 2-4 Sept | BSLM [2021 Annual Conference](#)
  - Use the code **ALIGNED15** to claim a 15% discount as an ASLM member
- 9 Sept | Possums & Co. [2021 Virtual Conference](#)
- 17 Sept | Mushroom Australia / Olive Wellness Institute / Nutrition Research Australia [\[Webinar\] Food as medicine for the modern health era: Mushrooms and olive oil](#)

### EDUCATIONAL ACTIVATIONS

#### MS116 GP TARGETED WEBINAR PRESENTATION (Appendix 23)

A robust and engaging webinar presentation was developed and presented in collaboration with Dr. Jill Gamberg discussing the topic of vitamin D deficiency and current guidelines in Australia, with Dr. Flavia Fayet-Moore recommending a whole food approach (mushrooms) to help increase vitamin D intake in patients.

**Date:** 29 October 2019

**Topic presented:** *When it comes to vitamin D, two sources are best: a new way to address vitamin D deficiency*

**Presenters:** Dr. Jill Gamberg and Dr. Flavia Fayet-Moore

**Target audience:** GPs

**Registrants:** 125 registered and 54 unique viewers (KPI: 80 registered and 40 unique views)

**Dr Flavia Fayet-Moore**  
PhD, MNutrDiet, RNutr, APD, FASLM

The CEO of Nutrition Research Australia, where she leads a team of highly skilled researchers to conduct end to end nutrition and communications projects.

Flavia is a Registered Nutritionist, Accredited Practising Dietitian, Honorary Associate of the University of Sydney, and the first dietitian in Australia to be board certified in Lifestyle Medicine.

**Dr Jill Gamberg**  
MBBS (Hons), FRACGP

Completed her medical degree at the University of New South Wales in 2007 and became a fellow of The Royal Australian College of General Practitioners in 2015.

Jill is a board certified lifestyle medicine physician who is passionate about communicating the importance of lifestyle interventions in the prevention and treatment of her patients.

**When it comes to vitamin D, two sources are best:**  
A new way to address vitamin D deficiency  
October 29, 2019  
NRAUS

**TAKE HOME MESSAGES**

- Australians have one of the lowest dietary intakes of vitamin D
- Few dietary sources of vitamin D can meet current guidelines & most are animal sources
- Sun-exposed mushrooms are the top source and are as effective as supplements
- To get vitamin D, you can tan your mushrooms when you can't tan your skin

#### GP TARGETED WEBINAR RECORDING: (Links: [YouTube](#) and [NRAUS](#))

The GP targeted webinar recording was curated and uploaded to YouTube and hosted on the NRAUS website as a blog piece.

**Presenters:** Dr. Jill Gamberg and Dr. Flavia Fayet-Moore

**Target audience:** HCPs

**Reach:** 922 views

**MS114 GPCE PRESENTATION** (Appendix 24)

A separate presentation was developed in PowerPoint for the General Practitioner Conference & Exhibition (GPCE) show repurposing existing content from initial webinar and redesigned into fresh and engaging key assets.

**Date:** 16 and 17 November 2019

**Location:** Melbourne

**Topic presented:** *Vitamin D decoded – how can we best address vitamin D deficiency in our patients?*

**Presenters:** Dr. Flavia Fayet-Moore

**Target audience:** GPs

**Registrants:** 91 (KPI:70)



**MELBOURNE 15-17 NOVEMBER 2019**

# VITAMIN D DECODED

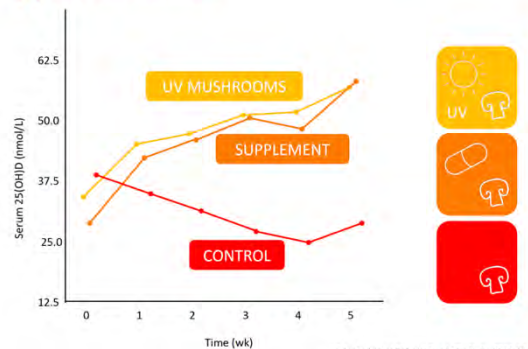
**How can we best address vitamin D deficiency in Australia?**

Flavia Fayet-Moore  
PhD, MNutrDiet, RNutr, APD, FASLM

**NRAUS**  
NUTRITION RESEARCH

- @nutritionresearchaus
- nr\_aus
- nutrition-research-australia
- info@nraus.com

## Bioavailability is equivalent to supplementation



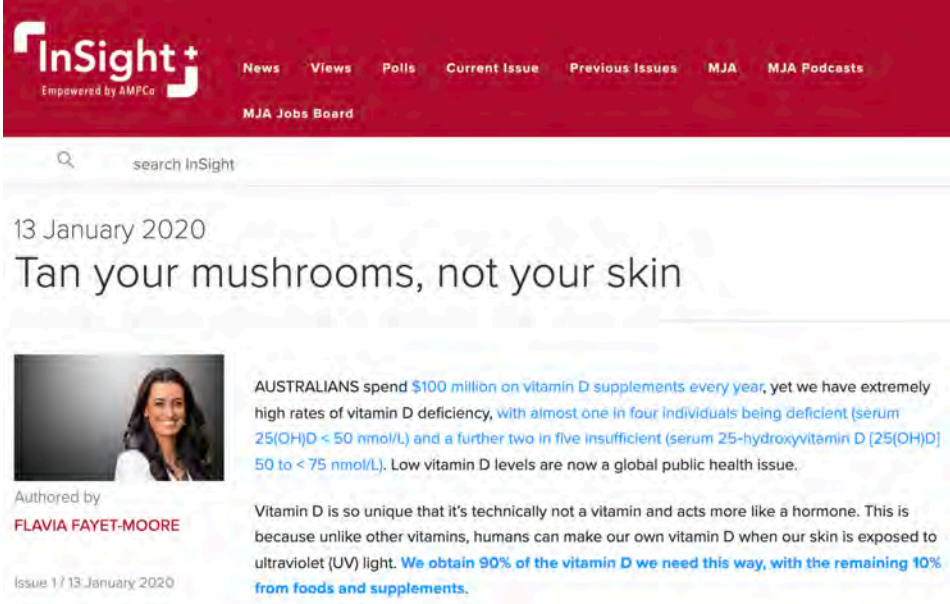
**MEDICAL JOURNAL OF AUSTRALIA ARTICLE** (Link [here](#))

An article titled *'Tan your mushrooms, not your skin'* published in MJA InSight to educate HCPs about the important role that UV-exposed mushrooms have in helping people increase their vitamin D intakes.

**Date sent:** 13<sup>th</sup> January 2020

**Target audience:** HCPs and researchers

**Reach:** 29,312 people (KPI: 20k)



The screenshot shows the MJA InSight website interface. At the top, there is a red navigation bar with the InSight logo (Empowered by AMPCo) and links for News, Views, Polls, Current Issue, Previous Issues, MJA, MJA Podcasts, and MJA Jobs Board. Below the navigation bar is a search bar with the text 'search InSight'. The main content area features the date '13 January 2020' and the article title 'Tan your mushrooms, not your skin'. On the left, there is a profile picture of the author, Flavia Fayet-Moore, with the text 'Authoried by FLAVIA FAYET-MOORE' and 'Issue 1 / 13 January 2020'. The main text of the article begins with: 'AUSTRALIANS spend \$100 million on vitamin D supplements every year, yet we have extremely high rates of vitamin D deficiency, with almost one in four individuals being deficient (serum 25(OH)D < 50 nmol/L) and a further two in five insufficient (serum 25-hydroxyvitamin D [25(OH)D] 50 to < 75 nmol/L). Low vitamin D levels are now a global public health issue.' The text continues: 'Vitamin D is so unique that it's technically not a vitamin and acts more like a hormone. This is because unlike other vitamins, humans can make our own vitamin D when our skin is exposed to ultraviolet (UV) light. We obtain 90% of the vitamin D we need this way, with the remaining 10% from foods and supplements.'



**MS122 EXPERT ROUNDTABLE (Appendix 25)**

A virtual roundtable event was organized to bring together experts across nutrition research, food science, indigenous culture and culinary nutrition to establish clear and authoritative recommendations on fungi (specifically mushroom); and communicate these findings to HCPs through a white paper report. The theme of the event was: *‘Fungi foods: How should they be included in dietary recommendations?’* The event included 5 key speakers including Dr Flavia Fayet-Moore.

**Date event:** 25<sup>th</sup> November 2020

**Target audience:** Nutrition research, food science, culinary nutrition and nutrition media key opinion leaders

**Reach:** 15 (KPI: 15)



**MS119 DIETITIAN UNITE SEMINAR PRESENTATION (Appendix 26)**

A breakfast event at Dietitian’s Unite, a key nutrition conference event run by Dietitian Connection for dietitians and nutritionists. The breakfast event was sponsored by Australian Mushrooms in partnership with Simplot Australia and focused on culinary nutrition. The breakfast event was titled *‘Taste: the forgotten message to enjoy a variety of vegetables and mushrooms.’*

**Date event:** 21<sup>st</sup> May 2021

**Target audience:** Dietitians Connection Members (dietitians and nutritionists)

**Registrants:** 226 (KPI 80)

**Other:** 96% rated as excellent or very good



**MS125 AUSTRALIAN DOCTOR ARTICLE (APPENDIX 27)**

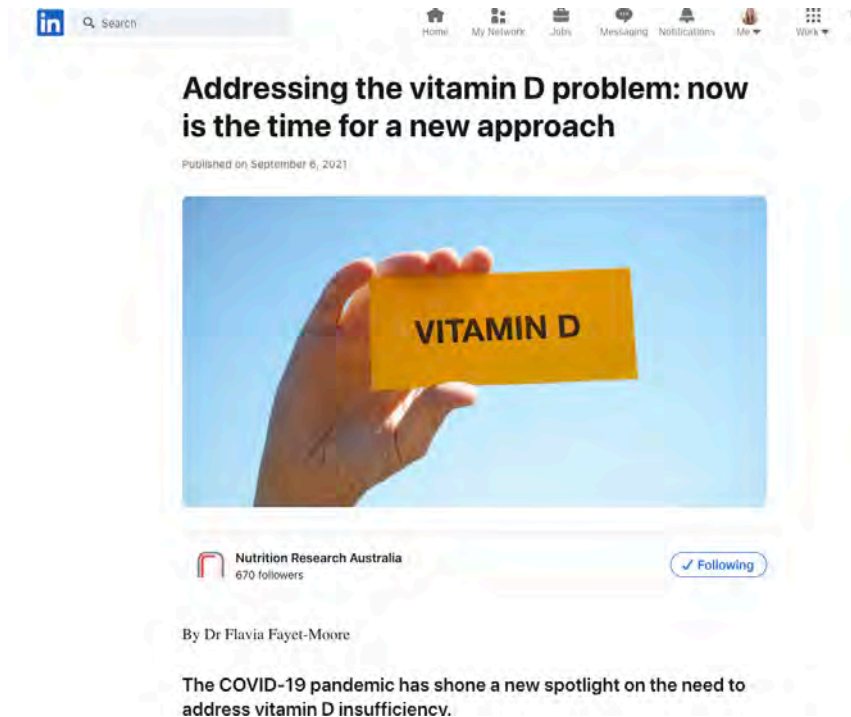
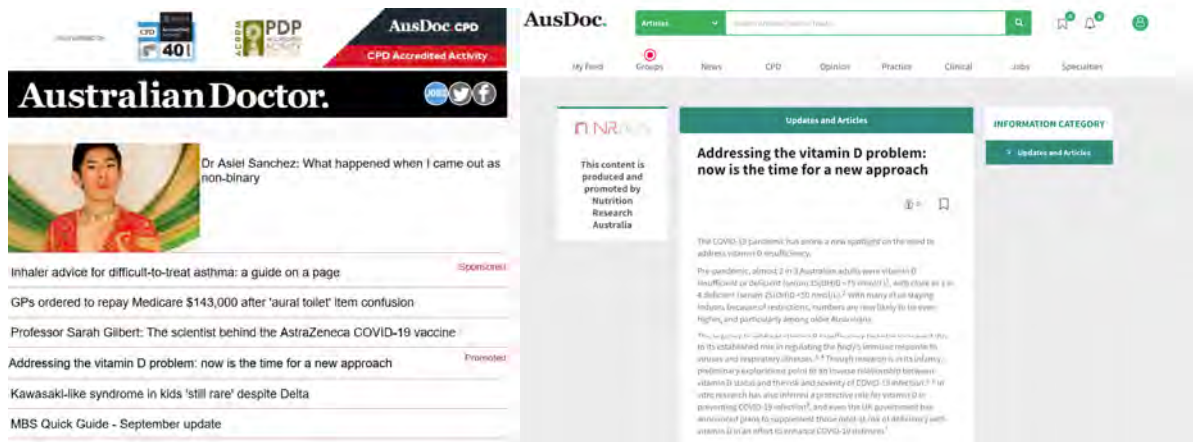
An advertorial piece written by Dr Flavia Fayet-Moore titled ‘Addressing the vitamin D problem: now is the time for a new approach’ was published and promoted by the Australian Doctor Group. The article focused on the re-emergence of infectious diseases as a public health problem, vitamin D’s role in immunity and incidence of vitamin D deficiency in Australia. It positioned mushrooms and specifically sun-exposed mushrooms, as an ultimate prescription for supporting healthy vitamin D status. The article was also published on NRAUS’ LinkedIn page ([Link](#))

**Date active:** August/September 2021

**Target audience:** GPs primary (Other HCP via LinkedIn)

**Reach:** 50,000

**CTR:** Australian Doctor email 2.06% (Average 1.07%) website 0.97% (Average 0.16%)



**MS128 FOOD AS MEDICINE WEBINAR** (Appendix 28)

An engaging Q&A style webinar titled *‘Food as Medicine for the modern health era – Mushrooms & Olive oil’* was developed and executed in partnership with The Olive Wellness Institute. Targeting naturopaths, it featured well respected and known Naturopath Ian Breakspear along with Accredited Practising Dietitian and Nutrition scientist Dr Flavia Fayet-Moore.

**Date event:** 13th September 2021

**Target audience:** Naturopaths

**Registrations:** 500 (KPI: 70-80)

**Attended:** 180; 36% registrants (KPI: 35-40; 50% registrants)

**Polling involvement:** 50% attendees (KPI: 15% attendees)



## Outcomes

### **Delivered positive impact for mushrooms within the scientific community and enabled thought leadership on the role of fungi foods and mushrooms particularly in plant-based diets**

The first-of-its kind SLR on *A. bisporus* and health outcomes and bioactive compounds was completed.

The SLR manuscript was accepted for publication in a top-ranking international journal, *The Journal of Nutritional Biochemistry*. It is the most comprehensive scientific report showcasing the health benefits of mushrooms in humans, and has created credible, evidenced-based messaging to inform future communications on mushrooms.

The published SLR served to help build the scientific evidence base for fresh Australian Mushrooms (*A. bisporus*), specifically that it is a significantly healthy food. The publication is not only advantageous in influencing HCPs who disseminate advice to consumers but also serves to help influence the wider HCP landscape including national nutrition policy development.

The expert roundtable event brought together nutrition and scientific experts across disciplines who agreed that fungi foods and mushrooms specifically are a separate food group, and increased focus is needed, along with thought leadership discussion on how mushrooms can achieve greater recognition in dietary recommendations going forward. The expert roundtable was translated into a White Paper which was distributed to HCPs, with the primary target dietitians, recognized nationally for their nutrition expertise and influence on national nutrition practice guidelines and policies. From the audience sentiment research, 90% of HCPs agree or would consider mushroom deserving greater recognition in the Australian Dietary Guidelines. Dr Joanna McMillian, who attended the roundtable as a guest, brought this into discussion in a talk she gave on the upcoming Australian Dietary Guidelines, post the event.

### **Ensured that the first-of-its kind scientific database on *A. bisporus* is kept current**

As with most projects and SLRs, research stops at the end date of a search strategy. The opportunity was identified to set up an auto-alert using our NUTRITIONiQ database update service to collate research that could be used to update our review. Every study ever published on *A. bisporus* in the world related to nutrient, health and bioactives is captured in this database. The database currently sits at 590 articles. The database has been used continuously throughout the campaign to inform communication messaging.

### **Built a strong HCP database to support communication beyond the project end**

Over the campaign, a HCP database was established. The strategies employed throughout the project managed to grow it by nearly 50% to include 1925 respondents at project completion.

### **Developed engaging and impactful key messages for HCP and consumer audiences**

Using the SLR and NUTRITIONiQ database, 48 fun facts and key messages were compiled into a dossier, and utilised throughout the project in EDMs, social ads, brochures, presentations, webinars, partner advertising materials and as ongoing support for Australian Mushrooms and Australian Mushrooms Grower's Association communication activities.

### **Created creative visuals were easy to digest and aligned in overall look and feel.**

We ensured that the communication materials all had bite-sized information that HCPs could share with their clients. Information was deliberately provided in a more infographic style format that allows easier uptake of information. The characteristic design of the Australian Mushrooms information was established and carried through all collateral. Feedback on the communication throughout the campaign has been consistently positive. The following includes verbatims from ASR surveys:

“Quality, engaging communications, thank you.”

“Very informative, well presented & easy to comprehend.”

“Really find the information/white paper etc. very useful and informative.”

“I received your excellent resource via LinkedIn on tanning - very insightful and also a very well-presented resource – thank you!”

“Resources and information have been useful.”

“I have had access to great information from NRAUS through their recent webinar and resources via EDMs and website.”

“Very useful resources that should be shared across as many platforms as possible.”

“Very succinct and useful information.”

#### **Ensured effective engagement with key HCP audiences: GPs, Dietitians & Naturopaths**

We developed a highly engaged database of HCPs whom we communicated to regularly. The effectiveness of our communication engagement is supported by the consistently high open rates across the project of ~35% (versus industry average 20-25%).

A key tenet of our communication approach was to ensure we got the right message to the right person with the greatest impact. Communication was always strategically thought through with the target audience in mind. Speakers for seminars and webinars were specifically chosen to ensure credibility and relatability to maximise recruitment and engagement within the event. For example, using a well-regarded GP for the GP conference, well-regarded chef/foodie in the dietetics community for the dietitian conference and well known and respected naturopath for the Naturopath webinar.

Furthermore, we championed creative and innovative approaches to encourage engagement and impact, including delivering a Q&A conversational and informal style webinar for our Naturopath webinar. The feedback (see below) from the event supported that our approach was well received.

The impact of these efforts has been reflected in the extremely positive evaluation and feedback gained from the events and the ASR survey with a snapshot as follows:

##### *GP webinar:*

All respondents advised that they would recommend to a colleague, and gave an average rating of 9.0 out of 10.

“Professionally put together and valuable info, thanks”, and “Dr. Flavia Fayet-Moore shares her experiences with such heart and clarity that makes it very engaging and insightful!”.

##### *GPCE seminar:*

“Thank you for your presentation. It was so practical and relevant- it’s the best that I’ve seen in this conference”

“I was texting my colleagues from inside the presentation room to get them to come watch it, because it was that good!”

The brochures were extremely popular with GPs at the GPCE in Melbourne. One GP stood up during the Q&A and said: “Can I just say, that this is the best brochure I have ever seen. It summarises everything that we need to know in only four pages. Congratulations!” This was followed by a round of applause from the whole keynote room of delegates.

##### *Dietitian Unite Seminar:*

On a 5-point scale, 96% of respondents rated the breakfast as "excellent" or "very good".

Engagement was also rated highly with 44% engaging with the online poll versus KPI 25%.

“Great to see culinary nutrition along with the science.”

“Loved the practical cooking session with mushrooms - gave me inspiration to use more mushrooms as a meal. ”

“Great balance of science and practical application. ”

“Valuable practical perspectives. ”

“Loved the cooking demo, fab info on mushroom.”

##### *Food as Medicine Naturopath webinar:*

99% learned something new

94% found informative (57% very informative)

97% found engaging (60% very engaging)

81% would use information in clinical practice

“I liked that both presenters were given the opportunity to talk to each theme and answer questions - interesting

to see the differences in responses from a dietitian and naturopath.”

“Overall I think it was fantastic. The speakers were clear in their discussions and I thought that it was a very practical presentation for clinicians.”

“It was interesting to apply both a dietetic and naturopath lens and the overlap/differences. It is not something I've come across before. Food first approach was great.”

“I would like to attend more of similar webinars.”

“Very informative and interesting to watch again. Could another webinar be made to follow on from this content?”

“Better if you conduct more of these in the future.”

“Try and get the contents of that webinar out to the general public - place it on YouTube - it was sensational.”

“This was the best food webinar I've participated in for a long time - keep up the great work. All the tips I can share with friends socially as well as in the work setting.”

“Thanks for sending the recording link. will listen again. I am a herbalist/homoeopath trying to improve my knowledge of nutrition especially through food.”

“The agenda as really on point, the MC handled the time we'll and the two speakers really knew their material.”

### **Supported the effective distribution of information to HCPs**

Increasingly, HCPs are moving towards the digital platform, which accelerated during the COVID-19 pandemic. We were able to adapt and pivot accordingly to ensure we maintained effective distribution of communication materials to HCPs. As well as using social digital platforms such as Facebook and LinkedIn, we leveraged third party platforms including the RAGCP, The Australian Society of Lifestyle Medicine and The Medical Republic and Australian Doctor Group.

As an additional output to the original budget and project plan, we built a 'go to' hub for HCPs called the 'Mushroom Hub' on the NRAUS website as an accessible and practical way for HCPs to access information throughout the project.

We worked throughout the campaign with a continuous improvement mindset, taking learnings and applying as we went. It was identified at the mid-way mark that over 60% of HCPs were not aware of our resources. This improved markedly over past year dropping 22 points, reflecting efforts in 2021 to improve this metric. Similarly, those using the resources and considering them useful doubled (21% to 41%) at project end.

### **Generated shareable content to distribute information beyond what was agreed in the project plan**

An additional scope was undertaken over and above original plan by NRAUS in order to support and facilitate decision making. Additionally a resource database was set up when undertaking the SLR and was maintained ongoing as an extra deliverable. COVID-19 restrictions postponed several opportunities to present and distribute information according to the original project plan. We proactively pursued additional opportunities to educate HCPs using a short Vitamin D animation, a short SLR video to communicate SLR findings and an additional scientific article published in MJA Insight. The MJA Insight article also informed a media release lead by Hort Innovation. In addition a recipe booklet and factsheet were created for Dietitian Connection conference. In total there was an additional seven additional outputs delivered above the agreed original budget and plan.

### **Achieved an uplift in sentiment in HCPs perception of mushrooms and their health benefits.**

From the final ASR survey, over half (53%) of HCPs perceived mushrooms to be very important to health, compared to only 1/3 (33.9%) of respondents at baseline. Personal frequency of consumption increased throughout the project, while recommendations to encourage clients to consume mushrooms 'always' or 'often' doubled to 1 in 2 HCPs.

While majority of HCPs (94%) reported they consume mushrooms, over the project time frequency of consumption increased with 83% now eating them at least once a week and 48.8% eating a few times per week or daily.

### **Increased number of HCPs being very familiar and able to state specific benefits of mushrooms**

From the ASR survey, knowledge of the health benefits and nutritional properties of mushrooms grew significantly over the three years.

Over half of HCPs surveyed reported to be very familiar with the health and nutrition properties (57.2% & 50.6% respectively) compared to around a quarter at baseline (25% & 23%), while those who were not familiar halved.

### **Increased HCP knowledge about the nutrition and health benefits of mushrooms**

97.6% of the respondents were able to specify at least one nutritional property, an increase of x% from baseline. At project end only 2.4% could not select a nutritional property, a huge drop from 2019 (7%).

94.6% were able to specify at least one health benefit compared to 89.8% at baseline. Across the board there were between 2.1%-19.7% increase on knowledge of all health benefits. Only 5.4% could not select a health benefit, almost a 50% drop (4.8 point) from 2020.

### **Increased HCP understanding about mushroom benefits enabling increased confidence in communicating to clients.**

Effectiveness of communication messages was reflected in the reported knowledge of key nutritional and health properties from the ASR.

75% HCPs now know sun-exposed mushrooms have the highest vitamin D content compared to only 60% a year ago and most HCPs (92%) know that putting mushrooms in the sun increases their vitamin D content compared to only two-thirds (68%) a year ago.

Unfamiliarity with the nutrition and health benefits of mushroom significantly decreased as a reason to not recommend (21.8-point and 32.9-point decrease, respectively).

### **Moved mushrooms from being seen as just another vegetable, to a must-have inclusion in a healthy diet.**

Compared to baseline, the ASR survey showed more HCPs perceive mushrooms to be unique, very important to health, more valuable than vegetables, with significant appetite to see mushrooms given greater recognition in dietary guidance.

- At the end of the project, over half (53%) of HCPs perceived mushrooms to be very important to health, compared to only 1/3 (33.9%) of respondents at baseline.
- 60% of HCPs perceived mushrooms to have unique nutritional benefits and health properties compared to around 41% a year ago.
- One quarter (26.7%) of HCPs perceived mushrooms to be more valuable than vegetables, which has nearly doubled since baseline.
- 91% HCPs are in favour (50.6%) or in favour of considering (40.4%) mushrooms deserve greater focus within national dietary guidelines. Only 3% do not agree and 6% were unsure.

### **Empowered HCPs to recommend to their clients to include mushrooms in their diet**

From the ASR survey around 80% of HCPs are now recommending mushrooms to their clients compared to just under half (47.7%) at baseline. Those HCPs who recommend mushrooms 'always' or 'often' jumped from only a fifth of HCPs to nearly 1 in 2.

- The main reasons for not recommending mushrooms are that they are not top of mind (62%) or no time (26%). Unfamiliarity with nutrition and health benefits as reason decreased significantly from baseline with only 11.5% reporting it was a reason compared to 33.3% and 44.4% in 2019, respectively.
- At baseline, the key reason for recommending mushrooms was 'to add flavor'. At project end this moved to 4th place, with 'nutrition', 'vegetarian option', and 'health benefits' all increasing significantly to be in the top 3 (23.8 points, 30.8 points, 36 points respectively).
- HCPs see the value of mushrooms for what they add to meals (i.e., 'adds flavor' and 'adds texture') rather than what is reduced by their inclusion (i.e., 'to help decrease meat intake' and 'reduce sodium').

### **Educated and kept mushroom growers informed**

Growers were updated on the project activities and achievements every 6 months through articles facilitated by Chris Rowley in the Australian Mushrooms Journal. Two presentations were developed and delivered in a webinar to mushroom growers by Dr Flavia Fayet-Moore. They were highly received and valued for its clarity and impact in the translation of the science.

## **Monitoring and evaluation**

### **To what extent has the project achieved its expected outcomes?**

Monitoring and evaluation throughout the project show this project has successfully met all the intended intermediate and end-of-project outcomes.

#### *Intermediate:*

- There was an uplift in sentiment around mushroom perceptions and health benefits.

At the end of the project, over half (53%) of HCPs perceived mushrooms to be very important to health, compared to only 33.9% of respondents at baseline. Personal frequency of consumption increased throughout the project, while recommendations to encourage clients to consume mushrooms ‘always’ or ‘often’ doubled to 1 in 2 HCPs.

- There was an increase understanding amongst HCPs of mushroom benefits:

75% of HCPs now know that sun-exposed mushrooms have the highest vitamin D content compared to only 60% a year ago and most HCPs (92%) know that putting mushrooms in the sun increases their vitamin D content compared to only two-thirds (68%) a year ago.

Unfamiliarity with the nutrition and health benefits of mushrooms significantly decreased as a reason to not recommend (21.8 point & 32.9 point decrease respectively).

- Mushrooms moved from being seen as just another vegetable, to a must-have inclusion in a healthy diet.

At the end of the project, 53% of HCPs perceived mushrooms to be very important to health, compared to only 1/3 (33.9%) of respondents at baseline.

60% of HCPs perceived mushrooms to have unique nutritional benefits and health properties compared to around 41% a year ago.

One quarter (26.7%) of HCPs perceived them to be more valuable than vegetables, which has nearly doubled since baseline.

91% of HCPs are in favour (50.6%) or in favour of considering (40.4%) that mushrooms deserve a greater focus within national dietary guidelines. Only 3% do not agree and 6% unsure.

- A database of HCPs was built so HIA can continue to communicate beyond 3-year project.

Database was established at project commencement and grew by nearly 50% to include 1925 respondents at project completion.

- Information distribution was improved.

Over project HCPs not aware of resources dropped 22 percentage points (63% to 41%). Similarly, HCPs using the resources and considering them useful doubled (21% to 41%) at project end.

- Key messages for HCPs and consumer audiences were developed.

Using the SLR and NUTRITIONiQ research database update service, 48 fun facts and key message were compiled into a dossier, and utilised throughout the project and for Australian Mushrooms and AMGA.

- HCPs were educated on mushroom benefits in an engaging way.

Overwhelming feedback was gained throughout all events and surveys and high engagement indicated from metrics from events:



*GP webinar:* All respondents advised that they would recommend to a colleague, and gave an average rating of 9.0 out of 10.

*Dietitian Unite Seminar:* On a 5-point scale, 96% of respondents rated the breakfast as "excellent" or "very good". Engagement was also rated highly with 44% engaging with the online poll versus KPI 25%.

*Food as Medicine Naturopath webinar:* 99% learned something new; 94% found it informative and 97% found it engaging (60% very engaging)

- Visuals that aligned in overall look and feel and that were easy to digest were created.

Verbatim feedback from ASR report was overwhelmingly positive on the information provided.

"Quality, engaging communications, thank you."

"Very informative, well presented & easy to comprehend."

"Really find the information/white paper etc.... very useful and informative."

"I received your excellent resource via LinkedIn on tanning - very insightful and also a very well-presented resource – thank you!"

"Resources and information have been useful."

"I have had access to great information from NRAUS through their recent webinar and resources via EDMs and website."

"Very useful resources that should be shared across as many platforms as possible."

"Very succinct and useful information."

#### *End-of-project:*

- HCP knowledge about the nutrition and health benefits of mushrooms was increased.

97.6% of the respondents were able to specify at least one nutritional property, a x% increase from 2019. At project end only 2.4% could not select a nutritional property, a huge drop from 2019 (9.4%).

Across the board there were between 2.1%-19.7% increase on knowledge of all health benefits. Only 5.4% could not select a health benefit, almost a 50% drop from 2020.

The number of HCPs that reported being very familiar with the health and nutrition properties of mushrooms doubled over the project. Over half of HCPs surveyed reported being very familiar with the health and nutrition properties (57.2% & 50.6% respectively) compared to around a quarter at baseline (25% & 23%), while those reporting to be not familiar halved.

- More HCPs are recommending that clients include mushrooms in their diet and those who recommend them are doing so more often.

At project end around 80% of HCPs are now recommending mushrooms to their clients compared to just under half (47.7%) at baseline. HCPs who recommend them 'always' or 'often' jumped from only a fifth of HCPs to nearly 1 in 2.

Overall, it is clear that as a result of the MU17002 project, HCPs knowledge of nutrition, health and culinary benefits of mushrooms has significantly increased and that their own personal consumption and recommendation to clients has increased.

#### **How relevant was the project to the needs of intended beneficiaries?**

This project aimed to support the growth and sustainability of the mushroom industry, specifically the key ambition of the HIA Mushroom 2017-2021 SIP to '*Achieve the bold and ambitious target of domestic consumption of 4 kilograms per person of mushrooms by 2021*'.

This project was highly relevant to the industry and the ambition to drive growth as HCPs are a key influence on the nutrition and health landscape and consumer food choices and consumption. It was evident from research that increasing knowledge in the nutrition and health properties of mushrooms was a key motivator to driving their recommendation of mushrooms to clients and their own personal frequency of consumption.

The project campaign influenced a 50% increase in the number of HCP who recommend mushrooms to clients and those who recommend them to clients ‘always’ or ‘often’ doubled. Unfamiliarity with the nutrition and health benefits as reason to not recommend mushrooms decreased significantly from baseline with only 11.5% reporting it was a reason compared to 33.3% and 44.4% in 2019, respectively. Similarly in terms of reasons why HCPs would recommend mushrooms, the key reason was ‘to add flavor’ at baseline, but at project end this moved to 4th place with ‘nutrition’, ‘vegetarian option’, and ‘health benefits’ all increasing significantly to be in the top 3 (23.8 points, 30.8 points, 36 points respectively).

### **How well have intended beneficiaries been engaged in the project?**

The industry growers have been regularly engaged in the project through regular updates on the project activities and achievements communicated through articles facilitated by Chris Rowley in the Australian Mushrooms Journal. Additionally, at the end of each year (2019 and 2020), a presentation on the project and opportunities were communicated to growers.

### **To what extent were engagement processes appropriate to the target audience/s of the project?**

The project team always approached the project with a strategic mindset, targeting communication messages and channel delivery with the specific target audience in mind. This was adapted for the key individual HCP groups i.e., GPs, Dietitians and Naturopaths that were identified as independent core targets for the project.

The successful engagement of the audiences was evidenced by high open rates for our EDMs to our established database of ~35% (compared to industry average 20-25%) and evaluation feedback post the event.

*GP webinar:* All respondents advised that they would recommend to a colleague, and gave an average rating of 9.0 out of 10.

*Dietitian Unite Seminar:* On a 5-point scale, 96% of respondents rated the breakfast as "excellent" or "very good". Engagement was also rated highly with 44% engaging with the online poll versus KPI 25%.

*Food as Medicine Naturopath webinar:* 99% learned something new; 94% found informative and 97% found engaging (60% very engaging)

Verbatim feedback from audience sentiment report was overwhelmingly positive on information provided.

“Quality, engaging communications, thank you.”

“Very informative, well presented & easy to comprehend.”

“Really find the information/white paper etc very useful and informative.”

“I received your excellent resource via LinkedIn on tanning - very insightful and also a very well-presented resource – thank you!”

“Resources and information have been useful.”

“I have had access to great information from NRAUS through their recent webinar and resources via EDMs and website.”

“Very useful resources that should be shared across as many platforms as possible.”

“Very succinct and useful information.”

### **What efforts did the project make to improve efficiency?**

The project team always aimed to operate with an efficiency and continuous improvement mindset. This is evidenced by a number of examples and includes:

COVID-19 restrictions postponed a number of opportunities to present and distribute information according to the original project plan. We proactively pursued additional opportunities to educate HCPs using a short Vitamin D animation, a short SLR video to communicate SLR findings and an additional scientific article published in MJA Insight. The MJA Insight article also informed a media release lead by Hort Innovation.

When the team proposed a Dietitian's Unite breakfast as part of our tender proposal, we had secured the breakfast spot, pending tender success. Unfortunately, a member of Dietitian's Connection had made a mistake, and given our spot to Simplot. We were able to negotiate with the organisers and Simplot to share the breakfast session. The positive outcome of this was that we had a 50% reduced fee for the same event presence, had a broader breakfast session where we highlighted the health benefits of mushrooms in the context of vegetables, and were able to develop more collateral at a reduced rate (recipe book and factsheet).

In strategically planning an activation to target Naturopaths we proactively identified a collaborative opportunity to undertake a webinar with The Olive Wellness Institute that provided multiple efficiencies for the project and ensured Australian Mushrooms successfully engaged with this new and important HCP group to the project. The collaborative opportunity provided Australian Mushrooms with access to The Olive Wellness Institute database of Naturopaths with its well-established trust and positive sentiment for the brand. Together we provided a highly credible and successful engagement event for not only Australian Mushrooms but also Olives.

## Recommendations

It was evident at baseline that HCPs were not aware of the unique nutrition and health properties of mushrooms, a food highly relevant for the current modern health era. As single foods, there is no mention of the unique nutritional value of fungi foods, nor their bioactive composition or health benefits in the current Australian Dietary Guidelines. The guidelines do however refer to food groups, and mushrooms are included in the vegetable group. This classification may mask the unique characteristics of mushrooms as fungi foods and miss opportunities for mushrooms to support health along with relevant cultural and cuisine-related uses.

It was unanimous from the expert key opinion leaders, brought together by this project at a roundtable event, that mushrooms deserve greater focus in dietary guidelines with three key recommendations made to achieve this, including: (i) greater body of human health research overall to strengthen the evidence base supporting mushrooms, with mushrooms categorized independently of vegetables, (ii) establishment of clear serving sizes, and (iii) more prominent recognition in dietary guidelines. This sentiment appears to be supported by the wider HCP community from the ASR.

This project successfully achieved its aim of increasing HCP knowledge about the nutrition and health benefits of mushrooms and empowered them to recommend mushrooms in their client's diet. It clearly demonstrated that the nutrition and health benefits of mushrooms are an important driver to consumption, hence validating those efforts to drive awareness of these with HCPs is a valuable strategy to unlocking and driving industry growth.

While this project has started to make an important and successful first step into educating and influencing this important stakeholder influencer group, it is recommended that further investment be continued. Success in any behaviour change lies in consistent and long-term focused investment. Further investment will maximise the current return on investment and help secure mushrooms a rightful place of greater prominence on the 'healthy plate'.

It is recommended that any future investment should have both short-, medium- and long-term strategies. While in the short to medium term, maintaining top of mind awareness with the established highly engaged HCP database is paramount, with opportunity to drive further penetration of the communication messages to reach more HCPs (including targeting other sub-groups such as fitness professionals). Additionally, while the number of HCPs recommending mushrooms has increased significantly, the main reason some HCPs do not recommend mushrooms was because they do not think about them specifically. Further investment can help close these gaps. Medium to longer term strategies include investment in research to further build the necessary evidence base and advocacy to achieve greater recognition of mushrooms in Australian Dietary Guidelines.

The following specific recommendations are made:

- Continue to maintain and **build on the currently highly engaged HCP database by focusing on increasing HCP penetration**. It is recommended that a greater proportion of investment is placed on the distribution of already great collateral into HCP channels. While continuing to maintain communication with tier 1 HCPs (GPs, Dietitians & Naturopaths) extend the target audience to include focus on fitness professionals.
- To further build momentum, consistency of message and amplify awareness, **target major health organisations and healthcare professionals within** like Osteoporosis Australia and Heart Foundation to push relevant mushroom messages, particularly the strong vitamin D message.
- While smaller proportion of investment is recommended on resources, this should be focused on developing **more client focused HCP resources** to support clinicians in message translation, including practical cooking and recipes.
- **Develop a visual cue and phrase for intake** like other foods have successfully created (i.e., 'handful of nuts', '2 & 5 Fruit and Vegetables and 3/day dairy'). Link this to the already established, 'Tan your mushrooms, not your skin'. Communicate it consistently across both HCP and consumer communications long term to help build and drive 'top of mind awareness' and relevancy.
- **Continue with consistent and repetitive messaging benefits of both taste (umami) and nutrition (vitamin D)** across HCP and consumer communication. Vitamin D and umami are unique and highly relevant attributes that provide mushrooms with a unique positioning to vegetables (and other plant foods). Simple, repetitive messaging of relevant and unique benefits is key to gaining traction and building brand differentiation that is memorable. While nutrition is key, enjoyment of food and taste is always number one.

Leveraging taste, cooking and/or meal ideas in HCP targeted communications is key for building an emotional connection that will build affinity and also help keep mushrooms more top of mind.

- **Invest in further research** on the human effects of *Agaricus bisporous* on health. Some key areas to pursue include interventions with cancer patients as adjunct therapy for chemotherapy, in aged care to support increase in vitamin D and bioactives such as vitamin D, beta glucan and ergothioneine for immunity.
- Develop an **advocacy plan to achieve greater recognition** of the nutrition and health benefits of mushrooms in the current revision of the **Australian Dietary Guidelines** to secure a stronger position for mushrooms long-term. The Australian Dietary Guidelines are an important evidenced based national nutrition document used by policy makers, researchers, educators and clinicians to inform the food, food groups and dietary patterns that support health and wellbeing. The guidelines were last updated in 2011-13 and are currently again under revision. There is significant background science and evidence base currently existing to form a submission to support greater recognition for mushrooms in the updated guidelines.
- Develop a **dedicated stand-alone ‘Mushroom Institute’ website** for health and food industry professionals to maximise information distribution more effectively and build mushroom’s unique position in the diet, similar to what the Olive Wellness Institute has done for olives and olive products.

## Refereed scientific publications

### Journal article

Blumfield, M., Abbott, K., Duve, E., Cassettari T., Marshall, S., Fayet-Moore, F., 2020. Examining the health effects and bioactive components in *Agaricus bisporus* mushrooms: a scoping review. *The Journal of Nutritional Biochemistry* **84**, 108453.

## **Intellectual property, commercialisation and confidentiality**

No project IP, project outputs, commercialization or confidentiality issues to report.

## Appendices



**APPENDIX 1: MS 109/115/118/126/127 PROJECT BENCHMARKING REPORTS**

## Milestone Report

**Project title:**

# Educating healthcare professionals about Australian mushrooms

**Project code:**

MU 17002

**Milestone number:**

109

**Project leader:**

Dr Flávia Fayet-Moore

**Delivery partner:**

Nutrition Research Australia Pty Ltd (NRAUS)

**Report author:**

Flávia Fayet-Moore (NRAUS)

Sophie Gudgeon (History Will Be Kind- HWBK)

**Milestone due date:**

end June 2019

**Submission date:**

1 July 2019

**Confidentiality:**

Is this report confidential?

No

Yes (whole report)

Yes (sections of report are confidential)

**Milestone description:**

6 Month Benchmarking Performance Report 1

**Milestone achievement criteria:**

101-104, 109 - completed

105-108, 110, 114, 119 - in progress

Milestone	Achievement Criteria
101	Agreement Signed. IP Arrangements in place
102	Project risk register and how risks will be managed
103	Program logic and monitoring and evaluation plan
104	Comms set up & activity planning
105	Audience sentiment research - benchmark
106	Technical and scientific support for the Australian Mushrooms campaign
107	Periodic comms program - planning, liaison, integration & content development
108	Systematic Literature Review (SLR) (Scope report, for Horticulture Innovation Australia only)
109	6 Month Benchmarking Performance Report 1
110	SLR Completion
114	General Practice Conference & Exhibition (GPCE) symposium sponsor + speaker
119	Dietitian’s Unite - Breakfast Seminar

**Funding statement:**

**Levy funds – R&D projects**

This project has been funded by Hort Innovation, using the Australian Mushrooms research and development levy and contributions from the Australian Government. Hort Innovation is the grower-owned, not-for-profit research and development corporation for Australian horticulture.

## General project overview

Despite the unique nutritional properties of mushrooms, there is currently a lack of knowledge of their nutrition and health benefits among healthcare professionals (HCPs). The objective of this three-year

project is to conduct original research on the health benefits of mushrooms and then educate health professionals about its key findings, supporting the wider industry objective of increasing the overall consumption of mushrooms in Australia.

## Summary

A detailed three-year campaign proposal to educate HCPs on the nutritional properties and health benefits of mushrooms, and provide credibility to consumer messages, was developed and agreed on, to support Hort Innovation's wider objective of increasing the overall consumption of mushrooms in Australia. The campaign proposal included a different theme for each year:

- 2019 - "The Mushroom Multi: Mushrooms are nutritionally unique", with a focus on vitamin D (for GPs);
- 2020 - "Not a plant, nor an animal: Mushrooms are associated with a wide range of health benefits", highlighting the findings from the systematic literature review (for Dietitians & Nutritionists); and
- 2021- "More to mushroom than nutrition: Mushrooms taste great and are environmentally friendly", with a focus on the culinary aspects of consuming mushrooms (for all other healthcare professionals including naturopaths).

To measure the effectiveness of the campaign, an Audience Sentiment Research survey was designed for HCPs. This survey captures:

- knowledge levels of the nutritional properties and health benefits of mushrooms
- perception and opinions of mushrooms in the diet, and
- behaviour and frequency around recommending mushrooms.

As part of the monitoring and evaluation plan, the results of this survey will help to inform the strategy for the communications plan, and will be repeated to allow us to track changes over the course of the project. The research was distributed via the new Australian Mushrooms healthcare professional newsletter and designed to align with the look and feel of the consumer campaign. The electronic direct mail (EDM) included an invite to participate in the research, along with mushrooms facts which were created to provide value and encourage respondents to receive future correspondence.

These facts were created using Flav's Fun Facts, an ongoing research document showcasing interesting facts that the research team deems appropriate and interesting for healthcare professionals, and will unlikely be captured as part of the systematic literature review. These insights were utilised as part of the newsletter and included:

- World's Top Pick- *Agaricus bisporus* is the most commonly consumed mushroom;
- Three of the same- Button, cup and flat mushrooms all come from the same mushroom, just left longer to grow!;
- A Natural Innovator- Unlike plants, mushrooms lack chlorophyll and obtain sustenance from complex organic materials of plants and animals;

The survey is underway and will close on 24 July 2019. The newsletter was sent to the NRAUS purpose created key opinion leader database (which had a 0% un-subscription rate), the previous database from Australian Mushrooms, and distributed via the professional association newsletters of the Royal Australian College of General Practice, the Nutrition Society of Australia and the Australasian Society of Lifestyle Medicine, totalling 32,617 healthcare professionals.

To identify the best approach and the most up-to-date literature on mushrooms and health, a research scope was conducted, which searched scientific databases for studies on edible mushrooms (excluding extract) and health outcomes. The purpose of this scope was to identify the current research and determine the best approach for the commissioned systematic literature review (SLR). From this report, a decision was made for the SLR to determine the nutrient composition and bioactives of *Agaricus bisporus* and their effect on all health outcomes, including all types of studies (humans and non-human studies). The SLR is underway with over 5,000 titles and abstracts being investigated for inclusion.

Planning is also underway for two main upcoming communication events: The GP conference presentation/workshop (November 2019) and the Dietitian's Unite Breakfast (March 2020). Our drafted presentation/workshop proposal for GPs has been approved by the conference organisers, and is centred around vitamin D, with mushrooms showcased as the star dietary strategy for meeting needs.

The dietitian's breakfast seminar, that includes the SLR findings and practical tips, will be co-hosted with Simplot and centre on how and why to get people to eat more mushrooms and vegetables.

## Achievements

### **MILESTONE 101: AGREEMENT SIGNED. IP ARRANGEMENTS IN PLACE**

*December 2018*

The agreement was signed on 17 December 2018 by NRAUS and co-signed on 19 December 2018 by Hort Innovation.

The term is from 19 December 2018 until 31 December 2021.

### **MILESTONE 102: PROJECT RISK REGISTER**

*January 2019*

A [risk register](#) was created to ensure the team had identified any possible risks and provided a way to best mitigate these in advance (Appendix 1).

### **MILESTONE 103: PROGRAM LOGIC AND MONITORING AND EVALUATION PLAN**

*January 2019*

A [program logic and evaluation plan](#) was developed (Appendix 2). This was devised in line with Hort Innovation guidelines to ensure all activity, outputs and outcomes were clearly mapped out at the start of the campaign.

### **MILESTONE 104: COMMS SET UP & ACTIVITY PLANNING**

**Context collaboration workshop:** *December 2018*

To ensure project alignment from the outset, a context collaboration session was undertaken to delve into six fundamental aspects of the project (business context, objectives, ways of working, project approach, risks and KPIs). This session was hosted by HWBK and all core team members were in attendance, including key stakeholders from the consumer agency, Bite Communication.

This workshop allowed us to align on project goals, gain a better understanding of the technical aspects of the current Australian Mushrooms website, gain a deeper understanding of previous newsletters, database management, solidify the communications approach, gain a better understanding of the consumer marketing messages and fine tune next steps.

**Three-year project overview agreed plan:** *January 2019*

A detailed three year campaign proposal, including objectives, deliverables and updated milestones, was developed (Appendix 4). Milestone dates were also updated to reflect the revised project start date and progress to date.

The proposal featured a clear road map of industry events and national organisations which the team will engage with, alongside a robust measurement process to track changes in awareness among HCPs associated with the program.

*Some key highlights of the three-year project overview include:*

Objectives:

1. To provide credibility and amplification of consumer messages delivered through the mushroom marketing campaign by educating healthcare professionals about the health benefits of mushrooms.
2. To develop and provide resources for healthcare professionals to encourage and motivate clients to include mushrooms in their diet.

Year by year themes:

**2019-** The Mushroom Multi: Mushrooms are nutritionally unique.

**2020-** Not a plant, nor an animal: Mushrooms are associated with a wide range of health benefits.

**2021-** More to mushroom than nutrition: Mushrooms taste great and are environmentally friendly.

2019 objective:

Increase awareness of the role of mushrooms as a functional food for helping clients to meet Vitamin D needs along with their other health benefits.

2019 detailed theme:

- Mushrooms are unique as they are a fungi and provide nutrients in amounts not usually found in vegetables.
- The mushroom is a star player in vegetarian diets, and in global recommendations to eat a plant-based diet.
- Mushrooms are the only food to provide 100% of your daily Vitamin D needs- no other food provides more Vitamin D in a serving (100g of mushrooms exposed to the sun/UV light).

2019 key messages:

- Nutritional uniqueness of mushrooms
- High content of vitamin D

2019 deliverables:

- HCP database development
- Flav's Fun Facts
- Benchmark Audience Sentiment Research
- E-newsletters x 2-3
- GP conference presentation/workshop
- GP webinar
- GP brochure
- SLR scope
- SLR report
- SLR key messages document

**Communications and activity planning meeting:** *January 2019*

In this meeting we updated the project overview and milestones document, revised the milestones based on the new project commencement date and planning meeting date, and obtained approval for the proposed approach that was in our tender proposal.

The approach for Year 1 ("The Mushroom Multi") was confirmed. This approach is focused on showcasing how mushrooms are nutritionally unique and how they help people to meet their vitamin D needs. The target audience is predominantly GPs.

**Critical Path developed:** *January 2019*

The team developed a critical path and master timeline document that detailed key milestones for the Year 1 and aligned with Hort Innovation's wider business planning activity. This document is updated regularly and can be reviewed [here](#) (Appendix 3).

**Shared learning session with Glenn Cardwell:** *April 2019*

Glenn Cardwell previously led a project educating healthcare professionals about the health benefits of mushrooms. To expand on our knowledge and ensure learnings were transferred from the previous campaign, NRAUS hosted a critical learnings session with Glenn Cardwell to take the team through key milestones to inform the approach for the next phase of this project. The session was attended by HWBK, Hort Innovation and NRAUS team members and allowed the team to benefit from key learnings across partners, activity, terminology and communication tools. Glenn confirmed that the vitamin D message was strong and one to promote, that GPs 'loved' mushrooms at their conferences (even other exhibitors loved mushrooms), that breakfast seminars were always well attended, recipe cards were well liked and that the message of being 'unique' was a strong one ("mushrooms are genetically closer to humans than a carrot"). These learnings were integrated into the communications plan and key messages.

## MILESTONE 105: BENCHMARK AUDIENCE SENTIMENT RESEARCH

### Audience Sentiment Research: June 2019

As part of the monitoring and evaluation plan, and to help inform our strategy for the communications plan to ensure its effectiveness, a detailed sentiment analysis is underway. The research is being conducted at the start of the project (June - July 2019) and will also be conducted at the 18-month point (Sep - Oct 2020) and end point (Dec 2021) and will help to establish current and changing attitudes and knowledge of health professionals with regards to mushrooms. The survey was originally scheduled for March 2019, but had to be delayed to align with the Australian Mushrooms consumer website which was currently being updated.

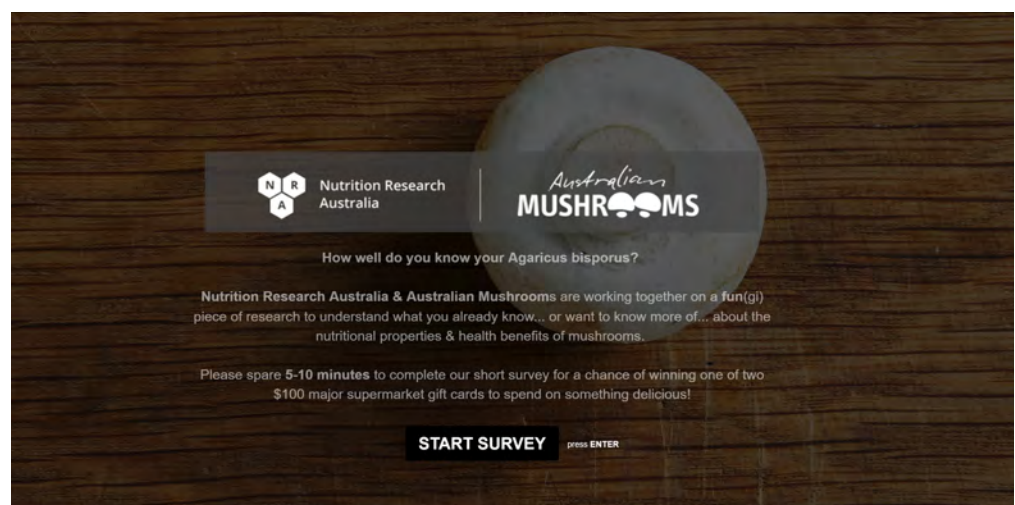
Research findings will help tailor the communications program and allow us to track changes over the course of the project in order to:

- Increase awareness of the role of mushrooms as a functional food for helping clients to meet Vitamin needs along with their other health benefits
- Increase awareness of the unique nutritional properties and health benefits of mushrooms amongst health professionals (including dietitians, nutritionists, naturopaths) based on the SLR findings

The sentiment analysis research consists of a detailed questionnaire which has been designed to extract both qualitative and quantitative data from the responses. Each question has been crafted around a core objective to ensure we are collating the most robust information to help inform and guide the overall approach. The survey included questions on knowledge levels of the nutritional properties and health benefits of mushrooms, the value placed on mushrooms for their nutritional and health properties, perception around mushrooms and opinions of mushrooms in diet relating to health, behaviour around recommending mushrooms, and the frequency of recommendations. Each person who participates in the research will go into a draw to win one of two \$100 vouchers to spend at a major supermarket. The survey closes on 24 July 2019.

A detailed Audience Sentiment Research document was developed and can be found [here](#) (Appendix 5a).

The research questions have been uploaded to a central platform which has been designed to align with the overall look and feel of the Australian Mushrooms consumer brand. This platform will enable the team to effectively measure, analyse and compare data as the program evolves. A link to the research survey can be accessed [here](#) (Appendix 5b).



The questions have been distributed via a high quality electronic direct mail (EDM) designed to reflect the look of the updated (*launched April 2019*) Australian Mushrooms website. As the first EDM in our series it was critical that this campaign asset captured the attention of audiences and provided value to them with digestible, engaging and relevant content. To ensure the EDM fulfilled this brief, three mushroom ‘fun facts’ that provided bitesize, informative content were developed.

Three EDMs were designed:

1. An invitation to the Australian Mushrooms newsletter to the NRAUS database (Appendix 7).
2. An invitation to participate in the Audience Sentiment Research (Appendix 8).
3. A reminder to participate in the Audience Sentiment Research

The Audience Sentiment Research EDM was distributed to the previous Australian Mushrooms database (n= 1,000). An invitation EDM was also sent to the new database of contacts provided by NRAUS (n= 317), with 0% unsubscription. Therefore, the EDM was also distributed to all of the contacts in the NRAUS database.

**NRAUS EDM:**





Audience Sentiment Research EDM:

**N R A** Nutrition Research Australia

Australian MUSHROOMS

## HEALTHCARE PROFESSIONAL RESEARCH

*When it comes to mushrooms, we know our stuff!  
But what about you?*

It goes without saying that we're passionate about mushrooms... however there is a limited awareness in the community around the many health benefits and nutritional properties which make this food so unique.

That's why we're conducting the very first systematic literature review on the world's most commonly consumed edible mushroom: *Agaricus bisporus*.

As a member of the Australian Mushrooms' healthcare professional network, you'll be the very first to receive updates and key findings as the research unfolds.

*But first we want to hear from you!*

We understand that you're busy, and we'd greatly appreciate if you could take 5-10 minutes to answer this anonymous **short survey** on mushrooms.

Our aim is to understand your thoughts on mushrooms, their health benefits and nutritional properties, if you like mushrooms and if you recommend them.

**WIN ONE OF TWO  
\$100  
VOUCHERS  
FROM A MAJOR SUPERMARKET**

As a thank you for participating, you'll be in with the chance of winning one of two \$100 gift vouchers to spend on something delicious.

**START SURVEY**

Thanks in advance for your time!  
Nutrition Research Australia  
& Australian Mushrooms



To further boost our reach, and ensure we capture a spread of respondents across our core audience groups, the research was also distributed to the Australian Society of Lifestyle Medicine (ASLM) (n= 8,700), Nutrition Research Australia (NSA) (n= ~1,000) and the Royal Australian College of General Practitioners (GPCE) databases (n= 21,900), for a total of 32,617 HCPs. An additional follow up email will be sent 2 weeks before the survey closes for responses, and will contain three more mushroom facts.

The responses will be analysed in order to provide our baseline measures, which we will review future findings against in order to measure cut through of messaging and retention rate amongst our audiences. The sentiment analysis report will be presented and shared with the team at the end of August 2019.

#### MILESTONE 106: TECHNICAL AND SCIENTIFIC SUPPORT FOR THE MUSHROOM CAMPAIGN

##### Interview with Dr Flavia Fayet-Moore on the project: Dec 2018

Flavia was contacted by Aaron Darc, Communications Manager- Strategic Co-Investment Content while attending the Nutrition Society of Australia conference to provide a brief, impromptu interview on the project as project leader. The interview was uploaded to Australian Mushrooms' consumer media outlets (Facebook, LinkedIn):

- Facebook can be accessed [here](#).
- LinkedIn can be accessed [here](#).

- Vimeo can be accessed [here](#).

### Recipe development and photoshoot feedback: Feb 2019

NRAUS provided detailed nutritional guidance and suggested recipe modification to Hort Innovation to inform the consumer recipe development and photoshoot.

Examples of the recipe modifications included: adding a recipe for ‘nachos’ to be made of whole grain tortillas; to provide a vegan nacho recipe choice with beans and mushrooms; to remove pizza and loaded fries from the recipe shoot and replace with loaded ‘potatoes and healthier pizza recipes; ensuring all grains are wholegrain and high fibre varieties; adding extra vegetables to recipes where appropriate; and limiting the use of processed meats such as bacon.

This support ensured all assets captured at the photoshoot could be utilised across the HCP campaign to show how mushrooms can be added to, or be part of, a balanced healthy meal to provide additional nutritional properties.

The guidance on how recipes could be made healthier helps to make the content more suitable for HCPs and ensures that we can use this in upcoming materials, such as the GP brochure.

### Flav’s Fun Facts: Feb 2019

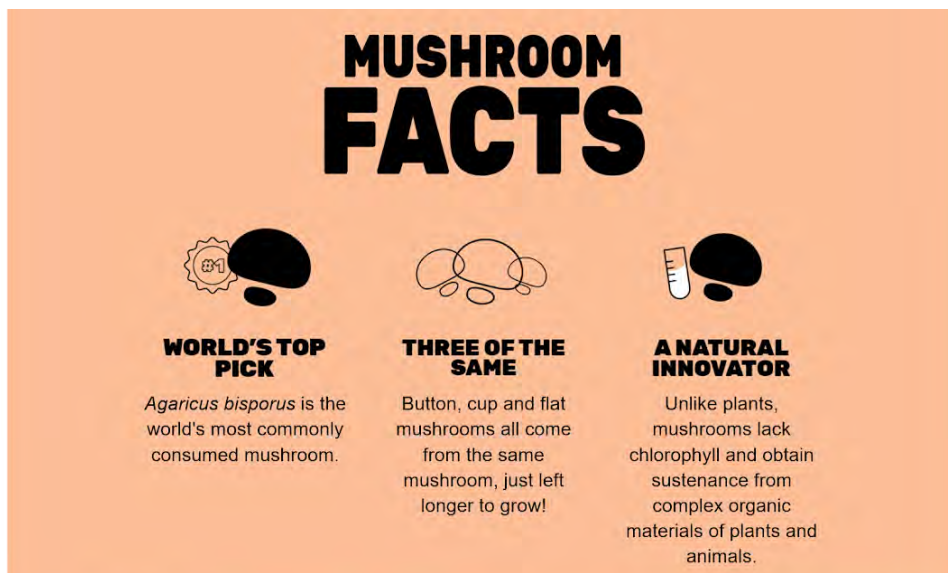
We developed and began populating an ongoing document called ‘Flav’s Fun Facts’ with scientific but interesting facts about mushrooms, for example, “mushrooms have a lot of nutrients not normally found in vegetables” (Appendix 6). These are collated throughout the research process for the review on mushrooms and health, and can be used in both the communications messages to HCP (including the newsletters, presentations and brochures), and in the consumer marketing messaging. The Fun Facts that are highlighted are those that we feel will be of most interest from a consumer perspective so you can review these at a glance.

The references and statements provided in the Fun Facts document are those that will likely not be captured as part of the systematic literature review and includes things like the effect of cooking on nutrient loss, the effect of UV exposure on mushrooms, the types of carbohydrates in mushrooms and so on.

This document also provided a recommendation on how this information could be conveyed to a consumer audience.

During the research, these Fun Facts will be turned into engaging, one-liner key messages for HCPs, to help form interesting content in the educational materials and events. We will draft simple messages for all the key facts we identify as potentially useful. Hort Innovation will then provide input as to which fact they would like to use, or investigate further, and we will provide further guidance on references and message wording to ensure they are credible and evidence-based consumer messages.

Fun Facts were used in the newsletter to invite HCPs to complete the Audience Sentiment Survey and include:



They have also been used to in the survey reminder EDM:

1. **Nutrition allrounder:** Mushrooms not only provide nutrients found in fruit and vegetables, but also those found in meat and grains too
2. **Beta-ful on the inside:** The cell wall of mushrooms consists of the soluble fibre beta-glucan
3. **The special sterol:** While animal foods contain cholesterol, mushrooms contain a unique sterol called ergosterol, that converts to Vitamin D when exposed to light.

Hort Innovation has requested that we continue to populate this document as the research unfolds, and provide a final version for discussion once the research is completed.

## **MILESTONE 107: PERIOD COMMS PROGRAM**

### **Building the database of healthcare professionals for Australian Mushrooms**

*Feb 2019*

In order to ensure we have a robust database of key contacts, NRAUS and HWBK have created a database development and growth strategy to continue to build our network during the three-year period. This is a key focus as the previous campaign database has been significantly reduced, meaning we needed to re-establish an audience base before we could commence activity.

Part of the project proposal was to build a database of HCPs for Australian Mushrooms. We were fortunate to be able to obtain the previous project's stakeholder database of about 1,000 people. The remaining Australian Mushrooms database has been captured to provide a baseline audience and this has been boosted by an additional bespoke database created by NRAUS including key opinion leaders, contacts and HCPs of ~ 300 healthcare professionals that we personally know. The combination of the previous Mushroom database, and the NRAUS database resulted in our baseline of HCPs to send the first EDM to. The total Hort Innovation Mushrooms + NRAUS database numbers were 1,360.

*June 2019*

To further grow the network, we leveraged our current contacts with leading organisations and negotiated exciting opportunities to further build the database so we can secure a strong sample size for the sentiment analysis and target wider audiences with research findings. This included the sentiment analysis and newsletter sign up to be distributed via the Australasian Society of Lifestyle Medicine's (ASLM) newsletter, the Nutrition Society of Australia (NSA) newsletter, and the Royal Australian College of General Practitioners (RACGP) newsletter, who also disseminated the sentiment research to their networks and calling for participants to sign up to the database to hear more about our upcoming research.

The team have also worked alongside consumer agency, Bite Communications, to create a dedicated HCP sign-up form on the Australian Mushrooms website. These contacts have been uploaded to the central database so they can be contacted with timely and relevant information. The sign-up form can be previewed [here](#).

**Grower's Newsletter and Industry Update:** We have provided updates on the project to appear in the grower's newsletter to ensure stakeholders are kept informed of our progress and key milestones (*Feb 2019* and *June 2019*) via Chris Rowley. Two newsletters have been drafted to date, as well as a grower's update provided to Hort Innovation (*May 2019*).

# HEALTHCARE PROJECT: *An Update*

It makes perfect sense that to educate health professionals about mushrooms, then you need to know as much as possible and understand what health professionals know about mushrooms. So it should be no real surprise to know that the Audience Sentiment Research is now underway as a crucial first step for the three-year project - Educating health professionals about Australian mushrooms.

As outlined in the last Journal, the project is led by Dr Flavia Fayet-Moore from Nutrition Research Australia (NRA).

Dr Fayet-Moore explained that the Audience Sentiment Research survey was being undertaken to provide a baseline of information that will be used to refine how the project is delivered and to measure its success.

"We intend to send it out as widely as possible using the NRA database, combined with the mushroom industry database, and tapping into healthcare associations (such as the Australasian Society of Lifestyle Medicine) to distribute it even further to their membership."

"The survey has been carefully designed so it can be completed quickly and as an added incentive, each participant can choose to enter a competition to win supermarket vouchers."

To be able to understand the needs of healthcare professionals, the survey will look to capture the areas of nutrition in which participants work and their level of education if in a nutrition-related field (degree, certification or online course). Questions will also be asked to determine how much is known of the nutritional and bioactive properties of mushrooms.

At a more personal level, they will also be asked whether they like mushrooms and if so, how they eat them; whether they have been to the Australian Mushrooms website; where they find their recipe inspiration; and whether they recommend mushrooms or give

clients and patients recipes or meal suggestions.

Dr Fayet-Moore said the survey would provide an interesting insight into how mushrooms are viewed by healthcare professionals and will greatly assist the overall delivery of the project.

## GETTING THE WORD OUT

The first electronic direct mail has now been sent to health professionals, inviting recipients to participate in the survey and to update them on the longer-term efforts of industry to keep them informed about the health benefits of mushrooms.

Dr Fayet-Moore said that while the survey was an initial priority, the longer-term objective of the email was to encourage the widest cross-section of healthcare professionals to opt-in to receive regular updates about mushrooms.

"Healthcare professionals receive a lot of information. Our task is to use the results of the survey to gain a better understanding of who we are talking to, and then to deliver relevant information that is a mix of good science and fun facts – the type of information that is easily repeatable when talking to consumers about good health."

## DIETICIANS UNITE BREAKFAST

While the work from the survey commences, the project is moving ahead to establish strong connections with the health professional community. One event that is already on the calendar is the Dietitians Unite Breakfast, held in Melbourne in May 2020. The event, organised through Dietitians Connection provides a fantastic opportunity to promote Australian Mushrooms to an engaged healthcare community.

Dr Fayet-Moore outlined that arrangements have been made for sharing the branded breakfast event with Simplot.

"The great thing is that working with Simplot will allow us to deliver a "mushrooms and vegetables" message that is in keeping with our objectives to ensure health professionals receive consistent, science backed information about Australian Mushrooms. I am excited about the opportunity and will be working to finalise the details over the coming months to ensure a very successful event."



The Audience Sentiment Research survey will provide a baseline of information for Australian Mushrooms.

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Comms program planning, liaison and content development details have begun for milestones 114 and 119. For further details, please refer to those milestones.

## MILESTONE 108: SLR SCOPE REPORT

**The effect of edible mushrooms on health: a scope for a systematic literature review: end March 2019**

To identify the best approach and the most up-to-date literature, scientific databases were searched for studies on edible mushrooms (excluding extract) and health outcomes. The aim of the scope was to identify and summarise the current evidence-base for edible mushrooms and human health to determine the best approach for the commissioned SLR.

**The literature was scoped across two main areas of research:**

1. What is the available evidence on the nutritional and bioactive components of edible mushrooms?
2. What is the available evidence on the health effects of edible mushrooms?

Gaps in existing systematic literature review were identified to generate options for the commissioned SLR, evaluating the pros and cons of each option.

The in-depth SLR scope report (Appendix 10) was presented to the Hort Innovation team alongside a recommendation for the final SLR. Two options for a SLR were provided to Hort Innovation in the scope report:

1. The effect of *Agaricus bisporus* on all nutritional and health outcomes, including all types of studies (human research studies, pre-clinical studies, and in vitro/cell line studies).
2. The effect of the top five\*most consumed edible mushrooms on all human health outcomes, including prospective cohort and intervention studies (recommended option).

\**Agaricus bisporus*, *Pleurotus ostrateus* (oyster mushroom), *Lentinus edodes*(shiitake mushroom), *Auricularia polytricha*(black fungus) and *Flammulina velutipes*(enoki mushroom).

The recommended SLR option would examine the effect of the top five edible mushrooms or *Agaricus bisporus* alone. There are sufficient original research studies in humans to examine the top five edible mushrooms, which will ensure relevance of the results in the communications messages. There are however, insufficient original research studies in humans to examine the effect of only *Agaricus bisporus*, and therefore if the choice is to focus the SLR on *Agaricus bisporus* only, then all study types (i.e. non-human studies) would need to be included. This approach would ensure alignment of the communications messages to the most commonly consumed edible mushrooms available in Australia (i.e. *Agaricus bisporus*), but would limit the relevance and translatability of the evidence to the Australian public.

There were over 300 narrative reviews (i.e. discussion papers which do not use rigorous scientific methods to evaluate the literature) on mushrooms and health outcomes, most of which were published since 2013, which reveals there is substantial interest in this topic. The only health outcome that there are sufficient studies available to complete a SLR is on vitamin D, but one SLR has been recently published (2016), and no new primary research studies have been published since that time. Based on this research, Hort Innovation may pursue a nutrient content or health claim for UV-irradiated mushrooms on vitamin D with Food Standards Australia New Zealand but this would require further research outside the scope of this project.

Hort Innovation was concerned that option 2 would be dominated by studies that do not include *Agaricus bisporus*, and that the scientific communications would not apply to Australian Mushrooms, who is funding this project. Option 1 is the most relevant to Australian Mushrooms, but since most studies are not in humans, the scientific communications on the findings would need to reflect the level of evidence. Hort Innovation requested for a quote to do both SLRs, but publish only the relevant one (likely option 1). Feedback on the SLR scope approach was provided in *mid April*, with a request for an additional scope of the science.

Therefore an additional scope was conducted to determine the proportion of human research studies on *Agaricus bisporus* versus the other edible mushrooms in option 2 to have an idea if most of the science will be applicable to Australian Mushrooms (*A. bisporus*) or to the other mushrooms.

#### **The additional scope: end April**

This scope was contributed as an additional project investment by NRAUS above the agreed scope of work (Appendix 11). The additional scope revealed that the top three mushrooms had roughly similar proportions of human studies: eight studies using *Agaricus bisporus*, five studies using oyster mushrooms, and seven studies using shiitake mushrooms.

It is unlikely that there are enough well designed RCTs with strong evidence for the effect of mushrooms (of any kind) on anything except bioavailability of vitamin D. There are no studies that show vitamin D has a clear 'health benefit' either. Further, it is difficult to demonstrate a clear health benefit without at least a few studies of decent sample size, methodology and comparable interventions/outcomes, so you can have confidence in the findings and your communications messages. For this reason, the communications will likely be nutrient focused and/or include animal studies to support the findings. With this in mind, option 1 (exploring the effect of *Agaricus bisporus* on all health outcomes, including all types of studies) is the decided option to be pursued.

### **The commissioned SLR: approval mid May**

Hort Innovation approved option 1 as the SLR option to pursue.

Despite the delay in Hort Innovation's approval of the SLR approach, it was crucial that time was taken to discuss all options and approaches available, including the pros and cons of each, as this research would form the basis of the three-year campaign.

The updated expected date for delivery of the SLR, taking into account the large number of literature identified, and the concurrent work on the GP communications that is required, is *end of September 2019*. Timelines for the SLR are dependent on the final number of studies that will be included in the SLR, as a higher number of studies increases the time required to extract the required data.

Due to the delay, we could no longer leverage the SLR findings to create content for the GP webinar and conference. Rather than delaying the project further, we provided Hort Innovation with a solution. The SLR scope revealed that there were no new SLRs published on mushrooms and vitamin D, and no new research studies. Therefore, we could use the latest vitamin D and mushroom SLR, and other related reviews, to provide us with the most recent science on that topic. The team can therefore use this information to inform the content for the GP conference and webinar. We will also use content from Flav's Fun Facts alongside new insights from the SLR which are uncovered whilst content for the webinar and conference are being drafted.

### **MILESTONE 109: 6 MONTH BENCHMARKING PERFORMANCE REPORT 1**

Completed as per this report. 1 July 2019

### **MILESTONE 110: SLR COMPLETION** *estimated end September 2019*

The SLR completion milestone date was dependent on the SLR Scope decision by Hort Innovation, which was approved *mid-May*. The SLR began at the *end of May 2019*. The team is currently working on the SLR and it has been registered on PROSPERO, a database of systematic literature reviews that are currently being undertaken across the globe. It is best practice for a SLR that will be published in a peer-review journal to be registered on PROSPERO prior to the data extraction.

The search strategy has been developed, tested, revised, finalised and executed. A total of 5,710 titles and abstracts are currently being screened to be included in the SLR.

### **MILESTONE 114: Conference symposium (GPCE) sponsor + speaker**

#### **Planning and liaison for the GPCE conference:** *June 2019*

To align with our Year 1 focus on GPs, a presentation at a GP conference was planned as part of the project proposal. The General Practice Conference and Exhibition (GPCE) holds four major events per year in Sydney, Melbourne, Brisbane and Perth.

The GPCE Melbourne event will be held on at the Convention & Exhibition Centre from 15-17 November 2019, celebrating 25 years supporting excellence in Australian General Practice.

We approached the education board and event committee for GPCE Melbourne and submitted a detailed proposal for a conference presentation that aligns with the RACGP best practice guidelines and interests of GPs attending this conference. For this reason, it could not be on mushrooms only, and had to relate to the broader topic of vitamin D, while adding valuable information from the research on vitamin D and mushrooms and key findings from the SLR.

We developed a detailed proposal for a keynote presentation or a workshop for approval by the scientific committee. The committee accepted our proposal and we are now selecting the best dates and time slots for the workshop and are currently working on a bespoke content package to amplify attendance and reach GPs.

The workshop will be sponsored by Australian Mushrooms, and will feature the project leader and technical ambassador for Australian Mushrooms, Dr Flavia Fayet-Moore. Dr Fayet-Moore has recently published on vitamin D status of office workers in Sydney, Australia, is the first dietitian in Australia to be nationally and internationally certified as a Lifestyle Medicine Professional, and will provide delegates with an overview on vitamin D, and give practical recommendations for GPs on

helping patients meet their daily needs (including mushrooms). We will host 2 x 1 hour education sessions with delegates, and the branding will be featured throughout.

**The proposed and GPCE-approved synopsis and workshop/education outline (Appendix 12):**

*In a country where sunshine isn't lacking, it's surprising to see that almost 1 in 3 Australians have vitamin D insufficiency. At the same time, Australia has one of the highest rates of skin cancer. So what can you do, to ensure your patients are getting enough of this essential vitamin? Do you recommend sun exposure? Diet?*

*With more than 9 out of 10 Australians not meeting recommended intakes for fruits, vegetables and exceeding intake of discretionary and non-nutritious foods, how can you get them to actually get enough vitamin D through diet? What can you do? What should you recommend and how can you assess a need for intervention?*

**Format overview for the workshop/education sessions:**

1. Brief background on vitamin D and its importance to health
2. The Lifestyle Medicine approach
3. Prevalence of insufficiency in Australia- Prevalence of deficiency in Australia
4. Factors that contribute to vitamin D status
5. Fayet-Moore et al 2019 paper: recently published paper on determinants of vitamin D status of office workers in Sydney, Australia
6. Putting recommendations into practice- nutrition prescription for vitamin D

The proposal will be shared with the team for review once finalised.

**MILESTONE 119: DIETITIAN'S UNITE BREAKFAST SEMINAR**

**Dietitians Unite Breakfast 2020 (DU2020):** To maximise opportunities in 2020, the team have secured a place at the Dietitians Unite Breakfast as part of the Year 2 communications plan, in order to reach Australian dietitians and nutritionists.

The event will enable us to position Australian Mushrooms as an authority on nutrition, whilst providing practical advice and recommendations which audiences can implement with their patients.

The team have secured an event partnership with Simplot Australia, which has resulted in a 50% cost reduction for the event fee. The brands are working on a dual brief and event format which cross promotes and complements both brand missions - to get Australia eating more mushrooms and vegetables. A first draft of the event brief has been completed (Appendix 13).

The breakfast will focus on culinary nutrition and practical recommendations. The objectives are to:

1. Build Australian Mushrooms & Simplot Brands reputation for nutrition expertise
2. Drive awareness of Australian Grown Mushrooms + Birds Eye / Edgell brand benefits
  - a. build product familiarity & deliver key nutrition messages via research presentations
  - b. create novel opportunities for dietitians to discuss culinary inclusion of vegetables to increase vegetable/ legume/ fungi consumption rates and frequency
3. Showcase opportunities to incorporate key products into food recommendations to clients via endorsement or communication of recipe ideas, food tips & nutrition benefits

The breakfast event will showcase mushrooms as part of a nutritionally delicious meal and will be served to delegates to enjoy as they hear more about the benefits of mushrooms and the findings of our SLR. We will showcase the research evidence and give practical recommendations on how to get the most from mushrooms (e.g. cutting mushrooms in sunlight exposure increases Vit D levels).

To drive additional engagement, the team will facilitate a panel discussion, driving conversation around the unique properties of mushrooms to explain how delegates and their patients can benefit from making them part of day-to-day diets.

The initial proposal has been approved and the team are now working with Simplot and Dietitians Unite to identify key milestones in 2019 which will be agreed in order to deliver a first class event for



delegates.

## Outputs

### **PROJECT RISK REGISTER:** (Appendix 1)

The [risk register](#) was developed to ensure the team had identified any possible risks and provided a way to best mitigate these in advance.

### **PROGRAM LOGIC AND MONITORING AND EVALUATION PLAN:** (Appendix 2)

A program logic and evaluation plan was developed and can be found [here](#). This was devised in line with Hort Innovation guidelines to ensure all activity, outputs and outcomes were clearly mapped out at the start of the campaign.

### **CRITICAL PATH:** (Appendix 3)

The team developed a critical path and master timeline document, detailing key milestones for the year ahead. You can preview the critical path [here](#).

### **PROJECT OVERVIEW & MILESTONES:** (Appendix 4)

A detailed three year campaign proposal, including objectives, deliverables, and updated milestones were developed to illustrate how the project will meet the agreed objectives.

### **AUDIENCE SENTIMENT RESEARCH PLANNING DOCUMENT:** (Appendix 5a)

A research survey has been developed to effectively measure shifts in sentiment across our audience over time. The detailed research questions have been created in conjunction with NRAUS and will be issued at three different milestones to measure changes in knowledge, awareness and propensity to recommend. You can preview the question document [here](#).

### **AUDIENCE SENTIMENT RESEARCH PLATFORM:** (Appendix 5b)

The research has been uploaded to a dedicated online platform to ensure all data can be effectively captured and exported to illustrate the findings. The team have worked within the existing design and functionality parameters to create a visually striking survey with a unique interface. You can preview the platform [here](#).

### **FLAV'S FUN FACTS:** (Appendix 6)

A detailed word doc outlining key facts from the SLR was developed and shared with the consumer agency. This was developed to ensure key messages could be aligned for both audiences.

### **EDM- NRAUS DATABASE WELCOME:** (Appendix 7)

A welcome email, introducing respondents to the Australian Mushrooms newsletter was distributed to the NRAUS database.

### **EDM- SENTIMENT RESEARCH INVITATION:** (Appendix 8)

To maximise participation with the sentiment research and ensure we were reaching a robust and qualified audience from the outset, the team designed an engaging EDM, announcing the upcoming news and content from Australian Mushrooms. This included a clear call to action for respondents to complete the survey.

### **EDM - NSA, RACPG & ASLM NEWSLETTERS:** (Appendix 9)

To further boost our reach, the research was also distributed to the Australian Society of Lifestyle Medicine (ASLM) (n= 8,700), Nutrition Research Australia (NSA) (n= ~1,000) and the Royal Australian College of General Practitioners (GPCE) databases (n= 21,900) for a total of 32,617 HCPs.

### **SYSTEMATIC LITERATURE REVIEW SCOPE:** (Appendix 10)

A 37 page document provided to the team which includes details on the existing available research alongside a recommendation to determine the best approach for the commissioned SLR. The SLR scope included a detailed overview of referred scientific publications which were

cited within the initial research.

**SYSTEMATIC LITERATURE REVIEW ADDITIONAL SCOPE:** (Appendix 11)

An additional scope was conducted to determine the proportion of human research studies on *Agaricus bisporus* versus the other edible mushrooms in option 2 to have an idea if most of the science will be applicable to Australian Mushrooms (*A. bisporus*) or to the other mushrooms.

**GPCE CONFERENCE PROPOSAL:** (Appendix 12)

To align with our Year 1 focus on GPs, the team developed and presented a proposal to the education board. The General Practice Conference and Exhibition (GPCE) holds four major events per year in Sydney, Melbourne, Brisbane and Perth. The GPCE Melbourne event will be held on at the Convention & Exhibition Centre from 15-17 November 2019.

**DIETITIAN'S UNITE BREAKFAST SEMINAR BRIEF:** (Appendix 13)

To maximise opportunities in 2020, the team have secured a place at the Dietitians Unite Breakfast as part of the Year 2 communications plan, in order to reach Australian dietitians and nutritionists. The brief outlines the presentation focus and partnership with Simplot Australia, which has resulted in a 50% cost reduction for the event fee.

## Outcomes

**Established the focus for the SLR:**

To ensure the team could make an informed decision on the direction of the SLR, NRAUS identified the gaps in the existing literature and presented the findings in a report. This initial scope ensured the team were aligned on the direction and possible outcomes, which will inform the content throughout the course of the three-year campaign. The team are progressing with a SLR on the effect of *Agaricus bisporus* on all health outcomes, from all types of studies (human, research studies, pre-clinical studies, and in vitro/ cell line studies).

**Established current knowledge levels amongst HCPs:**

To effectively measure changes in knowledge and propensity to recommend, we first needed to understand current knowledge levels to provide a baseline metric. This has been established through the first round of sentiment analysis and will enable the team to effectively measure changes as we look to share more information with HCPs during the course of the project.

**A growing database of contacts:**

By working with wider networks and NRAUS, the team are growing the current database of contacts which Australian Mushrooms can reach out to with updates, news and events. This data is also well segmented (occupation, location, qualification level) to ensure the team can tailor communications more effectively, building on the previous database which was segmented by geography. This will ensure the team are investing in producing materials which will deliver the best cut through and results for Australian Mushrooms.

**A tailored campaign approach:**

By including questions in the sentiment research around the current materials on mushrooms and how interesting / helpful respondents find these, the team will be able to utilise this data to inform the content we produce, enabling us to deliver more compelling materials and insights.

**Improve the distribution of information:**

The newly created series of EDMs are visually engaging, digestible and use accessible, yet scientific language to communicate with our audiences. As the first point of contact, it was key that the design was high quality in order to capture the attention of respondents. The fresh format will form the basis for all EDMs moving forward and they have a recognisable design so that audiences are able to distinguish content they receive from Australian Mushrooms.

**Secured key opportunities to promote the findings of the SLR:**

The proposals submitted to Dietitians Unite and the General Practitioners Conference & Exhibition

ensured that the team has identified and secured key opportunities to reach two of our core audiences with key messages and educational material. The team will refine the material for each event to ensure it is highly relevant and addresses the top issues each audience encounters with their patients (e.g taste perceptions, barriers around nutritional properties, recipe inspiration etc).

## Issues and risks

**Campaign Risk Register** - An update of the issues and risks on the register can be viewed [here](#).

### **Audience Sentiment Research**

The Audience Sentiment Research benchmark survey was scheduled to be undertaken in March 2019 but is being undertaken in June 2019. Delays in approvals from Hort Innovation for the three-year campaign project proposal, as well as a delay in the consumer Australian Mushrooms website re-launch, resulted in this delay.

### **Systematic Literature Review commencement date delayed**

The SLR scope was delivered within estimated milestone timelines. However, there was a delay in Hort Innovation's approval of the SLR approach. It was important that time was taken to discuss all options and approaches available, including the pros and cons of each, as this research would form the basis of the three-year campaign, thereby minimising any risks associated with not being able to accurately communicate the research findings. Despite the delayed SLR commencement, we were able to leverage current research findings from the SLR scope to inform a strategy for the upcoming GP webinar and conference. The SLR scope revealed that there were no new SLRs published on mushrooms and vitamin D, and no new research studies. Therefore, we could use the latest vitamin D and mushroom SLR, and other related reviews, to provide us with the most recent science on that topic. The team can therefore use this information to inform the content for the GP conference and webinar and remain within the current milestone dates. We will also use content from Flav's Fun Facts alongside new insights from the SLR which are uncovered whilst content for the webinar and conference are being drafted.

### **Dietitian's Unite 2020**

When we proposed a Dietitian's Unite breakfast as part of our tender proposal, we had secured the breakfast spot, pending tender success. Unfortunately, a member of the organisation had made a mistake, and given our spot to Simplot. Dietitian Connection then spoke to Simplot who agreed to share the breakfast session with Australian Mushrooms. The positive outcome of this was that we had a 50% reduced fee for the same event presence, have a more broad breakfast session where we highlight the health benefits of mushrooms in the context of vegetables, and have a new collaborative relationship with Simplot.

### **Sentiment Research Participation**

The team has partnered with leading industry organisations (The Australian Society of Lifestyle Medicine, Nutrition Research Australia and the Royal Australian College of General Practitioners) to generate additional exposure and participation with the sentiment research, in addition to offering a \$100 supermarket voucher for 2 x respondents selected at random. However, the team are unable to control the final number of research responses submitted. We will therefore calculate averages for the first wave of research which can be used as the baseline data to benchmark against.

## Appendices

**Appendix 1: PROJECT RISK REGISTER**

**Appendix 2: PROGRAM LOGIC AND MONITORING AND EVALUATION PLAN**

**Appendix 3: CRITICAL PATH**

**Appendix 4: PROJECT OVERVIEW & MILESTONES**

**Appendix 5a: AUDIENCE SENTIMENT RESEARCH PLANNING DOCUMENT**

**Appendix 5b: AUDIENCE SENTIMENT RESEARCH PLATFORM**

**Appendix 6: FLAV'S FUN FACTS DOCUMENT**

**Appendix 7: EDM- NRAUS DATABASE WELCOME**

**Appendix 8: EDM- SENTIMENT RESEARCH INVITATION**

**Appendix 9: NSA, RACGP & ASLM NEWSLETTERS**

**Appendix 10: SYSTEMATIC LITERATURE REVIEW SCOPE**

**Appendix 11: SYSTEMATIC LITERATURE REVIEW ADDITIONAL SCOPE**

**Appendix 12: GPCE CONFERENCE PROPOSAL**

**Appendix 13: DIETITIAN'S UNITE BREAKFAST SEMINAR BRIEF**

## **Intellectual property, commercialisation and confidentiality**

No project IP, project outputs, commercialisation or confidentiality issues to report.

## **Other information**

Nutrition Research Australia has a new team member who is currently working on this project:

Tim Cassettari, Project Manager, B.App.Sc.(Ex&SpSc), B.Sc.(Nutr)(Hons), GradDipCoachPsych; APD

e: [tim@nraus.com](mailto:tim@nraus.com)

## Milestone Report

**Project title:**

### **Educating healthcare professionals about Australian mushrooms**

**Project code:**

MU 17002

**Milestone number:**

115

**Project leader:**

Dr Flávia Fayet-Moore

**Delivery partner:**

Nutrition Research Australia Pty Ltd (NRAUS)

**Report author:**

Flávia Fayet-Moore (NRAUS)  
Jodie Hart (History Will Be Kind - HWBK)

**Milestone due date:**

End November 2019

**Submission date:**

29 November 2019

**Confidentiality:**

Is this report confidential?

- X  No  
 Yes (whole report)  
 Yes (sections of report are confidential)

**Milestone description:**

6 Month Benchmarking Performance Report 2

**Milestone achievement criteria:**

105, 110, 112-115 - completed

111 119 - in progress

106, 107 - ongoing

Note that the following are updated milestones as agreed by Hort Innovation in January 2019.

Milestone	Achievement Criteria
105	Audience Sentiment Research - Benchmark
106	Technical and Scientific Support for the Australian Mushrooms Campaign
107	Periodic comms program - planning, liaison, integration & content development
110	SLR Completed (pending scope decision, no report)
111	SLR Draft and SLR key points brochure/doc
112	Webinar “No side effect”
113	Brochure – GP
114	Conference symposium- General Practice Conference & Exhibition (GPCE)
115	6 Month Benchmarking Performance Report 2
119	Dietitian’s Unite - Breakfast Seminar

**Funding statement:**

**Levy funds – R&D projects**

This project has been funded by Hort Innovation, using the Australian Mushrooms research and development levy and contributions from the Australian Government. Hort Innovation is the grower-owned, not-for-profit research and development corporation for Australian horticulture.

## General project overview

Despite the unique nutritional properties of mushrooms, there is currently a lack of knowledge of their nutrition and health benefits among healthcare professionals (HCPs). The objective of this three-year project is to conduct original research on the health benefits of mushrooms and then educate health professionals about its key findings, supporting the wider industry objective of increasing the overall consumption of mushrooms in Australia.

## Summary

Year One showcased mushrooms as nutritionally unique, with a focus on sharing with GPs mushrooms' exceptional contribution to vitamin D specifically. The Audience Sentiment Research- benchmark survey surpassed our goal with 225 respondents and confirmed our hypothesis that knowledge of the key nutritional properties of mushrooms is low, that few perceive mushrooms as more important than vegetables, and that mushrooms are not a front of mind recommendation to patients.

At the same time, the SLR identified over 500 studies on the nutritional and health properties of *Agaricus bisporus* mushrooms. A specific focus on their health effects in humans, including their flavonoid and glucan properties, was recommended for the SLR to provide relevant key messages and R&D insights. The SLR has been completed and the manuscript draft is on track to be submitted by the end of February 2020, along with the summary SLR document.

The 500+ research papers identified have also been collated to form the first ever scientific database on every single study published worldwide on the health or nutritional aspects of *A. bisporus*. We have applied our NutritioniQ service to ensure this research database remains current as new research is published. Additional Fun Facts from this database were created and incorporated throughout our activities and communications. We also used this research database to support the development a first-of-its-kind webinar on vitamin D, to highlight UV mushrooms as the 'no side effect' vitamin D pill and top dietary source of vitamin D. We partnered with several HCP groups to help promote the webinar, in addition to paid social media and the current NRAUS and Hort Innovation databases, surpassing expectations with 125 registrations in total. The webinar recording is hosted online and already has over 540 views. The post-webinar survey is still open and to date 100% of respondents would recommend the webinar to their colleagues, with an average 9/10 overall enjoyment score. Several key opinion leaders in nutrition and dietetics also posted information from the webinar on their social channels.

From this successful webinar content, we developed a presentation for the General Practitioner's Conference & Exhibition (GPCE) and a high quality 4-page brochure, to bring to life the key research findings and showcase mushrooms as a unique vitamin D source. The workshop presentation was moved to the keynote room by the organisers due to the high number of registrations received, ran overtime with the Q&A session due to the significant interest, had 91 delegates attend, and saw us distributed 200 brochures. The GPCE team was so impressed that they have requested we present again at the Sydney conference in May 2020. One GP said: "Can I just say, that this is the best brochure I have ever seen. It summarises everything that we need to know in only four pages. Congratulations!" followed by a round of applause by the audience. Planning for the Dietitian's Unite breakfast now held in May 2020 continues and will include content from the SLR findings and practical tips on how to encourage mushroom and vegetable consumption, with a focus on culinary nutrition.

## Achievements

### **MILESTONE 105: AUDIENCE SENTIMENT RESEARCH- BENCHMARK**

**Audience Sentiment Research Report: August 2019**

#### ***Background***

An audience sentiment research survey was developed to provide initial baseline findings for the campaign. It is the first in a series of three surveys and will help to measure changes in attitudes, knowledge and propensity to act over time. Insights gathered from this research survey will also help us to strategically tailor the communications program over the course of the project to best increase awareness of the nutritional and health benefits of mushrooms among HCPs.

Within the report we measured awareness and attitudes across five core areas:

- Knowledge of the nutritional properties and health benefits of mushrooms
- Value placed on mushrooms for their properties
- Perception of mushrooms for health

- Behaviour around recommending mushrooms
- Frequency of recommendation or behaviour

A link was included within an Electronic Direct Mail (EDM) to a live competition that gave participants the opportunity of winning one of two \$100 supermarket vouchers for completing the survey. The core target audience was general practitioners (GPs), dietitians, nutritionists and naturopaths, with other health professionals (e.g. fitness professionals, chefs, home economists) as secondary audiences.

### **Activity completed**

Previous to this report, a health care professional (HCP) sign-up form was created on the Australian Mushrooms website and an introduction email was created, followed by an EDM that contained a link to our sentiment analysis questions. The survey was advertised with a number of third-party organisations: The Royal Australian College of General Practitioners (RACGP), the Australasian Society of Lifestyle Medicine (ASLM) and the Nutrition Society of Australia (NSA). Since the previous milestone report, a reminder EDM was developed which encouraged HCPs to complete the questionnaire and included three additional mushroom fun facts. This reminder EDM was sent to the to all those who previously received the survey EDM from the NRAUS and Hort Innovation database on 8 July 2019 (**Appendix 1**).

On the 11 of July (less than two weeks prior to the closing survey date of 24 July) there were 133 surveys completed, below our initial target of 200. We made the decision to run a short, hidden and targeted campaign on Facebook promoting the survey to GP's, physicians, nutritionists and dietitians. Facebook ads were developed for a non-public paid social campaign via the Australian Mushrooms Facebook page, and the campaign ran from the 16<sup>th</sup> to the 20<sup>th</sup> of July 2019. The ads successfully drove an additional 88 HCPs to complete the survey, exceeding the initial target set. It also provided us with confirmation that HCPs engage well with Facebook.

The benchmark Audience Sentiment Research survey closed on the 24 of July 2019, and two winners of the supermarket vouchers were chosen at random (using random.org). Winners were notified by email and followed with a up phone call on the 29 and 30 July, respectively.

### **Sponsored Facebook Post – Sentiment Research: July 2019**

**Australian Mushrooms**  
Sponsored · 🌐

We're conducting new research on the health and nutrition properties of the world's most popular mushroom. Enter the survey to tell us what you know + to join our community to stay up to date with the latest research.

**IS THE WORLD'S MOST COMMONLY CONSUMED MUSHROOM?**

AUSTRALIANMUSHROOMS.TYPEFORM.COM

**Australian Mushrooms needs you!**  
Take the survey for your chance to win one of two \$100 gift vouchers to spend on something delicious.

Subscribe

👍👎👤 Majella Ryan and others      5 Comments 2 Shares 7.6K Views

### **Impact**

Through the six different channels, the survey reached a total of 49,816 HCPs:

1. Australian Mushrooms database = 1,002 contacts



2. NRAUS database= 314 contacts
3. Nutrition Society of Australia newsletter = 1,000 contacts
4. Australasian Society of Lifestyle Medicine newsletter = 8,700 contacts
5. Royal Australian College of General Practitioners= 21,300 contacts
6. Social campaign= 17,500 reach

A total of 225 HCPs completed the survey, exceeding our target of 200. This included 137 via the EDM link, and 88 from the paid social media activities.

The EDM engagement surpassed expectations, with a 34.5% open rate (the industry average is 20-25%) and a 22.8% click through rate. Additionally, only 1% of HCPs unsubscribed from the existing database during the promotion period. The paid social media had a click through rate of 1.46%, including a click through rate of 4.67% for GPs, which is higher than the industry average of 1%. The additional contacts made from the paid social media campaign were also added to the master database, helping us to grow this database.

## **Results**

Key learnings and future opportunities were captured within the Audience Sentiment Research benchmark report (**Appendix 2**), including a thorough analysis of our distribution plan, EDM strategy, design and creative, research questions, and our agile approach to implementing social paid to bolster responses. Some of the key findings are summarised below, and these data suggest that there are many HCPs unaware of the unique nutritional properties of mushrooms:

### *Audience segmentation*

- 83% of respondents were female
- 39% of respondents were dietitians or nutritionists; 22% were GPs; and 2% were naturopaths

### *Knowledge of health & nutritional properties*

- 63% of respondents were familiar with 'some' of the health benefits of mushrooms, but cannot specify what they are
- A large proportion (8%, 20 respondents) were 'not familiar at all' with the health benefits – 9 of these were 'other health professionals' and 6 were 'GPs'
- Dietitians and 'other healthcare professionals' were the group most familiar with 'some' of the health and nutritional benefits of mushrooms
- 72% of respondents were able to specify at least one nutritional property
- Nearly 10% could not select a nutritional property for mushrooms
- Dietary fibre, cholesterol free, and vitamin D were the most common nutritional properties selected when asked what the key nutritional properties of mushrooms were

### *Value of mushrooms*

- Mushrooms were most commonly seen as 'somewhat important' for overall health (57.1%), with a lower proportion viewing mushrooms as 'very important' (33.9%)
- 75.9% of respondents placed equal value on mushrooms compared to vegetables

### *Existing resources*

- Almost two-thirds (63%) reported they did not know of any existing resources on mushrooms

### *Personal consumption habits*

- Nearly all (98%) of HCPs eat mushrooms, and do so at least once a week
- Taste and/or texture were the only reasons for never consuming mushrooms

### *Frequency of mushroom recommendation to clients*

- A third (33.9%) of respondents do not see patients/clients
- 18% do see patients, but don't recommend mushrooms.
- The top reason for not recommending mushrooms was that they are not familiar with health or nutritional properties (45% of respondents)

#### *Online resources*

- Knowledge of the Australian Mushrooms website is low (74% have never visited)
- Recipe sharing is not popular among respondents who see patients/clients (nearly 60% do not give recipes or cooking materials)
- 59% visit industry websites for inspiration, showing that a broader approach which is perhaps not specific to one vegetable may be effective
- Beyond industry websites, HCPs turn to Google, magazines, blogs and social media

#### **Next steps**

The Audience Sentiment Research benchmark survey results highlighted a number of strategies for us to use, and these are listed in full in the report. Below is a summary of strategies that have worked well and that we can continue to use throughout the campaign.

#### *Strategy & planning:*

- Using third party opportunities and reminder emails helped us to maximise exposure
- Tailored EDMs allowed us to track the performance and sign up rate for each of our databases
- Our HCP database has a high interaction, and therefore it is important that we utilise and build upon this for future activities

#### *Research questions:*

- The survey took less than 5 minutes to complete, and had a high average completion rate of 71%
- The gift vouchers were a cost-effective way of incentivising the survey
- Providing interesting bitesize content was vital to ensure all of our EDM content was engaging and useful, which we have continued to leverage in further EDMs, in the brochure and in the conference presentation

#### *Distribution plan:*

- The addition of the paid social media campaign enabled us to reach new audiences quickly, and we will be using it as a key channel for future campaigns.
- The Sunday distribution resulted in a particularly high open rate, demonstrating that this is an effective time to communicate to health-care professionals via email.

There was also a number of learnings identified from the survey, which will be captured throughout the course of the campaign:

- Remove open ended questions as these did not provide quality responses
- Work with third parties to post on their social channels and to use tracked links, to increase engagement and be able to measure the success of each partner channel
- Use paid ads to promote upcoming activity to facilitate more sign ups to the database, which we utilised to help drive registrations to the November GP webinar
- Drive traffic to the Australian Mushrooms Website, which we did as a call to action at the end of the webinar, since 74% of respondents had not visited the website

We have and will continue to implement these learnings into upcoming activities. We will refine the survey questions based on these findings for the next phase of the audience sentiment research in July 2020. The sentiment analysis report was shared with Hort Innovation at the end of August 2019 and no additional changes or requests were made.

## **MILESTONE 106: TECHNICAL AND SCIENTIFIC SUPPORT FOR THE MUSHROOM CAMPAIGN**

**Dr Flav's Fun Facts:** *Ongoing – 2019*

Hort Innovation has requested that we continue to populate Dr Flav's Fun Facts document as the SLR research unfolds, and to provide a final version for discussion once the research is completed.

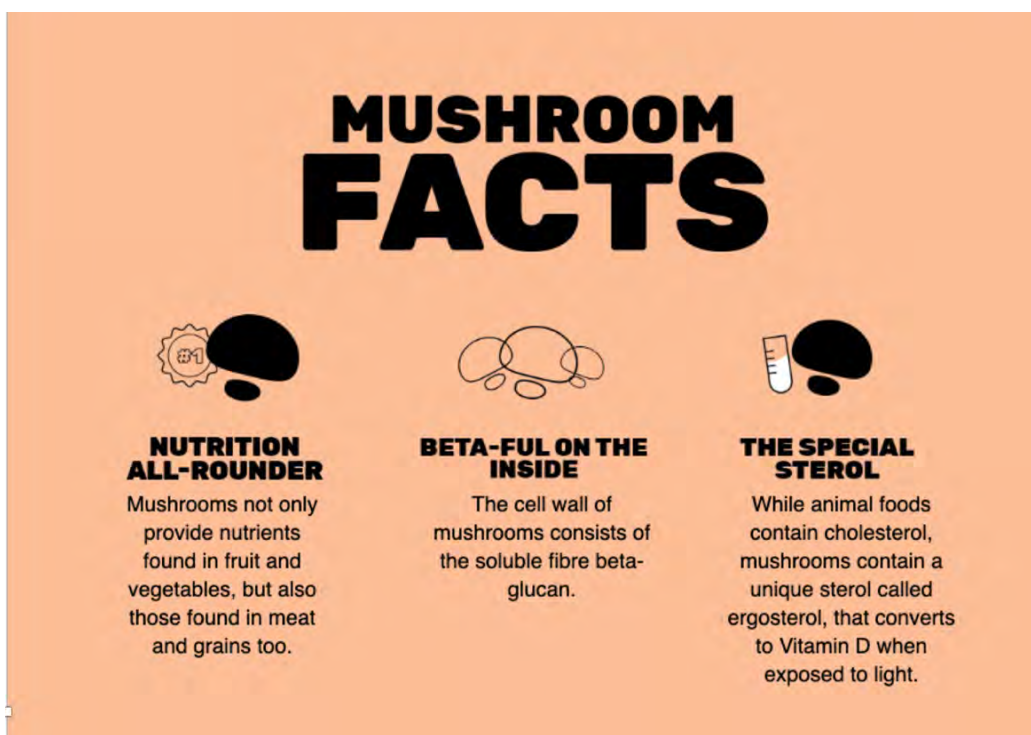
The Fun Facts document has been continuously updated throughout the year in conjunction with the systematic review. From this document, the following fun facts have been used to date in the EDMs:

1. **World's top pick:** *Agaricus bisporus* is the world's most commonly consumed mushroom.
2. **A natural innovator:** Unlike plants, mushrooms lack chlorophyll and obtain sustenance from complex organic materials of plants and animals.
3. **Three of the same:** Button, cup and flat mushrooms all come from the same mushroom, just left longer to grow!
4. **Nutrition allrounder:** Mushrooms not only provide nutrients found in fruit and vegetables, but also those found in meat and grains too
5. **Beta-ful on the inside:** The cell wall of mushrooms consists of the soluble fibre beta-glucan
6. **The special sterol:** While animal foods contain cholesterol, mushrooms contain a unique sterol called ergosterol, that converts to Vitamin D when exposed to light.
7. **A true whole food:** While the 'cap' of mushrooms is a richer source of antioxidants, its stem contains more of the soluble fibre beta-glucan.
8. **Putting the one in ergothioneine:** Mushrooms contain more ergothioneine: a unique sulphur-containing antioxidant - than any other food.
9. **Devoted to vitamin D:** The vitamin D content of dried mushrooms is still 50% of its original value after 18 months.




These fun facts have been utilised in the following channels:

- Social media posts to promote the webinar
- GP webinar presentation
- GP brochure
- Sentiment survey EDM
- Webinar EDM registration invitations
- Post-webinar EDM
- Partner advertising materials

Dr Flav's Fun Facts – examples included in the EDM: July to November 2019



# MUSHROOM FACTS

 <b>NUTRITION ALL-ROUNDER</b> Mushrooms not only provide nutrients found in fruit and vegetables, but also those found in meat and grains too.	 <b>BETA-FUL ON THE INSIDE</b> The cell wall of mushrooms consists of the soluble fibre beta-glucan.	 <b>THE SPECIAL STEROL</b> While animal foods contain cholesterol, mushrooms contain a unique sterol called ergosterol, that converts to Vitamin D when exposed to light.
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### Australian Mushrooms Website Claims – 2019

Hort Innovation requested that we provide scientific support for the Australian Mushrooms health section of the website, to ensure that the current nutrient and health claims are based on robust scientific evidence. There are currently 80 claims made on the website, that may or may not reflect the latest evidence. There may also be additional claims based on recent science that are not being communicated on the website.

We are currently utilising our newly developed *A. bisporus* research database to validate the claims and to provide evidence to the marketing campaign. We developed a 'claim validation' template, and are currently populating it. A summary of what can or cannot be said on the website will be provided to Hort Innovation, in addition to a summary of alternative claims that can be communicated.

### MILESTONE 107: PERIODIC COMMS PROGRAM - PLANNING, LIAISON, INTEGRATION & CONTENT DEVELOPMENT

#### Background

Part of the communications program is to support events by communicating and promoting them to our database of HCPs. To ensure that we have a robust database of key contacts, NRAUS and HWBK have created a database development and growth strategy to continue to build our network during the three-year period. Several EDMs, promotional materials and social strategies were designed and developed to assist with driving HCPs to our benchmark survey and to promote the webinar, while building the database of HCPs. A complete summary of the data from all our digital activity is provided in **Appendix 3**.

#### Building the database of healthcare professionals for Australian Mushrooms

The HCP database has grown by 35% over 5 months, starting at a total of 1,002 (June 2019), and now sitting at 1,354 (November 2019) (**Appendix 3**). The growth in this database is a result of targeting activity including promotion of the Audience Sentiment Research, the webinar presentation and promotion (such as the social ads), and the GPCE conference.

#### Grower's Newsletter and Industry Update

We have provided updates on the project to appear in the grower's newsletter to ensure stakeholders are kept informed of our progress and key milestones (*August 2019* and *November 2019*) via Chris Rowley. We also provided Hort Innovation with slides on the project progress for the August and December SIAP meetings. Dr. Flavia Fayet-Moore will be presenting at the annual 2019 SIAP meeting in December.

#### EDMs

### ASR reminder EDM (Appendix 1)

A reminder EDM to complete the Audience Sentiment Research survey was completed. This included a link to the survey and three fun facts on mushrooms.

### Webinar promotion EDMs (Appendix 4)

An EDM was created to promote the webinar. This included a registration link, and the opportunity to answer any questions prior to the webinar. A follow up reminder EDM to register for the webinar was also sent.

### Post webinar EDMs (Appendix 5a and 5b)

Two EDMs were created following the webinar; one for those who registered (**Appendix 5a**), and one for those who did not (**Appendix 5b**). These EDMs directed people to watch the webinar, provide feedback on the webinar (if they watched it), and included Dr Flav's fun facts on mushrooms.

### Building our social presence and awareness across social channels: July – November 2019

To help promote the key activities (such as the GP webinar) in a credible and independent way, it was recommended that the communications should be NRAUS branded, and this was approved by Hort Innovation. NRAUS branding was applied to the creation of the webinar slides, GP brochure and advertisements, including social ads. This included building our social presence and awareness across social channels, to maximise the impact of these advertisements. To ensure that the Australian Mushrooms website was promoted, we incorporated the website at the end of the webinar presentation and directed delegates to it for recipe inspiration during the webinar Q&A.

## MILESTONE 110: SYSTEMATIC LITERATURE REVIEW (SLR) COMPLETED

### Background

A literature scope was previously conducted to determine whether there are sufficient human research studies alone to perform a SLR on the health effects of *Agaricus bisporus*. The scope concluded that it is unlikely that there were enough original human research studies examining the health effects of *Agaricus bisporus* alone. Therefore, a SLR reviewing *Agaricus bisporus* was recommended to include pre-clinical (i.e. animal studies) and *in vitro* studies (i.e. cell studies) in addition to human studies to generate enough data to draw key messages.

Upon discussion with Hort Innovation, we agreed to pursue the option of conducting a **SLR on the effect of *Agaricus bisporus* on all health and nutrient outcomes, including all types of studies** (human research studies, pre-clinical and *in vitro* studies). Based on the scope report, the updated expected date for delivery of the SLR, taking into account the large number of literature identified, and the concurrent work on the GP communications that is required, was end of September 2019. Timelines for the SLR were discussed as dependent on the final number of studies that were identified to be included in the SLR, as a higher number of studies substantially increases the time required to extract the required data.

### Activity completed

Following a comprehensive literature search, 501 papers were identified that met the predetermined inclusion criteria:

- **5795** references were identified and imported for screening. Of these, 85 were duplicates and removed
- **5710** studies were screened against title and abstract, and 4673 of these studies were excluded
- **1037** studies assessed for full-text eligibility, and 536 of these studies were excluded
- A total of **501** studies were included.

The average number of papers in a SLR is about 20-30. As the ~500 papers were an unfeasible number of papers to include in a SLR, the inclusion criteria for this SLR was further refined based on the studies found, which spanned the following categories:

- 17 human studies
- 85 animal studies
- 108 cell line/*in vitro* studies
- 57 macronutrient studies
- 67 micronutrient studies
- 92 bioactive studies
  - 74 phenolic studies
    - 22 flavonoid studies, a sub-category of bioactives
  - 7 glucan studies

A detailed report of next steps for the SLR was provided to Hort Innovation in September (**Appendix 6**). NRAUS assessed the possible options to deliver a systematic review that is novel, relevant to the Australian population, is translatable to humans, adds value to the current area of mushroom research, and will provide the maximum number of key messages for communication and educational components of the project.

The recommended SLR was one which focused on human studies and included an ‘add on’ component of interest: flavonoids and glucans. Human studies were chosen as these provide the best evidence to assess health effects, and we found more studies than originally scoped, which was now sufficient for the SLR. This SLR would provide a good overview of where more research should be directed, although firm conclusions on each health outcome would be limited. Animal and cell line studies in our *A. bisporus* database could then be used to support mechanisms and to inform future research and development. The bioactive compounds (flavonoids and glucans) can help support identified health effects of mushrooms and may also allow us to distinguish them from either plants or animals as an independent food group, with relevant messaging for our communications campaign.

Hort Innovation approved our recommendation to proceed with a **SLR on the health effects of *Agaricus bisporus* mushrooms in humans, including its flavonoid and glucan properties.**

## NUTRITIONiQ

We applied a new NRAUS service (NutritioniQ) to this project in order to capitalise on the vast amount of research we obtained as part of the SLR process (~500 studies). This service ensures that the [research database](#) stays current during the course of this project and beyond year three if funds are available. We have set up an automated research publication alert for the search strategy utilised in the SLR and are collating papers across the databases that are relevant as new research is published. This service allows updates to the database to be streamlined, and for any internal or external communications to be based on the latest science, while providing insights for R&D.

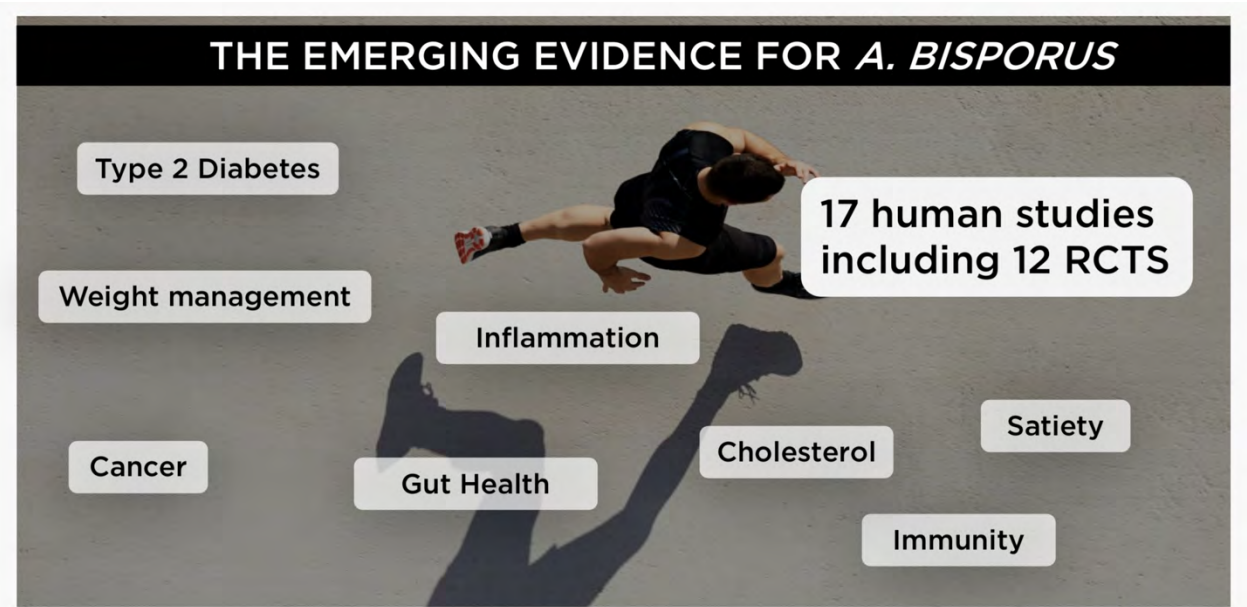
The SLR has been completed and the manuscript writing is well underway. No new research has been identified via NutritioniQ that fits the criteria of our SLR since we ran the search strategy in June 2019.

### **Impact**

The 17 human studies included 12 randomised controlled trials and covered a wide range of health effects, including inflammation, immunological, cholesterol, cancer, gastrointestinal, glycaemic/insulin, halitosis (body odour), satiety and vitamin D status, and will provide an extensive review of the health effects of *A. bisporus* in humans.

In addition, we now have an *A. bisporus* scientific health database of over 500 articles. It is a complete and up-to-date database of every study published on the *A. bisporus* mushroom and health related outcome or nutritional/bioactive component, including papers published in languages other than English.

Despite the delay in the SLR scope and the high number of identified studies, the estimated date of manuscript submission has not been impacted. It is estimated to be submitted by the end of February 2020.



### **Next steps**

The *A. bisporus* research database will be used during this project to inform the SLR, communications such as new claims that can be made on the current website copy, Dr Flav's Fun Facts, and future research. Already, the 35 papers that reported on the vitamin D content of mushrooms, while not being included in the SLR, were used to inform the webinar content and helped to ensure the webinar reflected the most recent science.

### **MILESTONE 111: SLR DRAFT AND SLR KEY POINTS BROCHURE/DOC**

The SLR is completed and the manuscript writing is well underway. A SLR key points document will be provided prior to submission. Hort Innovation has also requested that the SLR summary report include key areas for future research that we recommend.

### **MILESTONE 112: MILESTONE 116: WEBINAR – NO SIDE EFFECT**

#### **Background**

The webinar's purpose was to highlight UV exposed mushrooms as similar to a vitamin D pill, and without negative side effects. GP's were the primary target audience for 2019, hence the messaging around mushrooms and vitamin D was tailored to be in the context of the high vitamin D deficiency in Australia in order to make it topical and relevant to GPs. We strategically held the webinar on Wednesday 29 October 2019, to coincide with International Vitamin D Day on Saturday November 2.

Dr Fayet-Moore agreed to present the webinar as she had recently published on vitamin D status in Australia and has recently obtained her international certification in lifestyle medicine (the first dietitian in Australia to do so). GP Dr. Jill Gamberg, a lifestyle medicine physician, was also invited to co-present the webinar to bring further relevance to the GP audience. Jill agreed to deliver the webinar free of charge, providing no additional cost to the project. We also invited dietitian Jemma O'Hanlon, Research & Development Manager at Hort Innovation, as the Chair and Master of Ceremonies; introducing both speakers and facilitating the Q&A panel discussion following the presentations.

Dr. Jill Gamberg's talk was titled: **What is the role of lifestyle medicine in addressing vitamin D deficiency?**  
Dr. Flavia Fayet-Moore's talk was titled: **A whole food approach to meeting vitamin D recommendations**

**Speaker Bios – from Webinar EDM: October 2019**



**Dr Flávia Fayet-Moore**  
PhD, MNutrDiet, RNutr, APD, FASLM

The CEO of Nutrition Research Australia, where she leads a team of highly skilled researchers to conduct end to end nutrition and communications projects.

Flávia is a Registered Nutritionist, Accredited Practising Dietitian, Honorary Associate of the University of Sydney, and the first dietitian in Australia to be board certified in Lifestyle Medicine.



**Dr Jill Gamberg**  
MBBS (Hons), FRACGP

Completed her medical degree at the University of New South Wales in 2007 and became a fellow of The Royal Australian College of General Practitioners in 2015.

Jill is a board certified lifestyle medicine physician who is passionate about communicating the importance of lifestyle interventions in the prevention and treatment of her patients.

A summary of the proposed webinar, including learning objectives, timings, content, campaign elements, partners, promotion, and key assets was sent to Hort Innovation for approval (**Appendix 7**). The webinar was titled **“When it comes to vitamin D, two sources are best: a new way to address vitamin D deficiency”**, since the GP guidelines currently recommend that vitamin D deficiency be addressed by either sunlight or supplementation; and diet is not included.

A total of 125 registrations were received prior to the event (versus a target of 80).

### **Activity completed**

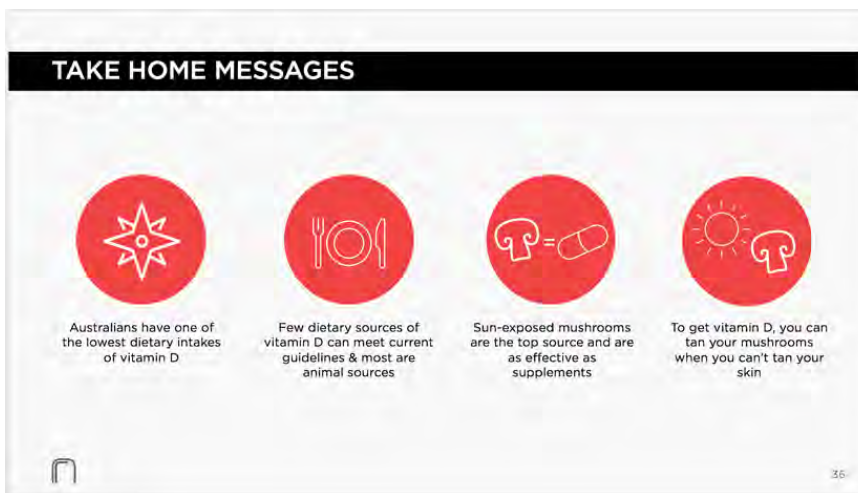
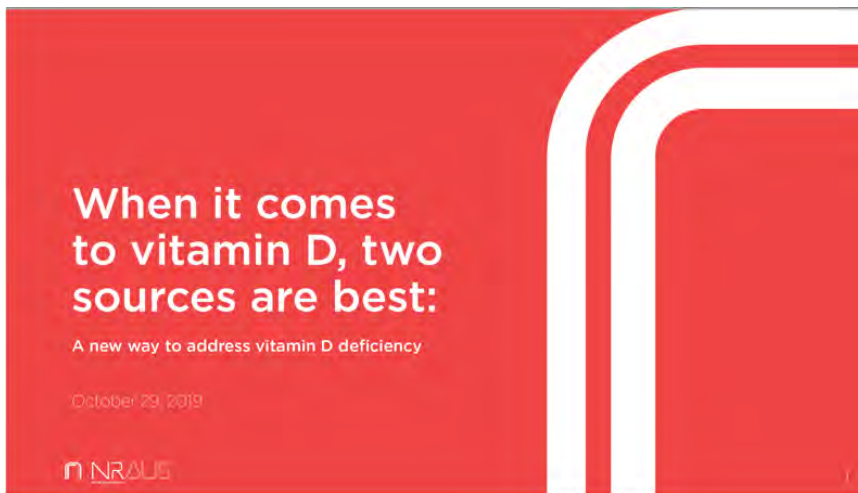
#### **Content development & design**

We utilised extensive evidence to develop the content for the webinar, including the newly developed *A. bisporus* research database and recently published reviews on vitamin D and mushrooms. We also included fun facts that we had developed, and evidence around vitamin D deficiency in Australia to inform the content for the webinar. A novel, practical and evidence-based lifestyle checklist to help GPs and HCPs determine which of their patients are at higher risk of vitamin D deficiency was also created specifically for the webinar.

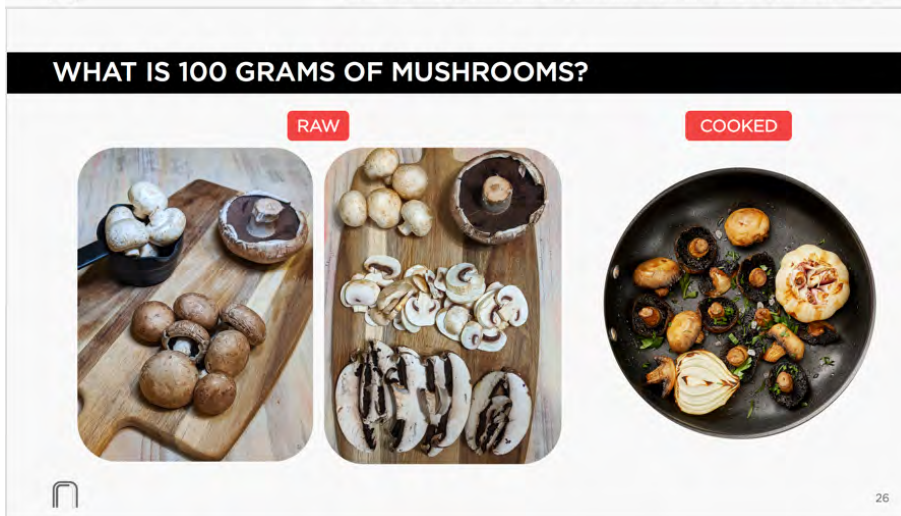
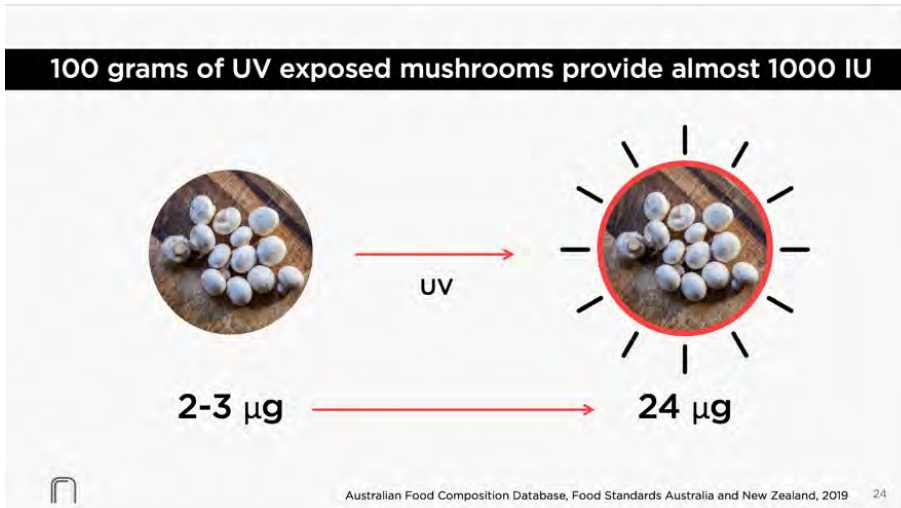
Once the content was developed, we worked with our partner agency HWBK to design a visually appealing and easy to understand presentation, incorporating the bite-sized messaging that we identified as resonating with HCPs in our sentiment research. The presentation (**Appendix 8**) employed iconography and bespoke stock imagery and animations to create a visually striking design. It also included a question and answer slide for the panel discussion to close, and a co-branded call to action slide which directed the audience through to NRAUS and The Australian Mushrooms social and digital channels.



Webinar Slides: October 2019



Additionally, we purchased and weighed three different types of commonly sold *A. bisporus* mushrooms (White button, Swiss brown and Portobello) and took photos (both sliced/unsliced and cooked/uncooked) to be used in the GP webinar, brochure and conference presentation. The purpose of these images was to showcase what a serving of mushrooms looks like, to help make recommendations relatable and visual.



## Webinar promotion

### Newsletter

Pre and post-webinar EDMs were distributed to our HCP database to encourage registration and engagement post event. The pre-event EDM (**Appendix 4**) was created and distributed on 18 October 2019 to the Hort Innovation and NRAUS databases (n=1,301) to drive sign-ups to the webinar. A further reminder EDM was sent in October to ensure attendees remembered to register for the webinar. The EDM featured a brief synopsis of the topic, the timing and logistics for the webinar, a registration button that linked through to the Eventbrite page, and a unique ‘submit a question’ click through button allowing attendees to submit a question for the speakers prior to the event, which were managed via Typeform. The EDM drove 87 direct registrations to the webinar.

The team drafted 10 sample questions for the Q&A panel discussion at the end of the webinar presentation, in the event that there were an insufficient number of questions posed by the audience. The questions were included within the [run sheet](#) as part of the briefing process prior to the webinar. Additional questions will be added to the document during the course of the project.

Two versions of the post-EDM content were created (**Appendix 5a and 5b**): one directed at those who attended the webinar, and one to those who didn’t attend the webinar. Both provided a link to the full webinar recording.

Two emails were curated to send to the HORT Database and NRAUS Database (totalling of 1,221) and to the new registered contacts for the database of 125. These are the interim results and thus far we are achieving above the expected industry standard of 20-25% open rates and 5% click through rate (CTR).

### Partners

We crafted a robust [communications plan](#) targeting GPs both pre and post-webinar. The strategy involved leveraging bespoke static and GIF adverts across high-reaching social platforms including Facebook, Instagram and LinkedIn to drive thought leadership and fuel webinar registrations, backed by three leading industry organisations: RACPG, The ASLM and The Medical Republic. The communications began in mid-October with our

first EDM and boosted social posts, followed by ads across the GP platform websites and newsletters in the lead-up to the webinar.

RAGCP has the strongest reach of audience of any of our external HCP platforms, with a total of 80,000 impressions, and is considered one of the leading sources of industry information for GPs. The Medical Republic, has an audience of 21 000 GPs, and was our second preferred platform, with a new and progressive approach to advertising and a reasonably priced advertising package. The ASLM was a bonus ad-on, and we managed to secure a free webinar advert within the ASLM EDM due to Dr. Flavia Fayet-Moore's existing relationship with the society. We also explored advertising via a number of other HCP channels, including ThinkGP but these were not cost-effective. We explored advertising with the Nutrition Society of Australia, but they failed to respond to our requests and Flavia will personally follow up with the society for the next round of project adverts and promotion.

### Social campaign

Ads were shared to NRAUS' social channels, including Facebook, Instagram and LinkedIn. The look and feel of assets developed was consistent with our branded EDMs. These ads featured Flav's Fun Facts and shared links to directly sign up to the webinar via the Eventbrite page. Supporting pre-webinar ads were shared to LinkedIn, driving 16 visits to the Eventbrite page and 1 registration; and Facebook, fuelling 1,032 visits and 10 registrations.

### NRAUS social ads (LinkedIn, Facebook & Instagram):

#### AD ONE

Nutrition Research Australia  
Sponsored · 🌐

WEBINAR 29 OCT 2019 12.30pm -1:30pm: Nutrition scientist Dr Flávia Fayet-Moore and GP Dr Jill Gamberg will explore new ways to improve the vitamin D status of Australians.

WEBINAR:  
WHEN IT COMES  
TO VITAMIN D,  
TWO SOURCES  
ARE BEST

HTTPS://WWW.EVENTBRITE.COM.AU/  
Vitamin D: Two sources are best

Elizabeth Mirza and others 11 Comments 11 Shares 9.2K Views

#### AD TWO

Nutrition Research Australia  
Sponsored · 🌐

WEBINAR: Did you know that 1 in 4 Australians are vitamin D deficient? Join us to discuss different strategies to improve the vitamin D status of Australians.

STILL CONTAIN 50% OF  
THEIR ORIGINAL VITAMIN D  
CONTENT AFTER 18  
MONTHS?

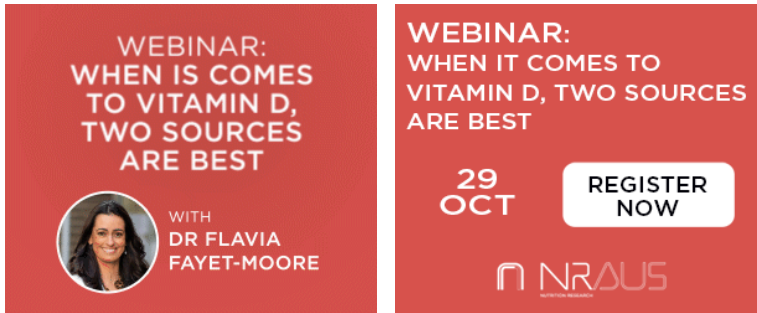
HTTPS://WWW.EVENTBRITE.COM.AU/  
Vitamin D: Two sources are best

Marg Pearce and others 7 Comments 24 Shares 4.3K Views

### The Medical Republic

An advertising package was agreed with The Medical Republic, that consisted of three pre-campaign emails to 21,000 GPs. Static and GIF assets were created to support the promotion of the webinar within The Medical Republic EDMs, distributed across three days, on 23, 25 and 28 of October 2019, as part of the sponsorship package. The combined EDMs resulted in 3,027 unique impressions, 35 ad server clicks and an average click through rate of 0.33%.

**Medical Republic GIF advert– 2 x Transitions**



**Medical Republic static advert**



**RACPG**

Two adverts were designed for the RAGCP website, including the same Medical Republic static and GIF adverts, as well as a leaderboard GIF and static posts, which was housed on the news section of the website from 21 to 28 October 2019. Collectively, these adverts generated 37,000 impressions, 76 individual visits to the Eventbrite page and 10 webinar registrations.

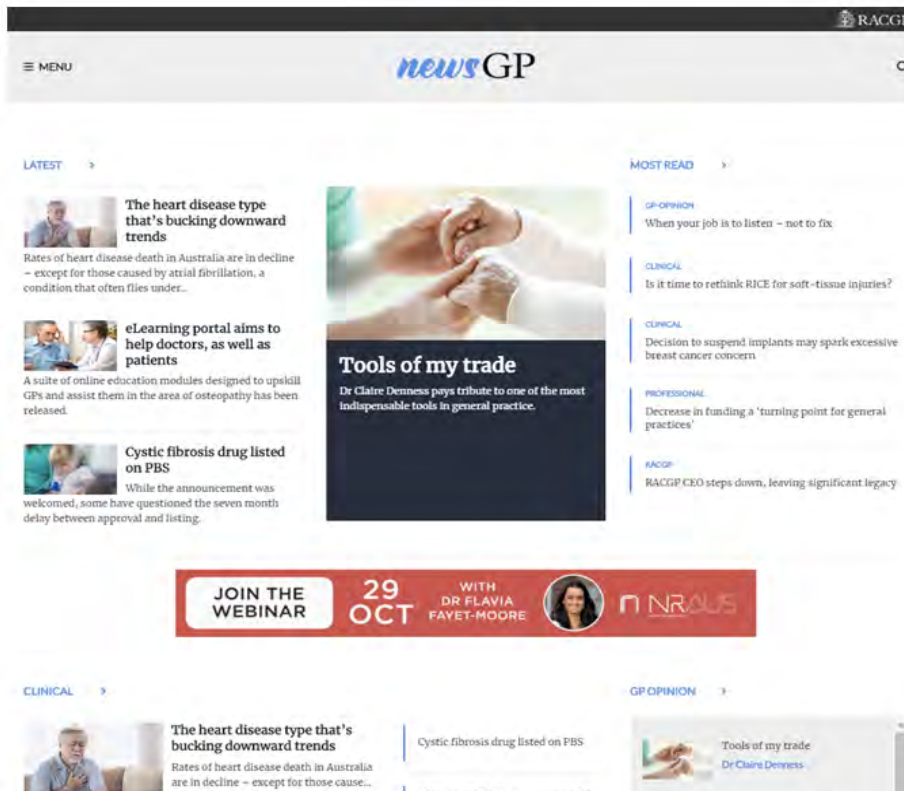
**RACPG Leaderboard GIF – 3 x transitions**



**RACPG Leaderboard static**



RACGP Advert in situ– RAGCP Website



The Australasian Society of Lifestyle Medicine advert

The free advertising secured within ASLM leveraged existing designed assets for their e-newsletter. The EDM was delivered to 8,500 contacts, drove 33 unique page visits, and 5 registrations to the webinar.



Registration

The webinar was hosted via the platform Zoom. An Eventbrite page was set up to capture registration sign-ups, with the contact details added to our growing database. Leveraging the free platform Eventbrite, we created a unique listing page for the webinar to allow HCPs to register to the event and save the date in their diaries. The Eventbrite page included the overarching discussion topic, dial in details to access the Zoom link via different countries, and a co-branded NRAUS and Australian Mushrooms banner to drive recognition of the hosts. Six registrations to the webinar came directly via the Eventbrite free listings. The platform also provided a reminder mechanisms, to notify the registered attendees 24 hours out from the event, to ensure we achieved the best live attendance we could

**WEBINAR:**  
WHEN IT COMES TO VITAMIN D,  
TWO SOURCES ARE BEST

OCT. 29

**Webinar: When it comes to vitamin D, two sources are best**

by Nutrition Research Australia

[Following](#)

Free

Sales Ended [Details](#)

Nutrition scientist Dr Flávia Fayet-Moore and GP Dr Jill Gamberg will explore new ways to improve the vitamin D status of Australians

**Date And Time**

Tue., 29 October 2019  
12:30 pm - 1:30 pm AEDT  
[Add to Calendar](#)

**About this Event**

In this webinar, you'll learn about:

- Pros and cons of different strategies to improve vitamin D status
- How to determine which clients are at risk
- Lifestyle strategies to meet vitamin D needs
- New research on mushrooms and the connection to vitamin D

At the end of the webinar, you'll understand why when it comes to vitamin D, two sources are best.

[JOIN THE WEBINAR](#)

29 OCTOBER FROM 12:30PM -1:30PM AEDT

**Have a question for the panel?**

Submit your questions now on what you would like to know about the latest vitamin D or mushroom research ahead of the webinar.

[SUBMIT YOUR QUESTION](#)

Did you know that Australians spend over \$100 million a year on vitamin D supplements and we have the highest rate of skin cancer globally? Yet, 1 in 4 Aussies are vitamin D deficient.



\* By registering for this event you are subscribing to the Nutrition Research Australia and Australian Mushrooms healthcare professional newsletter. You can unsubscribe at any time.

**Webinar**

To ensure a robust and thorough briefing process for all speakers, attendees and webinar hosts, a comprehensive [run sheet](#) was developed outlining key timings, technical information, logistics, roles and responsibilities and speaker requirements. HWBK ran five separate practice test sessions prior to the webinar, to help ensure that the webinar ran smoothly on the day.

Run Order:

Time	Key Details	Jemma O'Hanlon	Dr. Jill Gamberg	Dr. Flavia Fayet-Moore
10:30 – 12:30 (2 hours)	Webinar testing, final prep  <b>Zoom PUBLIC link:</b> <a href="https://zoom.us/j/147344669">https://zoom.us/j/147344669</a> <b>Final presentation (3x versions):</b> [JH to insert]			
12:25 – 12:30 (5 mins)	Webinar open for participants to join / enter waiting room area	Join Webinar  Unmute	Join Webinar  Mute  Share screen – cover slide	Join Webinar  Mute
12:30 – 12:35 (5 mins)	Webinar introduction – event overview, agenda & housekeeping (how to pose questions etc)	Facilitate webinar intro  Notes <a href="#">here</a>	Move to speaker slide  Mute	Mute
12:35 – 12:50 (15 mins)	<b>Presentation:</b> What is the role of lifestyle medicine in addressing vitamin D deficiency?		Drive presentation	Switch to presentation, share screen.
12:50-12:52 (2 mins)	Presentation Ends	Thank Dr. Jill Gamberg and introduce second speaker, Flavia Fayet-Moore  Notes <a href="#">here</a> .	End share screen  Mute	Switch to presentation, share screen  Unmute
12:52 – 13:15 (25 mins)	<b>Presentation:</b> A whole food approach to meeting vitamin D intakes	Mute	Mute	Drive presentation
13:15 – 13:17 (2 mins)	Presentation Ends	Introduce Q&A panel discussion	Unmute	Unmute
13:17 – 13:27	Live Q&A panel discussion – open to all	Facilitate Q&A. Select		Move to Q&A slide

NRAUS

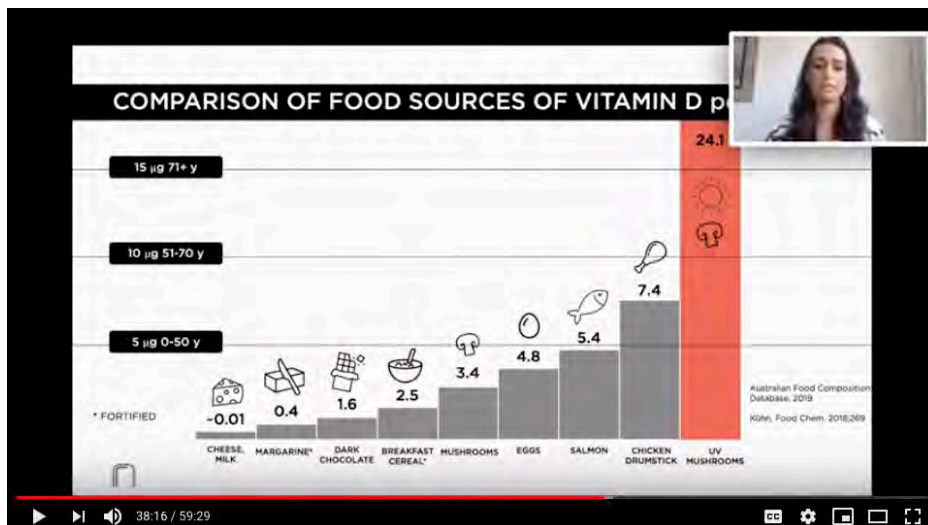
5

The webinar results surpassed the KPIs set, with a total of 125 registrations, 54 unique viewers, 67 total users and 50 concurrent viewers at any one time. The target was 80 registrations and 40 unique viewers.

Post-Webinar

Following the webinar, the Zoom video recording was curated and a HD video was uploaded to [YouTube](#) to host on our digital assets. The video is also hosted on the NRAUS website as a blog piece [<https://www.nraus.com/blog-webinar-vitamind-2019/>].

The presentation was edited with white frames around the speakers faces and the MC. Design work included making the speaker’s box visually appealing, streamlining the content presentation, and zooming in on Flavia when she was showing the mushroom with the ‘gills up’.



In addition to the post-webinar EDMs, the webinar recording is being promoted via a link in the GP brochure and paid social media targeted at HCPs. All questions submitted on the live webinar plus the one question submitted pre-webinar were answered by the NRAUS research team and a copy of the Q&A is on the webinar page (Appendix 9).

A brief 2-minute [feedback survey](#) was designed to understand the value of the webinar and how likely someone would recommend it to a colleague, through a Net Promoter Score.



In the two weeks following the webinar, a series of EDM adverts were distributed via The Medical Republic, backed by post-campaign EDMs to re-engage GPs (who had either attended the webinar or who registered for the webinar but were unable to attend). An advertising package was agreed with The Medical Republic with three post-campaign emails starting on 4 November 2019 to 21,000 GPs. Static and GIF assets were created to support the post-event promotion of the webinar within The Medical Republic EDMs, distributed across three days (Monday, Wednesday and Friday) as part of the sponsorship package.

Further boosted social posts were also developed for Facebook and Instagram. These ads are still running and total reach as of 21 November was 29 766 (**Appendix 3**).

#### Medical Republic Static





### Medical Republic Gif



### Instagram Stories: 2 x Ad types



### Facebook Ads



### Impact

The first EDM on 18 October 2019 was delivered to 1,019 recipients in the Australian Mushrooms database with an open rate of 24.8% and CTR of 16%, while the NRAUS EDM was delivered to 282 recipients with an open rate of 34.4% and CTR of 21% (**Appendix 3**). Both EDMs performed above the industry average for email newsletters within the agriculture and food services industry, at 23.1% open rate and 2.94% CTR. The combined post-campaign EDMs resulted in 8,574 unique impressions, 32 ad server clicks and an average CTR of 0.37%.

Summary of reach and registrations across the seven channels:

- EDM: 87 registrations
- RACGP: 37,000 impressions, 76 visits and 10 regos
- MEDICAL REPUBLIC: 50 visits and 6 registrations
- LINKEDIN: 16 visits and 1 ego
- FACEBOOK: 1,032 visits and 10 registrations
- ASLM: 33 visits and 5 registrations
- EVENTBRITE CHANNEL: 6 registrations

Since posting the webinar on YouTube and running the post advertising campaign we have achieved a total of 645 views on the NRAUS YouTube channel (as of 28 November 2019) and the collective watch time was 73.1 hours. Average watch time per view was 7 mins 18 secs, indicating that the introduction could have been too long. To assist in people accessing the important information first in the video, on the NRAUS website we have created two links, one video is set up to start as Dr Flavia Fayet Moore starts her section on diet and mushrooms and the other starting at the beginning of Dr Jill Gamberg's. We will reconsider the order and introduction to ensure we have the right hooks to keep participants engaged for future webinars.

As of 28 November 2019, the webinar has received 9 completed surveys, achieving a Net promoter Score (NPS) of 100%, with all respondents advising that they would recommend to a colleague, and an average rating of 9.0 out of 10. Qualitative feedback to date includes, "Professionally put together and valuable info, thanks", and "Dr. Flavia Fayet-Moore shares her experiences with such heart and clarity that makes it very engaging and insightful!". The survey will close on 30 November, 2019. There has been positive commentary about the key messages presented on the webinar among key social media influencers, including Nicole Senior and Dr Tim Crowe.



Post on Facebook from dietitian Nicole Senior



Facebook post from Thinking Nutrition (Professor Tim Crowe)

### **Next steps**

To help encourage and better track social commentary, we will create a hashtag for future webinars to follow the impact from social influencers and other HCPs posting on social media. During the webinar design development stage, we identified an opportunity to design an animated storyline with the key messages of the webinar that can be shared via social media and pre-post events, which fits within the current webinar budget. A story board content and design concept has been drafted, and the animation design work will start in December 2019. The story board will be sent to Hort Innovation for approval prior to the design stage.

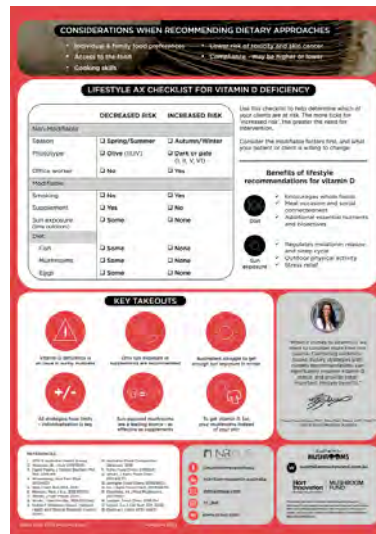
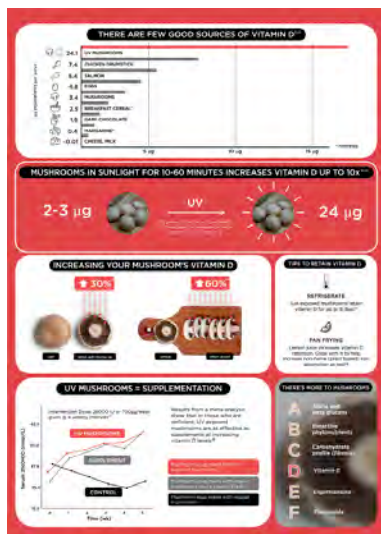
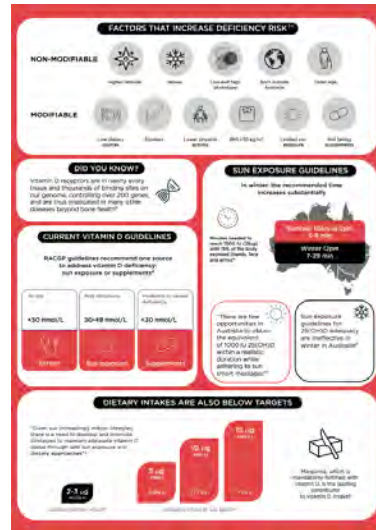
## **MILESTONE 113: BROCHURE – GP**

### **Background**

We developed a bespoke branded four page A4 brochure to bring to life the key findings of the research in bite sized digestible pieces of information, in line with the ASR recommendations (**Appendix 10**). This brochure was produced primarily for GPs at the GPCE conference but designed so that any HCP will find the information easy to understand and can also be distributed at other events and online for HCPs as part of this project.

### **Activity completed**

Webinar content was re-designed and curated for a brochure. In line with global sustainability, we sourced paper for the brochure that was 100% recyclable. The brochures were printed on matte high quality paper and handed out to 200 practitioners at the GPCE conference prior to and following our workshop presentations.



**Impact**

The brochures were extremely popular with GP’s at the GPCE in Melbourne. One GP stood up during the Q&A and said: **“Can I just say, that this is the best brochure I have ever seen. It summarises everything that we need to know in only four pages. Congratulations!”** This was followed by round of applause from the whole keynote room of delegates.

The brochure was also distributed to all registered attendees for the workshop by GPCE as a PDF. We are awaiting the final numbers from GPCE to understand the exact reach.

**Next steps**

Both the hard copy and PDF of the brochures can be shared at all future events with HCP and uploaded online via an EDM created to encourage people to download it. We have sourced an Australian supplier for printing paper made of mushrooms as the source and are investigating this for our future brochures.

**MILESTONE 114: CONFERENCE SYMPOSIUM (GPCE) SPONSOR + SPEAKER**

**Background**

We developed a presentation on vitamin D for GPs at GPCE, held in Melbourne on 15-17 November, 2019. This was to showcase the potential of diet, and specifically mushrooms, in helping to address vitamin D deficiency in Australia.

A detailed proposal was developed by NRAUS and approved by GPCE’s scientific committee to host two 1-hour workshops. This included a workshop featuring Dr. Flavia Fayet-Moore, project leader and technical ambassador for Australian Mushrooms. The workshops were titled: **“Vitamin D Decoded: How can we best address vitamin D deficiency in Australia”**. The sessions provided delegates with an overview on vitamin D, including its importance and the prevalence of deficiency, and gave practical recommendations for GPs to help their patients meet their daily needs (with mushrooms as a key source).

### **Activity completed**

#### Presentation development & slide design

Content for the GPCE workshop was developed based on the proposal submitted to RACPG and repurposing existing content from our webinar. This presentation was much broader and longer than the webinar (50 minutes) and included additional topics not covered by the webinar on vitamin D (including history, testing, metabolism, recent papers published determining how much sun and supplementation is needed, and more). The research was collated and curated to make it clear, concise and practical. The lifestyle assessment checklist developed for the webinar was also utilised for the presentation.

The presentation (**Appendix 11**) was divided into three sections:

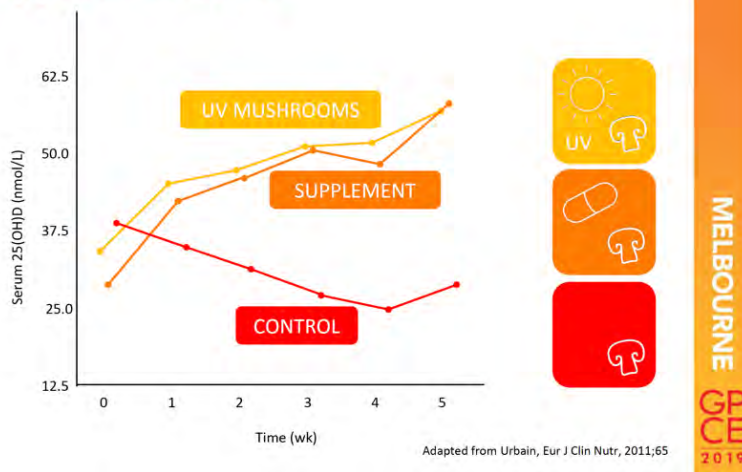
1. Vitamin D: importance, deficiency and risk factors
2. Current guidelines and strategies
3. The role of lifestyle medicine

The conference organisers specified strict guidelines for the presentation template design, which was provided by GPCE and included GPCE branding. We created a visually attractive presentation using iconography and imagery representative of the original webinar presentation that met these guidelines. The presentation utilised simple animations to bring the content to life.

The image shows a presentation slide with a vertical orange banner on the left side. The banner contains the text 'GPCE 2019' at the top, 'MELBOURNE' at the bottom, and '15-17 NOVEMBER' in the middle. The main content of the slide is as follows:

- VITAMIN D DECODED** (Large red heading)
- How can we best address vitamin D deficiency in Australia?** (Sub-heading)
- Flavia Fayet-Moore  
PhD, MNutrDiet, RNutr, APD, FASLM
- NRAUS NUTRITION RESEARCH logo
- Social media and contact information:
  - Facebook: @nutritionresearchaus
  - Instagram: nr\_au
  - LinkedIn: nutrition-research-australia
  - Email: info@nraus.com

## Bioavailability is equivalent to supplementation



### Promotion

We created a branded advert to promote the speaker sessions, and this was inserted into the event guide which was handed out to all GPCE attendees upon arrival at the conference. The advert featured highlights from Flav's Fun Facts and drove HCPs to subscribe to the NRAUS database to be kept updated about the latest research news and activity database, via a unique QR code.

A 90 x 130 cm full colour advert was designed for the GPCE event guide, handed out to all attendees upon entry to the show.

**NRAUS**  
NUTRITION RESEARCH AUSTRALIA

End to End Nutrition Research & Communication

**Vitamin D decoded:  
how can we best address  
Vitamin D deficiency in  
our patients?**

**Dr Flavia Fayet-Moore, CEO**  
Saturday & Sunday  
10:15am - 11:15am

**SUBSCRIBE**  
TO NRAUS FOR THE LATEST  
RESEARCH UPDATES

Australia has one of the highest rates of skin cancer, and almost 1 in 4 Australians have vitamin D deficiency. Scan the QR code above and subscribe to stay up to date with current research projects.

www.nraus.com | © Copyright 2019 Nutrition Research Australia Pty Ltd.

The sessions were also advertised on the [GPCE website](#) and to their database of 1100 delegates registered for the GPCE.

The screenshot shows the GPCE (General Practice Conference & Exhibition) website. At the top, there are logos for GPCE and a 25th Anniversary badge. Navigation links include HOME, ABOUT, SYDNEY, PERTH, BRISBANE, MELBOURNE, and EXHIBIT OR SPONSOR. A 'REGISTER NOW' button is prominent. The main content area features a profile for Dr. Flavia Fayet-Moore, including her photo, bio, and a list of conference sessions. A 'SUBSCRIBE FOR UPDATES' form is also visible, with fields for First Name, Last Name, Email, State, and Ten plus 97, and a 'Subscribe' button.

### Conference presentation

Two 60-minute sessions (50 minute presentation + 10 minute Q&A) were delivered on 16 and 17 November 2019. The NRAUS team on site included: Dr. Flavia Fayet-Moore, CEO of NRAUS, Mr Tim Cassettari, Research & Communications Manager, and Dr Michelle Blumfield, senior nutrition scientist.

Tim introduced Flavia and the lifestyle medicine concept and lead the audience through three lifestyle medicine breaks. During the first break, Tim led delegates to stand and stretch, during the second break they were taken on a journey of long and deep breaths to help destress, and once the presentation finished, they were encouraged to introduce themselves to the person next to them and discuss what they learnt from the presentation. This was then followed by a very integrative and engaging Q&A session, which ran over time on both sessions due to the high interest from delegates. The lifestyle interventions were designed to address sitting as a risk factor for disease, stress reduction and social connectedness- all pillars of lifestyle medicine.

Michelle ensured that each participant entering the workshop received a copy of the brochure and assisted with the Q&A session with microphones and order of questions. The 200 printed brochures were handed out over the two days.

### **Impact**

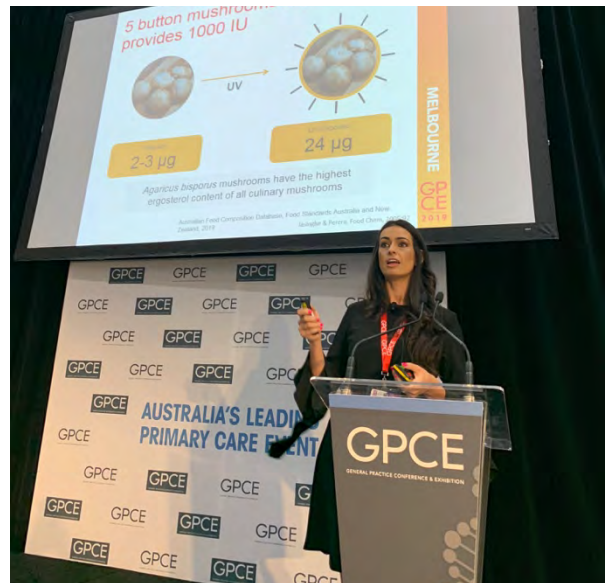
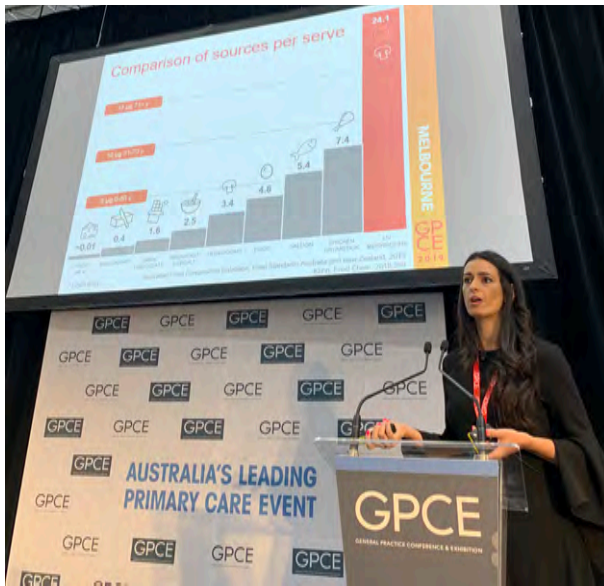
The presentation moved to the 250-capacity keynote room on Saturday due to the high number of registrations received by GPCE for the session. It also ran overtime, due to the high interest from delegates in the Q&A session. 91 delegates attended (head count). Several delegates approached the NRAUS team individually to personally thank us for the presentation, to discuss further questions that they had about it, and if they could obtain a copy of the presentation.

Quotes from delegates:

**“Thank you for your presentation. It was so practical and relevant- it’s the best that I’ve seen in this conference”**

**“I was texting my colleagues from inside the presentation room to get them to come watch it, because it was that good!” (Monica, an exhibitor from Entoura)**

We are currently waiting on GPCE to send us the final numbers of delegates who originally registered for the event.



Dr Flavia Fayet-Moore, CEO of NRAUS presenting at the workshop



Delegates at the Sunday workshop stretching during the session



Tim Cassettari, NRAUS Research & Communications Manager, hosting the lifestyle 'breaks' during the workshop



The Keynote Room



The NRAUS team at GPCE



### **Next steps**

A PDF copy of both the presentation and brochure was sent to GPCE post workshop, which has been distributed to those who registered via GPCE's delegate hub. We are currently awaiting the final number of registrations and the number of members in the delegate hub who have accessed the presentation.

We are also in discussion with ASLM to determine if we can present this at the conference in Melbourne 15-17 May 2020, as Dr Fayet-Moore will be attending the conference and there will be no travel costs incurred. We are assessing the budget as the presentation will need to be re-branded with the NRAUS colours as it has the GPCE branding.

We were also approached by GPCE to present again at their Sydney conference in May 2020, as they were so impressed with the presentation and engagement. Again, we are considering this possibility based on timings and budget.

### **MILESTONE 115: 6 MONTH BENCHMARKING PERFORMANCE REPORT 2**

Completed as per this report. *30 November 2019*

### **MILESTONE 119: DIETITIAN'S UNITE BREAKFAST SEMINAR**

**Dietitians Unite Breakfast 2020 (DU2020):** *October - November 2019*

#### **Background**

We will be hosting a joint breakfast event at Dietitian's Unite, an event run by Dietitian Connection (DC), in partnership with Simplot Australia, and their brands Edgell and Birds Eye. The event will be held on 1 May 2020 instead of March 2020 (date changed by the organisers). The breakfast will focus on culinary nutrition and include practical recommendations for dietitians on how to increase vegetable and mushroom consumption. The breakfast is titled: 'Is Taste the Forgotten Message?'

#### **Activity completed**

We have undertaken additional planning activity to support the event and established rolling monthly planning meetings with Simplot. The general theme of the breakfast will be: 'How do you use veggies and make them taste good?'. Dietitian Connection expects approximately 60 key opinion leaders and 200-240 attendees at the general event. The breakfast will be provided to attendees free of charge, and is provided by DC as part of the sponsorship package. We will work with DC to finalise the menu to include mushrooms as part of the meal. Tables will have cans of Simplot products (i.e. legumes) and fresh mushrooms along with fresh herbs to make it visually appealing. We are currently discussing the provision of a one-page flyer or handout to attendees as well as a recipe booklet which will be part of the Dietitian brochure planning and execution. Simplot will cover the expenses related to the recipe booklet development as they have an in-house recipe booklet development team, photographers and chef. We will also provide the GP brochure and the SLR brochure at the event to maximise messaging.

A master of ceremonies will be provided by DU (to be confirmed). The breakfast will be held for one hour, from 7:30 – 8:30am, with a keynote speaker from Simplot and Dr. Flavia Fayet-Moore from NRAUS followed by a panel Q&A discussion, and a live demonstration by a chef.

The proposed agenda for the session is:

- 7:30-7:40am: Breakfast buffet on arrival, guests serve themselves and be seated
- 7:40-7:45am: MC introduction - 'Why veggies are good for you, we need to eat more' - 2mins
- 7:45-7:55am: Consumer research from lab (by Simplot), barriers to entry and where mushrooms fit in that - 10mins
- 7:55-8:05am: NRAUS scientific research insights from SLR evidence, ways to introduce mushrooms into the diet, practical tips and recommendations- 10mins (presented by Dr Fayet-Moore)
- 8:05-8:10am: Culinary chef demo - 5mins
- 8:10-8:20am: Panel discussion 'Is Taste the Forgotten Message?', Q&A - 10mins
- 8:20-8:30am: Wrap up - 5-10mins

We will look to educate dietitians on how vegetables and mushrooms contribute to healthy living and then inspire them on how vegetables can taste amazing and delight the senses, including aspects of the umami flavour found in mushrooms.

The NRAUS presentation will showcase top line findings on the importance of mushrooms for health, then include fun facts from the research database and practical tips to encourage consumption. We will be placing mushrooms as a unique food group, additional to vegetables, as they have many properties found in animals too. If time permits, we will link to other research on vegetable consumption among Australians that Dr Fayet-Moore has recently published.

During the kick-off meeting with Simplot, we discussed the agenda including inspiration for recipe cards, branding opportunities for the workshop, prospective culinary/nutrition talent, key messaging from the consumer vegetable research conducted by Simplot and a brief look at potential menu items for the breakfast.

As part of the breakfast sponsorship, we will have a stand at the conference, which will be purely branded and managed by NRAUS or Australian Mushrooms as Simplot had no interest in the stand. Brochures and collaterals can be placed here so that all of the conference attendees can obtain a copy.

The proposed culinary talent options being discussed are:

**Miguel Maestre**, Australian chef and Australian Mushrooms ambassador.

Miguel Cascales Maestre is a Spanish-born Australian chef, restaurateur, author and television presenter.

Maestre is best known for presenting TV programmes such as Miguel's Feast, Miguel's Tropical Kitchen and Boys Weekend, and co-hosting the lifestyle television series The Living Room.

Miguel's contract with Australian Mushrooms is currently being reviewed and we are awaiting confirmation from Hort Innovation if he will be available.

**Tawnya Bahr** – Chef, spoke at our recent Food Industry Nutrition Group mtg in Vic & was well received, Sydney based, needs a tight brief

2018 Culinary Advocate of the Year

Tawnya combines her extensive culinary experience and passion for understanding ingredient provenance to support hospitality, food service and corporate clients in achieving success.

Worked 21 years in the food industry as a consultant, chef, owner of a food production and gourmet distribution company and bespoke tour operator, her knowledge of the local and global food landscape is a secret weapon trusted by industry leaders worldwide.

**David White** - Simplot Exec Chef, free of charge and covered by Simplot, but not a draw card. Event back up chef if required as he is a professional, experienced presenter, will look the part in chef's whites.

David White is a Professional Development Chef with over 18 years' experience in product development and 35 years' as a qualified chef.

European qualified as a Master Chef.

Extensive experience in acting as an ambassador for corporate brands, with retailer, QSR and food industry.

**Emma Stirling** – Dietitian, AdvAPD presented culinary Nutrition at DU 2019

Emma Stirling is an advanced accredited practising dietitian, Director of Scoop Nutrition consultancy and a Senior Lecturer at La Trobe University.

Emma specialises in food studies, gastronomy and culinary nutrition. Her research interests including consumer food trends and data analytics.

**Impact**

We will start to workshop potential branding concepts and explore how we can best drive engagement at the event via owned and paid channels. The breakfast session is currently advertised on the [Dietitian Connection website](#).



## PROGRAM

### Breakfast

- **Using microbiome testing to inform and guide personalised nutrition**  
This session, powered by Microba, is for anyone who wants to learn more about what the **gut microbiome** is, how it can **influence health**, and how diet interacts with it. Speakers: Dr Paula Smith-Brown, Accredited Practising Dietitian and Dr Alena Pribyl, Senior Scientist. *Supported by Microba*
- **Taste: the forgotten message to enjoy a variety of vegetables and mushrooms**  
Vegetables are core foods for a healthy eating plan, yet only 1 in 10 Australians eat the recommended Dietary Guidelines of 5 servings each day. And how many Aussies actually **enjoy** their 5 serves of vegies daily? Join us as we explore how **Dietitians & Nutritionists** can **influence culinary nutrition** and entice people to **enjoy food for good health** with key **insights and recipe ideas**. At our morning breakfast event, we'll share the barriers & drivers to **vegetable consumption** for Australians, alongside the latest **scientific research** on the health benefits of mushrooms; and discuss a new approach to utilise culinary nutrition to increase vegetable, legume, and fungi intakes for your clients. You will take home practical food tips and bitesize messages to help you communicate the nutritional benefits of vegies for good health, leveraging taste, food preparation and recipe ideas. *Supported by Birds Eye, Edgell and Australian Mushrooms*

### Next steps

We are exploring the potential to present this at DAA or other conference, as all of the preparations would have been made, budget pending.

## Outputs

### AUDIENCE SENTIMENT RESEARCH REMINDER EDM (Appendix 1)

A reminder EDM for the audience sentiment research was distributed to the NRAUS and Australian Mushrooms database.

**Date sent:** 8 July 2019

**Target audience:** Project database

**Reach:** 1201

### BENCHMARK AUDIENCE SENTIMENT RESEARCH REPORT (Appendix 2)

The first in a series of three audience sentiment research reports was finalised to establish current and changing attitudes and knowledge of health professionals with regards to mushrooms.

**Submitted:** August 2019

**Survey reach:** 49,816

**Surveys completed:** 225

### PRE-WEBINAR EDM: (Appendix 4)

An engaging and informative EDM was developed in line with the content of the webinar, including Flav's Fun Facts, and distributed to our NRAUS database to encourage our audience to register for the webinar.

**Date sent:** 18 October 2019

**Target audience:** Project database

**Reach:** 1301

**SLR NEXT STEPS: (Appendix 6)**

A recommendation for the SLR to be on the health effects of *Agaricus bisporus* mushrooms in humans including its flavonoid and glucan properties.

**Date sent:** September 2019

**AGARICUS BISPORUS RESEARCH DATABASE: (Link here)**

A database of all 500+ research papers on the nutrient and health properties of *Agaricus bisporus* mushrooms.

**Date sent:** September 2019

**Number of research papers:** 501

**WEBINAR PRESENTATION: (Appendix 8)**

A robust and engaging webinar presentation was developed in PowerPoint, in collaboration with Dr. Jill Gamberg discussing the topic of vitamin D deficiency and current guidelines in Australia, with Dr. Flavia Fayet-Moore recommending a whole food approach (mushrooms) to help increase vitamin D intake in patients.

**Date:** 29 October 2019

**Topic presented:** When it comes to vitamin D, two sources are best: a new way to address vitamin D deficiency

**Presenters:** Dr. Jill Gamberg and Dr. Flavia Fayet-Moore

**Target audience:** GPs

**Reach:** 125 registered and 54 unique viewers

**WEBINAR RECORDING: (Links: [YouTube](#) and [NRAUS](#))**

The webinar recording was curated and uploaded as HD to YouTube. The video is also hosted on the NRAUS website as a blog piece.

**Presenters:** Dr. Jill Gamberg and Dr. Flavia Fayet-Moore

**Target audience:** HCPs

**Reach:** 645 views

**POST-WEBINAR EDMS: (Appendix 5a and 5b)**

To further bolster reach and engagement for the webinar, the team developed two post-event EDMs to be distributed via our network of contacts. One e-newsletter was directed specifically towards those who missed the session, meanwhile the other was targeted towards webinar attendees.

**Date:** 20 November 2019

**Target audience:** Project database

**Reach:** 1221

**GPCE PRESENTATION: (Appendix 11)**

A separate presentation was developed in PowerPoint for the GPCE show in November, repurposing existing content from our initial webinar and redesigning some key assets to ensure content felt fresh and engaging. The presentation had to follow the style guidelines requested by the GPCE event organisers so could not align to NRAUS's branded colours.

**Date:** 16 and 17 November 2019

**Location:** Melbourne

**Topic presented:** Vitamin D decoded – how can we best address vitamin D deficiency in our patients?

**Presenters:** Dr. Flavia Fayet-Moore

**Target audience:** GPs

**Reach:** 91

Note: the presentation has been shared as a PDF to workshop registered GPCE delegates.

**GP BROCHURE: (Appendix 10)**

A bespoke branded four page A4 brochure, printed on 100% recyclable paper, that brings to life the key findings of the research in bite sized digestible pieces of information for HCPs to share with clients.

**Date:** Printed on 15 and distributed on 16 and 17 November 2019.

**Target audience:** General Practitioners

**Number printed:** 200

**Number distributed:** 200

**WEBINAR EVALUATION SURVEY** (Link [here](#))

A brief 2-minute feedback survey was designed to understand the value of the webinar and how likely someone would recommend it to a colleague, through a Net Promoter Score (NPS).

**Date sent:** 20 November 2019

**Reach:** 1344

## Outcomes

**Collated the relevant literature to inform campaign key messages**

Completed the first ever systematic literature review on mushrooms, and first ever review on *A. bisporus* specifically. Developed an ongoing research database on every study ever published on *A. bisporus* in the world related to nutrient, health and bioactives.

**Ensure that the first-of-its kind scientific database on *A. bisporus* is kept current:**

As with most projects and SLRs, research stops at the end date of a search strategy. We identified the opportunity to set up an auto-alert using our NutritionIQ service that collates research that fits our SLR search strategy, which is continuously being updated.

**A tailored campaign approach based on sentiment research findings:**

Four key takeaways of the audience sentiment survey were to: focus on bitesize, digestible content; drive traffic to the Australian Mushrooms website; identify opportunities to work with third-party platforms; and to focus on food properties of mushrooms beyond dietary fibre. These results helped inform our campaign: We ensured that the GP webinar, brochure and presentation all had bite-sized information that HCPs could communicate with their clients. We included a link to the Australian Mushrooms website on the GP brochure, on the webinar slide, and ensured that we directed HCPs to the website during the webinar for recipe ideas. We built on existing relationships with other organisations including ASLM and developed new relationships with others including The Medical Republic, GPCE and the RACPG. Our fun facts and campaign messaging focused on nutritional properties of mushrooms beyond dietary fibre, including glucans, vitamin D and ergothioneine.

**A growing database of contacts:**

Our HCP database has grown by 35%, with an additional 352 people added from June to November 2019.

**A growing list of fun facts and key messages:**

Using the research database and SLR research process, we have developed several fun facts and key messages, utilised in the EDMs, social ads, presentations, webinar, brochure, and partner advertising materials.

**Engagement and education via several platforms:**

We have utilised a wide range of engagement and education platforms. This includes multiple EDMs (to promote events, drive the sentiment survey, promote the webinar, and drive responses for the evaluation); social media, communications through with partner organisations; conference workshops; and posts from key opinion leaders as a result of our communications.

**Developed and distributed resources to HCPs, including a brochure on the role of mushrooms for vitamin D:**

The GP brochure has been shared in both print and soft copies, and a PDF copy of the GPCE presentation has been shared with GPCE delegates and the ASLM members. We also developed a novel, practical and evidence-based lifestyle checklist to help GPs and HCPs determine who is a higher risk of vitamin D deficiency, incorporated as part of the GP webinar and the GP brochure.

**Providing credibility for the Australian Mushrooms marketing campaign:**

Using our health claim validation template, we are providing the campaign with evidence-based key messages and ensuring that all current messages are substantiated by science.

**Hosted first-of-its-kind webinar on the importance of vitamin D and mushrooms:**

To effectively kick-start our communications campaign, we delivered a best-in-class webinar with two key opinion leaders in this space, setting a precedent for future communications from NRAUS and Australian Mushrooms. This is recorded and available online.

**Built upon existing relationships with HCPs:**

The newly created series of EDMs driving webinar messaging, combined with external advertising across third party platforms including the RAGCP, The Australian Society of Lifestyle Medicine and The Medical Republic, helped to build credibility outside of our core network of contacts and reach new audiences.

**Identified opportunities to present and distribute information beyond what was agreed in the project plan:**

Two executive members of the ALSM were at the GPCE workshop and requested that we present it at the ASLM May 2020 conference. GPCE has also contacted us to see if we can present again at the Sydney 2020 conference. We are currently investigating these opportunities to see if it can fit within our project budget. The ASLM project coordinator also requested a copy of the GPCE presentation and GP brochure to be shared with ASLM members as an educational resource.

## Intellectual property, commercialisation and confidentiality

No project IP, project outputs, commercialisation or confidentiality issues to report.

## Issues and risks

**Campaign Risk Register** - The risks register for this project can be viewed [here](#).

The below identified risks have been managed and all outputs as per the contractual agreement for year one have been met, with the exception of the SLR summary document which is underway and will be delivered in early 2020. None of our outputs have been impacted by the delay in the SLR, and our outputs and events for years two and three have not been affected.

**SLR Timelines**

As previously described, the SLR timeline estimates were dependent on the final number of papers found. A total of 501 papers met our inclusion criteria and given most SLRs typically include 20-30 papers, we needed to make a decision on a smaller SLR to pursue. A decision was made after discussion with Hort Innovation, and the SLR is now completed, with the manuscript on track to be submitted according to the original timelines.

Despite the delay, none of year one outputs were affected as we managed the risk and developed a plan for content development for the webinar, brochure and conference. We now also have an incredibly valuable research database of 500+ papers beyond what will be included in the SLR, that we can use to inform the rest of the project's outputs.

**Webinar Platform Hosting**

When we initially investigated hosting partners for the webinar, we explored opportunities with key GP platforms including Think GP, the RAGCP and The Australian Medical Association (AMA). Associated costs were out of scope, and so we agreed to host the webinar ourselves and supported with advertising in other formats including within the newsletters and website of The Medical Republic, ASLM and RAGCP.

**Working with third party promoters**

We had originally intended to work with Nutrition Society Australia (NSA) as part of the webinar promotional activity. Unfortunately, the team there were unresponsive and due to limited resource and an urgency to work through the webinar presentation content and other external advertising platforms, we were unable to secure an advert with NSA.

**Post-Webinar EDMs**

Due to design hold-ups, coupled with limited team resource and a collective decision to hold on distribution of the post-webinar EDMs until closer to GPCE (to be able to promote our sessions at the event), the EDMs were sent out three weeks after the webinar. In future, the post-campaign EDMs should be delivered no more than a week after the event to maximise engagement while the content is still timely and relevant.

#### **GPCE Conference Filming**

The team explored costs for filming the presentation session with the conference organiser, but this did not fit within the confines of the project budget scoped. It is important moving forward that we explore how we can capture or negotiate for filming of any talks or workshops within the budget outlined by the event organiser.

#### **GPCE Conference Brochure & Review Timings**

When we explored the GPCE sponsorship package options, we initially proposed producing 1,100 additional GP brochures, which were due to be inserted into the event satchels provided to all attendees upon arrival. Due to delays with artwork sign off and a backlog of campaign activity (including the webinar and GPCE presentation development) however, the printing and delivery of these brochures was not possible within the final provided deadline. As a result, we will now leverage the budget saved here to support a presentation at ASLM in 2020.

For the next conference or event, we will map in an additional three weeks to support design reviews and a robust final round of approval, so that artwork can be dispatched in time for any satchel inserts. Moving forward, all efforts will also be made to ensure Hort Innovation has one week minimum for material reviews – something which was not provided for the GPCE brochure and will be rectified.

To support this, NRAUS and HWBK have also formalised a refreshed briefing process for more complex design work to support this. This will kick off with a completed design brief to be provided by NRAUS via email (soft copy version), followed by a verbal briefing with the team over the phone or video call to ensure that HWBK has a sufficient understanding of the requirements involved and can raise any questions early. Once design work has commenced, no edits should be made to detailed visuals (e.g. graphs, infographics or complex imagery) or copy, as this will incur additional delays in finalising the design work.

## **Other information**

Nutrition Research Australia (NRAUS) has rebranded since the last report, with a new logo, imagery and [website](#).

NRAUS also has a new team member currently working on this project: Dr. Michelle Blumfield. Michelle Blumfield, BSc (Hons), PhD, is an Accredited Practising Dietitian with over 10 years' experience.

## Milestone Report

Project title:

# Educating healthcare professionals about Australian mushrooms

Project code:

MU 17002

Milestone number:

MS104

Project leader:

Dr Flávia Fayet-Moore

Delivery partner:

Nutrition Research Australia Pty Ltd (NRAUS)

Report author:

Dr Flávia Fayet-Moore

Milestone due date:

End June 2020

Submission date:

30 June 2020

Confidentiality:

Is this report confidential?

No

Yes (whole report)

Yes (sections of report are confidential)

If sections of the report are confidential, list them here:



**Milestone description:**

6 Month Benchmarking Performance Report 3

**Milestone achievement criteria:**

MS102, MS104 – in progress

MS103 – completed

MS104 – postponed

Milestone	Achievement Criteria
MS102	Technical and scientific support for the Australian Mushrooms campaign
MS102	Periodic comms program - planning, liaison, integration & content development
MS102	SLR Draft and SLR key points document
MS103	SLR Brochure
MS103	SLR Manuscript Submission
MS104	Dietitian’s Unite - Breakfast Seminar
MS104	Brochure - Dietitian
MS104	6-month Report 3
MS104	Audience Sentiment Research 2
MS104	Small Sydney Expert Roundtable

**Funding statement:**

**Levy funds – R&D projects**

This project has been funded by Hort Innovation, using the Mushroom Fund research and development levy and contributions from the Australian Government. Hort Innovation is the grower-owned, not-for-profit research and development corporation for Australian horticulture.

## General project overview

Despite the unique nutritional properties of mushrooms, there is currently a lack of knowledge on their nutritional and health benefits among healthcare professionals (HCPs). The objective of this three-year project is to conduct original research on the health benefits of mushrooms and then educate health professionals about its key findings, supporting the wider industry objective of increasing the overall consumption of mushrooms in Australia.

## Summary

The key theme of the project’s second year is to hero the unique nutritional properties of mushrooms: that they are not a plant nor an animal; yet contain nutritional properties from both. The messaging underpinning this theme was informed by the systematic literature review (SLR).

The SLR is a robust scientific paper that, for the first time, systematically investigated the nutritional and health properties of the world’s most popular mushroom, *Agaricus bisporus*. It was accepted for publication in June 2020

in *The Journal of Nutritional Biochemistry*, a leading and highly impactful journal in the field of nutrition research. The SLR included a total of 68 articles, with 15 reporting the effect of mushroom consumption on human health. Of these 15 articles, *A. Bisporus* was associated with seven different health benefits. The strongest evidence was for UV-exposed mushrooms increasing a person's vitamin D levels, where the effect was equivalent to taking a vitamin D supplement. Evidence also suggested that *A. bisporus* may reduce inflammation and cancer risk, and improve cardiometabolic health, immunity, gut health and satiety. The remaining 53 articles reported the amount of key bioactive compounds that are unique to many other foods: beta-glucans, ergosterol, ergothioneine, vitamin D, chitin and antioxidants usually reported as flavonoids. The amount of these nutrients may explain the health benefits of *A. Bisporis*, and were shown to differ depending on the type of *A. Bisporus* (white button vs. Portobello), part (stem vs. cap) and cooking method used.

A SLR key points document was developed to provide a plain language summary of key findings from the SLR for stakeholders, including recommendations for future research. An eight-page brochure summarising the key findings from the SLR in bite-sized messaging has also been developed for healthcare professionals. Our specialised NUTRITIONiQ service has also been applied to ensure that the research database developed from the SLR remains up to date as new research is published.

Using the scientific findings from the SLR, counsel was provided to ensure that previous nutritional claims made on the Australian Mushrooms website are current and remain scientific substantiated. Every nutrition claim on the website was reviewed, with 26 of 82 identified claims not having scientific substantiation according to recent science. A further 31 claims were scientifically accurate but required additional referencing or rewording. Alternative wording for these claims were provided. Opportunities for new claims based on the SLR research, which were not listed on the website, were also presented in the 'Dr Flav's Fun Facts' document. This document lists 48 evidenced-based facts that can be used to inform current and future communication activities for both HCPs and to support the Australian Mushrooms marketing campaign.

To extend on the research insights from Year 1, which showcased the role of UV-exposed mushrooms in both preventing and reversing vitamin D deficiency, an article was published in the Medical Journal of Australia (MJA) Insight online newsletter. The article encouraged HCPs help their clients to increase vitamin D status by advising them to, "tan your mushrooms, not your skin". A 2-minute animated video was also created to summarise the science of UV-exposed mushrooms increasing vitamin D status and was communicated on social media. The animation achieved a total of 93,035 video plays (as of 11 June 2020; KPI: 15,000), with 699 people watching the video in full. Two electronic direct mails (EDMs) were also been developed to communicate these assets to the HCP database.

Social distancing restrictions due to COVID-19 have unfortunately impacted some of the major timelines in 2020. The Dietitians Unite breakfast event, originally scheduled for 1<sup>st</sup> May 2020, was initially postponed by the organisers to 26<sup>th</sup> October 2020, with a further postponement announced in June 2020 moving it to 21<sup>st</sup> May 2021. The Audience Sentiment Report 2 was also rescheduled as a consequent of this postponement (Initial date: end Aug 2020; Revised date: end Jan 2021) to ensure that data are captured after HCPs have seen the educational campaign (via the event). Work continues on these activities, as well as communications of the SLR manuscript and brochure and planning of the expert roundtable, which are scheduled for the second half of 2020.

## Achievements

### MILESTONE 102: TECHNICAL AND SCIENTIFIC SUPPORT FOR THE AUSTRALIAN MUSHROOMS CAMPAIGN

#### 1. Australian Mushrooms Website Content: April 2020

##### **Background**

The Australian Mushrooms website ([www.australianmushrooms.com.au](http://www.australianmushrooms.com.au)) houses a large number of nutritional claims about mushrooms. A review of these claims was conducted for scientific accuracy.

##### **Activity completed**

A report with three additional documents were prepared (**Appendix 1**):

- (1) An assessment of all nutrient and health claims made on the website related to mushrooms. This included the wording of the current claim; its categorisation as a nutrient or health claim; an assessment as to whether the claim had scientific substantiation; and, where claims did not have scientific substantiation or could be improved, both the rationale for this assessment and the recommended wording to use as an alternative.
- (2) A word document with the website copy and references updated, based on the assessment and recommended alternative wording. The website copy was also reviewed and updated for grammar, flow and readability. All changes were made as tracked changes to highlight the location of copy changes.
- (3) A clean version of (2) with all track changes accepted.

### **Impact**

Eighty-two nutritional claims were identified on the Australian Mushrooms website. Twenty-six claims were deemed to lack a robust scientific substantiation, and 31 claims were considered scientifically accurate but recommended to incorporate additional referencing or to be reworded for reasons other than scientific accuracy.

A number of additional claims were identified while researching the SLR that were not currently listed on the website. These claims have been summarised in the 'Dr Flav's Fun Facts' document and may be considered as additional claims for the website.

## **2. Dr Flav's Fun Facts: April 2020**

### **Background**

During the research process for the SLR, interesting research insights ('fun facts') that had potential as stand-alone communication messages were identified. The 'Dr Flav's Fun Facts' document was updated throughout the SLR research process, which spanned more than 5000 articles.

### **Activity completed**

The document includes 48 unique fun facts spanning the following 15 topics (**Appendix 2**):

- Nutrient composition
- Prebiotics
- Glucans and chitin
- Ergothioneine
- Ergosterol
- Polyphenols
- Vitamin D
- Metabolic markers
- Immune system
- Satiety
- Cancer
- Patterns of consumption
- Cooking
- Culinary applications
- Other

Each fun fact was supported by a brief scientific description of the fun fact, other information that should be considered with its use, and a reference(s). Examples of fun facts from this document are listed below.

1. **World's top pick:** *Agaricus bisporus* is the world's most commonly consumed mushroom.
2. **A natural innovator:** Unlike plants, mushrooms lack chlorophyll and obtain sustenance from complex organic materials of plants and animals.
3. **Three of the same:** Button, cup and flat mushrooms all come from the same mushroom, just left longer to grow!
4. **Nutrition allrounder:** Mushrooms not only provide nutrients found in fruit and vegetables, but also those found in meat and grains too.
5. **Beta-ful on the inside:** The cell wall of mushrooms consists of the soluble fibre beta-glucan.
6. **The special sterol:** While animal foods contain cholesterol, mushrooms contain a unique sterol called ergosterol, that converts to Vitamin D when exposed to light.
7. **A true whole food:** While the 'cap' of mushrooms is a richer source of antioxidants, its stem contains more of the soluble fibre beta-glucan.
8. **Putting the one in ergothioneine:** Mushrooms contain more ergothioneine: a unique sulphur-containing antioxidant – than any other food.
9. **Devoted to vitamin D:** The vitamin D content of dried mushrooms is still 50% of its original value after 18 months.
10. **Tan those mushies:** Place your mushrooms in the sun gills side up to increase their vitamin D content by up to 30%.
11. **Vitamin D all week:** Sunlight-exposed mushrooms can retain vitamin D in the fridge for up to 8 days.
12. **Squeeze it to keep it:** Adding lemon juice to your mushrooms before cooking can help to increase their vitamin D retention.
13. **Peerless prebiotic:** Mushrooms contain chitin, a unique prebiotic fibre that's not found in fruits, vegetables or grains.
14. **Nature's supplement:** UV-exposed mushrooms can be as effective as a vitamin D supplement for increasing vitamin D.
15. **Tan your mushrooms:** In the sun for 15 mins can provide you with your daily vitamin D needs.
16. **Your gut bacteria loves them:** Mushrooms contain special prebiotics which can act like catnip for your flora.
17. **Fill up with fungi:** Mushrooms have been shown to help reduce hunger and increase fullness compared to a protein-matched beef meal.
18. **Looking to eat less meat?** Adding mushrooms to your meals can help to provide a unique umami (or savoury) flavor and maintain a meaty texture.
19. **Cooking tip:** Cook over low temperature to retain antioxidant content

### **Impact**

The fun facts may be of use for both HCP and consumer messaging as support for the Australian Mushrooms marketing campaign. They have already been utilised in a large number of HCP channels over the course of the project, including social media posts, the GP webinar presentation, the GP brochure, EDMs, partner advertising materials, and the SLR brochure.

Prior to using the facts use with consumers, we have asked to be notified so that we can ensure their scientific accuracy for public use.

**Dr Flav's Fun Facts – examples included in an EDM: April 2020**



**MILESTONE 102: PERIODIC COMMS PROGRAM – PLANNING, LIAISON, INTEGRATION & CONTENT DEVELOPMENT**

**1. Building the database of HCPs for Australian Mushrooms: Ongoing**

The HCP database is a key channel for communicating information and promoting events throughout the project. The total number of people on the database is 1467 subscribers, a 34.4% increase from the start of the campaign. The HCP database has largely remained flat since the previous report (30 November 2019), with eight new subscribers and 14 unsubscribes giving a net total of six fewer people on the database.

The lack of new subscribers over the previous six months is a direct consequence of event cancellations due to the COVID-19 social restrictions, as these communication and events have a direct call to action to subscribe. We anticipate the database to return to growth following upcoming communications events, including proactive communications around the SLR, the expert roundtable, and the Dietitians Unite event.

A complete summary of the data from all our digital activity are provided in **Appendix 3**.

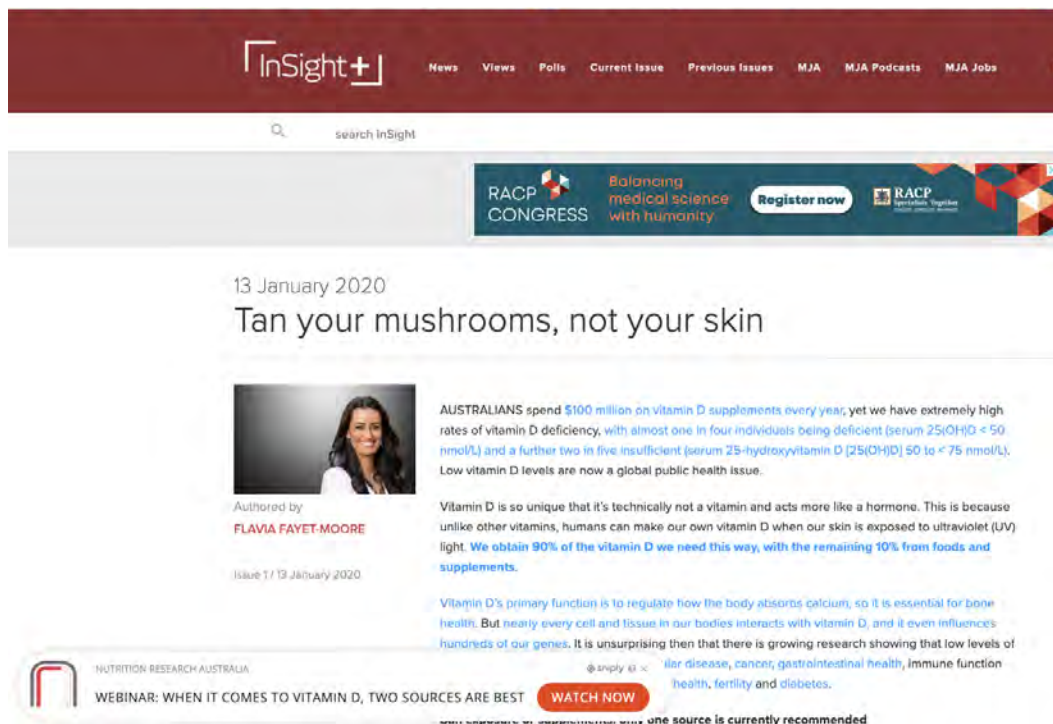
**2. Medical Journal of Australia (MJA) InSight+ article: January 2020**

MJA InSight+, produced by the Medical Journal of Australia, is a newsletter of key developments and research in health and medicine for clinicians.

Using the NRAUS network of stakeholders, we contacted the MJA InSight editor and the editor was extremely interested in having an article written. Based on the research insights of the important role that UV-exposed mushrooms can have for preventing and reversing vitamin D deficiency from Year One of the campaign, a 1400-word article titled 'Tan your mushrooms, not your skin' was written and published in MJA InSight+. The article extends to a wider audience of clinicians on the important role that mushrooms exposed to sunlight has in helping people to improve vitamin D intake and status, and included limitations with supplements and sunlight, the role of diet and in particular UV-exposed mushrooms, and evidenced-based tips for tanning your mushrooms.

The Medical Journal of Australia InSight+ article can be viewed here: <https://insightplus.mja.com.au/2020/1/tan-your-mushrooms-not-your-skin/>

MJA Insight article: January 2020

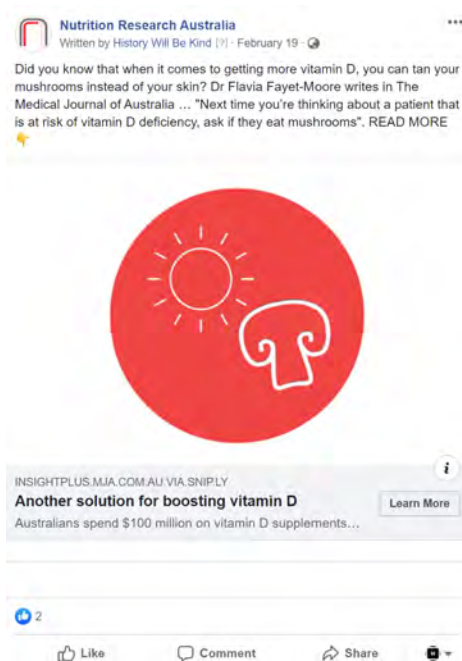


Positive commentary from readers was received on the article, including:

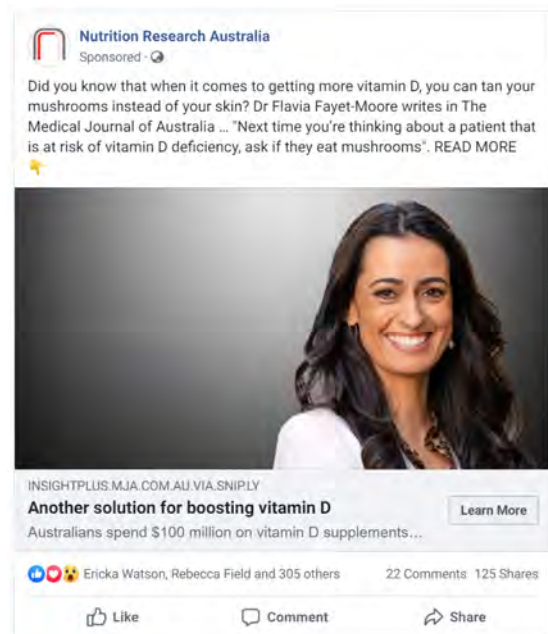
- “What a great and easy idea! Thank you!”
- “Very interesting findings & with an easy solution for those with low Vit D levels.”
- “This is fascinating! Thanks.”

The MJA InSight+ article was promoted to HCPs through a targeted social media strategy. The spend was primarily via Facebook, with some very small Instagram advertising as well. Two variations of the creative were run against each other to determine which performed best, one with an image of Dr Flavia Fayet-Moore and the other with an illustrated image. After a short test period, the first variation resonated most strongly with audiences and generated the most traction and was left to run solo for the remainder of the campaign. The social media posts linked directly to the MJA InSight+ article, with an overlaying a sniply link was also created within the MJA InSight+ article, as a further call-to-action for readers to click through to watch the ‘Two sources are best’ webinar.

### Facebook Ad One



### Facebook Ad Two



From these ads, the article had a click through rate of 16.8% (vs. industry standard: 3-5%) and reached a total of 29 312 people (vs. KPI: 20 000). A summary of the reach from the paid MJA InSight+ article campaign (February 2020) is below:

- Link clicks: 2,820
- Total reach: 29,312 people (KPI: 20k)
- Total impressions: 43,104
- CTR (Link Click-Through-Rate): 16.82% (Industry standard 3 – 5%)
- Cost per result: \$0.18 (KPI: \$0.60)

The article also informed a media release for the general public, which was written by Hort Innovation and included quotes from Dr Flavia Fayet-Moore. The article was an add-on to the scheduled activities agreed at the start of the campaign.

### 3. *Vitamin D animated video*: March 2020

To help share the research insights uncovered in Year One of the campaign about mushrooms and vitamin D further, a 2-minute animated video was created for social media. The animation was another add-on to the scheduled activities agreed at the start of the campaign, using graphics already developed in last year's successful webinar. The vitamin D animation sets up the unique vitamin D problem in Australia with a call to action to consume UV-exposed mushrooms to increase vitamin D intake, and can be viewed here:

<https://www.youtube.com/watch?v=vlzdKx3g-Bo&amp=&feature=youtu.be>

A targeted communications strategy was developed to communicate the animated video to the HCP community. This included an EDM, Facebook video placement using a dark campaign (i.e. only seen by target audiences) and uploading the video to the Nutrition Research Australia (NRAUS) website.

A total of 93,035 video plays has been recorded (as of 11 June 2020; KPI: 15,000), with an average watch time per person of 0:09 seconds. A total of 699 people viewed the whole 2:09 minute video in full (vs. industry average: 3 seconds). The animation is available to be used on other platforms, presentations and events.

The total Facebook engagements were 100 likes, 19 comments, 23 post saves and 71 post shares.

Facebook Ad

**Nutrition Research Australia**  
Sponsored

Are your clients spending more time inside lately? The good news is that it is still easy for you to help them to meet their daily needs of vitamin D! Watch our practical step-by-step guide on how mushrooms can be transformed into a rich vitamin D source! 🍄

**10 - 15 MIN**

NRAUS.COM  
**How to get more Vitamin D while indoors with this Fun-gi!** [Learn More](#)

Like Comment Share

NRAUS Blog Page

**NRAUS**  
NUTRITION RESEARCH AUSTRALIA

Your Ultimate 2 mins Guide to Tanning your Mushrooms

Learn how to get more Vitamin D while living indoors with this Fun-gi!

Feel like you're stuck indoors? This is now the reality for almost all of us, and unfortunately one of the consequences is that it will have a direct impact on our ability to obtain vitamin D. What's more, winter is not too far away, meaning limited sun exposure for months to come. The good news is that you can still easily get your daily vitamin D needs, and we've created your ultimate, evidence-based video to show you how. It's a fun and practical step-by-step guide on how to transform your mushrooms into a rich vitamin D source! What's more, you can do all of this from the comforts of your own home:

- In your backyard
- On your balcony
- On your windowsill (with the window open)

**E**  
**ERGOTHIONEINE**

By [NRAUS](#) · 1 Apr 2nd 2021 | [100+ views](#) | [0 Comments](#)

Share This Story, Choose Your Platform!

Facebook comments

**Anna Matthews** A very informative video. So glad that I love eating mushrooms.  
Like · Reply · 4w

**Author**  
**Nutrition Research Australia** Anna Matthews We're glad you found the video informative. We love sharing the mushroom love!  
Like · Reply · Commented on by [Kylie Abbott](#) [?] · 4w

**Nola Watt** Love mushrooms  
Like · Reply · 4w

**Author**  
**Nutrition Research Australia** Thanks Nola, we ❤️ them too!  
Like · Reply · Commented on by [Kylie Abbott](#) [?] · 4w

**Karen Sanders** That's wonderful, not being a meat eater i have grown to actually like mushrooms!  
Like · Reply · 4w

**Author**  
**Nutrition Research Australia** Now there's even more to like about mushrooms! 🍄🍄  
Like · Reply · Commented on by [Kylie Abbott](#) [?] · 4w

[View 1 more reply](#)

**Carol Dunbar** Thanks for your info I love mushrooms 🍄  
Like · Reply · 4w

**Author**  
**Nutrition Research Australia** Carol Dunbar You're welcome!! And thank you for watching 🍄  
Like · Reply · Commented on by [Kylie Abbott](#) [?] · 4w

**Silvio Fontana** Mushrooms, a high fodmap food  
Like · Reply · 4w

**Author**  
**Nutrition Research Australia** Silvio Fontana True, some mushrooms can be high in polyols, which could trigger symptoms in someone needing a low FODMAP diet. The good news for mushroom lovers is a 75g serve of Oyster Mushrooms have been tested and rated as a low FODMAP food by Monash University  
Like · Reply · Commented on by [Kylie Abbott](#) [?] · 4w

[View 2 more replies](#)

**Jennifer Creighton** Excellent  
Like · Reply · 4w

**Alma McHugh** Interesting love them  
Like · Reply · 4w

**Author**  
**Nutrition Research Australia** We think that 🍄 are super interesting (and tasty!) as well!  
Like · Reply · Commented on by [Kylie Abbott](#) [?] · 4w



4. **Industry Update and Grower's Newsletter:** December 2019 and April 2020

A presentation was developed for the December 2019 SIAP meeting to inform key stakeholders on the project progress (**Appendix 4**), with Dr. Flavia Fayet-Moore presenting this update in Sydney.

An update on the project was also provided in April 2020 for Issue 2 of the 2020 grower's newsletter via Chris Rowley.

5. **EDMs:** Ongoing

Two EDMs were developed and sent to the HCP database:

**Year in review EDM:** February 2020

The *Year in review* EDM (**Appendix 5**) provided a summary of the key findings and outputs developed on mushrooms and vitamin D throughout 2019. This included:

- (1) A snapshot of the key research insights,
- (2) The new educational resource, *A whole food, lifestyle approach to addressing vitamin D deficiency*, that summarised the key research highlights on mushrooms and vitamin D,
- (3) The webinar, *When it comes to vitamin D, two sources are best*,
- (4) The hot-off-the-press article in MJA Insight, *Tan your mushrooms, and not your skin*,
- (5) An update on the first-of-its-kind systematic review on the health effect of mushrooms,
- (6) Key insights on mushroom attitudes and knowledge among HCPs, taken from the 2019 Audience Sentiment Research Survey, and
- (7) An invitation to register to the Dietitians Unite breakfast event.

The EDM was sent to 1372 recipients, with 497 recipients opening the email (36% open rate vs. industry average of 20 – 25%). Sixty-eight recipients clicked a link that took them to either the new educational resource, the MJA Insight article or the webinar.

Year in Review EDM: January 2020

**MUSHROOMS AND VITAMIN D UPDATE**  
NEW RESEARCH ON AUSTRALIAN MUSHROOMS

Hello,

What a year!

In 2019, we were hard at work researching all things vitamin D, and mushroom's unique role as the *champignon* source of this important vitamin.

In case you missed it, here's a recap of our key research insights:

- Almost 1 in 4 Aussies are vitamin D deficient, with a further 43% insufficient.
- Like in our skin, it only takes 10-15 minutes of sunlight for your mushrooms to produce almost 1000IU of vitamin D.
- Slicing your mushrooms before putting them in the sun, or placing them with the underside ("gills") up, can increase production of vitamin D by up to a whopping 60%!
- Mushrooms exposed to sunlight are as effective as a vitamin D pill at increasing blood levels of the vitamin, especially in those who are vitamin D deficient (many of us!).

In this newsletter, we're excited to bring you more details on that research, including a **brand new educational resource**, a webinar on why **when it comes to vitamin D, two sources are best**, and a hot-off-the-press article in *MJA InSight* on why you should **tan your mushrooms**, and not your skin.

We've also got exciting updates for you on the first of its kind **review on the health effect of mushrooms**, and some key insights from **healthcare professionals** on what they think about mushrooms.

Thank you for your continued support, and stayed tuned for some exciting things that we have planned for 2020!

Best wishes,

**Dr Flavia Fayet-Moore**  
CEO  
Nutrition Research Australia

**Free Brochure: A whole food, lifestyle approach to addressing vitamin D deficiency**

We've developed a brand new educational resource that summarises the key research highlights on mushrooms and vitamin D. It even includes a checklist for assessing the risk of vitamin D deficiency in your clients!

[DOWNLOAD BROCHURE](#)

**Tan Your Mushrooms and Not Your Skin**

Don't have time for the webinar? Not to worry. This recently published *MJA InSight* article by Dr Flavia Fayet-Moore, unpacks the limitations with current vitamin D recommendations, and explains why "tanned" mushrooms are the star vitamin D food.

[READ NOW](#)

**Webinar: When it comes to Vitamin D, Two Sources are Best**

Dr Flavia Fayet-Moore and GP Dr Jill Gamburg explore the role of diet in meeting vitamin D needs. It contains practical, evidenced-based tips for boosting your client's vitamin D intake, including the often forgotten about source

[WATCH HERE](#)

**Review on Agaricus Bisporus (your common mushroom) and Health**

We're putting the finishing touches on the first-of-its-kind systematic review on the health effects of *Agaricus bisporus* mushrooms in humans, which will soon be submitted for publication. Informed by over 60 studies, it also contains some interesting facts about the bioactive compounds in mushrooms. We'll be releasing a brochure summarising its key findings in May 2020 and you'll be amongst the very first to receive it!

**What's coming up?**

**1 May 2020, Melbourne**  
**Breakfast Event @ Dietitians Unite**

In this co-hosted workshop with Simplot, you'll hear all about the importance of culinary nutrition in helping clients consume more vegetables - and mushrooms!

You'll learn about:

- **Our new scientific research** on the health benefits of mushrooms
- **How to utilise culinary nutrition** to increase vegetable, legume, and fungi intakes for your clients, and
- **Key barriers & drivers** to vegetable consumption.

And there'll even be a **chef's demonstration**, putting it all into practice!

[REGISTER](#)

**What do healthcare professionals know about Australian Mushrooms?**

We conducted a survey of 225 healthcare professionals to understand their knowledge of mushrooms and if they recommend them to their patients.

**81% of those we surveyed enjoyed mushrooms at least once a week, yet 75% could not specify their key nutritional properties and only 31% who see clients or patients regularly recommended them.**

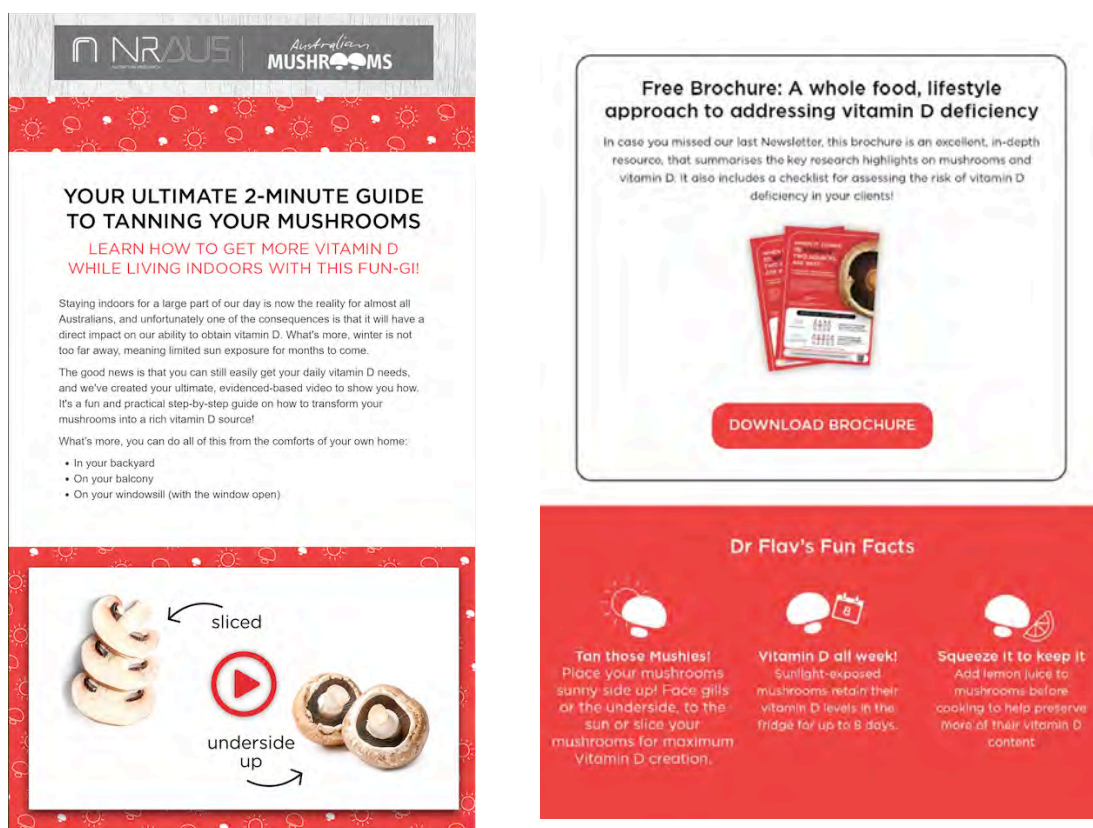
If you were part of the survey, thank you! The second survey is set for June 2020, so watch your inbox for an invitation later in the year.

**Vitamin D animation EDM: April 2020**

The Vitamin D animation EDM (**Appendix 6**), titled *Your Ultimate Video Guide to Tanning your Mushrooms*, was created to communicate the 2-minute animated video on vitamin D and mushrooms to HCPs. Sent out around the height of the social restrictions due to COVID-19, the EDM positioned mushrooms as a natural way to maintain vitamin D status while having limited time outdoors. A link to the vitamin D brochure, and three ‘Dr Flav’s Fun Facts’, were also included within the EDM.

The EDM was sent to 1325 recipients, with 441 recipients opening the email (33% open rate vs. industry average of 20 – 25%) and 87 recipients clicking a link that took them to the animation.

**Vitamin D animation EDM:**



**6. SLR Manuscript and Brochure Communications: June 2020**

A communications strategy to promote the publication of the SLR is in the final stages of development. It includes:

- **Proposal to create a video of the researchers presenting their findings:** A proposal has been put forward to plan, produce and execute a 90-second, interview-style video to communicate the newly published SLR as part of the wider campaign. Its purpose is to help humanise the science and create sharable content. The video will centre on NRAUS researchers, including Dr Flavia Fayet-Moore, speaking to camera to highlight the uniqueness of mushrooms and key findings from the research. The video will include overlaid text, pre-designed graphics from the SLR brochure, music and voiceovers. If approved, it will be an add-on to the scheduled activities agreed at the start of the project.
- **An EDM:** An EDM to promote the publication of the SLR and brochure, titled *Just published: The world’s first systematic review on Agaricus bisporus*, has been drafted and is in the final stages of design and will be sent to Hort Innovation for review in early July. The EDM includes a link to the open access article and the SLR

brochure.

- **Social Media Advertising:** The new SLR manuscript and brochure to HCPs will also be communicated via a social media campaign that will be conducted across Facebook and LinkedIn using a video asset.
- **Landing page on NRAUS website:** The SLR brochure will be housed on the NRAUS website for timeless access.

## MILESTONE 102: SYSTEMATIC LITERATURE REVIEW & KEY POINTS DOCUMENT

### **Background**

Research from both laboratory experiments and animal studies suggest that eating edible mushrooms can improve health. These studies show that mushrooms are a valuable source of a number of unique bioactive compounds, including ergothioneine, ergosterol, vitamin D and beta-glucan, and that these bioactives may explain their health potential. However, there are very few comprehensive and systematic reviews of this evidence. It is also unclear whether the health potential of mushrooms occurs in humans. To inform the key messages of Year 2 of the campaign, a comprehensive and systematic review of the evidence on mushrooms and their health and bioactive properties was needed.

Due to the large variety of mushroom species, a focus on those that are most commonly eaten by humans will have the greatest translational value. The most commonly eaten mushrooms worldwide belong to the *A. bisporus* species, which includes white button, brown button, portobello, and cremini mushrooms. Therefore, a SLR was done to -- for the very first time -- synthesise all of the evidence on *A. bisporus* mushrooms globally. This SLR studies both its effects on human health outcomes, as well as the amount of its key bioactive compounds that have been identified to have potential in explaining these health effects.

### **Activity completed**

**Systematic literature review.** A systematic literature search of five scientific electronic databases (MEDLINE, EMBASE, Scopus, CINAHL, and The Cochrane Library) was conducted (**Appendix 7**). To be included in this review, a study needed to be conducted in humans, and use *A. bisporus* in whole or process (e.g. dried extract) form. All studies types, publication date and languages were eligible for inclusion.

A total of 9,811 records were found, and of these, 501 articles were on *A. bisporus* specifically. These 501 articles represent a complete and up-to-date database of every study ever published across the globe on the *A. bisporus* mushroom and its health-related outcomes or nutritional/bioactive compounds. It includes studies in humans, but also animal and cell line studies.

Of the 501 articles which investigated *A. bisporus*, a further eligibility criteria was applied to limit to studies that report effects on a health outcome in humans or report on one or more of the following bioactive compounds: ergosterol, ergothioneine, vitamin D, flavonoids, glucans or chitin. A total of 68 articles met this eligibility criteria and were included in the final SLR. Fifteen articles reported the effect of mushroom consumption on human health, and 53 articles reported on the amount of one or more bioactive compounds.

Key findings:

- *A. bisporus* is linked to seven different health outcomes in humans, including vitamin D absorption, inflammation, satiety (e.g. hunger and fullness), gut health (e.g. microbiota, stool weight, bowel strain, faecal odour and bad breath), cancer, cardio-metabolic markers (e.g. glucose, cholesterol, triglycerides and body weight), and immune function.
- *A. bisporus* contains valuable sources of the key bioactive components beta-glucans, ergosterol, ergothioneine, vitamin D, chitin and unknown antioxidants usually reported as flavonoids. These may explain the health effects of mushrooms, and the quantities can differ depending on the mushroom type, cooking method, cooking length and part of the mushroom.
- Eating UV-exposed mushrooms is equivalent to taking a vitamin D supplement to increase and maintain a person's vitamin D levels.

**Key points document.** A 17-page 'key points document' on the SLR (**Appendix 8**) was created alongside the SLR. Its

purpose was to translate the methods, results and impact of the SLR in simple language, so that it can be shared with key stakeholders who are not scientists. The document also included 16 ideas for future research, based on the findings from the SLR. These ideas include clinical trials, analysis of its bioactive properties and communication opportunities. Each opportunity includes a background on the idea, what is required and the benefit to the mushroom industry if the research idea is pursued. The research ideas include:

- Conduct a randomised controlled trial to investigate the cholesterol lowering effect of beta-glucans in mushrooms: Are mushrooms as effective as oats?
- Conduct a randomised controlled trial of the effect of sun exposed mushrooms on vitamin D within the Australian context.
- Beta-glucan Food Standards Australia New Zealand (FSANZ) regulation submission.
- Vitamin D FSANZ regulation change submission.
- Examine different types of cooking methods and the effects they have on mushroom flavour and texture profile.

## NUTRITIONiQ

**NUTRITIONiQ.** Our NUTRITIONiQ service, which involves setting up an automated research publication alert to collate relevant papers as new research is published, has been applied to this SLR. It ensures that the comprehensive [research database](#) stays current during the course of this project and beyond, if funds are available.

Since the systematic literature search was conducted in June 2019, the NUTRITIONiQ service has screened 269 records and 83 new articles have been identified. These include articles relating to the mushroom industry (e.g. production or processing of mushrooms), animal nutrition, *in vitro* studies, genetic identification or analysis of mushrooms, a clinical intervention trial in humans using an *A. blazei* extract, and two observational studies on mushroom allergies. None of the identified studies have met the inclusion criteria for the SLR.

### **Impact**

The SLR provides an extensive, world-first review on the health effects and bioactive components in *A. bisporus* mushrooms. It is the strongest evidence to date that mushroom consumption benefits human health. The SLR key points document provides a plain language summary of key findings from the SLR manuscript so that the research can be used to communicate its key messages to a variety of different stakeholders beyond HCPs.

In addition, there is a comprehensive and growing *A. bisporus* scientific database with over 580 articles. It presents an up-to-date resource of every study ever published on the *A. bisporus* mushroom and health related outcome or bioactive component, including papers published in languages other than English. This can be used as a scientific resource to inform future opportunities, such as the planned expert roundtable in 2020 and the development of a webinar on the science of mushrooms in 2021.

The SLR manuscript has been accepted for publication in a top-quality, international peer-reviewed journal (see Milestone 104: Systematic Literature Review Manuscript Submission).

### **Next steps**

The *A. bisporus* research database will be updated on a monthly basis so that it remains current.

## **MILESTONE 103: SYSTEMATIC LITERATURE REVIEW BROCHURE**

### **Background**

A bespoke branded 8-page brochure to bring to life the key findings from the SLR in bite sized digestible pieces of information, so that any HCP will find the information memorable and easy to understand.

### **Activity-in-progress**

The key messages from the SLR was re-designed and curated for a brochure for HCPs. The brochure includes:

- The unique classification of mushrooms and the current research gap.
- A simple depiction of the study's methodology and key results.
- An easy-to-understand way to memorise the unique bioactive profile of *A. bisporus* mushrooms.
- A graphical comparison of the quantities of its bioactive properties with other foods.
- A summary of the 15 human studies across the seven beneficial health outcomes.
- Ten memorable mushroom messages that can be shared with clients.

In line with global sustainability, the brochure will be printed on 100% recyclable, matte high-quality paper. The print run will include 300 copies.



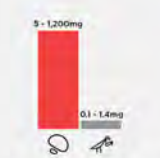

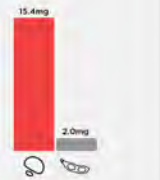



**Next steps**

The brochure has been designed and will be sent to Hort Innovation to review by Friday 3<sup>rd</sup> July. A PDF of the brochure will be communicated alongside the manuscript as part of the SLR communications activation, which includes an EDM and social media advertisement. The hard copy will be distributed at the Dietitians Unite (DU) event to approximately 300 delegates. It can also be shared at future HCP events.

**Systematic Literature Review Brochure: June 2020**



**What are the key bioactives in *Agaricus bisporus*?**

	<b>A</b>	<b>B</b>	<b>C</b>	<b>D</b>	<b>E</b>
	<b>ANTIOXIDANTS</b>	<b>BETA-GLUCANS</b>	<b>CHITIN</b>	<b>VITAMIN D</b>	<b>ERGOTHIONEINE</b>
<b>What is it?</b>	An array of antioxidants usually reported as flavonoids and polyphenols, including catechin, myricetin, quercetin & kaempferol, although levels are generally lower than fruits or vegetables <sup>[2]</sup> .	A soluble fibre, commonly found in oats, that has cholesterol lowering properties <sup>[2]</sup> .	A unique prebiotic polysaccharide that makes up the cell wall of fungi – it's like cellulose in plants <sup>[2]</sup> . It's not found in any other foods, except for insects and yeasts.	The sunshine vitamin. Mushrooms naturally contain vitamin D2, with levels increased up to 10 times after the surface of the mushroom is exposed to UVB light <sup>[10]</sup> (i.e. sunlight).	An antioxidant that can only be made by some fungi and bacterial <sup>[11]</sup> . Mushrooms are the largest dietary source.
<b>How much?</b>	 Kaempferol in <i>Agaricus bisporus</i> vs. Strawberries (/100g wet weight)	 Beta-glucans in <i>Agaricus bisporus</i> vs. Oats (/100g dry weight)	 Chitin in <i>Agaricus bisporus</i> vs. Edible Insects (/100g wet weight) <sup>[12]</sup>	 Vitamin D equivalents in UV-exposed <i>Agaricus bisporus</i> vs. Raw Eggs (/100g wet weight) <sup>[21]</sup>	 Ergothioneine in <i>Agaricus bisporus</i> vs. Tempeh (/100g dry weight)
<b>How to maintain in cooking?</b>	Cook for a shorter amount of time <sup>[4]</sup> .	Not affected by cooking. <sup>[13]</sup>	Increases with cooking, regardless of whether the mushroom was fresh, frozen or canned <sup>[9]</sup> .	Using UV-exposed mushrooms, squeeze some lemon juice in the pan, cook at lower temperatures and for shorter times <sup>[10]</sup> .	Cook for a shorter amount of time <sup>[4]</sup> .
<b>WHICH TYPE IS BEST?</b>	<div style="display: flex; justify-content: space-around;"> <div style="text-align: center;">  White Button                 </div> <div style="text-align: center;">  Portobello                 </div> </div>		<b>WHICH PART IS BEST?</b>  <p>28% more antioxidants in the cap (vs the stem)<sup>[12, 18]</sup></p> <p>40% more beta-glucans in the stem (vs the cap)<sup>[13]</sup></p>		<b>FUN-gi FACT</b> The stem is a valuable source of bioactives. Don't waste it!

**MILESTONE 104: SYSTEMATIC LITERATURE REVIEW MANUSCRIPT SUBMISSION**

**Activity completed**

The manuscript was submitted to *The Journal of Nutritional Biochemistry* in March 2020 and was officially accepted for publication on 8<sup>th</sup> June 2020: <https://doi.org/10.1016/j.jnutbio.2020.108453>

The journal is a leading journal that publishes nutrition research relating to biochemistry, molecular biology, toxicology and physiology. In December 2019, the journal issued a special call for research on polyphenols with a focus on inflammation, obesity and cardiometabolic health. This presented us with a great opportunity to fact track the publication of the SLR manuscript in a high-quality journal.

**Impact**

*The Journal of Nutritional Biochemistry* has an impact factor of 4.490 and ranks in the top 7% of nutrition journals for its impact. Impact Factors measure the importance of a journal by calculating the number of times selected articles from that journal are cited within the last few years. The higher the impact factor, the more highly ranked the journal. Within the field of nutrition, impact factors range from 7.24 to 0, with most nutrition journals having an impact factor of less than 2. Publication in *The Journal of Nutritional Biochemistry* therefore means that the research is more likely to be read and cited by other researchers.

**Next steps**

The accepted manuscript is currently in press. We are awaiting confirmation of when the article will be freely available online. Once the published manuscript is available online, the publication will be shared through a strategic communications plan alongside the SLR brochure.

## Systematic Literature Review Submission: June 2020



The Journal of Nutritional Biochemistry

Available online 13 June 2020, 108453  
In Press, Journal Pre-proof



## Examining the health effects and bioactive components in *Agaricus bisporus* mushrooms: A scoping review ☆

Michelle Blumfield <sup>a</sup>, Kylie Abbott <sup>a, b</sup>, Emily Duve <sup>c</sup>, Tim Cassettari <sup>a</sup>, Skye Marshall <sup>a, d</sup>, Flavia Fayet-Moore <sup>e, f, g</sup>

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<https://doi.org/10.1016/j.jnutbio.2020.108453> [Get rights and content](#)

### Abstract

There is evidence from both *in vitro* and animal models that the consumption of edible mushrooms has beneficial effects on health. It is unclear whether similar effects exist in humans and which bioactive compounds are present. This review synthesises the evidence on the world's most commonly consumed mushroom, *Agaricus bisporus* to (i) examine its effect on human health outcomes; and (ii) determine the nutrient density of its bioactive compounds, which may explain their health effects. A systematic literature search was conducted on the consumption of *A. bisporus*, without date and study design limits. Bioactive compounds included ergosterol, ergothioneine, flavonoids, glucans and chitin. Two authors independently identified studies for inclusion and assessed methodological quality. Beneficial effects of *A. bisporus* on metabolic syndrome, immune function, gastrointestinal health and cancer, with the strongest evidence for the improvement in Vitamin D status in humans, were found. Ultraviolet B (UVB) exposed mushrooms may increase and maintain serum 25(OH)D levels to a similar degree as vitamin D supplements. *A. bisporus* contain beta-glucans, ergosterol, ergothioneine, vitamin D and an antioxidant compound usually reported as flavonoids; with varying concentrations depending on the type of mushroom, cooking method and duration, and UVB exposure. Further research is required to fully elucidate the bioactive compounds in mushrooms using vigorous analytical methods and expand the immunological markers being tested. To enable findings to be adopted into clinical practice and public health initiatives, replication of existing studies in different population groups is required to confirm the impact of *A. bisporus* on human health.



## MILESTONE 104: DIETITIAN'S UNITE BREAKFAST SEMINAR

**Dietitian's Unite Breakfast 2020 (DU2020):** December 2019 – June 2020

### **Background**

We are hosting a joint breakfast event at Dietitian's Unite, an event run by Dietitian Connection. The breakfast event will be sponsored by Australian Mushrooms in partnership with Simplot Australia. The event, in its seventh year, brings together dietitians and nutritionists from around Australia to unite and showcase inspiring leadership and innovations. Our breakfast will focus on culinary nutrition and include practical recommendations for dietitians on how to increase vegetable and mushroom consumption. The breakfast is titled: *'Is taste the forgotten message?'* with the general theme of the breakfast: *'How do you use veggies and make them taste good?'*

In addition to the breakfast, Australian Mushrooms will have a trade stand to further provide information about the benefits of mushrooms. Following the event, an EDM will be sent out to attendees from Dietitian Connection (DC), who run the event. NRAUS will also evaluate how successful the event has been to help shape future activity.

The breakfast session was promoted on the DC [website](#) and [social media pages](#) in early 2020 and has been sold out since the 6<sup>th</sup> March 2020, with a capacity of approximately 200 attendees. Due to COVID-19, a decision was made by the organisers in March to reschedule the event from 1<sup>st</sup> May 2020 to 26<sup>th</sup> October 2020. On 19<sup>th</sup> June, the event was rescheduled again and is now set to take place on 31<sup>st</sup> May 2021.

### **Activity in-progress**

Despite the delays due to COVID-19, we have progressed with the majority of the planning and activities associated with this event, although timelines have been extended.

**Breakfast.** We have planned to provide each attendee at the breakfast session with a bag of mushrooms to take home. The proposal is that these will sit on the round tables when guests arrive and contain around six mushrooms per bag. The mushrooms will be beautifully presented and will feature different fun facts about mushrooms, from the 'Dr Flav's Fun Facts' document. We will be working with a local Melbourne greengrocer, Simply Fresh Fruit, to supply us with the mushrooms.

**Recipe booklet and fact sheet.** In partnership with Simplot, we have been developing a recipe booklet and fact sheet as resources for the event. The recipe booklet contains six vegetarian recipes, four of which hero mushrooms. The recipe booklet also includes information about the health benefits of vegetables, what is a serve of vegetables, eating vegetables at breakfast, the nutritional uniqueness of mushrooms, and the role of UV-exposed mushrooms in increasing vitamin D intakes. The booklet has been on hold due to social distancing restrictions prohibiting the photography from taking place, but the project has recently been able to start again, with photography taking place on 10<sup>th</sup> and 11<sup>th</sup> June. The recipe booklet has now been designed with recipes and copy and is currently going through editing and review. It is scheduled to be sent to Hort Innovation for final review in late July.

The fact sheet contains key information and fun facts on both vegetables and mushrooms in infographic style. The tiles that make up the resource can also be used for social media. The development of the fact sheet was also postponed due to COVID-19 related implications. The project has also now restarted, and the first draft of the copy and design has been developed. This is currently going through editing and review.

**Presentation.** The DU presentation that Dr Flavia Fayet-Moore will present during the breakfast session is currently under development. The goal of this presentation is to inspire and empower dietitians to increase their mushroom consumption amongst their clients by providing them with relevant and evidenced based tips, insights and bite-sized messages on mushrooms. By discussing both the science and the culinary aspects of mushrooms, the presentation will propose that dietitians can improve the health of Australian's by embracing culinary nutrition, and that there is no better place to start than with mushrooms. The presentation outline has been developed and the slides are currently being designed.

**Chef.** The celebrity chef who will run the cooking demonstration remains unconfirmed. We have been in constant discussions with Bite Communications to book the celebrity chef Miguel Maestro. An agreement has not yet been reached due to matters outside of our control. Should Miguel be unavailable, or outside of our price range, we

have received interest from Tawnya Bahr as an alternative. Tawnya was awarded the 2018 Culinary Advocate of the Year and has extensive culinary experience.

**Trade stand.** As part of the breakfast sponsorship we will have an Australian Mushrooms trade stand at the conference that will be managed by Nutrition Research Australia. The objective of the trade stand is to inspire mushroom consumption and recommendations by providing bespoke information and tips, and to grow the Australian Mushrooms database. We are currently finalising the trade stand set up, where we will be looking to collect email addresses to be part of the Australian Mushrooms database through two free standing iPads. To drive entries, there will be the opportunity to win one of three culinary prizes. The following resources will also be available at the trade stand: (1) Australian Mushrooms and Simplot recipe booklet, (2) Australian Mushrooms and Simplot factsheet, (3) SLR Brochure, and (4) Vitamin D brochure.

**Evaluation.** Measures of success will be used to assess the impact and reception of the presence of Australian Mushrooms at the 2020 DU event. We will evaluate the breakfast event, trade stand, EDM and general response via the DU post event survey, social media tracking, EDM tracking, and attendance.

## Website Ad



## PROGRAM

Breakfast – We have **TWO** separate streams this year:

- **Managing metabolic health through the microbiome**  
This session, powered by Microba, will discuss the relevance of the gut microbiome in metabolic health and the utility of microbiome profiling to guide personalised dietary strategies to support metabolic balance. Presented by Dr Paula Smith-Brown, PhD, Senior Accredited Practising Dietitian and Dr Alena Pribyl, PhD, Senior Scientist. *Supported by Microba (Updated 31 Jan 2020). This breakfast stream is sold out as at 5 Mar 2020.*
- **Taste: the forgotten message to enjoy a variety of vegetables and mushrooms**  
Vegetables are core foods for a healthy eating plan, yet only 1 in 10 Australians eat the recommended Dietary Guidelines of 5 servings each day. And how many Aussies actually *enjoy* their 5 serves of vegies daily? Join us as we explore how **Dietitians & Nutritionists can influence culinary nutrition** and entice people to **enjoy food for good health** with key **insights and recipe ideas**. At our morning breakfast event, we'll share the barriers & drivers to **vegetable consumption** for Australians, alongside the latest **scientific research** on the health benefits of mushrooms; and discuss a new approach to utilise culinary nutrition to increase vegetable, legume, and fungi intakes for your clients. You will take home practical food tips and bitesize messages to help you communicate the nutritional benefits of vegies for good health, leveraging taste, food preparation and recipe ideas. *Supported by Birds Eye, Edgell and Australian Mushrooms. This breakfast stream is sold out as at 6 Mar 2020.*

Instagram Ad

The Instagram ad features a flowchart for the event 'dietitiansunite 1 MAY 2020, MELBOURNE'. The flowchart starts with the question 'GOT PLANS ON 1 MAY?'. If 'YES', it leads to 'BREAKFAST STREAM' and then to 'DURING THE DAY' with two options: 'Managing metabolic health through the microbiome' and 'Taste: the forgotten message to enjoy a variety of vegetables and mushrooms'. If 'NOT YET', it also leads to 'BREAKFAST STREAM'. Below this, a question asks 'WHAT MATTERS MOST TO YOU?' with three categories: 'BUSINESS' (listing Karen Inge, Tara Diversi, Tawnya Bahr, and Lucy Allon), 'CLINICAL' (listing Prof Felice Jacka & Health at Every Size / Weight Management Discussion Panel), and 'INSPIRATION' (listing Sam Bloom & The Resilience Project). A final button says 'I WANT IN GET YOUR TICKET'.

Accompanying the flowchart is a tweet from 'dietitianconnection Melbourne' dated February 27. The tweet text reads: 'Still on the fence about attending #dietitiansunite 2020? Don't talk yourself out of it! Here's our flowchart of everything that's happening: •Free breakfast session [get in quick to secure a spot] supported by @microbaofficial, @birdseyevegetables, @edgellau and @australianmushrooms. •Game-changing opening and closing speakers @samjbloom and @theresilienceproject. •Business skills from @taradiversi, @margaretmccormack and @lucyallon. Liked by @australianmushrooms and 128 others'. The tweet includes a 'Like' icon, a 'Comment' icon, and a 'Share' icon.

Facebook Ad – One

The Facebook ad is from 'Dietitian Connection' dated 21 February. The text asks 'What is your favourite meal of the day?' and answers 'Ours is BREAKFAST. So, this year we have decided to create TWO separate breakfast streams at #dietitiansunite. The streams will be: -Managing metabolic health through the microbiome supported by Microba AND - Taste: the forgotten message to enjoy a variety of vegetables and mushrooms, supported by Australian Mushrooms, Edgell Australia, Birds Eye Vegetables'. It notes 'SPACES ARE LIMITED, first in best dressed!' and provides a registration link: 'https://dietitianconnection.com/event/dietitians-unite-2020/'. Below the text is a photograph of several bowls filled with colorful, healthy-looking food, including shredded carrots, tomatoes, and proteins.

The ad shows 6 likes and includes 'Like', 'Comment', and 'Share' buttons.

Facebook Ad - Two

The Facebook ad is from 'Dietitian Connection' dated February 27. The text asks 'Did you know, that only 1 in 10 Australians eat the recommended Dietary Guidelines of 5 serves of vegetables each day? What if, we could teach people how to cook vegies and make them taste even better?'. It invites users to join the 'breakfast stream' to explore how dietitians and nutritionists can influence culinary nutrition. It lists sponsors: 'Supported by Australian Mushrooms, Edgell Australia and Birds Eye Vegetables'. It provides a registration link: 'https://dietitianconnection.com/event/dietitians-unite-2020/'. Below the text is a graphic featuring a basket of fresh vegetables (broccoli, tomatoes, mushrooms, etc.) and a bowl of mushrooms. The text 'dietitiansunite 1 MAY 2020, MELBOURNE' and 'BREAKFAST STREAM Taste: the forgotten message to enjoy a variety of vegetables and mushrooms' is overlaid on the graphic.

The ad shows 8 likes and includes 'Like', 'Comment', and 'Share' buttons.

### **Next steps**

To finalise preparations for the DU event, including DU event logistics, informational resources, the celebrity chef, panel discussion and run sheet. Despite the unfortunate delay in timelines due to COVID-19, we are well on track to deliver a high quality and engaging event in 2021.

## **MILESTONE 104: DIETITIAN BROCHURE**

### **Background**

The initial purpose of the dietitian brochure was to act as a profession-specific brochure for dietitians on the health benefits of mushrooms. After reviewing the resources that have been developed, it was recommended to Hort Innovation that this brochure was better placed to become a white paper document to communicate the findings and implications from the expert roundtable event, initially scheduled for November 2020. This recommendation was approved by Hort Innovation on 21<sup>st</sup> April 2020.

## **MILESTONE 104: 6 MONTH BENCHMARKING PERFORMANCE REPORT 3**

Completed as per this report. *30 June 2020*

## **MILESTONE 104: AUDIENCE SENTIMENT RESEARCH 2**

### **Background**

A detailed sentiment analysis that explores the attitudes and knowledge of health professionals with regards to mushrooms is conducted at three stages of the project. Its purpose is both to help with monitoring and evaluation, and to help inform our communications strategy to ensure its effectiveness. The first research was conducted at the start of the project, the second was originally planned for the 18-month point, and the final will take place at the end point of the project (December 2021).

Findings from the first Audience Sentiment Research survey confirmed that knowledge of the key nutritional properties of mushrooms is low, that few perceive mushrooms as more important than vegetables, and that mushrooms are not a front of mind recommendation to patients.

The second survey was scheduled for June 2020 but was delayed due to COVID-19 restrictions postponing the DU event. Hort Innovation approved our request to move the Audience Sentiment Report 2 to after the DU event so that we could better examine the effect of our communications of the SLR (Initial date: end Aug 2020; Revised date: end Jan 2021).

### **Activity in-progress**

Despite the delay due to COVID-19, the planning of this research has progressed, and the Audience Sentiment Research survey has been drafted and uploaded onto the survey platform for testing. The research survey is similar to the first survey to help comparisons over time.

### **Next steps**

To test the survey in the survey platform and finalise the EDM that will promote the research. Given the recent delays of the DU event again, from October 2020 to May 2021, the timeline for the Audience Sentiment Research 2 is also currently under review again. Hort Innovation will be consulted if any further changes to timelines are recommended.

## **MILESTONE 104: SMALL SYDNEY ROUNDTABLE**

### **Background**

We will invite experts across different fields to discuss the theme, *Fungi foods: where should they fit within current*

*dietary recommendations?* The theme was strategically chosen to maximise relevance to HCPs and increase potential for public health impact. Its objective is to bring together experts in nutrition research, food science, and culinary nutrition to establish clear and authoritative recommendations on the what, how and why of fungi (specifically mushroom) consumption.

Each expert will be briefed to prepare and present a short presentation on a particular topic, followed by a panel discussion. The meeting will be closed and intimate, with all attendees receiving a personal invite. Findings from the roundtable will be communicated to HCPs after the event.

### **Activity in-progress**

A one-page document has been created that describes the purpose of the roundtable (**Appendix 9**). It includes the theme of the roundtable, how it works, objective, background, possible research Q's and key messages, collateral, and a draft outline of the communications plan.

Work is currently underway to develop the different presentations and potential speakers.

### **Next steps**

Once the different presentation ideas and potential speakers have been finalised and approved by Hort Innovation, the date, location and project plan for the event will be confirmed and finalised.

## **Outputs**

### **AUSTRALIAN MUSHROOMS WEBSITE CONTENT (Appendix 1)**

An assessment of all nutritional claims made on the Australian Mushrooms website, with alternative claims, references and copy editing provided.

**Date sent:** 8<sup>th</sup> April 2020

### **DR FLAV'S FUN FACTS (Appendix 2)**

A final document was provided to Hort Innovation at the completion of the SLR which included 48 research insights with potential as communication messages, or 'fun facts'. These can be used in communication messages to both HCP or consumer marketing campaigns with further guidance.

**Date sent:** 12<sup>th</sup> March 2020

### **YEAR IN REVIEW EDM (Appendix 5)**

The EDM provided a summary of the research insights and resources completed in 2019. It included key research insights, the mushrooms and vitamin D brochure, a link to the webinar presentation, a link to the MJA Insight article, an update on the SLR, and brief insights from HCPs on what they know about mushrooms.

**Date sent:** 4<sup>th</sup> February 2020

**Target audience:** HCP database

**Reach:** 1372

### **VITAMIN D ANIMATION EDM (Appendix 6)**

An EDM to communicate the 2-minute animation on vitamin D and mushrooms to the HCPs.

**Date sent:** 9<sup>th</sup> April 2020

**Target audience:** HCP database

**Reach:** 1325

#### **SYSTEMATIC LITERATURE REVIEW MANUSCRIPT (Appendix 7)**

The SLR manuscript is a comprehensive and world-first systematic literature review on *A. Bisporus*, consisting of 68 research articles. It was completed and sent to Hort Innovation for review prior to manuscript submission and accepted for publication in *The Journal of Nutritional Biochemistry*.

**Date sent:** 24<sup>th</sup> February 2020

**Date accepted for publication:** 8<sup>th</sup> June 2020

#### **SYSTEMATIC LITERATURE REVIEW KEY POINTS DOCUMENT (Appendix 8)**

A SLR key points document was created to provide a simple language summary of the key findings and implications from the SLR manuscript to stakeholders.

**Date sent:** 12<sup>th</sup> March 2020

#### **A. *BISPORUS* RESEARCH DATABASE (Link [here](#))**

A comprehensive database of every research paper on the nutrient and health properties of *A. bisporus* mushrooms.

**Date updated:** June 2020

**Number of research papers:** 586 studies

#### **MEDICAL JOURNAL OF AUSTRALIA ARTICLE (Link [here](#))**

An article titled '*Tan your mushrooms, not your skin*' published in MJA Insight to educate HCPs about the important role that UV-exposed mushrooms have in helping people increase their vitamin D intakes.

**Date sent:** 13<sup>th</sup> January 2020

**Target audience:** HCPs and researchers

**Reach:** 29,312 people (KPI: 20k)

#### **VITAMIN D ANIMATION (Link [here](#))**

A 2-minute animation created to capture the key research on mushrooms and vitamin D, with practical tips on consuming UV-exposed mushrooms to increase vitamin D intake.

**Date sent:** 7<sup>th</sup> April 2020

**Target audience:** HCPs

**Reach:** 57,744 people (KPI: 20k)

## Outcomes

### **Completed the first-of-its kind SLR on *A. bisporus* and health outcomes and bioactive compounds**

The SLR manuscript was accepted for publication in a top-ranking international journal, *The Journal of Nutritional Biochemistry*. It is the most comprehensive scientific report showcasing the health benefits of mushrooms in humans, and has created credible, evidenced-based messaging to inform future communications on mushrooms. The SLR key points document allows this information to be communicated to stakeholders beyond HCPs.

### **Continue to keep the *A. bisporus* research database current**

Through the NRAUS NUTRITIONiQ service, we have continued to collate recent, relevant research articles on mushrooms. The database currently contains 586 articles and the process remains on-going.

### **A growing list of fun facts and key messages in simple language**

We identified 48 'fun facts', 19 of which have been utilised in communication materials such as EDMs, social ads, brochures, presentations and partner advertising materials.

### **Engagement and education across multiple platforms**

We have utilised a wide range of engagement platforms to educate HCPs despite social distancing restrictions. This includes multiple EDMs (to share educational resources and promote the animated video), social media and scientific research articles and newsletters.

### **Provided credibility for the Australian Mushrooms campaign**

Using our health claim validation template, we provided the Australian Mushrooms website with a scientific assessment of every nutritional claims made on the Australian Mushrooms website.

### **Impact on the scientific community**

The SLR manuscript was accepted for publication in a high impact journal, *The Journal of Nutritional Biochemistry*, meaning that the research is more likely to be read and cited by other researchers.

### **Generated shareable content to distribute information beyond what was agreed in the project plan**

COVID-19 restrictions have postponed our opportunities to present and distribute information according to the original project plan. We pursued additional opportunities to educate HCPs using a short Vitamin D animation, and an additional scientific article published in MJA Insight. The MJA Insight article also informed a media release lead by Hort Innovation.

## Intellectual property, commercialisation and confidentiality

No project IP, project outputs, commercialization or confidentiality issues to report.

## Issues and risks

**Campaign Risk Register** – The risks register for this project can be viewed [here](#).

The identified risks are listed below are all are currently being managed. While timelines have needed to be changed due to reasons outside of our control, all revised delivery dates have been approved by Hort Innovation:

## COVID-19

Social distancing restrictions due to COVID-19 have significantly impacted timelines in 2020.

The DU event was initially postponed from 1<sup>st</sup> May to the 26<sup>th</sup> October because of COVID-19 restrictions. Since the DU event was our main event to educate HCPs about the SLR findings in 2020, it was also decided to postpone the Audience Sentiment Research after the DU event. Hort Innovation approved our request to move the Audience Sentiment Report 2 to after the DU event (Initial date: end Aug 2020; Revised date: end Jan 2021).

A second delay to the event was announced this month, with the new date to be 21<sup>st</sup> May 2021. It is also possible that COVID-19 restrictions have an impact on the expert roundtable event, currently scheduled for November 2020. We are reviewing the project plan in light of these changes and will present a recommended timeline to Hort Innovation in July 2020.

The timelines for the DU recipe booklet and factsheet were also modified due to COVID-19 restrictions. New social distancing requirements caused photography delays and reduced Simplot's availability. The recipe booklet and factsheet have since restarted and will be sent to Hort Innovation for review in July 2020.

We have also developed a recommended communications strategy to maximise the gap in the communications calendar and share the findings from the SLR online.

## Celebrity chef at DU breakfast event

Initial plans were to have celebrity chef Miguel Maestre, under contract with Australian Mushrooms, to attend and present at the DU breakfast event.

Due to the postponement of the event from May 2020 to May 2021, it will now take place after Miguel's current contract with Australian Mushrooms, which is due to expire on 30 June 2020. There has been no confirmation that his contact will be extended. Without an extension, the cost of Miguel to attend the DU event will double and his attendance will be outside of budget.

Since securing Miguel is doubtful, we have been in discussions with Tawnya Bahr as a backup option. Tawnya expressed interest in presenting at the event and discussions are continuing with her management to confirm her fee, which is expected to be significantly less than Miguel.

## HCP Research Database

While there has been significant positive growth in the size of the HCP database since the beginning of the project, this growth has stopped over the last six months. This is due to a lack of events and incentives to subscribe, a direct result of COVID-19.

For the remainder of 2020, proactive communications are scheduled for both the SLR and the Audience Sentiment Research survey, where there is a direct call to action to subscribe, such as 'enter email to download' or 'win a supermarket voucher by completing the survey'. As such, we expect the database to return to growth in the second half of 2020.

## Other information

None.



## Milestone Report

**Project title:**

# Educating healthcare professionals about Australian mushrooms

**Project code:**

MU 17002

**Milestone number:**

MS105

**Project leader:**

Dr Flávia Fayet-Moore

**Delivery partner:**

Nutrition Research Australia Pty Ltd (NRAUS)

**Report author:**

Dr Flávia Fayet-Moore (NRAUS)

Heidi Rose (History Will Be Kind – HWBK)

**Milestone due date:**

End November 2020

**Submission date:**

30 November 2020

**Confidentiality:**

Is this report confidential?

No

Yes (whole report)

Yes (sections of report are confidential)

If sections of the report are confidential, list them here:

**Milestone description:**

6 Month Benchmarking Performance Report 4

**Milestone achievement criteria:**

MS102, MS104 – in progress

MS103 – completed

MS104 – postponed

Milestone	Achievement Criteria
MS102	Technical and scientific support for the Australian Mushrooms campaign
MS102	Periodic comms program - planning, liaison, integration & content development
MS103	SLR Brochure
MS103	SLR Manuscript Submission
MS104	Dietitian’s Unite - Breakfast Seminar
MS104	Roundtable White Paper (previously Dietitian Brochure)
MS104	Audience Sentiment Report 2
MS104	Expert Roundtable
MS105	6-month Report 4

**Funding statement:**

**Levy funds – R&D projects**

This project has been funded by Hort Innovation, using the Mushroom Fund research and development levy and contributions from the Australian Government. Hort Innovation is the grower-owned, not-for-profit research and development corporation for Australian horticulture.

## General project overview

Despite the unique nutritional properties of mushrooms, there is currently a lack of knowledge of their nutritional and health benefits among healthcare professionals (HCPs). The objective of this three-year project is to conduct original research on the health benefits of mushrooms and then educate health professionals about its key findings, supporting the wider industry objective of increasing the overall consumption of mushrooms in Australia.

## Summary

The objective of Year 2 was to showcase the unique nutritional properties of mushrooms, specifically that they are not a plant nor an animal but contain key nutritional properties from both. The messaging underpinning this theme was informed by the systematic literature review (SLR) and enhanced with communications via an 8-page SLR brochure, a short video with the researchers, a media appearance, a small expert roundtable, electronic direct

mails (EDMs), and social media engagement.

The SLR manuscript has now been officially published as open access (freely available) in the *Journal of Nutritional Biochemistry*. To promote the innovative and exciting findings from this newly published manuscript, an 8-page brochure and SLR video were developed and disseminated. The 8-page SLR brochure has currently been downloaded by over 100 HCPs and a further 300 hard copies will be distributed at the Dietitian's Unite (DU) event in May 2021. The SLR video was an additional item to the original communications plan, created to share the perspectives of the mushroom science researchers. It was promoted to HCPs through a paid Facebook advertising campaign. The campaign reached 34,128 people (KPI: 20k), with 1,887 who clicked a link directly to the SLR video and 22,499 3-sec video plays (KPI: 15k).

Social media influencers have been promoting the SLR key message. Dr Emma Beckett, an Accredited Practising Dietitian and Lecturer in Food Science and Human Nutrition at the University of Newcastle, shared some fun facts about mushrooms and vitamin D to her 18.5K followers on Twitter, with 1.1K likes, 75 comments, 211 retweets and 39 quote tweets. She was also asked about mushrooms and vitamin D during a local Central Coast radio station interview, where the interviewer asked questions about the mushroom posts that Emma shared on her social media. Dietitian Leanne Ward 'aka *The Fitness Dietitian*' shared a TikTok video on social media to her 307.8K followers about mushrooms and vitamin D. The video received 51.2k views, 4960 likes and 65 comments (8<sup>th</sup> November 2020).

The small expert roundtable brought together experts across nutrition research, food science and culinary nutrition to establish clear and authoritative recommendations on fungi (specifically mushroom) consumption; and to create a white paper to communicate these findings to HCPs. The theme of the event was: 'Fungi foods: How should they be included in dietary recommendations?'. The event established a need for increased focus on fungi foods in dietary recommendations, and posed ideas and discussion to realise this opportunity, including how should foods be grouped in dietary recommendation, and how culinary practices impact the nutritional profile of foods. All key findings and recommendations from the event are now being reviewed and summarised for inclusion in the roundtable whitepaper, so that the outcomes can be communicated to HCPs.

The second Audience Sentiment Research (ASR) survey was conducted to track the shift in sentiment, growth of the positive responses, and understanding of the messages that the activity over the past year has delivered. The analysis of survey results is currently in progress, with preliminary results show year on year (2019 to 2020) increases across the board in understanding, knowledge, recommendations and value of mushrooms. Specifically, 91.2% of respondents were able to specify at least one nutritional property of mushrooms (+19.2% from 2019). Vitamin D saw the biggest increase in awareness (+15.7%), more than three times any others, showcasing the impact of the campaign's first year focus. These change in knowledge appear to be impacting behavior, with 53.8% recommend mushrooms to their clients either often, always or sometimes (+7.8% since 2019), and those that never recommend mushrooms but see clients decreased by 10.6%.

Social distancing restrictions due to COVID-19 continued to impact timelines in the second half of 2020. The DU event, planned as our main event to educate HCPs about the SLR findings in 2020, was postponed to May 2021 and this meant that the second ASR survey was conducted without this opportunity to influence the knowledge of HCPs.

## Achievements

### MILESTONE 102: TECHNICAL AND SCIENTIFIC SUPPORT FOR THE AUSTRALIAN MUSHROOMS CAMPAIGN

Dr Flav's Fun Facts: November 2020

#### Background

During the research process for the SLR, interesting research insights ('fun facts') that had potential as stand-alone communication messages were identified and 48 unique fun facts were provided to Hort Innovation in April 2020.

#### Activity completed

The following fun facts have been used to date in engagement and education materials:

1. **World's top pick:** *Agaricus bisporus* is the world's most commonly consumed mushroom.
2. **A natural innovator:** Unlike plants, mushrooms lack chlorophyll and obtain sustenance from complex organic materials of plants and animals.
3. **Three of the same:** Button, cup and flat mushrooms all come from the same mushroom, just left longer to grow!
4. **Nutrition allrounder:** Mushrooms not only provide nutrients found in fruit and vegetables, but also those found in meat and grains too.
5. **Beta-ful on the inside:** The cell wall of mushrooms consists of the soluble fibre beta-glucan.
6. **The special sterol:** While animal foods contain cholesterol, mushrooms contain a unique sterol called ergosterol, that converts to Vitamin D when exposed to light.
7. **A true whole food:** While the 'cap' of mushrooms is a richer source of antioxidants, its stem contains more of the soluble fibre beta-glucan.
8. **Putting the one in ergothioneine:** Mushrooms contain more ergothioneine: a unique sulphur-containing antioxidant – than any other food.
9. **Devoted to vitamin D:** The vitamin D content of dried mushrooms is still 50% of its original value after 18 months.
10. **Tan those mushies:** Place your mushrooms in the sun gills side up to increase their vitamin D content by up to 30%.
11. **Vitamin D all week:** Sunlight-exposed mushrooms can retain vitamin D in the fridge for up to 8 days.
12. **Squeeze it to keep it:** Adding lemon juice to your mushrooms before cooking can help to increase their vitamin D retention.
13. **Nature's supplement:** UV-exposed mushrooms can be as effective as a vitamin D supplement for increasing vitamin D.
14. **Tan your mushrooms:** Putting 1 cup in the sun for 15 mins can provide you with your daily vitamin D needs.
15. **Your gut bacteria loves them:** Mushrooms contain special prebiotics which can act like catnip for your flora.
16. **Fill up with fungi:** Swapping beef for mushrooms has been shown to lower calorie intake, with no difference to satiety.
17. **Looking to eat less meat?** Adding mushrooms to your meals can help to provide a unique umami (or savoury) flavor and maintain a meaty texture.
18. **Unparalleled prebiotic:** Mushrooms contain chitin, a unique prebiotic that's not found in fruits, vegetables or grains.
19. **Healthy heart:** Mushrooms cooked in extra virgin olive oil may help to improve markers of heart health.

20. **Double agent:** Mushrooms are one of the few non-plant foods that also contain polyphenols.
21. **Keep your cool:** Cooking mushrooms at lower heat helps to protect their antioxidant content.
22. **A fun-gi therapy:** Mushroom extract has shown promise to help manage prostate cancer in preliminary experimental trials.
23. **Go for 1, 3 or 5:** One serve (1 cup) of mushrooms is equivalent to just 1 portobello, 3 cup or about 5 button mushrooms.
24. **Know your ABCs:** Windows block UV-B light, so be sure to open your window if you are tanning your mushrooms on the windowsill.
25. **A 5-star food:** Mushrooms contain 5 different types of carbohydrates that may support a healthy microbiome: chitin, beta-glucan, raffinose, oligosaccharides and resistant starch.

**Impact**




The fun facts are an engaging tool that may support both HCP and consumer messaging within the Australian Mushrooms marketing campaign. They have continued to be utilised in a large number of HCP communications in the second half of 2020, including the SLR brochure, SLR video, social media posts to promote both the SLR video and manuscript, Dietitian’s Unite recipe booklet and factsheet, EDMs, and partner advertising materials.

**Dr Flav’s Fun Facts – examples included in EDMs: June to November 2020**

**A TASTE OF WHAT’S INSIDE**

		
<b>Unparalleled prebiotic</b>	<b>Healthy heart</b>	<b>Nature’s supplement</b>
Mushrooms contain chitin, a unique prebiotic that’s not found in fruits, vegetables or grains.	Mushrooms cooked in extra virgin olive oil may help to improve markers of heart health.	UV-exposed mushrooms can be as effective as a vitamin D supplement.

**DR FLAV’S FUN FACTS**

		
<b>Go for 1, 3 or 5</b>	<b>Know your ABCs</b>	<b>A 5-star food</b>
One serve (1 cup) of mushrooms is equivalent to just 1 portobello, 3 cup or about 5 button mushrooms.	Windows block UV-B light, so be sure to open your window if you are tanning your mushrooms on the window sill.	Mushrooms contain 5 different carbohydrates that may support a healthy microbiome: chitin, beta-glucan, raffinose, oligosaccharides and resistant starch <sup>1</sup> .
1. Alda et al. Trends in Food Sci Tech. 2009;20(11-12):567-575.		



**Social media impact:** (June to November 2020)

**Dr Emma Beckett**

Dr Emma Beckett is an Accredited Practising Dietitian and Lecturer in Food Science and Human Nutrition at the University of Newcastle. Dr Beckett has shared multiple content from the mushrooms campaign, including:

- The Insight Vitamin D article across her Facebook and Twitter social media platforms.
- Some fun facts about mushrooms and vitamin D on Twitter to her 18.5K followers (30<sup>th</sup> June 2020). The post received 1.1K likes, 75 comments, 211 retweets and 39 quote tweets.

**Facebook - Insight Vitamin D**



**Twitter – Insight Vitamin D**



**Mushroom Fun Facts - Twitter**

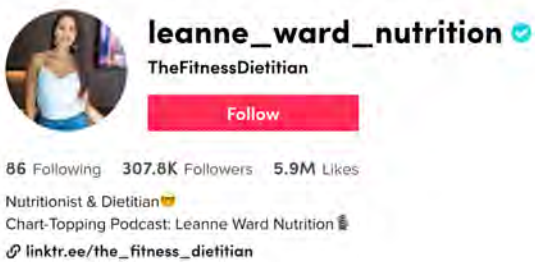


Dr Beckett was also asked about mushrooms and vitamin D during a local Central Coast radio station interview. The interviewer asked questions about the mushroom posts listed above that Emma shared on her social media. The audio for this interview is available on request.

### Leanne Ward, The Fitness Dietitian

Leanne Ward is an Australian media dietitian, nutritionist, sports dietitian and online social media influencer known as *The Fitness Dietitian*. Leanne shared a TikTok video on social media to her 307.8K followers about mushrooms and vitamin D. In the video, Leanne recommended placing mushrooms in the sun for 15 minutes before you eat them to get your daily vitamin D. The video has 51.2k views, 4960 likes and 65 comments (8<sup>th</sup> November 2020).

### TikTok – Mushrooms and Vitamin D



### Australian Mushroom's Media Release: September 2020

Scientific peer-review was provided to Hort Innovation for the Australian Mushroom Media Release titled 'New research shows everyday mushroom can be as effective as vitamin D supplements.' (**Appendix 1**).

### National Mushroom Day

On National Mushroom Day (15<sup>th</sup> October), Dr Flavia Fayet-Moore alongside Chef Matt Donovan talked about the nutrition benefits of mushrooms on Studio 10, an Australian morning talk show on Network 10. This event was supported by the Australian Mushroom Grower's Association, and the research insights unveiled from this project were used to draft the key messages and script for the interview. Studio 10 averages an audience reach of approximately 60,000 viewers per day.

**Studio 10 TV appearance:** 15<sup>th</sup> October



A copy of the television segment, can be viewed at the following website:

<https://www.northqueenslandregister.com.au/story/6988706/national-mushroom-day-given-air-time/?cs=4752>

## **MILESTONE 102: PERIODIC COMMS PROGRAM – PLANNING, LIAISON, INTEGRATION & CONTENT DEVELOPMENT**

### **1. Building the database of healthcare professionals for Australian Mushrooms: Ongoing**

The HCP database is a key channel for communicating information and promoting events throughout the project. The total number of people on the database is 1,404 subscribers, a 6.6% increase since July 2020. The growth in the database is a direct result of the Audience Sentiment Research survey campaign incentive. Participants were required to subscribe to the database for a chance to win a visa gift card and mushroom grow kit prize, which was part of the key messaging of the social and EDM campaign (i.e., Complete the survey for your chance to win).

A complete summary of the data from all our digital activity are provided in **Appendix 2**.

### **2. Australian Mushrooms Journal: September 2020**

An update on the project was provided in September 2020 for the Australian Mushroom’s Journal via Chris Rowley. A further update is planned for the issue scheduled for early December 2020.

### **3. EDM’s: Ongoing**

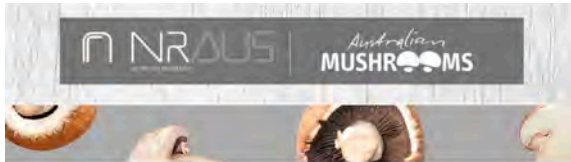
Four EDMs were developed and sent to the HCP database:

**SLR brochure and manuscript EDM:** 26<sup>th</sup> July 2020



The SLR brochure and manuscript EDM (Appendix 3) was created to communicate the newly published, world first SLR manuscript and accompanying SLR brochure.

The EDM was sent to 1317 recipients, with 436 recipients opening the email (33.1% open rate vs. industry average of 20-25%). A total of 199 recipients clicked a link, with 66 recipients who clicked a link to view the SLR brochure, 43 recipients who clicked to download the full manuscript, and the remaining who clicked to access the mushroom hub and footer links.



**JUST PUBLISHED:  
THE WORLD'S FIRST SYSTEMATIC  
REVIEW ON AGARICUS BISPORUS**

**WHAT'S SO SPECIAL ABOUT  
AUSTRALIA'S MOST POPULAR FUNGI?**

Dear ,

You probably know that mushrooms are not your typical vegetable. Being a fungi, mushrooms are not classified as a vegetable at all, and have nutritional properties similar to whole grains, animal foods and nuts, too.

But what you may not know is the science behind a mushroom's unique nutritional and health properties. Indeed, there has never been a systematic review published on the world's most popular mushroom, *Agaricus bisporus* - which includes the flat, swiss brown, cup, white button and portobello mushroom varieties.

It's our pleasure to share with you this newly published world-first systematic review, hot off the press!

**WHAT WAS DONE?**

Combining the data from 68 studies on *Agaricus bisporus*, this systematic review is a comprehensive look at decades of work.

In it, you'll learn all about the world's most popular mushroom, including:

- What are its key bioactive components?
- What are its seven different health effects?
- How strong is the evidence from human studies?

Time poor? We've created a downloadable brochure that takes you through the key findings at a glance.

**DOWNLOAD THE FREE BROCHURE**

Want the full details? Read the complete systematic review published in *The Journal of Nutritional Biochemistry*.

**CLICK HERE TO READ THE FREE PAPER**

Available to download for free

**A TASTE OF WHAT'S INSIDE**

**Unparalleled prebiotic**

Mushrooms contain chitin, a unique prebiotic that's not found in fruits, vegetables or grains.

**Healthy heart**

Mushrooms cooked in extra virgin olive oil may help to improve markers of heart health.

**Nature's supplement**

UV-exposed mushrooms can be as effective as a vitamin D supplement.

**Hungry for more?**  
Visit our mushroom hub

[www.nraus.com/mushroomhub](http://www.nraus.com/mushroomhub)

It's got all the latest mushroom resources in one place, developed especially for professionals like you.

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**CONTACT US**      **MEDIA ENQUIRIES**      **WEBSITE**

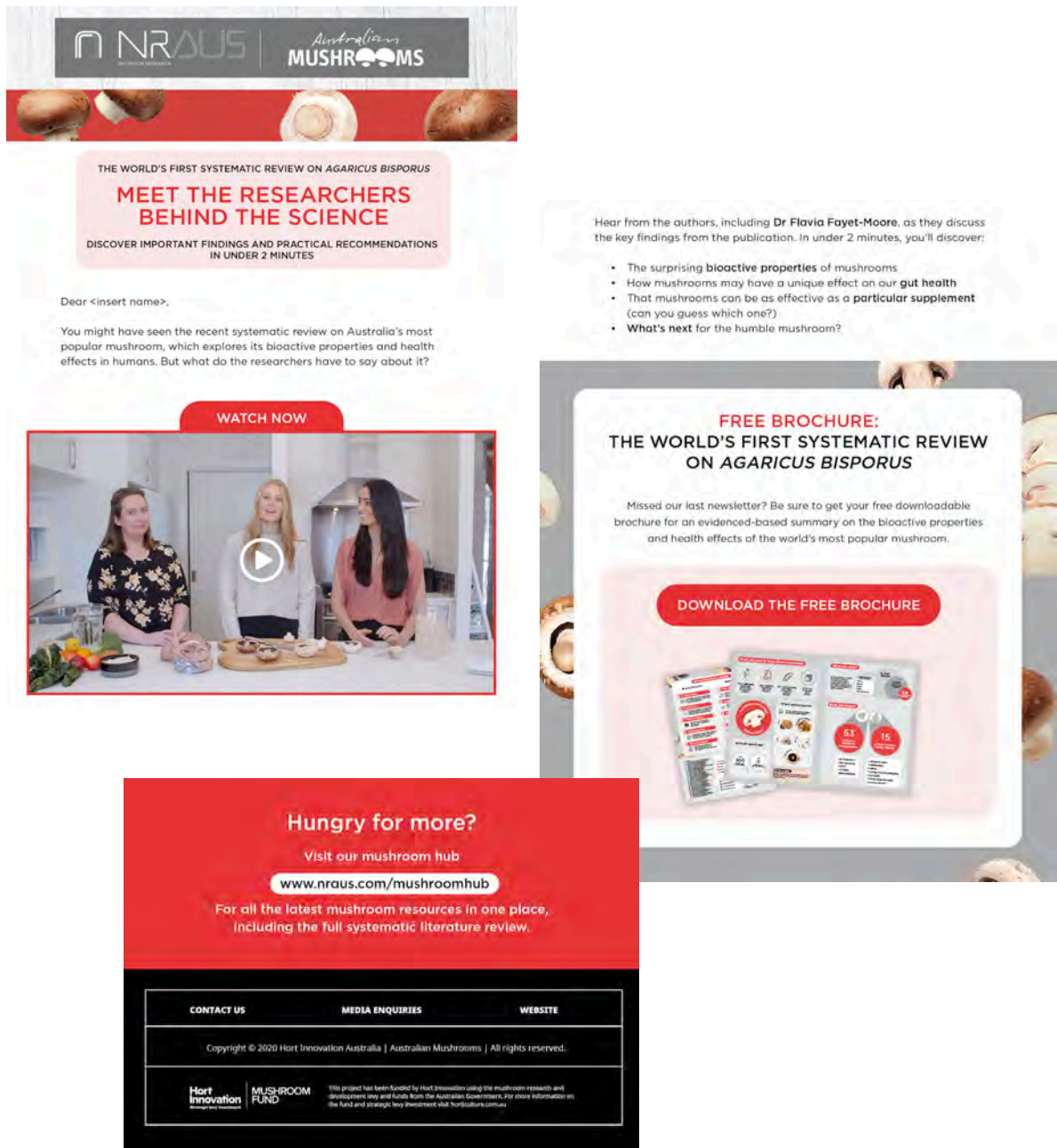
Copyright © 2020 Hort Innovation Australia | Australian Mushrooms | All rights reserved.

This project has been funded by Hort Innovation using the mushroom research and development levy and funds from the Australian Government. For more information on the fund and its usage, visit [www.horticulture.com.au](http://www.horticulture.com.au)

**SLR video:** 1<sup>st</sup> September 2020

The *SLR video EDM (Appendix 4)*, titled ‘Meet the researchers behind the science’, was created to share the innovative and exciting research insights in the SLR from a different perspective than the manuscript and accompanying brochure. The SLR video showcased the scientific credibility of the research team and methodology, while allowing people to meet those behind the science and connect with the researchers. It provided a credible voice to communicate one of the campaign’s key messages, that mushrooms aren’t just a vegetable, and for that reason they have unique nutritional properties and health benefits.

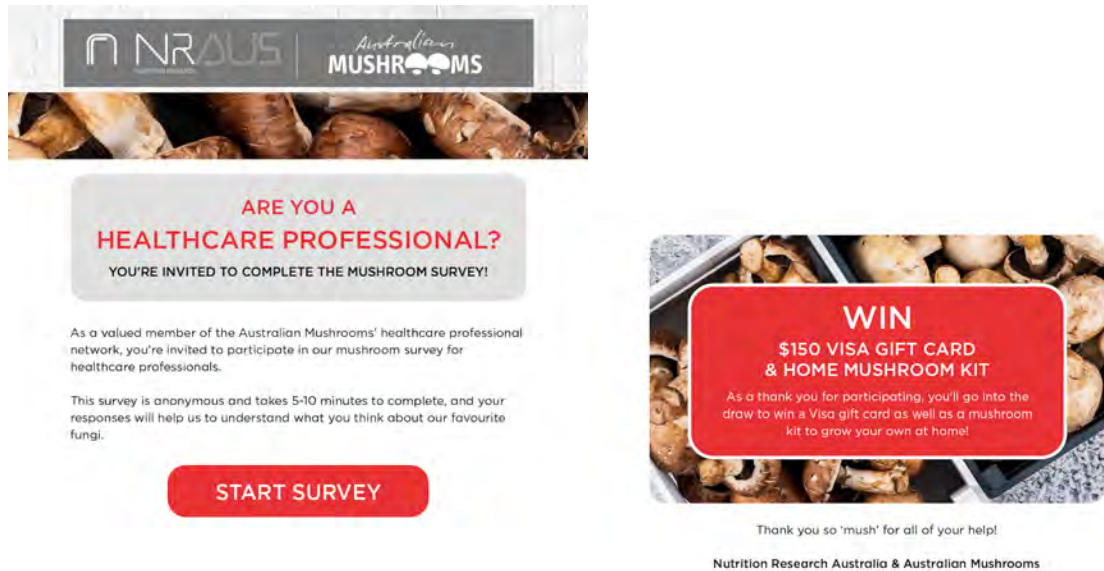
The EDM was sent to 1285 recipients, with 366 recipients opening the email (28.5% open rate vs. industry average of 20-25%). A total of 141 recipients clicked a link, with 76 recipients who clicked to view the SLR video, 30 recipients who clicked to download the SLR brochure and the remaining who clicked to access the mushroom hub and footer links.



**ASR survey invite: 5<sup>th</sup> October 2020**

An EDM was created to promote Audience Sentiment Research survey (**Appendix 5**). This included a link to the survey, promotion of the prize and three fun facts on mushrooms.

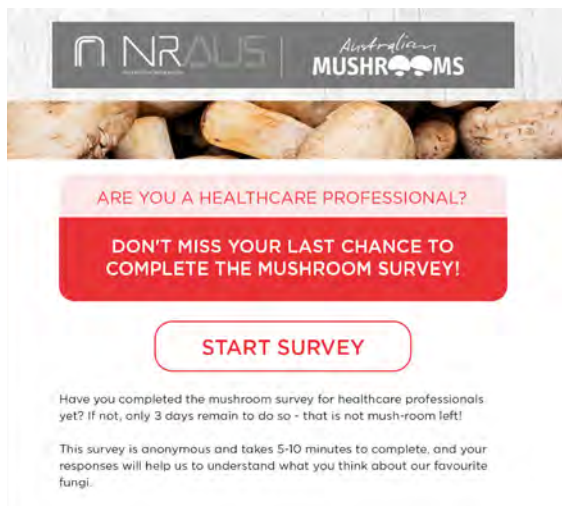
The EDM was sent to 1271 recipients, with 419 recipients opening the email (33.0% open rate vs. industry average of 20-25%). 138 recipients clicked a link that took them to the survey.



**ASR survey reminder EDM: 20<sup>th</sup> October 2020**

A reminder EDM to complete the Audience Sentiment Research survey was completed (**Appendix 6**). This included a link to the survey and three fun facts on mushrooms.

The EDM was sent to 1261 recipients, with 385 recipients opening the email (30.5% open rate vs. industry average of 20-25%). 71 recipients clicked a link that took them to the survey.



Thank you so 'mush' for all of your help!  
Nutrition Research Australia & Australian Mushrooms



#### 4. Communications: September 2020

##### Video

To help share the SLR research from a different perspective to the published manuscript and accompanying SLR brochure, a 90 second video titled *'Meet the researchers behind the science of mushrooms'* was created. The SLR video showcased the scientific credibility of the team and the scientific rigour of the research, while allowing HCPs to meet the researchers behind the science. It was an additional item to the communications plan.

The SLR video was promoted to HCPs through a targeted social media strategy. The spend was primarily via Facebook, with some small LinkedIn advertising that was turned off after 5 days to optimise the better performing Facebook campaign with the remaining budget. The social media posts linked directly to the SLR video.

A summary of the reach from the paid Facebook advertising campaign is below:

- Link clicks: 1,887
- Total reach: 34,128 people (KPI: 20k)
- Total impressions: 78,356
- CTR (Link Click-Through-Rate): 2.41% (Industry standard 1%; Mushroom campaign average 2.31%)
- Cost per result: \$0.53 (KPI: \$1)
- 3-sec video plays: 22,499 (KPI: 15k)
- Average seconds watched: 9 seconds

A summary of the reach from the 5-day paid LinkedIn advertising campaign:

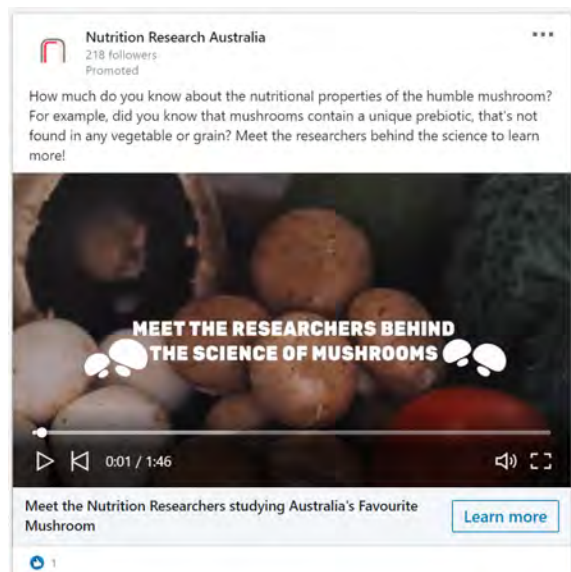
- Link clicks: 39 clicks
- Impressions: 9,135
- CTR (Link Click-Through-Rate): 0.43% (Industry standard 3 – 5%)
- Cost per result: \$0.09

Despite LinkedIn having capabilities to directly target HCPs, below industry average engagement was experienced using this strategy. This was identified early through close monitoring of initial results, which enabled resources to be re-directed to the better performing Facebook campaign. The paid Facebook advertising campaign once again exceeded KPI's and will be considered the preferred platform in 2021.

### Facebook Ad



### LinkedIn Ad



### Facebook comments – GP and HCP audience



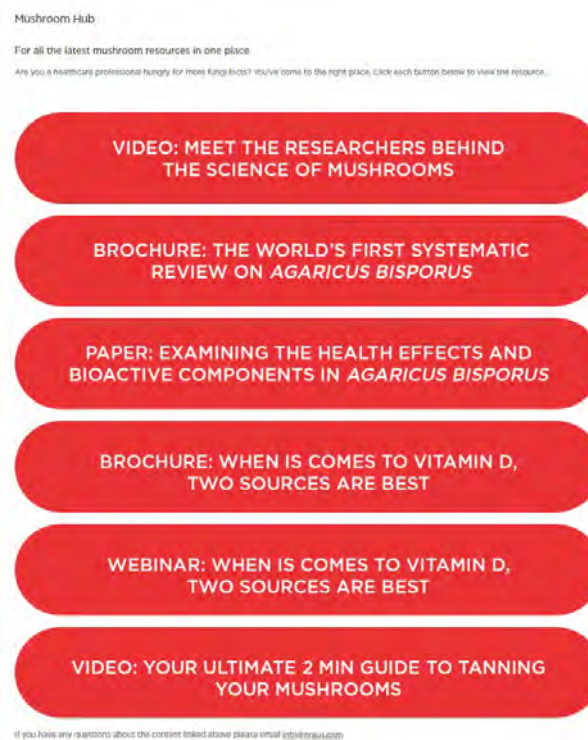
Facebook comments – Dietitian audience



Mushroom Hub

A landing page on the NRAUS website has been created to house all the latest mushroom resources in one place, so HCPs have timeless access to these resources. The landing page is called the ‘Mushroom Hub’ and first went live on the 2<sup>nd</sup> July 2020.

Mushroom Hub landing page



## **NUTRITIONiQ**

Our NUTRITIONiQ service has continued to collate relevant papers as new research is published on *A. bisporus* mushrooms. This ensures that the comprehensive research database created from the SLR stays current during the course of this project and beyond, if funds are available.

Since the SLR was conducted in June 2019, the NUTRITIONiQ service has screened 496 records, with 227 records screened between the 1<sup>st</sup> July 2020 and 20<sup>th</sup> November 2020. No new papers were identified that met the inclusion criteria from our published SLR. Eleven articles were located that were relevant to health or the nutritional effects of *A. bisporus* mushrooms. These included one preclinical study, three *in vitro* studies and seven articles relevant to the nutritional characteristics of *A. bisporus* mushrooms. The primary reasons for papers not being relevant included studies published prior to 2019, or papers not related to mushrooms. The main mushroom used in the majority of preclinical and *in vitro* studies was *Agaricus Blazei*, and the studies investigated cancer-fighting properties, glucose control, antioxidant activity, lipid regulation, and immune-modulation.

### ***Impact***

This comprehensive and growing *A. bisporus* database is a valuable resource that contains every study ever published on the *A. bisporus* mushroom and health related outcome or bioactive component. The database currently contains over 590 articles. This can be used as a scientific resource to inform future opportunities, such as the webinar on the science of mushrooms in 2021.

### ***Next steps***

The *A. bisporus* research database will be updated on a monthly basis until the end of the project (unless otherwise requested) so that it remains current.

## **MILESTONE 103: SYSTEMATIC LITERATURE REVIEW BROCHURE**

### ***Background***

The key messages from the SLR were designed and brought to life in a brochure for HCPs. The bespoke branded 8-page brochure included information relating to: (i) the unique classification of mushrooms and the current research gap, (ii) the study methodology and results, (iii) an easy way to memorise the unique bioactive profile of *A. bisporus* mushrooms, (iv) a graphical comparison of the quantities of its bioactive properties with other foods, (v) a summary of the 15 human studies across the seven beneficial health outcomes, and (vi) ten memorable mushroom messages that HCPs can share with clients.

### ***Activity completed***

The SLR brochure has been completed (**Appendix 7**). A PDF of the brochure was communicated to HCPs alongside the manuscript as part of the SLR communications activation, which included the SLR brochure and manuscript EDM (66 brochure downloads), SLR video EDM (30 brochure downloads) and social media advertisement. Timeless access to the SLR brochure is available on the Mushroom Hub and a further 300 copies of the brochure were printed on 100% recyclable, matte high-quality paper to be distributed at the Dietitian's Unite (DU) event in 2021. It can also be shared at future HCP events.

Systematic Literature Review Brochure: July 2020

**THE WORLD'S FIRST SYSTEMATIC REVIEW ON AGARICUS BISPORUS**

What's so special about Australia's most popular fungi?

Read the full paper  
Link: [bit.ly/mushroomsresearch](http://bit.ly/mushroomsresearch)

Shumfeld et al., J Nutr Biochem 2020;84:105163

**MNR** **MUSHROOMS**

**What you need to know about mushrooms**

- NOT A VEGETABLE** But contains: essential starch, phytochemicals, potassium
- NOT AN ANIMAL** But contains: Vitamin B12, Vitamin D
- NOT A WHOLE GRAIN** But contains: beta-glucans, prebiotics, cellulose
- NOT A NUT** But contains: copper, selenium

**What is Agaricus bisporus?**

Mushrooms are a fungus. They are unique.

It's the world's most popular mushroom and includes:

- Button
- Portobello
- Crab
- Wild Bunch/Cremati
- Shiitake
- Puffball

**What's the research gap?**

Over 300 studies exist on mushrooms. Yet 0 identify the health benefits of Agaricus bisporus.

**FUN-GI FACT**  
Button, crab and flat mushrooms all come from the same mushroom, just grown for different lengths of time.

**What was done?**

5,707 records found  
1,037 full text articles screened  
68 articles included in the review

**What was found?**

53 articles on bioactive components  
15 articles on human health effects

**ANTIOXIDANTS**  
BETA-GLUCANS  
CHITIN  
VITAMIN D  
ERGOTHIONEINE

- Vitamin D status
- Inflammation
- Satiety
- Cancer risk & its metabolites
- Gut health
- Cardiometabolic health
- Immune function

**What are the key bioactives in Agaricus bisporus?**

A	B	C	D	E
ANTIOXIDANTS	BETA-GLUCANS	CHITIN	VITAMIN D	ERGOTHIONEINE
<b>What is it?</b> An array of antioxidants usually reported as flavonoids and polyphenols, including catechin, myricetin, quercetin & kaempferol. Mushrooms are one of the few non-plant foods that contain antioxidants.	<b>What is it?</b> A soluble fibre, commonly found in oats, that has cholesterol lowering properties.	<b>What is it?</b> A unique prebiotic polysaccharide that makes up the cell wall of fungi - it's like cellulose in plants. It's not found in any other foods, except for insects and yeasts.	<b>What is it?</b> The sunshine vitamin. Mushrooms naturally contain vitamin D2, with levels increased up to 30 times after the surface of the mushroom is exposed to UVB light (i.e. sunlight).	<b>What is it?</b> An antioxidant that can only be made by some fungi and bacteria. Mushrooms are the largest dietary source.
<b>How much?</b> 0.2mg Kamameshi in Agaricus Bisporus vs. Shiitake (100g wet weight)	1-1.5g Beta-glucans in Agaricus bisporus vs. Oats (100g dry weight)	6-120mg Chitin in Agaricus bisporus vs. Edible insects (100g wet weight)	243 IU Vitamin D2 in Agaricus bisporus vs. Sun-Egg (100g wet weight)	15.4mg Ergothioneine in Agaricus bisporus vs. Tomahawk (100g dry weight)
<b>How to maintain in cooking?</b> Cook for a shorter amount of time!	Not affected by cooking!	Increases with cooking, regardless of whether the mushroom was fresh, frozen or canned!	Using UVB-irradiated mushrooms, squeeze some lemon juice in the pan, cook at lower temperatures and for shorter times!	Cook for a shorter amount of time!
More vitamin D!		More ergothioneine!		
<b>WHICH TYPE IS BEST?</b> Portobello		<b>WHICH PART IS BEST?</b> 28% more antioxidants on the cap 40% more beta-glucans in the stem on the cap!		<b>FUN-GI FACT</b> The stem is a valuable source of bioactives. Don't waste it!

**What is the evidence for Agaricus bisporus and human health?**

Health outcomes	Reference	Study Type	Quality of Study*	Sample Size	Population	Intervention	Control	Result
1 Vitamin D status	Stephensen et al. (2012)	RCT	Higher	28	Healthy adults	80 g/day UV white button mushrooms for 8 weeks	Non-UV white button	↑ serum 25(OH)D
	Keegan et al. (2013)	RCT	Lower	25	Healthy adults	2000 IU vit D2 (UV white button mushroom extract for 12 wks)	Vitamin D supplement	↑ serum 25(OH)D (equivalent to a supplement)
	Urban et al. (2017)	RCT	Higher	36	Healthy adults	28 000 IU vit D2 (UV white button mushrooms for 5 wks)	Non-UV white button's placebo supplement	↑ serum 25(OH)D
2 Inflammation	Shamety et al. (2014)	RCT	Neutral	14	Adults deficient in vitamin D	600 IU vit D2 (UV powdered porcini mushroom for 4 wks)	Placebo	↑ serum 25(OH)D
	Calvo et al. (2016)	RCT	Higher	37	Adults with metabolic syndrome	100 g/day UV white button mushrooms for 16 wks	Vitamin D supplement	↓ ergothioneine, OSA, adiponectin, ↓ oxidative stress factors
	Volman et al. (2010)	RCT	Neutral	16	Adults with hypercholesterolemia	Juice with 6 g/day of β-glucans extracted from white button mushrooms for 5 wks	Juice without β-glucans extracted from white button	↑ TNF-α, ↓ IL-1, IL-6 and IL-8
3 Satiety	Weigand-Heller et al. (2012)	RCT	Neutral	20	Healthy adults	8 g and 16 g/day powdered mushrooms over 3 days	Placebo	↑ oxygen radical absorbance capacity, ↑ ergothioneine
	Hess et al. (2017)	RCT	Neutral	70	Healthy adults	228 g/day mushrooms for 10 days	Low (w/ and w/out protein match)	↓ satiety, ↑ energy intake
4 Cancer risk & its metabolites	Cherkin et al. (2008)	RCT	Neutral	102	Healthy adults	148 g/day white button mushrooms for 4 days	Low (volume matched)	↑ energy intake
	Lee et al. (2015)	Case-control	Higher	1000	Cases of ovarian cancer	N/A	Healthy adults (no ovarian cancer)	↑ ovarian cancer risk of 1.6x if 12 g/day after 2 years
5 Gut health	Twardowski et al. (2015)	Phase 1 trial	Higher	35	Adults with elevated prostate specific antigen	4-14 g/day powdered white button for 10 months	N/A	↓ prostate specific antigen
	Hess et al. (2017)	RCT	Neutral	70	Healthy adults	228 g/day mushrooms for 10 days	Low (w/ and w/out match)	↑ faecal weight and microbial composition
6 Cardiometabolic markers	Nofrains et al. (2017)	RCT	Lower	40	Adults with pre-diabetic, fasting or body colour	50 to 1000 mg/day mushroom extract for 4 weeks	Placebo	↑ colour and bowel tone
	Abd-Allah et al. (2018)	Non-randomised trial	Lower	50	Not specified	2 g/day dried weight mushroom (on olive oil) for 30 days	Lowest diet	↑ glucose, LDL cholesterol, triglycerides, body weight, ↓ HDL cholesterol
7 Immune function	Weigand-Heller et al. (2018)	RCT	Neutral	20	Healthy adults	8 g or 16 g/day powdered mushrooms for 3 days	Placebo	↑ cholesterol and phytoestrogens
	Jeong et al. (2018)	RCT	Higher	20	Healthy adults	100 g/day white button mushrooms for 7 days	Lowest diet	↑ salivary IgA secretion

\*Quality of study assessed using the Quality Criteria Checklist by the Academy of Nutrition and Dietetics.






**MILESTONE 104: SYSTEMATIC LITERATURE REVIEW MANUSCRIPT SUBMISSION**

**Activity completed**


The accepted SLR manuscript was published open access in the Journal of Nutritional Biochemistry, making it freely available online: <https://doi.org/10.1016/j.jnutbio.2020.108453> (Appendix 8).

The publication has been shared to HCPs alongside the SLR brochure, in the SLR manuscript and brochure EDM, and in social media advertisement. It is also available in the Mushroom Hub.

**Systematic Literature Review Open Access Publication: August 2020**



ELSEVIER



Available online at [www.sciencedirect.com](http://www.sciencedirect.com)

**ScienceDirect**

Journal of Nutritional Biochemistry 84 (2020) 108453

**Journal of  
Nutritional  
Biochemistry**

REVIEWS: CURRENT TOPICS

**Examining the health effects and bioactive components in *Agaricus bisporus* mushrooms: a scoping review☆**

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<sup>d</sup>BSc(Hons), BAppSc, Nutrition Research Australia, Sydney, New South Wales, Australia  
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Received 8 March 2020; received in revised form 19 May 2020; accepted 8 June 2020

**Abstract**

There is evidence from both *in vitro* and animal models that the consumption of edible mushrooms has beneficial effects on health. It is unclear whether similar effects exist in humans and which bioactive compounds are present. This review synthesises the evidence on the world's most commonly consumed mushroom, *Agaricus bisporus* to (i) examine its effect on human health outcomes; and (ii) determine the nutrient density of its bioactive compounds, which may explain their health effects. A systematic literature search was conducted on the consumption of *A. bisporus*, without date and study design limits. Bioactive compounds included ergosterol, ergothioneine, flavonoids, glucans and chitin. Two authors independently identified studies for inclusion and assessed methodological quality. Beneficial effects of *A. bisporus* on metabolic syndrome, immune function, gastrointestinal health and cancer, with the strongest evidence for the improvement in Vitamin D status in humans, were found. Ultraviolet B (UVB) exposed mushrooms may increase and maintain serum 25(OH)D levels to a similar degree as vitamin D supplements. *A. bisporus* contain beta-glucans, ergosterol, ergothioneine, vitamin D and an antioxidant compound usually reported as flavonoids; with varying concentrations depending on the type of mushroom, cooking method and duration, and UVB exposure. Further research is required to fully elucidate the bioactive compounds in mushrooms using vigorous analytical methods and expand the immunological markers being tested. To enable findings to be adopted into clinical practice and public health initiatives, replication of existing studies in different population groups is required to confirm the impact of *A. bisporus* on human health.

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**Keywords:** Systematic review; *Agaricus bisporus*; Mushroom; Health; Human; Bioactive

## MILESTONE 104: DIETITIAN’S UNITE BREAKFAST SEMINAR

Dietitian’s Unite Breakfast 2020 (DU2020): July 2020 – November 2020

### Background

A joint breakfast event at Dietitian’s Unite, a nutrition conference event run by Dietitian Connection. The breakfast event will be sponsored by Australian Mushrooms in partnership with Simplot Australia and will focus on culinary nutrition. The breakfast is titled: *‘Is taste the forgotten message?’* with the general theme of the breakfast: *‘How do you use veggies and make them taste good?’*

In addition to the breakfast, Australian Mushrooms will have a trade stand to further provide information about the benefits of mushrooms. Following the event, an EDM will be sent out to attendees from Dietitian Connection, who run the event.

Due to COVID-19, the event has been rescheduled to the 31<sup>st</sup> May 2021.

### Activity in-progress

Despite the event being delayed due to COVID-19, we have progressed with the following activities since June 2020:

**Recipe booklet and fact sheet.** In partnership with Simplot, an A5 format, 16-page recipe booklet and an A4 single page, double sided factsheet, have been developed as resources for the event. The recipe booklet has been completed (**Appendix 9**), while the factsheet is in the final stages of design.

Three-hundred copies of the recipe booklet will be printed on 100% recyclable, matte high-quality paper to be distributed at the Dietitian’s Unite (DU) event in 2021.

### DU Recipe booklet: October 2020





1 portobello mushroom or 3 cup mushrooms



1 cup of green leafy or raw salad vegetables



1/2 cup or 75g of cooked, frozen or canned vegetables (includes legumes)

**WHAT'S A SERVE?**

### What's a serve of vegetables and mushrooms?

The Australian Dietary Guidelines recommends adults aim for at least 5 serves of veggies every day, including different colours and types.

1 serve is about 75 grams, or

- 1/2 cup cooked vegetables (such as broccoli, carrot or pumpkin)
- 1 cup salad vegetables
- 1 cup uncooked mushrooms
- 1/2 cup cooked beans/legumes
- 1/2 medium potato or other starchy vegetable

**5 ways to achieve 5 serves:**

1. Focus on frequency: Enjoy vegetables or mushrooms at least 2-3 times a day.
2. Fill half the plate: Aim for your veggies or mushrooms to make up half your plate.
3. Snack attack: From capers or carrot sticks, to cherry tomatoes or celery with peanut butter, make veggies your next snack option.
4. Up your legumes: Include legumes 2-3 times a week.
5. Spice up your life: Embrace a variety of different coloured vegetables, every day.



VEGETABLE SERVES



### Savoury Cauliflower Pancakes with Mushrooms

PREPARATION 20 min • COOKING 20 min • SERVES 4

500g packet frozen Birds Eye Cauliflower Veggie Rice

3 eggs, lightly beaten

1 cup grated tasty cheese

2 tablespoons self-raising flour

1/2 teaspoon paprika

1/4 teaspoon dried oregano

3 tablespoons extra virgin olive oil

200g Swiss brown mushrooms, sliced

Breakfast sides, of choice e.g. tomatoes or wilted spinach.

1. Defrost frozen Birds Eye Cauliflower Veggie Rice in the refrigerator. Once defrosted, squeeze excess moisture from cauliflower rice using a muslin cloth, clean chux or through a fine sieve.
2. In a medium bowl, combine cauliflower rice, eggs, cheese, flour, paprika and oregano. Season to taste. Form mixture into 4 x 10cm patties.
3. Heat 1 tablespoon oil in a non-stick frypan over medium-high heat. Cook pancakes one at a time. Spoon a quarter of the mixture into the pan pressing down with a spatula to flatten to 10cm x 1cm thick. Cook for 2-3 minutes on both sides until golden brown. Add more oil to frypan between cooking pancakes, if required. Remove pancakes from pan, place onto absorbent paper and keep warm.
4. Wipe frypan clean, heat remaining oil and add mushrooms. Cook for 4-5 minutes stirring regularly until golden. Serve mushrooms with cauliflower pancakes and breakfast sides of choice.



VEGETABLE SERVES



### Mushroom 'Steak' Sandwich with Pea Pesto

PREPARATION 15 min • COOKING 10 min • SERVES 4

2 cups frozen Birds Eye Garden Peas

1 cup baby rocket leaves

1 small clove garlic, peeled

1/4 cup finely grated parmesan cheese

1/4 cup pine nuts, toasted

3 tablespoons extra virgin olive oil

4 portobello mushrooms

4 slices sourdough bread, toasted

Watercress and shaved radish, for serving

1. Drain cooked Birds Eye Peas and set 1/2 cup peas aside. Place remaining peas, rocket, garlic, parmesan, pine nuts and 2 tablespoons of oil in a food processor and process until pulsed. Season to taste. Stir reserved peas through pea pesto.
2. Place mushrooms on a baking paper lined tray and drizzle with remaining oil. Place under a preheated grill on high and cook for 2 minutes on either side until lightly browned.
3. Spread pea pesto on bread, top with mushrooms, watercress and radish. Serve immediately.



VEGETABLE SERVES

**TIP:** Use leftover pea pesto on toast with eggs as an alternative to smashed avocado.



### Mushrooms: The nutritional all rounder

Being classified as a fungi and not a plant, mushrooms contain nutritional properties that other vegetables don't:

1. Nutritionally unique: Mushrooms provide nutrients commonly found in vegetables, like fibre and potassium, but also some typically found in other food too, like vitamin B12 and selenium.
2. The special sterol: Mushrooms contain a unique sterol called ergosterol, that converts to vitamin D when exposed to sunlight.
3. Beta-glucan on the inside: The cell wall of mushrooms contains a special soluble fibre called beta-glucan, that is also found in oats.



VEGETABLE SERVES

**Looking to eat less meat?**  
 ✓ Adding mushrooms to your meals can help provide a satiating protein source and maintain a meaty texture.



### Sweet Potato Rice & Mushroom Nourish Bowl

PREPARATION 10 min • COOKING 15 min • SERVES 4

2 tablespoons extra virgin olive oil

200g Swiss brown mushrooms, halved

1 tablespoon salt reduced soy sauce

500g packet frozen Birds Eye Sweet Potato Veggie Rice

1 cup baby spinach leaves, roughly chopped

1 avocado, sliced

2 cups, finely shredded red cabbage

Roasted sesame dressing, for serving

1. Heat 1 tablespoon oil in a non-stick frypan over medium-high heat. Add mushrooms, and cook, stirring regularly for 4-5 minutes or until golden. Add soy sauce and stir to coat. Remove from pan, set aside and keep warm.
2. Add remaining oil to same frypan. Add frozen Birds Eye Sweet Potato Rice and cook for 6 minutes, stirring regularly.
3. Stir through spinach and continue to cook for a further 2 minutes.
4. Divide cooked sweet potato rice, mushrooms, avocado and cabbage in serving bowls. Drizzle over dressing and serve immediately.



VEGETABLE SERVES

**TIP:** Roasted sesame dressing can be found in the Asian aisle of most major supermarkets.



### Chick Pea, Mushroom & Sweet Potato Curry

PREPARATION 20 min • COOKING 40 min • SERVES 4

1 tablespoon oil

1 onion, diced

1 small bunch fresh coriander

1/2 cup korma paste

1kg sweet potato, peeled and cut into chunks

400ml coconut milk

1/2 cup water

400g can Edgell Chick Peas, drained

200g white button mushrooms, halved

Steamed brown rice, for serving

Chopped peanuts, for garnish

1. Heat oil in a large non-stick frypan over medium heat. Add onion and cook for 5 minutes or until soft. Finely chop coriander roots and add to onion. Cook for 1 minute. Stir in curry paste and cook for 1 minute or until aromatic.
2. Stir in sweet potato, coconut milk and water. Bring to the boil. Reduce heat and simmer covered for 20 minutes. Add Edgell Chick Peas and mushrooms and cook uncovered for a further 10 minutes or until potato is tender.
3. Chop half the remaining coriander, reserving some sprigs for garnish, and stir through curry. Serve with steamed brown rice and garnish with remaining coriander sprigs and peanuts.



VEGETABLE SERVES

**TIP:** Serve curry with cooked Birds Eye Cauliflower and Broccoli Floret as an alternative to brown rice.



**Activities that have been put-on hold from July 2020 until January 2021.**

- **Presentation:** The DU presentation that Dr Flavia Fayet-Moore will present during the breakfast session. The presentation outline has been developed and the initial stage of design has been completed.
- **Chef:** The celebrity chef who will run the cooking demonstration remains unconfirmed. Should Miguel Maestro be unavailable, Tawnya Bahr has been approached as an alternative.
- **Trade stand:** The objective of the trade stand is to inspire mushroom consumption and recommendations by providing information and tips, and to grow the Australian Mushrooms database. The Australian Mushrooms trade stand set up is in its final stages.
- **Evaluation:** The presence of Australian Mushrooms at the DU event will be evaluated. The evaluation plan has been completed.

**Next steps**

To finalise preparations for the DU event, including event logistics, factsheet, celebrity chef, panel discussion and run sheet. Despite the delay in timelines due to COVID-19, we are on track to deliver a high-quality event in 2021.

**MILESTONE 104: SMALL SYDNEY ROUNDTABLE**

**Background**

Fungi is a kingdom separate to both animals and plants. They offer unique nutritional, health and culinary properties, yet are largely ignored by current dietary guidelines, with mushrooms classified as a vegetable.

The objective of the small Sydney roundtable was to bring together experts across nutrition research, food science and culinary nutrition to establish clear and authoritative recommendations on fungi (specifically mushroom) consumption; and communicate these findings to HCPs. The theme of the event was: 'Fungi foods: How should they be included in dietary recommendations?'

The event was closed and intimate, with attendees limited and each receiving a personalised invite. Expert speakers were asked to deliver a short presentation that addressed several important questions on the topic. The presentations were followed by a roundtable discussion. The purpose of the roundtable discussion was to come to a consensus on evidenced-based fungi recommendations, specifically:

- How should fungi food be classified in dietary guidelines?
- How should fungi foods be recommended?
- How can we implement these recommendations?

The aim was to hold the event in person for maximum effectiveness. Therefore, the event was initially delayed until COVID-19 social distancing restrictions were lifted around the country. However, due to state border closures and ongoing COVID-19 restrictions, the event was held virtually. No target number of attendees were set; while the focus was on inviting a small, select number of experts to ensure everyone had the opportunity to contribute to the discussion.

Findings from the roundtable will be communicated to HCPs after the event via the roundtable white paper.

**Activity completed**

The event was held virtually on the 25<sup>th</sup> November 2020 from 12pm to 2pm AEDT.

In preparation for the event, NRAUS developed an event overview, the run sheet, agenda, speaker and facilitator briefs, confirmed the speaker and guest list, sent invitations, developed Dr Flavia Fayet-Moore’s speaker presentation and finalised the event, technology and communications plan. Each guest was sent a ‘grow your own’ mushroom kit and recipe card as a thank you for their attendance.

**‘Grow your own’ mushroom kit and recipe card: November 2020**



There was a total of 15 highly influential guests and speakers (excluding NRAUS and HWBK staff) who attended the event, including media nutritionists and researchers.

The event was facilitated by Dr Emma Beckett and speakers presented on the following topics:

- The facts on fungi: What are they and what makes them unique? (Glenn Cardwell)
- How healthy are fungi? Examining their bioactive and health benefits (Dr Flavia Fayet-Moore)
- Beyond nutrients: The role of fungi in culinary nutrition (Jim Fuller)
- Native mushrooms: The consumption of fungi in Indigenous culture (Arpad Kalotas)
- Translating science into dietary advice: Where and how would fungi foods fit? (Prof Linda Tapsell)

**Presentation:** The aim of Flavia’s presentation was to present the latest research on fungi and health outcomes in humans to establish their uniqueness from a nutrition science perspective. NRAUS developed this presentation to answer the following key questions:

- What are the health benefits of fungi and mushrooms in humans?
- What unique bioactive compounds do fungi and mushrooms contribute to the diet?
- How do these differ from vegetables and other foods?
- What considerations are needed to achieve the health effects?
- What are some of the key limitation or opportunities for mushroom research?

The final presentation slides can be found in **Appendix 10**.

The presentations were followed by a panel discussion, where the following question was discussed ‘*How should fungi be included in dietary recommendations?*’ Both panel members and guests actively participated in the discussion. All attendees agreed that mushrooms are a unique kingdom that needs increased focus, including dietary research is required to stop measuring mushrooms with vegetables. Some questions that were discussed that will be addressed in the white paper include:

- How should foods be grouped in dietary recommendation? Botanical classification?
- Dietary patterns versus processing? Should we be recommending a blended approach?
- How does culinary practices impact the access to nutrients?

Some comments that were made in the zoom chat function are presented below:

*What about a sub section in vegetables to make it easier for general public to understand and accept?*

*We can cope with legumes in 2 food groups.*

*If we have a reductionist approach, we have nutrient led food groups but what about synergy and diet patterns?*

*I agree, why are we married to the five food group? But there are also foods within the food groups currently that are quite different – legumes and broccoli for example, yet they can both count towards your vegetable intake.*

*But we BUY and SHOP for mushrooms as a vegetable? Mushrooms are included with the vegetable category. Just noting.*

*They can be compared against each type of food, and surely most nutritional value will come from mushrooms.*

Some feedback from the event:

*Thanks for the mushrooms event team NRAUS. It got my intrigued and I can’t wait to try Jim’s cooking technique!*

*Thanks again for including me. Loved it.*

Roundtable Invitation: October 2020 (Appendix 11)



**NRAUS** | **Australian MUSHROOMS**

Nutrition Research Australia invites you to join our expert panel and a small number of selected guests, for an exclusive virtual roundtable event:

**HOW SHOULD FUNGI FOODS BE INCLUDED IN DIETARY RECOMMENDATIONS?**

While categorising foods and diets based on their 'plant' or 'animal' profile has become increasingly popular due to health and environmental reasons, where does that leave our third food kingdom – fungi?

**PANELISTS**

- Arpad Kalotas
- Dr Emma Beckett
- Dr Flavia Fayet-Moore
- Glenn Cardwell
- Jim Fuller
- Professor Linda Tapsell

**EVENT DETAILS**

**DATE:** WEDNESDAY 25TH NOVEMBER 2020

**TIME:** 12.00PM - 2.00PM AEDT

This invitation only event will take place via Zoom.

**RSVP**

Please confirm your attendance by replying to this email: [events@nraus.com](mailto:events@nraus.com) by Wednesday 11 November 2020

Please include your full postal address in your RSVP to receive your **free mushrooms kit**, as a thank you for joining us at the event.

Hort Innovation MUSHROOM FUND This project has been funded by Hort Innovation using the mushroom research and development levy and funds from the Australian Government. For more information on the fund and strategic key investment visit [horticulture.com.au](http://horticulture.com.au)

Roundtable Agenda: November 2020 (Appendix 12)



**EXPERT ROUNDTABLE:  
HOW SHOULD FUNGI FOODS  
BE INCLUDED IN DIETARY  
RECOMMENDATIONS?**

Wednesday 25th November 2020  
12pm - 2pm AEDT

**Agenda**

12:00	<b>WELCOME ADDRESS</b>	<b>NUTRITION RESEARCH AUSTRALIA</b>
	Introduction: How should fungi foods be included in dietary recommendations?	<b>EMMA BECKETT</b>
12:15	<b>NETWORKING</b>	
12:25	The facts on fungi: What are they and what makes them unique?	<b>GLENN CARDWELL</b>
	How healthy are fungi? Examining their bioactive and health benefits	<b>FLAVIA FAYET-MOORE</b>
	Beyond nutrients: The role of fungi foods in culinary nutrition	<b>JIM FULLER</b>
12:45	<b>NETWORKING</b>	
12:55	Native mushrooms: The consumption of fungi in Indigenous culture	<b>ARPAD KALOTAS</b>
	Translating science into dietary advice: Where and how would fungi foods fit?	<b>LINDA TAPSELL</b>
1:15	<b>BREAK</b>	
1:20	Panel discussion on fungi foods: How should they be included in dietary recommendations?	<b>PANEL DISCUSSION</b>
2:00	<b>EVENT CLOSE</b>	

Hosted by Nutrition Research Australia **NRAUS**

**Emma Beckett**  
 Dr Emma Beckett is a food and nutrition scientist and lecturer at the University of Newcastle, specialising in gene-nutrient-environment interactions. Emma is also a passionate science communicator. She aims to empower people to make more informed choices about food, without fear or judgement.  
**Conflict of interest statement:**  
 Dr Emma Beckett has contracts or grants with the following entities: Kellogg, MADS Foods Australia, The National Health and Medical Research Council, AMP Foundation, and Central Coast Health.

**Jim Fuller**  
 Jim Fuller was born and raised in Texas. Fine BBQ drew him in and Jim worked as a fine-dining chef in Texas for 10 years. Natural curiosity and wanting to understand the science behind the food he was cooking, he went to University to study Chemical Engineering and, later, Agricultural Science. Jim started working on a mushroom farm, began collecting wild mushrooms and somewhere along the way became fascinated by mushrooms and has worked as a Mycologist (a mushroom scientist) for the last 12 years. Jim knows how to grow mushrooms, the science behind mushrooms, and how to cook them to be delicious, meaty, and healthy.  
**Conflict of interest statement:**  
 Jim Fuller is co-founder and Chief Science Officer of Fable Food Co, a company that uses mushrooms to recreate the taste and texture of meat.

**Glenn Cardwell**  
 Glenn Cardwell is an Advanced Accredited Practising Dietitian with 40 years of experience in clinical and public health nutrition. He has advised the public, the fresh produce industry, and lectures health professionals and university students. He has collaborated with farmers to promote the nutrition and health benefits of mushrooms, bananas, cherries and asparagus. He has written four books, including one that has been translated into Russian and Mandarin. Currently he is conducting a research project with Curtin University, farmers and the National Measurement Institute on the influence of pulsed UV radiation on dried mushrooms. He is a second term director of Dietitians Australia.  
**Conflict of interest statement:**  
 Glenn consults to the Australian Mushroom Growers' Association.

**Arpad Kalotas**  
 Arpad Kalotas graduated as a botanist (B.Sc. Hon) at University of Western Australia and after travelling through Central Australia developed an interest in Aboriginal cultural knowledge and use of flora. He has been involved in a range of natural and cultural resource projects throughout central and Western Australia, as well as projects with Aboriginal communities and organisations in documenting and applying Indigenous ecological knowledge for a variety of purposes including bush food feasibility studies. He has also maintained an interest in fungi first sparked by a fungal foray in his student days to the hills of Mundaring Weir with the late Roger Hilton, formerly Lecturer in Mycology at UWA. Among his publications is a chapter in the Fungi of Australia on 'Aboriginal knowledge and use of fungi'.  
**Conflict of interest statement:**  
 Arpad Kalotas has no conflict of interest.

**Flavia Fayet-Moore**  
 Dr Flavia Fayet-Moore is a registered nutritionist, Accredited Practising Dietitian, board certified Lifestyle Medicine Professional and Honorary Associate of the University of Sydney. As CEO of Nutrition Research Australia, Flavia leads a team of highly skilled researchers to conduct end to end nutrition and communications projects. Flavia graduated from the University of Toronto with an Honours Bachelor of Science in Nutritional Sciences, and obtained both her Master of Nutrition and Dietetics and PhD in nutrition at from the University of Sydney. Flavia is passionate about improving the health of Australians, especially among children and adolescents, through research and its communication. She is a member of the Nutrition Society of Australia, the Dietitian's Association of Australia, and is a founding board member and fellow of the Australasian Society of Lifestyle Medicine.  
**Conflict of interest statement:**  
 Dr Flavia Fayet-Moore has associations or grants with the following entities: Olive Wellness Institute Advisory Panel, Consultant to Nutrigenomix Inc, Founding board member of the Australasian Society of Lifestyle Medicine, and Funding from Hort Innovation (Australian Mushrooms).

**Linda Tapsell**  
 Professor Linda Tapsell is a distinguished academic in Medical and Health Sciences with discipline expertise in Nutrition and Dietetics. She is a Fellow of both the Dietitians Association of Australia (DAA) and the Nutrition Society of Australia, and in 2015 was recognised as a member of the Order of Australia for 'significant service to health science as an academic and clinician specialising in diet and nutrition'. Her contributions have extended from directing major food research centres, to participating on expert committees and panels relating to food, and nutrition, both nationally and internationally. Her numerous scientific publications, including the textbook Food, Nutrition and Health (Oxford University Press), address the impact of nutrients, foods and dietary patterns on health, and how this body of knowledge underpins food and nutrition policy and practice. Professor Tapsell continues to support future generations of nutrition scientists and dietetic practitioners through the School of Medicine at the University of Wollongong.  
**Conflict of interest statement:**  
 Professor Tapsell was formerly director of the ADC Key Centre for Smart Foods and the National Centre of Excellence in Functional Foods based at the University of Wollongong, and as such led numerous research and consultancy projects across various sectors of the food value chain. She has served on the Science Advisory Council of the California Walnut Commission and the McCormick Science Institute. She is currently on the steering committee of the Horticulture Australia project, 'Naturally Nutritious' and continues to advise and work with Nuts for Life. In 2019 she received the Excellence in Research award from the International Nut and Dried Fruit Council (INC). She is a member of the Consumer and Public Health Dialogue of Food Standards Australia New Zealand and served on the Advisory Committee of the 2013 Australian Dietary Guidelines.

**Hort Innovation** **MUSHROOM FUND**  
 This project has been funded by Hort Innovation, using the Mushroom Fund research and development levy and contributions from the Australian Government. Hort Innovation is the grower-owned, not-for-profit research and development organisation for Australian horticulture.

**Next steps**

To develop the roundtable whitepaper to communicate key findings and recommendations from the event to the wider HCP audience.

**MILESTONE 104: ROUNDTABLE WHITE PAPER (PREVIOUSLY DIETITIAN BROCHURE)**

**Background**

Approval to change the Dietitian Brochure to the roundtable white paper was approved by Hort Innovation in April 2020. The purpose of the roundtable white paper is to communicate the findings and implications from the small Sydney roundtable event, held virtually on the 25<sup>th</sup> November 2020.

**Activity in-progress**

The summary of key findings and recommendations from the roundtable event, and the drafting of the roundtable whitepaper has commenced.

The whitepaper will be available in electronic format and hard copy printed on 100% recyclable, matt high-quality paper (300 copies).

**Next steps**

The roundtable whitepaper and a PDF will be communicated as part of the roundtable communications activation, which includes an EDM and social media advertisement. The hard copy will be distributed at the DU event and it can also be shared at future HCP events.



## MILESTONE 104: AUDIENCE SENTIMENT RESEARCH 2

### **Background**

Audience Sentiment Research (ASR) is a detailed analysis, conducted at three stages of the project, to explore the attitudes, knowledge and behaviors of health professional with regards to mushrooms. The objective was to measure awareness and attitudes across five core areas: (i) knowledge of the nutritional properties and health benefits of mushrooms, (ii) value placed on mushrooms for their properties, (iii) perception of mushrooms for health, (iv) behaviour around recommending mushrooms, and (v) frequency of recommendation or behaviour. The first research was conducted at the start of the project, the second was planned for the 18-month point, and the final will take place at the end point of the project (December 2021).

For 2020, the objective was to track the shift in sentiment, growth of the positive responses and understanding of the messages that the activity over the past year has delivered. While COVID-19 meant that some key activity was delayed or put-on hold, we were still able to fulfil the majority of the milestones during this period.

Event delays due to COVID-19 resulted in the timeline for the ASR 2 to be reviewed. When the DU event was postponed to October 2020, Hort Innovation approved our request to move the Audience Sentiment Research 2 to after the DU event so that we could better examine the effect of our communications of the SLR. Despite the DU event being further postponed to May 2021, no further changes to timelines were recommended to avoid survey 2 being too close to the final research that will take place at the end of the project.

### **Activity in-progress**

The Audience Sentiment Research 2 survey went live in October 2020 for 5 weeks.

A total of 195 HCP recipients completed the survey (of which 49.2% were dietitians or nutritionists, 17.4% other allied HCPs, 14.9% nurses, 9.2% GPs, and 9.2% other).

Respondents were largely female (85.6%) and located in NSW (39.0%) and VIC (31.8%).

Key results:

- 91.2% of respondents were able to specify at least one nutritional property of mushrooms, an increase of 19.2% from 2019.
- Dietary fibre (74.3%), vitamin D (66.1%), cholesterol free (58.9%) and antioxidants (58.4%) were the most common nutritional properties selected.
- Vitamin D saw the biggest increase in awareness (+15.7%), more than three times any others, showcasing the impact of the first year of the campaigns focus.
- 43.1% of respondents value mushrooms as 'very important' in supporting overall health and increase of 9.2% since 2019.
- 89.3% of respondents still felt that mushrooms were either more or of equal value to vegetables, a similar proportion to 2019.
- 62.5% of respondents said UV mushrooms were the highest source of vitamin D.
- Almost every respondent (96.9%) eats mushrooms, with the majority doing so at least once a week.
- 53.8% of respondents specifically recommend mushrooms to the clients either often, always or sometimes (+7.8% since 2019). While those that never recommend mushrooms but see clients decreased by 10.6% since 2019 (7.7% total respondents).
- In 2020, the main reasons respondents recommend mushrooms are: (i) vegetarian meal option (66.9%), (ii) for their health benefits (61.7%), and (iii) they are easy to cook (58%), compared to 2019 which was to add extra flavour to meals.

### **Next steps**

The analysis of survey results is currently in progress, with the final report due to Hort Innovation on the 18<sup>th</sup> December 2020.

## MILESTONE 105: 6 MONTH BENCHMARKING PERFORMANCE REPORT 4

Completed as per this report. 30 November 2020

### Outputs

#### A. BISPORUS RESEARCH DATABASE (Link [here](#))

A comprehensive database of every research paper on the nutrient and health properties of A. bisporus mushrooms.

**Date updated:** 20<sup>th</sup> November 2020

**Number of research papers:** 591 studies

#### AUSTRALIAN MUSHROOMS MEDIA RELEASE (Appendix 1)

An Australian Mushroom Media Release titled 'New research shows everyday mushroom can be as effective as vitamin D supplements'.

**Date sent:** 17<sup>th</sup> September 2020

#### SLR BROCHURE AND MANUSCRIPT EDM (Appendix 3)

The SLR brochure and manuscript EDM was created to communicate the newly published, world first SLR manuscript and accompanying SLR brochure.

**Date sent:** 26<sup>th</sup> July 2020

**Target audience:** HCP database

**Reach:** 1317

#### SLR VIDEO EDM (Appendix 4)

The SLR video EDM was created to share the innovative and exciting research insights in the SLR from a different perspective than the manuscript and accompanying brochure.

**Date sent:** 1<sup>st</sup> September 2020

**Target audience:** HCP database

**Reach:** 1285

#### ASR SURVEY INVITE EDM (Appendix 5)

An EDM was created to promote Audience Sentiment Research survey. This included a link to the survey, promotion of the prize and three fun facts on mushrooms.

**Date sent:** 5<sup>th</sup> October 2020

**Target audience:** HCP database

**Reach:** 1271

#### ASR SURVEY REMINDER EDM (Appendix 6)

A reminder EDM to complete the Audience Sentiment Research survey was completed. This included a link to the survey and three fun facts on mushrooms.

**Date sent:** 20<sup>th</sup> October 2020

**Target audience:** HCP database

**Reach:** 1261

#### **SLR VIDEO (Link [here](#))**

To help share the SLR research from a different perspective to the published manuscript and accompanying SLR brochure, a 90 second video was created.

**Target audience:** HCPs

#### **SLR BROCHURE (Appendix 7)**

The key messages from the SLR were re-designed and brought to life in an 8-page brochure for HCPs

**Date sent:** 22<sup>nd</sup> July 2020

#### **SLR MANUSCRIPT – OPEN ACCESS (Appendix 8)**

The accepted SLR manuscript was published open access in the Journal of Nutritional Biochemistry.

**Date open access approved:** 7<sup>th</sup> August

#### **DIETITIAN'S UNITE RECIPE BOOKLET (Appendix 9)**

In partnership with Simplot, a 16-page recipe booklet has been developed as a resource for the event.

**Date sent:** 3<sup>rd</sup> November

## **Outcomes**

- **Continue to keep the A. bisporus research database current**

Through the NRAUS NUTRITIONiQ service, we have continued to collate research that fits our SLR search strategy. This process remains on-going.
- **A growing database of HCP contacts**

Our HCP database has grown by 6.6% since July 2020 to contain a total of 1,404 subscribers.
- **A growing list of fun facts and key messages**

We identified 48 'fun facts', 25 of which have been utilized in communication materials such as EDMs, social ads, presentations, DU recipe book and factsheet, and partner advertising materials.
- **Engagement and education across multiple platforms**

To maximise engagement during COVID-19 restrictions, a range of platforms were used to educate HCPs including multiple EDMs (to share educational resources and promote the SLR video), video, survey, social media, scientific research article and print material.
- **Impact on the scientific community**

The SLR manuscript was published open access in a high impact journal and the roundtable event brought together experts to establish clear and authoritative recommendations for how fungi should be included in dietary recommendations.
- **Generated shareable content to distribute information beyond what was agreed in the project plan**

COVID-19 restrictions have postponed our opportunities to present and distribute information according to

the original project plan. We proactively pursued alternative opportunities to educate HCPs which included a short SLR video to communicate SLR findings.

- **Thought leadership on how fungi foods and mushrooms are to be included in dietary recommendations**

The expert roundtable brought together experts across disciplines to confirm that increased focus is needed on fungi foods and discuss how mushrooms should be included in dietary recommendations.

## Intellectual property, commercialisation and confidentiality

No project IP, project outputs, commercialization or confidentiality issues to report.

## Issues and risks

**Campaign Risk Register** – The risks register for this project can be viewed [here](#).

The identified risks listed below have been managed and all outputs have been met:

### COVID-19

Social distancing restrictions due to COVID-19 have continued to impact timelines in the second half of 2020. Since the DU event was our main event to educate HCPs about the SLR findings in 2020, its postponement to May 2021 meant the second ASR survey was conducted without this opportunity to influence the knowledge of HCPs. We were able to deliver an additional output this year (SLR video) to help engage and educate HCPs on the health benefits of Australian mushrooms. The social media influencer engagement and targeted communication strategies continued the favourable outcomes seen in year 1 in year 2 of the mushroom campaign.

### SMALL SYDNEY ROUNDTABLE

The small Sydney roundtable event was intended to be held in person for maximum effectiveness. However, extended state border closures and ongoing COVID-19 social distancing restrictions led to the event being held virtually in November 2020. Important considerations were made to ensure this event could mimic an in-person event as closely as possible, with extended technology support being provided to facilitate networking and the panel discussion.

The attendance at the small Sydney expert roundtable was low, with 9 guests and 6 speakers attending on the day (exclusive of NRAUS and HWBK staff). While it is essential that the expert roundtable event was kept small and intimate, the number of attendees was slightly lower than anticipated. We are currently investigating possible reasons for this with HWBK who were sending and managing invites and RSVPs on behalf of NRAUS (using [event@nraus.com](mailto:event@nraus.com)), for a continuous improvement approach to this project. Guest lists targets will be set for future events and RSVP will be managed more closely by NRAUS. Invited attendees who couldn't attend will be sent the whitepaper and a recording of the roundtable event to watch, to maximise its impact and discussion.

## Other information

None

## Milestone Report

**Project title:**

# Educating healthcare professionals about Australian mushrooms

**Project code:**

MU 17002

**Milestone number:**

MS106

**Project leader:**

Dr Flávia Fayet-Moore

**Delivery partner:**

Nutrition Research Australia Pty Ltd (NRAUS)

**Report author:**

Dr Flávia Fayet-Moore (NRAUS)

Heidi Rose (History Will Be Kind – HWBK)

**Milestone due date:**

End June 2021

**Submission date:**

30 June 2021

**Confidentiality:**

Is this report confidential?

No

Yes (whole report)

Yes (sections of report are confidential)

If sections of the report are confidential, list them here:

**Milestone description:**

6 Month Benchmarking Performance Report 5

**Milestone achievement criteria:**

MS102, MS104, MS105, MS106 – in progress

MS104 – completed

MS105 – postponed

<b>Milestone</b>	<b>Achievement Criteria</b>
MS102	Periodic comms program - planning, liaison, integration & content development
MS104	Audience Sentiment Research 2
MS104	Dietitian’s Unite - Breakfast Seminar
MS104	Roundtable White Paper (previously Dietitian Brochure)
MS105	Digital Activation (previously ASLM conference)
MS105	HCP client focused brochure (previously Brochure – Naturopath)
MS106	6-month Report 5
MS106	Webinar

**Funding statement:**

**Levy funds – R&D projects**

This project has been funded by Hort Innovation, using the Mushroom Fund research and development levy and contributions from the Australian Government. Hort Innovation is the grower-owned, not-for-profit research and development corporation for Australian horticulture.

## General project overview

Despite the unique nutritional properties of mushrooms, there is currently a lack of knowledge of their nutritional and health benefits among healthcare professionals (HCPs). The objective of this three-year project is to conduct original research on the health benefits of mushrooms and then educate health professionals about its key findings, supporting the wider industry objective of increasing the overall consumption of mushrooms in Australia.

## Summary

The general theme of Year 3 was to showcase that there is more to mushrooms than just nutrition, with a focus on their culinary properties.

The second Audience Sentiment Survey (ASR2) was undertaken in late 2020 to understand the impact of previous activities and to refine the educational approach for Year 3. An increased understanding of the nutritional properties and health benefits of mushrooms was reported among HCPs (91.2% able to specify at least one nutritional property, an increase from 72% at baseline), along with increased numbers of HCPs recommending mushrooms to clients (from 31.6% to 46.6%). Overall, the results indicated that the messaging and resources are on target. Several opportunities were identified to refine the educational approach: increasing the reach to more HCPs, build the HCP database, and provide resources to help HCPs promote mushrooms to their clients.

Based on these findings, and COVID-19 interruptions, two recommended changes to the 2021 educational plan were made to Hort Innovation and accepted in March 2021. The first recommendation was that the Australian Society Lifestyle Medicine (ASLM) conference milestone, no longer being held in 2021, be redirected into a digital activation that includes an opinion-led editorial in a widely read HCP publication. The objective of the digital activation is to build further reach and direct traffic to the resources (mushroom hub) to increase the dissemination of current collateral and messaging. Impact and reach to be assessed by number of HCPs that sign up to the database.

The messaging for the editorial leverages current ‘hot’ research topics, including focus on the re-emergence of infectious diseases as a public health problem, vitamin D’s role in immunity and link to reducing risk of respiratory infections, and incidence of deficiency in Australia. The editorial positions mushrooms and specifically sun exposed mushrooms, as an ultimate prescription for supporting healthy vitamin D status, providing not only over 100% of the recommended adequate daily intake for vitamin D that has been shown to improve vitamin D status but also providing a range of unique bioactives and nutrients for health.

The second recommendation was that the Naturopath brochure planned for distribution at the ASLM conference be modified to a resource that could be utilised by all HCPs to promote mushrooms to their clients. This client-oriented brochure is planned to be a double sided A4 brochure. One side will be focused on vitamin D, highlighting the prevalence of deficiency, and educating on why we need it and where we get it from (sun, supplement, and food). The second side will be focused on presenting common edible mushrooms as the ultimate solution, educating on its content of vitamin D relative to other food sources, its other nutritional benefits and providing practical tips on preparation and serving size. These activities are currently in progress, with planned distribution in August 2021.

A breakfast seminar event was held for dietitians and nutritionists as part of Dietitian’s Unite 2021 virtual conference. This event, co-sponsored with Simplot, focused on ‘Taste: The forgotten message to enjoying vegetables and mushrooms’. The event included an engaging presentation by Dr Flavia Fayet-Moore on the health and culinary benefits of mushrooms, a virtual live mushroom cooking demonstration from celebrity Masterchef cook and author, Alice Zaslavsky along with distribution of mushroom and vegetable factsheet and recipe booklet to attendees. The key message delivered included that are a unique nutritional, bioactive and umami taste package, with demonstrated human health and culinary benefits, that make them worthy of greater focus by dietitians. Secondary key messages included sun exposed mushrooms being a great source of vitamin D and their unique meaty texture and umami profile making them a great way to reduce salt or substitute for meat for those looking to reduce meat intake. Over 220 dietitians attended the event, with 1 in 4 (59 attendees) subscribing to the mushroom HCP database. Ninety-six percent of attendees rated the event as excellent or very good. There were several positive social media posts about the breakfast, including @Busy Women Balance, “The goodness of mushrooms with @DrFlavs”.

A white paper report on the role of fungi foods in the diet, a key output of the expert roundtable meeting held at the end of 2020, has also been developed and is currently in design. This publication has evidence-based insights and recommendations for HCPs and policy makers and will be distributed in August 2021.

# Achievements

## MILESTONE 102: PERIODIC COMMS PROGRAM – PLANNING, LIAISON, INTEGRATION & CONTENT DEVELOPMENT

### 1. Building the database of healthcare professionals for Australian Mushrooms: Ongoing

The HCP database is a key channel for communicating information and promoting events throughout the project. The total number of people on the database is currently 1,464 subscribers, a 4% increase (59 additional subscribers) since November 2020. The growth in the database is a direct result of the Dietitian Unite Conference event, where 59 attendees (26% of total event attendance) signed up to the database. Attendees were incentivised to sign up to the database via a chance to win 1 of 5 mushroom culinary prize packs which included a wooden chopping board with Australian Mushrooms branding, a Mushrooms storage bag and a copy of Alice Zaslavsky’s ‘In Praise of Veg’ cookbook .

### 2. Grower’s Newsletter: June 2021

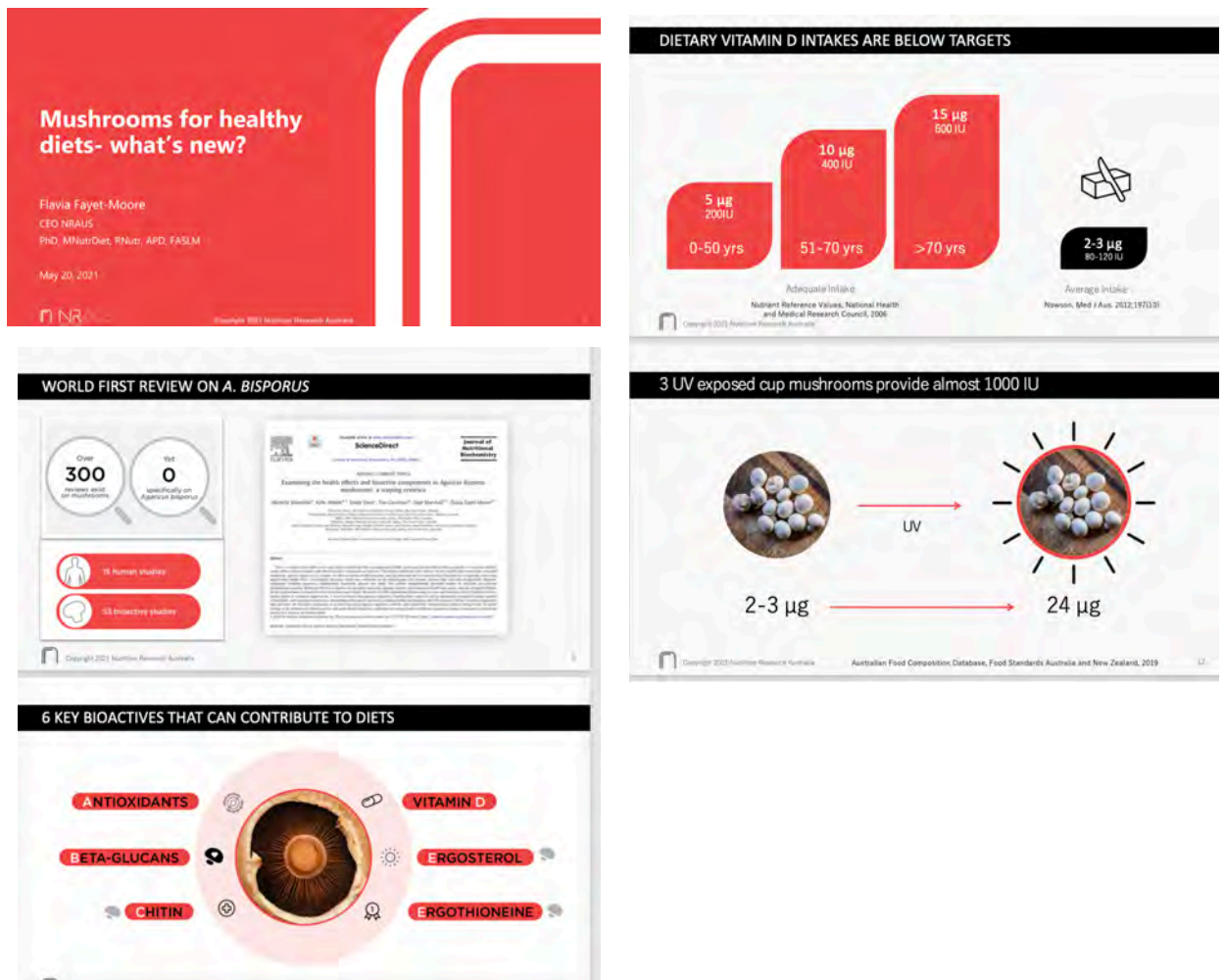
An update on the project was provided in March 2021 for the Australian Mushroom’s Journal via Chris Rowley. A further update is planned for the issue scheduled for early September 2021.





### 3. Applied Horticultural Research Webinar: May 2021

Dr Flavia Fayet-Moore delivered a presentation to the Australian mushroom growers in a recent set of webinars. The presentation was titled, *'Mushrooms for healthy diets: What's new?'*. The final presentation slides can be found in **Appendix 1**.



A total of 40 people registered for the webinar with 17 viewing live and 25 accessing the event afterwards.

The presentation was favorably received, including the following feedback:

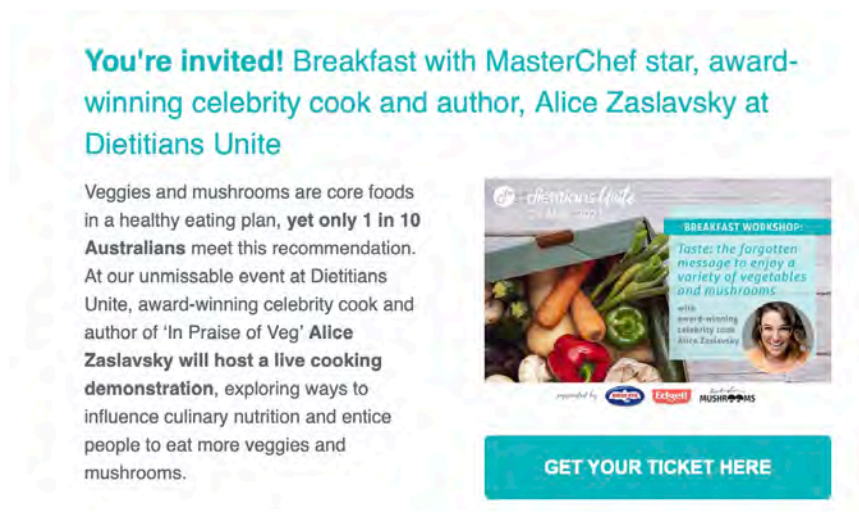
“Thank you so much for such a brilliant presentation – not only informative with important and fascinating information but, despite being vocally challenged, you got it all across so professionally with your clear slides and graphics” Kim Saville 21.05.21

### 4. EDM's: Ongoing

An EDM was sent on 29<sup>th</sup> April 2020 to the Dietitian Connection database (~8500 reach) to invite members to the Dietitian Connection breakfast event. A follow up EDM from the conference is scheduled to be sent to the same database in August 2021 to announce the release of the Expert Panel White Paper report; **Fungi Foods: Where do they fit in a plant based diet** in addition to the newly developed practical client-centred brochure for their use with educating clients on mushroom's benefits and providing practical tips. Dietitians will be directed to the resource hub for download and encouraged to sign up to the database if they have not done so for ongoing communications. Five EDMs are scheduled to be sent directly to the mushrooms database over the next 5 months.

### Dietitian Unite event invite

- An EDM was created to promote our breakfast event to the entire Dietitian Connection (DC) database leveraging Alice Zaslavsky, a key drawcard to the event (**Appendix 2**). Alice Zaslavsky is an award-winning celebrity cook from Masterchef and author of ‘In Praise of Veg’.
- The EDM was sent to 8500 recipients, with 32% of recipients opening the email (vs. industry average of 20-25%) and a click rate of 7%.



### Planned EDMs still to come July-Nov 2021

From Dietitian Unite database

- Showcase resource hub including new resources: Whitepaper launch & HCP brochure – Due Aug

From Owned database

- Webinar invite – Due July
- Expert Roundtable Whitepaper Report & HCP client-oriented brochure – Due Aug
- ASR sentiment invite – Due September
- ASR sentiment reminder – Due October
- Webinar/End of year follow up – Due November

## 5. Communications: Ongoing

### Mushroom Hub

A landing page on the NRAUS website was created in July 2020 to house all the mushroom resources in one place, so HCPs have timeless access to these resources. The landing page is called the ‘Mushroom Hub’. Data analytics showed spike in activity post Dietitian Unite conference in May with 46 unique people visits to the site on the conference day (21 May 2021).

### Mushroom Hub Landing Page

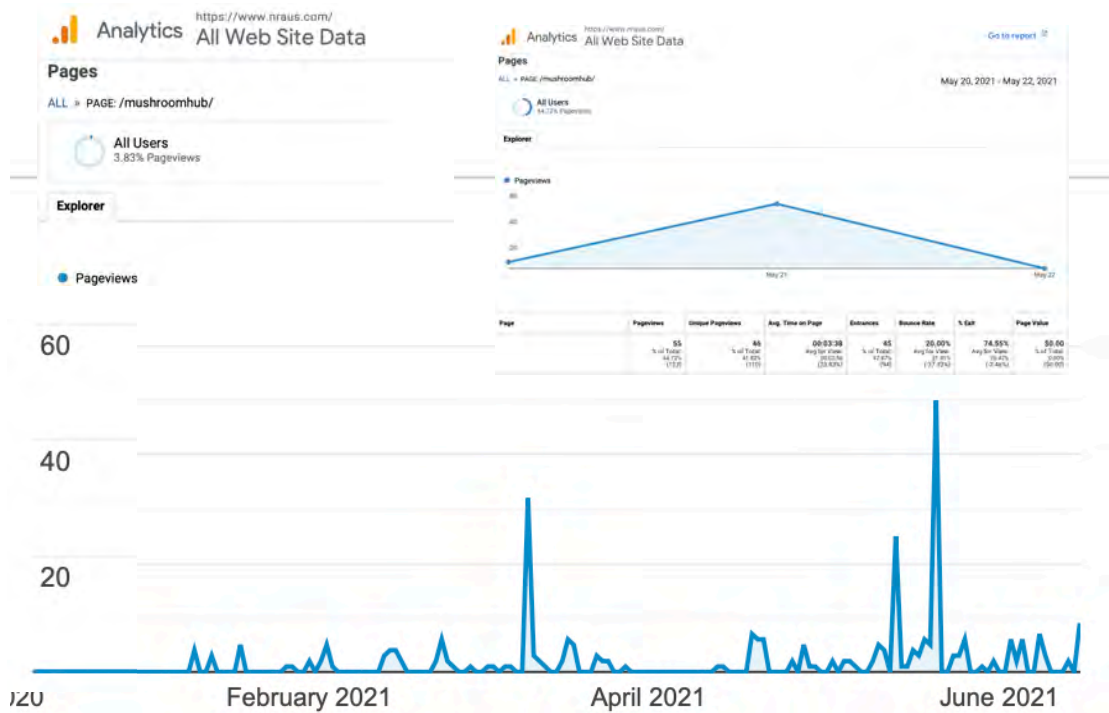
Mushroom Hub

For all the latest mushroom products in one place

Use our eHealthHub platform to manage all your health information in one place. It's all in one place. Use our eHealthHub to manage all your health information in one place.

- VIDEO** MEET THE RESEARCHERS BEHIND THE SCIENCE OF MUSHROOMS
- BROCHURE** THE WORLD'S FIRST SYSTEMATIC REVIEW ON *AGARICUS BISPORUS*
- PAPER** EXAMINING THE HEALTH EFFECTS & BIOACTIVE COMPONENTS IN *AGARICUS BISPORUS* MUSHROOMS: A SCOPING REVIEW
- WEBINAR** WHEN IT COMES TO VITAMIN D, TWO SOURCES ARE BEST
- BROCHURE** WHEN IT COMES TO VITAMIN D, TWO SOURCES ARE BEST
- VIDEO** YOUR ULTIMATE 2 MIN GUIDE TO TANNING YOUR MUSHROOMS
- FACT SHEET** DIETITIAN'S FACT SHEET
- BOOKLET** VEGGIE-LICIOUS - SIX DELICIOUS VEGGIE & MUSHROOM BASED RECIPES

### Page site visit activity to Mushroom Hub landing page



## MILESTONE 104: AUDIENCE SENTIMENT RESEARCH 2

### **Background**

The Audience Sentiment Research 2 (ASR2) was the second of three planned surveys to be conducted during the project (**Appendix 3**). The first ASR1 was conducted in July 2019 and provided baseline information on HCP knowledge, perceptions, behavior, and frequency in recommending mushrooms to clients. The repeated surveys help measure the success of the program through comparison to baseline data and gather insights that help to tailor the communications program.

### **Activity completed**

The survey used a state-of-the-art platform with a bespoke interface designed to maximise engagement and personalisation for owned branding. A series of informative and engaging EDMs were designed to be consistent with project branding. Additional social ads and campaign visuals were created for online audiences. An EDM was sent to the owned database (1271 recipients) with 31.8% click through rate and 78 survey responses completed. The social recruitment campaign ran for 15 days with reach of 31,767, drove 1,124 new visitors to the survey, and converted an additional 119, representing very high average click through rate 3.41% versus industry average 1%. In total for the combined database and social campaign recruitment there were 195 total survey responses with representation of 41.5% dietitians, 14.9% nurses, 9.2% GPs, 7.6% nutritionists and 26.8% other (including allied health professionals).

### **Impact**

The key findings included:

- Compared to baseline, there was an increase in respondents who were familiar with the health and nutritional benefits of mushrooms (from 20% to 27.7%) and were able to specify these (from 17% to 24.1%).
- While the majority (92.8%) of respondents regarded mushrooms as 'Important' or 'Very Important' for health, mushrooms being seen as 'Very Important' increased from 33.9% to 43.1%.
- 91% respondents were able to specify at least one nutritional component of mushrooms, a 19% increase. The biggest increase in knowledge was around mushrooms being source vitamin D, an increase of 15.7%.
- There was an overall increase (7.8%) in HCPs recommending their clients to consume mushrooms, with only 7.7% of those who see clients not recommending, a decrease from 18.3% at baseline. Key reasons to recommend included an increased understanding of their nutritional and health benefits, being a vegetarian option, and ease to cook.
- A higher proportion of HCPs had seen mushroom resources (increase of 6.3% from baseline), and those that had seen them ranked them as valuable. However, almost 60% still reported being unaware of their availability. There was also low awareness of where to find resources, particularly low awareness of the Australian Mushrooms website. There were numerous requests for resources that practitioners could use for education with their clients.
- The HCP database has been a key communication touchpoint, with around 1400 subscribers and representing around 1.5% of potential HCPs in Australia. The demographic of the database was also heavily weighted to dietitians (49%), then Nurses (14%), GPs (9.2%) and Naturopaths (1.5%).

In summary, the findings inferred that the current project messaging has strongly resonated with HCPs, who are increasingly aware of the unique nutrition and health characteristics of mushrooms, and actively recommending their intake. There is also an opportunity to increase the reach of messages to more HCPs, including a broader demographic including Naturopaths, and to provide HCPs with a resource that they can use with their clients.

## MILESTONE 104: DIETITIAN’S UNITE BREAKFAST SEMINAR

**Dietitian’s Unite Breakfast:** 21 May 2021

### **Background**

A breakfast event at Dietitian’s Unite, a key nutrition conference event run by Dietitian Connection for dietitians and nutritionists. The breakfast event was sponsored by Australian Mushrooms in partnership with Simplot Australia and focused on culinary nutrition. The breakfast event was titled ‘*Taste: the forgotten message to enjoy a variety of vegetables and mushrooms*’.

Originally scheduled as an in-person event in 2020, the conference was rescheduled to May 2021 and then changed to a virtual event, in view of COVID-19 restrictions. Whilst this presented challenges, it offered the opportunity for a greater number of attendees to take part.

### **Activity completed**

The one-hour event was hosted by well-known and highly respected dietitian Karen Inge. The breakfast event included:

- Consumer research insights on vegetable consumption, presented by Simplot.
- A live mushroom recipe virtual cooking demonstration, inspiring the audience with valuable culinary tips and hacks, presented by award winning celebrity cook and author of ‘In praise of Vege’, Alice Zaslavsky.
- A presentation on the health and culinary benefits of mushrooms (**Appendix 4**), including the key findings of the 2020 *Agaricus bisporus* systematic literature review, by Dr Flavia Fayet-Moore.
- 15 minute Question and Answer session with the presenters.

A recording of the breakfast session can be accessed here

<https://dietitianconnection.com/uncategorised/dietitians-unite-2021-recordings/> (password: DU202!r3c0rd!ng\$).

Attendees were also directed to an online resource hub (<https://nraus.com/mushroomhub/>) where they were able to access the research paper, infographic, recipe book and fact sheet. Printed recipe booklets were sent to the first 50 people to register for the event.

Five mushroom culinary prize packs (including a wooden chopping board with Australian Mushrooms logo, mushroom bag and copy of Alice Zaslavsky’s cookbook ‘In Praise of Veg’ were created as incentive to attendees to sign up to the database.

### **Impact**

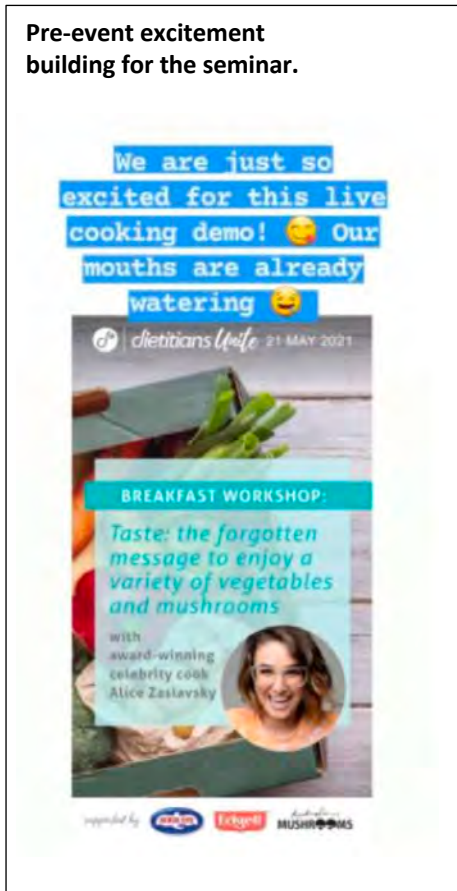
All Key Performance Indicators (KPIs) were exceeded.

- 226 dietitians attended the Breakfast Workshop, with 59 (26%) signing up to the mushrooms database. This performed well above our KPI for attendees which was 80 (20% of conference attendees) and database conversion 8%.
- On a 5 point scale, 96% of respondents rated the breakfast as "excellent" or "very good".
- Engagement was also rated highly with 44% engaging with the online poll versus KPI 25%.
- Comments from the Breakfast Workshop:
  - “Great to see culinary nutrition along with the science.”
  - “Loved the practical cooking session with mushrooms - gave me inspiration to use more mushrooms as a meal.”
  - “The recipe booklet is great.”
  - “Great balance of science and practical application. ”
  - “Valuable practical perspectives. ”
  - “Loved the cooking demo, fab info on mushroom.”
  - “Was practical, focused on taste. Will follow up on vitamin D & mushrooms story.”

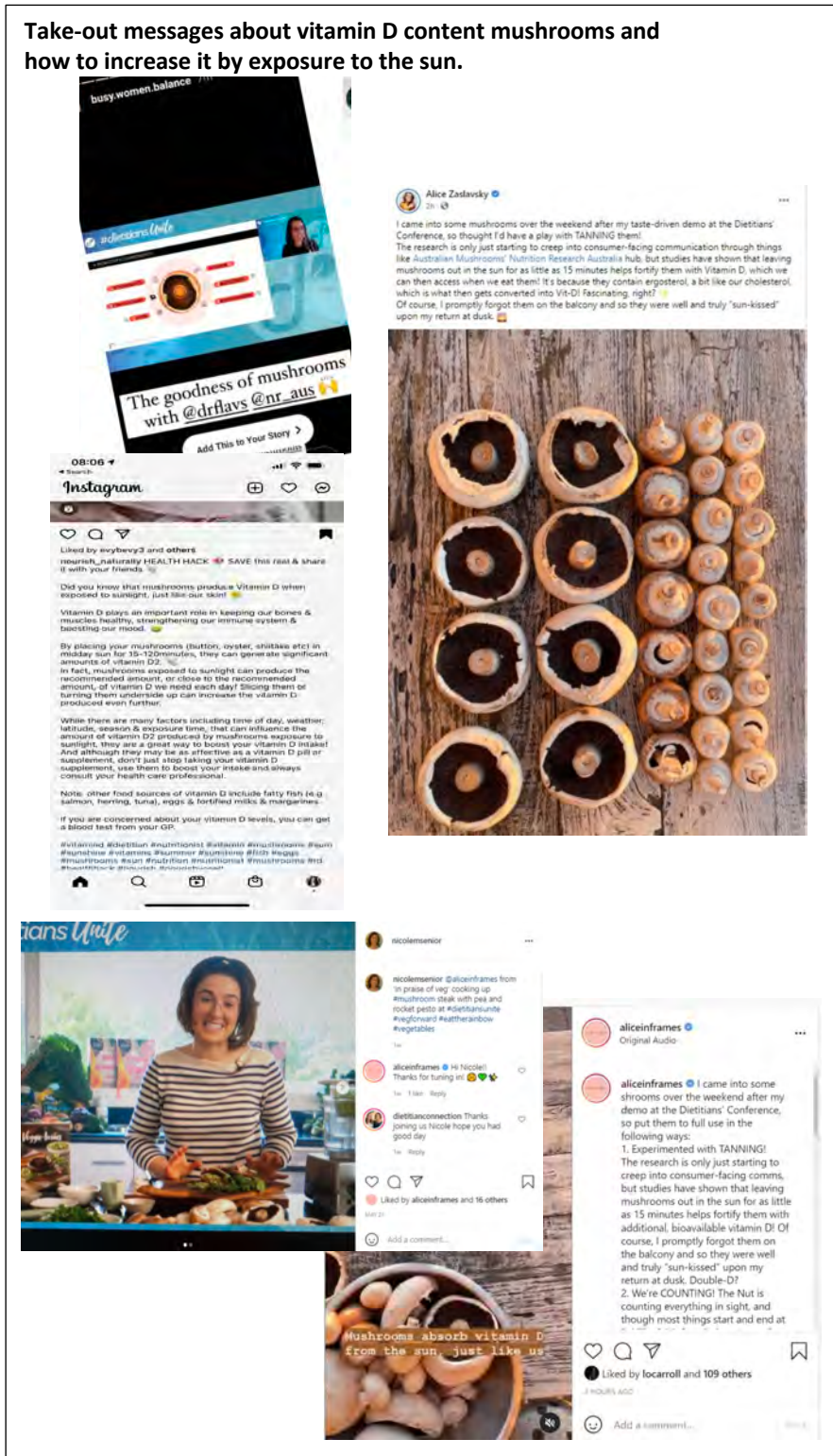
- There were a number of positive social media posts.
  - @busywomenbalance posted 'The goodness of mushrooms with @drflavs @nraus.
  - Alice Zaslavsky posted 'I came into some mushrooms over the weekend after my taste-driven demo at the Dietitians conference, so thought I'd have a play with TANNING them! The research is only just starting to creep into consumer-facing communication through things like Australian Mushrooms Nutrition Research Hub, but studies have shown that leaving mushrooms out in the sun for as little as 15 minutes helps fortify them with Vitamin D which we can access when we eat them! It's because they contain ergosterol, a bit like our cholesterol which is what then gets converted into Vit-D. Fascinating right!'
  - @NicoleSenior posted '@aliceframes from in praise of veg cooking up #mushroom steak with peas and rocket pesto.'

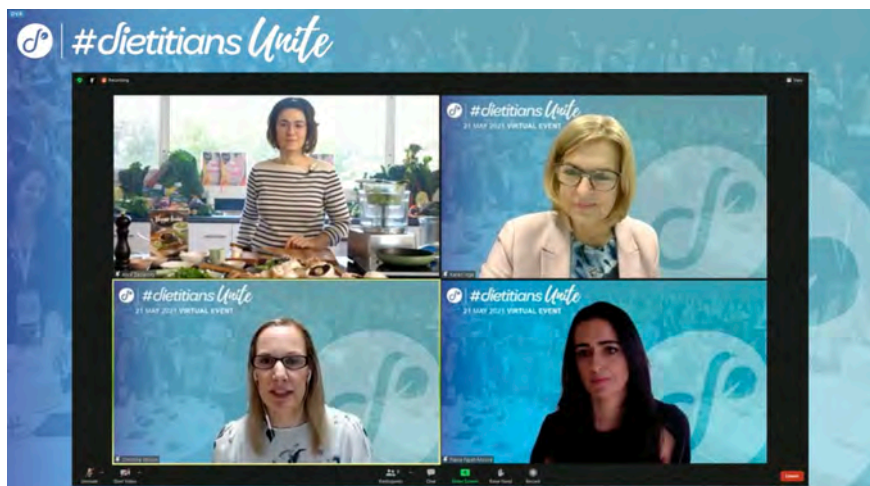
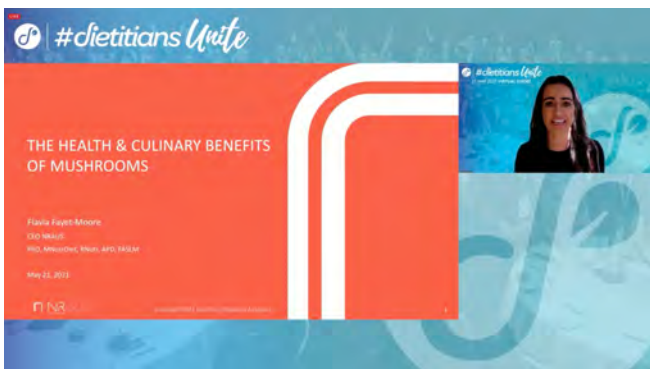
Social Media Posts

Pre-event excitement building for the seminar.

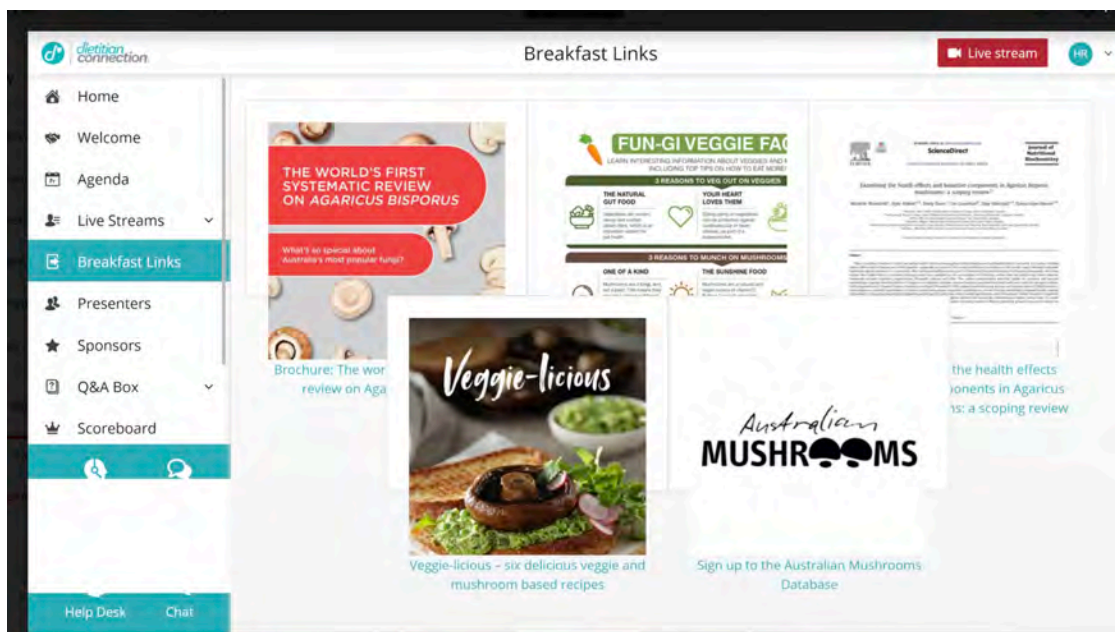
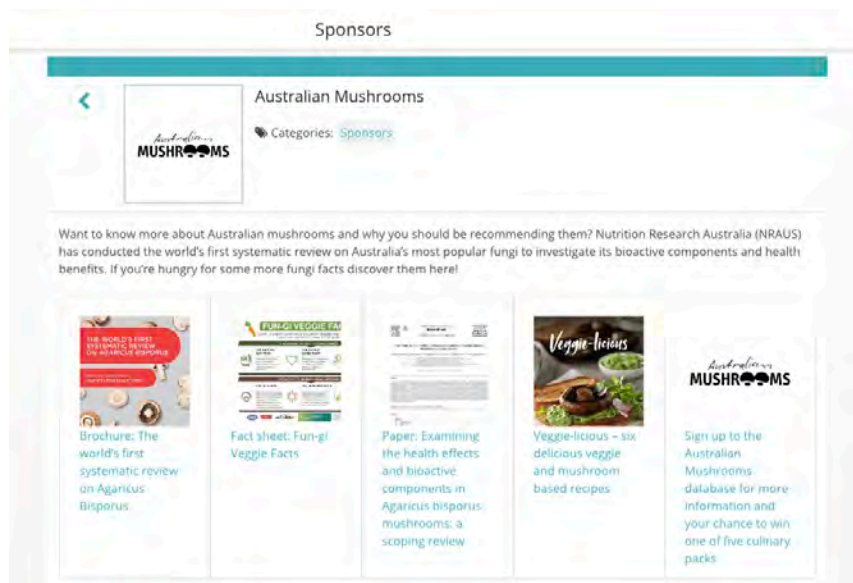
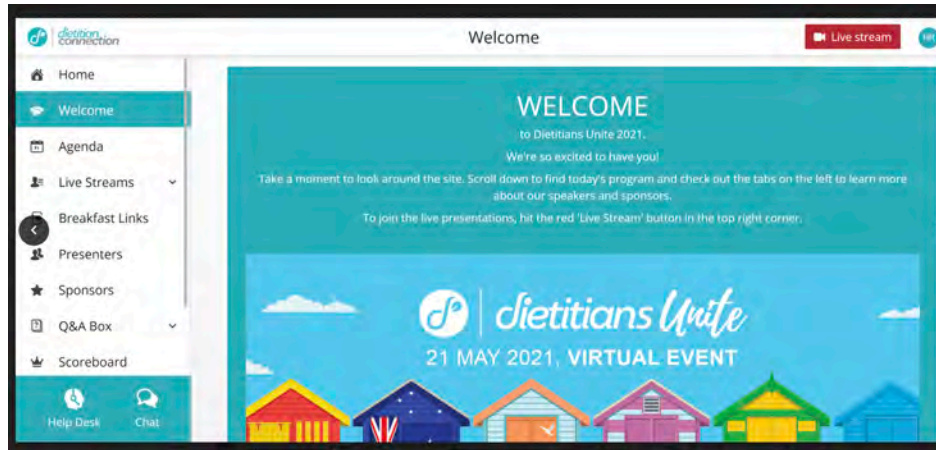


Take-out messages about vitamin D content mushrooms and how to increase it by exposure to the sun.









## **MILESTONE 104: ROUNDTABLE WHITE PAPER (PREVIOUSLY DIETITIAN BROCHURE)**

### ***Background***

Approval to change the Dietitian Brochure to the roundtable white paper was provided by Hort Innovation in April 2020. The purpose of the roundtable white paper is to communicate the findings and implications from the small Sydney roundtable event, held virtually on the 25th of November 2020.

The virtual roundtable event, hosted by Nutrition Research Australia (NRAUS), brought together five experts across different fields, including nutrition research, food science, indigenous culture, and culinary nutrition, to explore and discuss the specific role of fungi foods and mushrooms specifically in a healthy diet, particularly as dietary guidance is shifting from nutrients towards dietary patterns and 'plant-based' diets. The white paper summarises the main themes and key messages from the roundtable presentations and discussion, offering evidenced-based insights for the consideration of health professionals and policy makers.

### ***Activity in-progress***

The summary of key findings and recommendations from the roundtable event, drafting of the whitepaper content and sign off from all of the experts and design briefing have all been completed. The report is in final design peer review stages. It is planned to be 22 page A4 report (see **Appendix 5** for approved copy sent to design). There will be an executive summary, background and then 3 key sections; Fungi foods: What are they?, What makes mushrooms unique?, and How can we create greater focus for mushrooms as a significant healthy food?, in addition to a consensus summary statement and references. There is an important inclusion on the culinary benefits of mushrooms as this is one of the key objectives for year 3 along with practical tips for clinicians in recommending mushrooms to clients.

Key messages include:

- Fungi foods comprise their own food kingdom, distinct from both animals and plants.
- Traditionally valued for thousands of years, including with our First Nation People, and with a strong medicinal reputation in Asian cultures.
- Mushrooms contain unique flavour compounds that contribute to their well-regarded savoury 'umami' taste profile, a known desirable culinary driver of taste.
- Mushrooms have a unique nutritional composition, comprising micronutrients and bioactive compounds found in both plants and animals, along with three bioactive compounds (Ergosterol, Ergothioneine and Chitin) not commonly found in both.
- Emerging research has shown mushrooms to have favourable effects on gut health, inflammation, immune function, cancer risk and satiety. It has been established that consuming UV enriched types improve vitamin D status.

The whitepaper will be available and distributed in electronic format in week commencing 9th August.

### ***Next steps***

The roundtable whitepaper PDF will be communicated as part of the roundtable communications activation, which includes an EDM to our owned database, along with social media advertisement that will drive traffic to the mushroom hub and encourage database sign up.

### **MILESTONE 105: HCP Digital Activation: August 2021**

#### ***Background***

This milestone replaces the previously scheduled Australian Society Lifestyle Medicine (ASLM) Conference, with that conference being cancelled in 2021. This change was approved by Hort Innovation in March 2021.

The Digital Activation Campaign main objective is to increase total HCP reach and widen the demographic split in our owned database by including Naturopaths in the target audience. It also aims to drive awareness of resources and database signups. It consists of two main activations.

The first aims to specifically target GPs through the creation of an ***opinion-led editorial piece***, written by Dr Flavia Fayet-Moore, to be published in a widely read GP publication. The article is planned to be supported by advertising to drive GPs to the mushroom hub and encourage sign up to the database.

The second specifically targets extension of reach to HCPS (Primary target naturopaths and GPs) to drive signups and disseminate resources via a ***lead generation social media campaign***. HCPs will be targeted via LinkedIn with the offer to download the new HCP client focused brochure and in doing so sign up to our owned database.

#### ***Activity in-progress***

The messaging for the editorial leverages current ‘hot’ research topics, including focus on the re-emergence of infectious diseases as a public health problem, vitamin D’s role in immunity and link to reducing risk of respiratory infections, and incidence of vitamin D deficiency in Australia. The editorial positions mushrooms and specifically sun exposed mushrooms, as an ultimate prescription for supporting healthy vitamin D status, providing not only over 100% of the recommended adequate daily intake for vitamin D that has been shown to improve vitamin D status but also providing a range of unique bioactives and nutrients for health.

The opinion piece article is currently in the final stages of peer review and is being pitched to trade media outlets, with publication scheduled for August 2021.

#### ***Next steps***

The design for the social ad as part lead generation campaign that will entice HCPs to download our new HCP client focused brochure is soon to start with go live date planned for mid-August after the HCP client focused brochure is completed and will be live for 6 weeks.

### **MILESTONE 105: HCP Client focused Brochure: August 2021**

#### ***Background***

A key learning from the second Audience Sentiment Research was that HCPs wanted resources to help facilitate them to recommend mushrooms to their clients. This milestone replaces the Naturopath brochure milestone and was approved by Hort Innovation in March 2021.

#### ***Activity in-progress***

This client oriented brochure is centred on Vitamin D and Mushrooms being your ultimate source. It is planned to be a double sided A4 brochure with one side focused on vitamin D, highlighting the prevalence of deficiency and educating on why we need it (highlight on immunity) and where we can get vitamin D from (sun, supplement and food). The second side is focused on presenting common edible mushrooms as the ultimate source of vitamin D to support immunity. It will educate on the content of vitamin D in mushrooms and sun exposed mushrooms relative to other food sources, it’s other nutritional benefits and provide practical tips on preparation and serving size. The brochure content has been finalised and is currently in design. It is on track to be ready for distribution in August 2021.

#### ***Next steps***

The HCP client oriented resource is to be leveraged as the key resource used in the lead generation social campaign. It will also be disseminated via our owned database, social media posts and via a partner digital channel such as Naturopathic and Herbal Medicine Association, ASLM and/or Think GP.

## **MILESTONE 106: 6 MONTH BENCHMARKING PERFORMANCE REPORT 5**

Completed as per this report. *30 June 2021*

### **MILESTONE 106: Webinar: September 2021**

#### ***Background***

To date, activations have focused mainly on GPs and Dietitians. Naturopaths and Herbalists were considered another key audience to target as often they are servicing a different population group to conventional medical practitioners. It is estimated that there are ~3000 naturopathic practitioners consulting with approximately 6% of the Australian population, equating to some 1.5 million Australians, engaging in around four million consultations each year. While the event will be open to all HCPs, the event recruitment will be targeted specifically to this key HCP group.

#### ***Activity in-progress***

Planning is underway to finalise an inspiring theme and event that will be appealing to this HCP group. It is envisaged to be a 1-hour event with 2 key speakers, including Dr Flavia Fayet-Moore, and include a 15 minute Q&A session.

#### ***Next steps***

The webinar is planned to take place on Friday 1pm 13<sup>th</sup> September. Recruitment to the event will be through key membership bodies such as Naturopathic and Herbal Association of Australia (NHAA) and will also be advertised through the mushrooms database and targeted social media.

## Outputs

### A. DIETITIANS UNITE BREAKFAST SEMINAR EDM (Appendix 2)

An EDM to Dietitian Connection members to promote the breakfast session at the Dietitians Unite conference.

**Date sent:** 29<sup>th</sup> April 2021

**Target audience:** Dietitians Connection Members (dietitians and nutritionists)

**Reach:** 8500

### B. AUDIENCE SENTIMENT RESEARCH 2 (Appendix 3)

A repeat survey to the baseline research conducted in August 2019 to measure the success of the program through comparison to baseline data and gather insights that help to tailor the communications program going forward.

**Date conducted:** November 2019

**Target audience:** Health Care Professionals from owned EDM and social media recruitment.

**Reach:** 195

### C. DIETITIAN UNITE SEMINAR PRESENTATION (Appendix 4)

A breakfast event at Dietitian's Unite, a key nutrition conference event run by Dietitian Connection for dietitians and nutritionists. The breakfast event was sponsored by Australian Mushrooms in partnership with Simplot Australia and focused on culinary nutrition. The breakfast event was titled *'Taste: the forgotten message to enjoy a variety of vegetables and mushrooms'*.

**Date event:** 21<sup>st</sup> May 2021

**Target audience:** Dietitians Connection Members (dietitians and nutritionists)

**Reach:** 226

## Outcomes

- **A strong strategic plan for year 3 developed**

Audience sentiment survey was capitalised on to refine the intended objectives and to pivot plans to develop a HCP client oriented brochure, and extend the reach of messages through a digital activation campaign.

- **Strengthening communication and impact via educating on culinary nutrition**

Communication this year as per plan has moved towards building in communication that mushrooms are more than nutrition. Culinary nutrition builds on the rationale nutrition and health benefits of mushrooms and helps develop an emotional connection that can create greater impact in messaging delivery. The key messages include mushrooms can help reduce salt intake, enhance flavor of meals and being a meat alternative. The feedback from DU conference supports this was achieved.

- **Building a growing database of contacts**

The HCP database has grown by 4% from January 2021 to June 2021 to 1464 with an additional 59 people added.

- **Creating impact with mushroom growers**

Presentation developed and delivered in a webinar to 40 registered mushroom growers by Dr Flavia Fayet-Moore was highly received and valued for its clarity and impact in the translation of the science.

- **Creating a 'go to' hub for HCPs**

Continuing to house all resources and direct HCPs to the Mushroom Hub where they can go to access credible and practical information on mushrooms to support their continuing education and/or leverage with clients.

- **Hitting the mark with HCP recommending mushrooms to clients**

More HCPs are recommending mushrooms to clients (increase 14% from baseline), with only 7.7% of HCPs who see clients not recommending them, a decrease from 18% at baseline.

- **Delivered a resonating message with Dietitians - a key HCP audience**

Dietitians Unite reach exceeded KPIs, with 1 in 4 attendees subscribing to the database and 96% rating the event as excellent or very good. The key message: *While classified as a vegetable in the Australian Dietary Guidelines, mushrooms are biologically neither a plant, nor an animal, and belong to their very own kingdom, fungi. They contain a unique nutritional, bioactive and umami taste package, with demonstrated human health benefits, that make them worthy of greater focus.*

## Intellectual property, commercialisation and confidentiality

No project IP, project outputs, commercialization or confidentiality issues to report.

## Issues and risks

**Campaign Risk Register** – The risks register for this project can be viewed [here](#).

The identified issues listed below have been managed and all outputs will be met:

### White paper

The white paper was initially planned to be distributed in quarter 1 but was delayed as it took longer than anticipated to obtain all the expert feedback and approval of the copy. This is on track to be a high impact, high quality publication for distribution in August.

### Covid-19

The impact of COVID-19 continued in the past 6 months impacting both the ASLM and DU planned conferences. ASLM was delayed until 2022 and we readdressed this with the proposal of change to a Digital Activation Strategy that was accepted in March 2021.

The DU event that was planned as an in person event that included a trade display was moved to a virtual event which presented challenges in regard to maintaining motivation and recruitment to a breakfast online session (with no longer any breakfast to be served), engagement, and database acquisition, as well as ensuring the presentations and messages would all be delivered seamlessly.

Securing celebrity cook, Alice Zaslavsky who had her own professional kitchen set up for the virtual platform, along with well-respected dietitian Karen Inge to host the event, was instrumental in our strategy of creating buzz, excitement and engagement for the event. We developed comprehensive written briefs in addition to face to face briefings and rehearsals prior to the event for all our speakers and host that ensured they were well versed in expectations and key messaging via the virtual platform. It was noted that Alice and Karen both commended the team on a thorough briefing that they felt was key to the success.

A key objective of the trade display was planned database acquisition. We were still able to achieve this through an enticing prize incentive strategy that was communicated during the event. The virtual environment for the DU event also presented the challenge that we needed a landing page on the website developed to be able to capture HCPs from the event who wanted to subscribe to our database. This was not possible on the NRAUS mushroom hub and Australian Mushrooms were still not in a position to develop an HCP section on their website. Through problem solving with the agency, we were able to manage this with the development of a google forms approach that while not a long-term approach was highly effective and appropriate for this event.

## Other information

None

## **APPENDIX 2: MS105 BENCHMARK AUDIENCE SENTIMENT RESEARCH 1**



**Hort  
Innovation**  
Strategic levy investment

**MUSHROOM  
FUND**

Audience Sentiment Benchmark: Research Report - August 2019



# Background:

**Project Code:** MU 17002

**Project Name:** Educating health professionals about Australian mushrooms

**Project Leader:** Dr Flavia Fayet-Moore

**Delivery Partner:** Nutrition Research Australia Pty Ltd (NRAUS)

**Report Author:** NRAUS; History Will be Kind (HWBK)

**Contact:** Flavia Fayet-Moore (e: [flavia@nraus.com](mailto:flavia@nraus.com) m: 0415 990 050)

# Contents:

- Objectives and Audiences
- Approach
- Survey Results
- Learnings & Opportunities
- Setting Key Performance Indicators
- Next Steps

# Objectives and audiences

August 2019



# Overview:

**This report describes the findings from the first of three waves of the audience sentiment research. It's purpose is to:**

1. Help us to measure changes in attitudes, knowledge and propensity to act over time, by providing the baseline findings for our campaign.
2. Gather insights that will help us to tailor the communications program over the course of the project, in order to more strategically increase awareness of the nutritional and health benefits of mushrooms among HCPs.

# Objectives:

To measure awareness and attitudes across 5 core areas:



**Knowledge** of the nutritional properties and health benefits of mushrooms.



**Value** placed on mushrooms for their properties.



**Perception** of mushrooms for health.



**Behaviour** around recommending mushrooms.



**Frequency** of recommendation or behaviour.

# Audiences:

## Core campaign audiences:

1. GPs
2. Dietitians
3. Nutritionists
4. Naturopaths

## Secondary audiences:

5. Fitness professionals
6. Other (to be specified e.g. chef, home economist)



# Approach

August 2019





# Approach:

## STEP 1:

HCP signup form created on the Australian Mushrooms website.

## STEP 2:

Uploaded the former campaign database (n= 1,002 contacts) and combined this with the new NRAUS database.

## STEP 3:

Introduction email created for our new NRAUS database, welcoming this audience to the new Australian Mushrooms nutrition and health project.

## STEP 4:

Distributed our sentiment analysis questions to the NRAUS and Australian Mushrooms databases, as well as sending via third party organisations (RACPG, ASLM and the NSA).

## STEP 5:

Distributed a second follow up email to the Australian Mushrooms and NRAUS databases, for those who had not yet completed the survey.

## STEP 6:

Developed a paid social campaign targeting HCP audiences, to reach new audiences across Facebook and Instagram.

# Distribution channels:



**TOTAL COMBINED REACH OF: 49,816**

# Assets:



A state-of-the-art survey platform with a bespoke interface designed to maximise engagement.

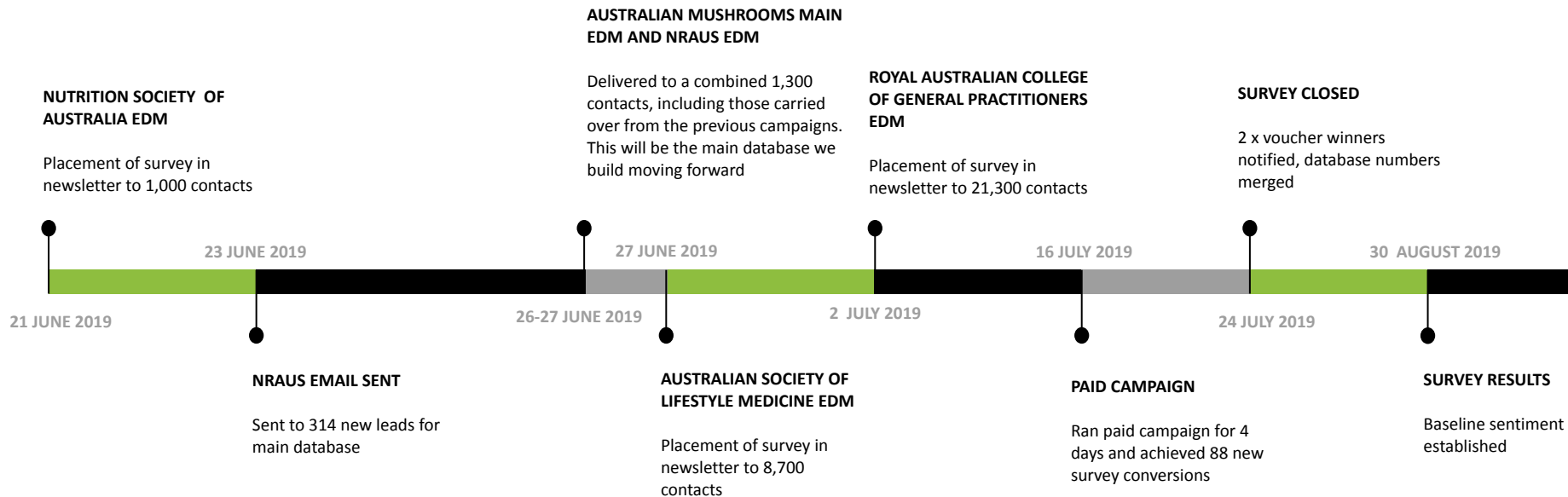


A series of compelling EDMs designed to reflect the new consumer look and feel.



Additional social ads and campaign visuals shared with third party organisations.

# Timeline:



# EDM and Paid Results

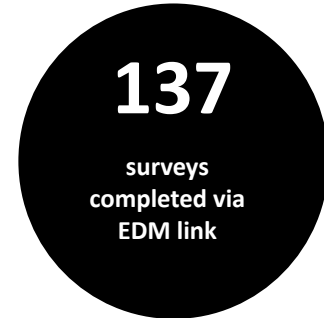
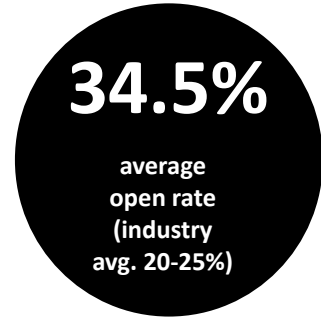
August 2019



# EDM performance to existing databases

**OBJECTIVE:** To distribute the EDM to existing HORT and NRAUS databases.

EDM	Database Size	Unique Opens	Open Rate	Click Through Rate	Unsubscribe Rate	Not Opened	Clicked the survey link
Welcome - NRAUS Database	314	133	47.7%	16.5%	0%	146	N/A
Baseline Survey - Aus Mushrooms Database	1,002	244	27.5%	24.2%	1.8% (16 people)	645	63
Baseline Survey - NRAUS Database	298	97	34.4%	36.1%	3.9% (11 people)	185	45
Reminder - Aus Mushrooms Database	914	237	27.2%	20.7%	0.69% (6 people)	633	53
Reminder - NRAUS Database	287	97	35.5%	16.5%	1.1% (3 people)	176	14
<b>TOTAL (average)</b>	<b>2,815 EDMs sent</b>	<b>808 unique opens</b>	<b>34.5% open rate</b>	<b>22.8% clicked a link</b>	<b>1% opting out</b>	<b>1,785 unopened EDMs</b>	<b>175</b>



# Paid social media

**OBJECTIVE:** To secure additional survey responses beyond the databases in order to reach the target of 200, a media spend burst was conducted via niche audience targeting.

Audience	Clicks to Site	Reach	Cost Per Click	Spend	Click Through Rate	Video Percentage Watched
General Practitioners	66	2,210	\$0.45	\$29.51	4.67%	36.4%
HCPs	254	14,861	\$1.75	\$444.93	1.20%	23.7%
Database Retargeting	9	383	\$2.84	\$25.56	1.73%	19.9%
<b>TOTAL (average)</b>	<b>329</b>	<b>17,384</b>	<b>\$1.52</b>	<b>\$500.00</b>	<b>1.46%</b>	<b>24.4%</b>

## RESULTS:

- Campaign ran for 4 days, drove 329 new visitors to the survey, and converted an additional **88 survey responses**
- GP audience size on social media was small but the CTR was very high at 4.67% (industry average is 1%)
- Additional contacts from the social strategy were added to the master database



88

surveys  
completed from  
paid activity

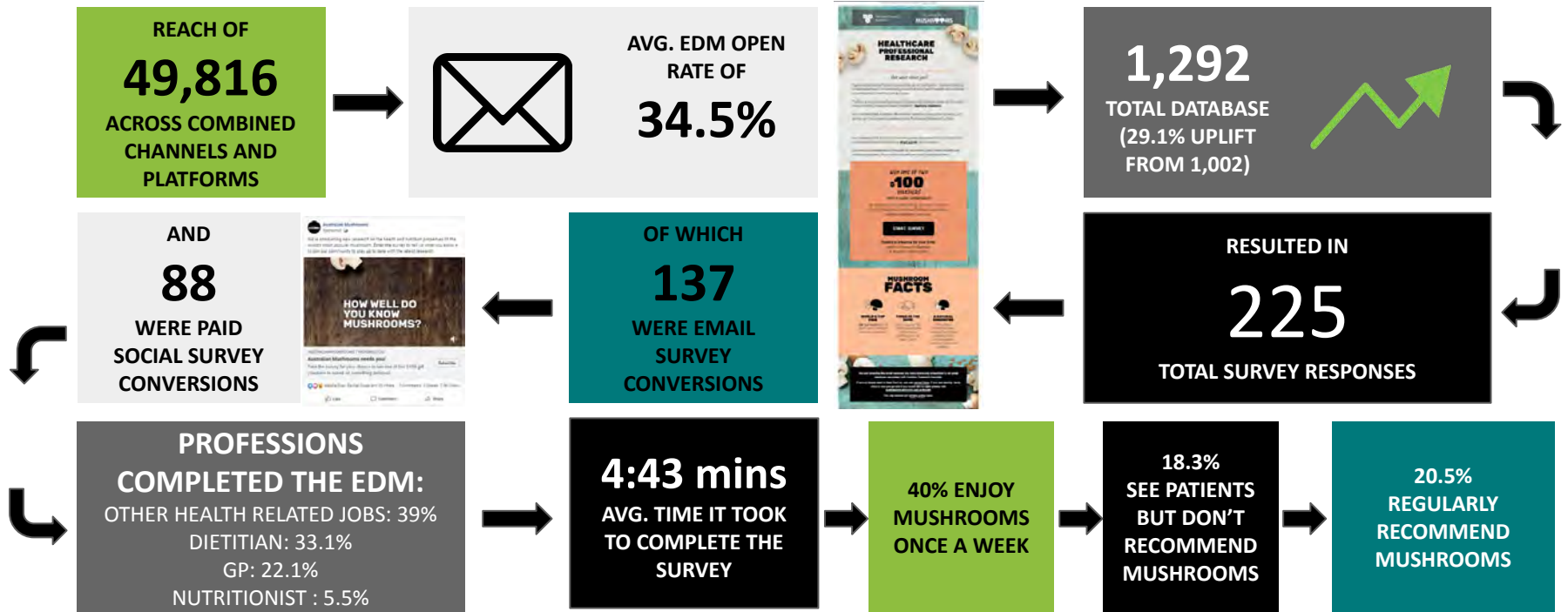
# Survey Results

August 2019





# The story in a snapshot:



# Survey Stats:

**319**

Unique visits of 433 total visits to the survey from all sources (email activity + paid)

**70%**

Completion rate of those that landed on the survey (n = 225)

**99.5%**

Of those that started the survey completed it (n=224/225)

**61%**

Took part from NRAUS and Partner EDMs (n = 139)

**39%**

Took part from paid media activities (n = 88)

Questions with secondary parts were non-mandatory and were often skipped. See results on individual questions

**OF THE 225 PARTICIPANTS WHO COMPLETED, ENGAGEMENT EXCEEDED EXPECTATIONS**

# Survey structure:

The following results have been set out in accordance with the overall survey structure as outlined below:

- **Part 1** - Audience segmentation
- **Part 2** - Knowledge of the health and nutritional properties of mushrooms
- **Part 3** - Value of mushrooms to HCPs
- **Part 4** - Existing resources
- **Part 5** - Personal consumption habits
- **Part 6** - Frequency of mushroom recommendation to clients
- **Part 7** - What online resources do they use?

# Part 1: Demographics and location

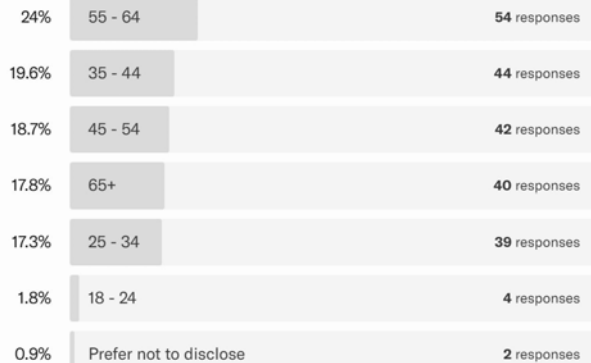
## GENDER

83% of respondents were female



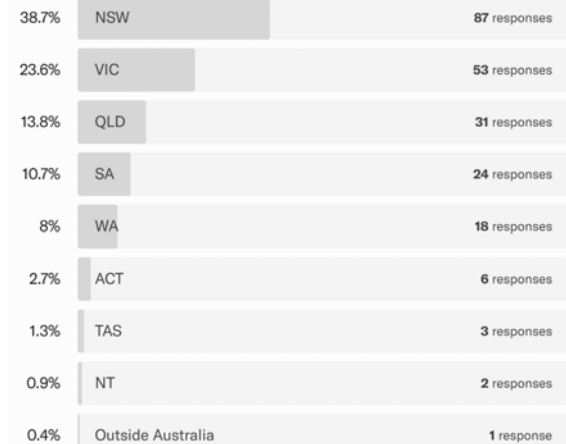
## AGE

The age sample size was evenly split



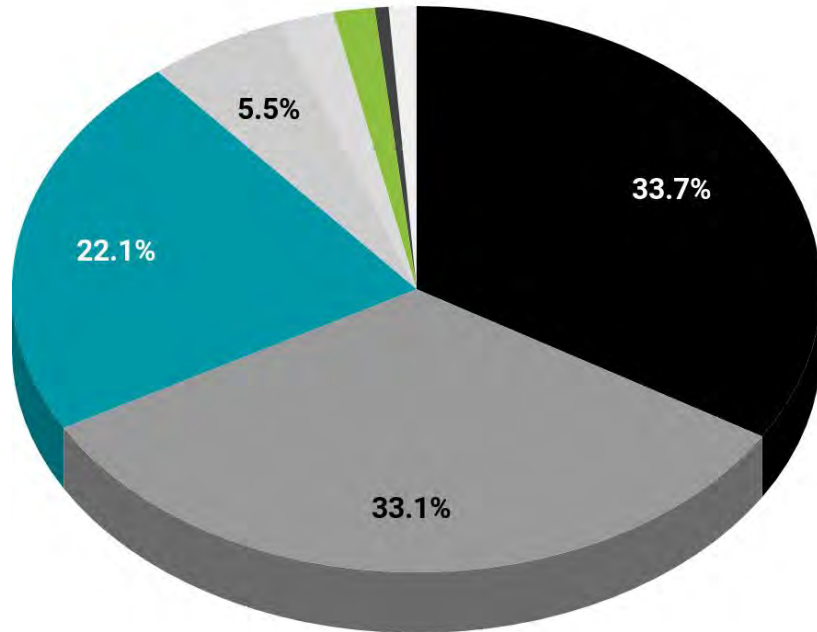
## LOCATION

NSW was the most represented state



225/225 ANSWERED  
MANDATORY

# Part 1: Profession



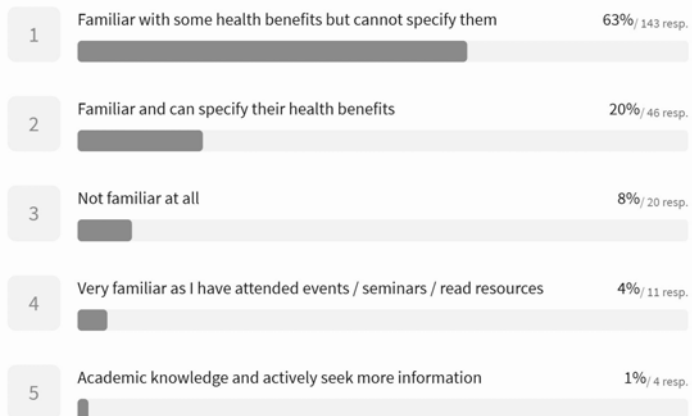
- 33.7% Other health professional (e.g. nurse, physiotherapist, social worker)
- 33.1% Dietitian
- 22.1% General Practitioner
- 5.5% Nutritionist
- 2.2% Other food professional (e.g. chef, home economist)
- 1.7% Naturopath
- 0.6% Fitness Professional
- 1.1% Other - Farmer & VET Nurse

<b>100%</b>	OF THE NUTRITIONIST / NATUROPATH / DIETITIAN HAD A DEGREE
<b>33.7%</b>	OF THE RESPONDENTS WERE OTHER HEALTH PROFESSIONALS (E.G. NURSE, PHYSIO, SOCIAL WORKER)

224/225 ANSWERED  
MANDATORY

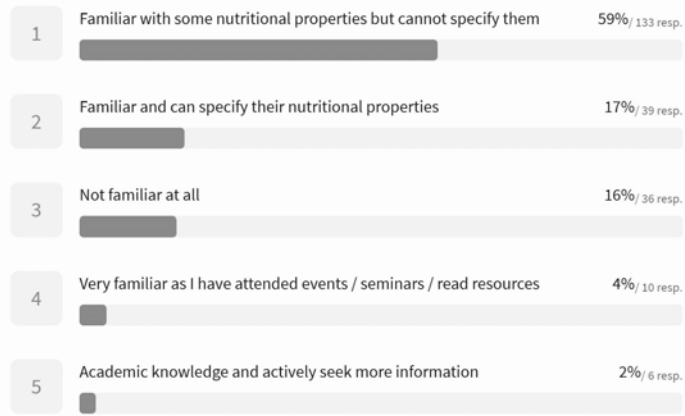
## Part 2: Health benefits and nutritional properties

### Q1. HOW FAMILIAR ARE YOU WITH THE HEALTH BENEFITS OF CONSUMING MUSHROOMS (E.G. BONE, GUT, HEART HEALTH)?



224/225 ANSWERED  
MANDATORY

### Q2. HOW FAMILIAR ARE YOU WITH THE KEY NUTRITIONAL PROPERTIES OF MUSHROOMS (E.G. NUTRIENT CONTENT)?



224/225 ANSWERED  
MANDATORY

#### FINDINGS:

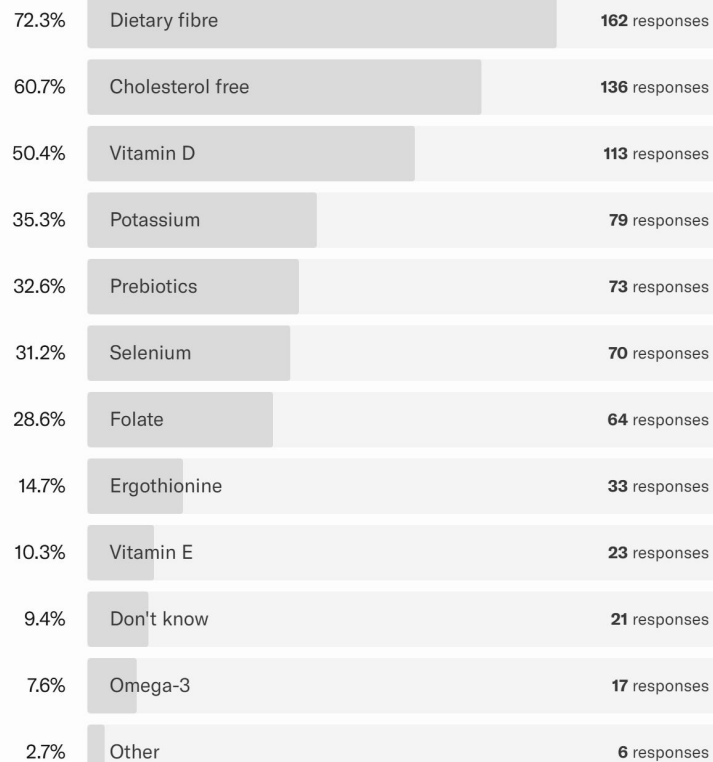
- 63% of respondents were **familiar with 'some'** of the health benefits, **but cannot specify** what they are
- A large proportion (8%, 20 respondents) respondents were **'not familiar at all'** with the health benefits - 9 were 'Other health professionals' and 6 were 'GPs'
- **Dietitians** and **'Other healthcare professionals'** were the most familiar group with 'some' of the health and nutritional benefits of mushrooms

## Part 2: Specifying the nutritional properties

### Q3. IN YOUR OPINION, WHAT ARE THE KEY NUTRITIONAL PROPERTIES OF MUSHROOMS (E.G. NUTRIENT CONTENT)?

#### FINDINGS:

- **72%** of the 224 respondents were **able to specify at least one nutritional property**
- Nearly 10% **could not select** a nutritional property
- **Dietary fibre, cholesterol free and vitamin D** were the **most common** nutritional properties selected, respectively
- Only **half of** the respondents **selected vitamin D**
- Few (2.7%) who listed 'Other' and manually entered vitamin B12, iron, vitamin B, and a single respondent said 'choline and some other minerals and vitamin C'



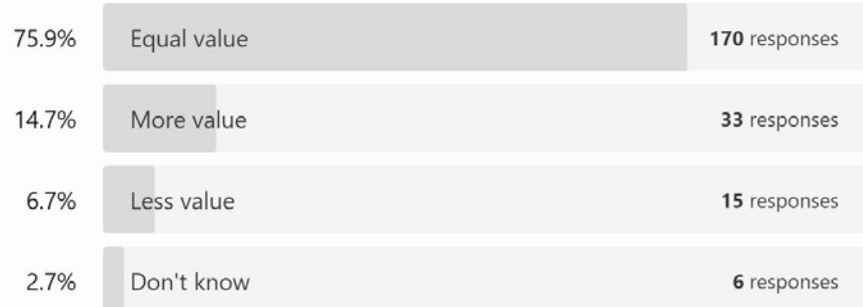
## Part 3: How valuable are mushrooms to HCPs?

### Q4. HOW IMPORTANT DO YOU THINK MUSHROOMS ARE IN SUPPORTING OVERALL HEALTH?



224/225 ANSWERED  
MANDATORY

### Q5. HOW MUCH VALUE DO YOU PLACE ON MUSHROOMS COMPARED TO VEGETABLES?



224/225 ANSWERED  
MANDATORY

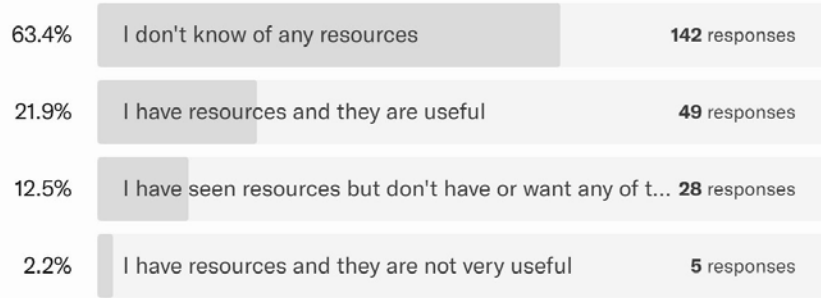
#### FINDINGS:

- Mushrooms are **most commonly seen as 'somewhat important'** for overall health (57.1%), with a lower proportion viewing mushrooms as 'very important' (33.9%)
- **Approx. 9%** in both of the above two questions respondents **'didn't know/not important'** or placed **'less value/didn't know'** on mushrooms being as important as vegetables, showing a large opportunity to showcase their differential nutritional and health properties
- An outstanding 75.9% of the respondents put **equal value on mushrooms to other vegetables**. HCP's told us that trying to get their patients to even eat vegetables is a challenge



# Part 4: What are the resources like?

## Q6. WHICH STATEMENT BEST DESCRIBES YOUR OPINION ON THE AVAILABILITY OF RESOURCES TO HEALTHCARE PROFESSIONALS ON THE HEALTH BENEFITS AND NUTRITIONAL PROPERTIES OF MUSHROOMS?



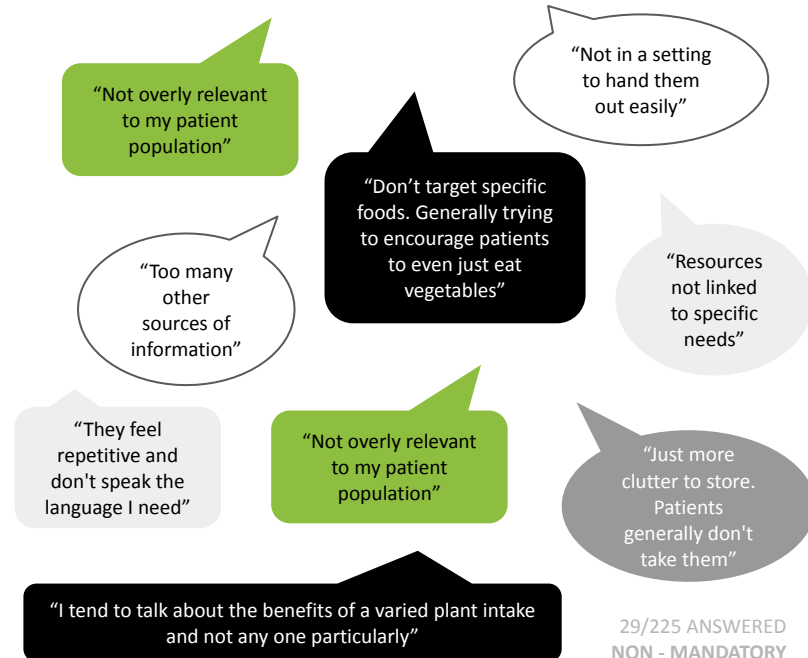
224/225 ANSWERED  
MANDATORY

### FINDINGS:

- Almost two-thirds reported **they did not know of any resources**
- Among those who did not have or want resources, they:
  - Did not need them
  - Were not targeting specific foods but rather encouraging consumption of all vegetables
  - Had a surplus of information leading
  - Had no time to consume multiple resources.

### OPEN ENDED RESULTS

#### Q6a. WHY ARE THEY NOT USEFUL?



29/225 ANSWERED  
NON - MANDATORY

# Part 5: Personal consumption of mushrooms

## Q7. HOW OFTEN DO YOU PERSONALLY CONSUME MUSHROOMS?



224/225 ANSWERED  
MANDATORY

## Q8. IF NEVER, WHY DON'T YOU CONSUME MUSHROOMS?



4/225 ANSWERED  
NON-MANDATORY

### FINDINGS:

- Nearly all (98%) of HCP eat mushrooms, and do so **at least once a week**
  - 40.2% ate it once per week and 37.9% ate it several times per week
- Less than 3% had it **daily**
- **Taste and/or texture** were the only reasons for never consuming mushrooms

## Part 6: Mushroom recommendations to clients

### Q9. HOW OFTEN DO YOU SPECIFICALLY RECOMMEND MUSHROOMS TO YOUR CLIENTS OR PATIENTS?

33.9%	Does not apply as I don't see patients/clients	76 responses
20.5%	Regularly recommend	46 responses
18.3%	Don't recommend, but I do see patients/clients	41 responses
18.3%	Occasionally recommend	41 responses
8.9%	Rarely recommend	20 responses

224/225 ANSWERED  
MANDATORY

### Q10. IF NOT, WHY DON'T YOU RECOMMEND MUSHROOMS?

50%	I do not think about mushrooms specifically	18 responses
44.4%	Not familiar with their health benefits	16 responses
33.3%	I have no time to discuss mushrooms specifically	12 responses
33.3%	Not familiar with their nutritional properties	12 responses
5.6%	Clients or patients do not have cooking skills	2 responses
5.6%	I do not believe mushrooms are unique	2 responses
2.8%	Clients or patients do not like mushrooms	1 response
5.6%	Other	2 responses

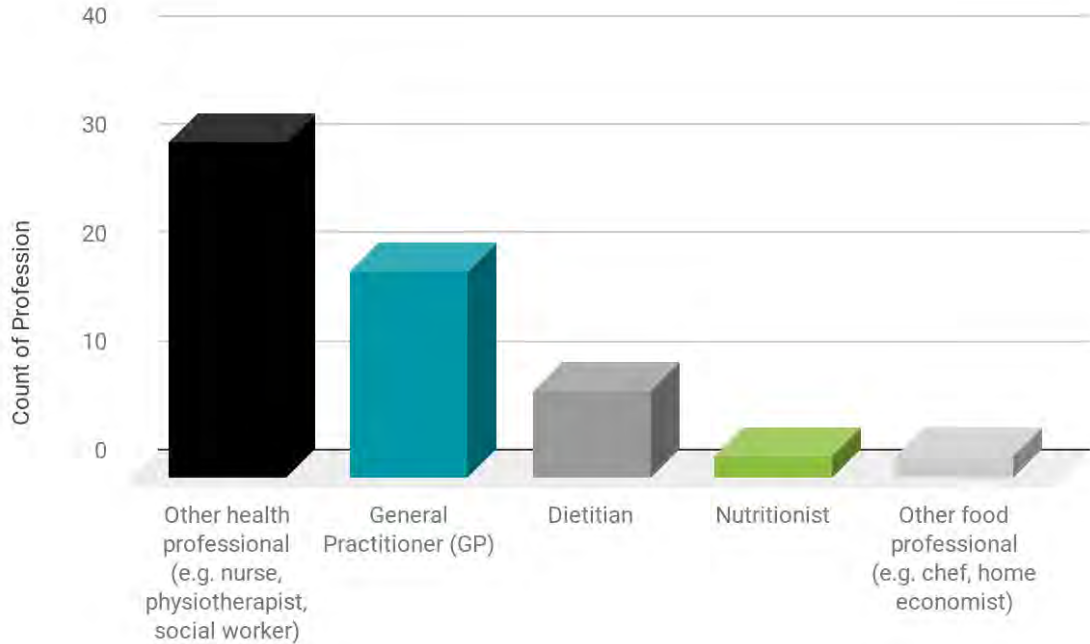
36/225 ANSWERED  
NON-MANDATORY

#### FINDINGS:

- A third (33.9%) of respondents **do not see patients/clients**
- Among those that recommend, **20.5% regularly recommend**
- Top reason for not recommending was **not familiar with health or nutritional properties** (45% of respondents)
- **18% do see patients, but don't recommend** mushrooms.
- 'Other' reason for not recommending included not being relevant in their field of practice eg: working in an operating theatre

# Part 6: Mushroom recommendations to clients

## Q10. PROFESSION AMONG THOSE THAT DO NOT RECOMMEND MUSHROOMS



### FINDINGS:

- 81% of respondents that don't recommend or rarely recommend mushroom were 'Other healthcare professionals' + 'GP's'
- HCP's other than nutritionist /dietitian were less likely to recommend mushrooms and place less value on mushrooms as an individual food - yet place great value on vegetables and a healthy diet i.e. trying to get their patients to get patients to eat a vegetable altogether can be a challenge

## Part 6: Mushroom recommendations to clients

### Q11. FOR THOSE WHO SELECTED 'OCCASIONALLY RECOMMEND' AND 'REGULARLY RECOMMEND' - WHY?



#### FINDINGS:

- **Nutritional properties and health benefits combined** (49 responses) were valuable factors to recommend mushrooms
- **Adding extra flavour** was the top **single top reason** to recommend mushrooms (29 responses)
- Of the 2 respondents who selected 'other' for why they recommend mushrooms, they said that they are a filling vegetable and help to add texture to meals

#### OPEN ENDED RESULTS

"This also depends on the circumstances of the patient."

"Get your fiber and Vitamin D! Mushrooms are filling and add texture to dishes"

43/225 ANSWERED  
NON-MANDATORY

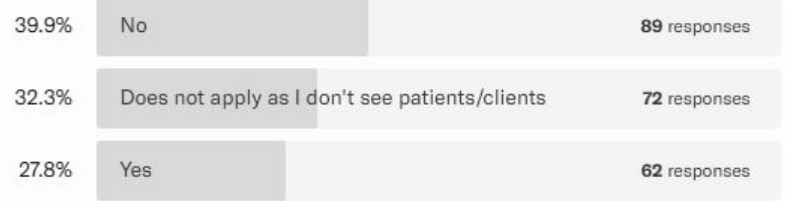
## Part 7: Online resources?

Q12. HAVE YOU VISITED THE AUSTRALIAN MUSHROOMS WEBSITE FOR HEALTH OR NUTRITIONAL INFORMATION?



223/225 ANSWERED  
MANDATORY

Q13. DO YOU GIVE YOUR CLIENTS OR PATIENTS RECIPES OR COOKING MATERIALS?



223/225 ANSWERED  
MANDATORY

### FINDINGS:

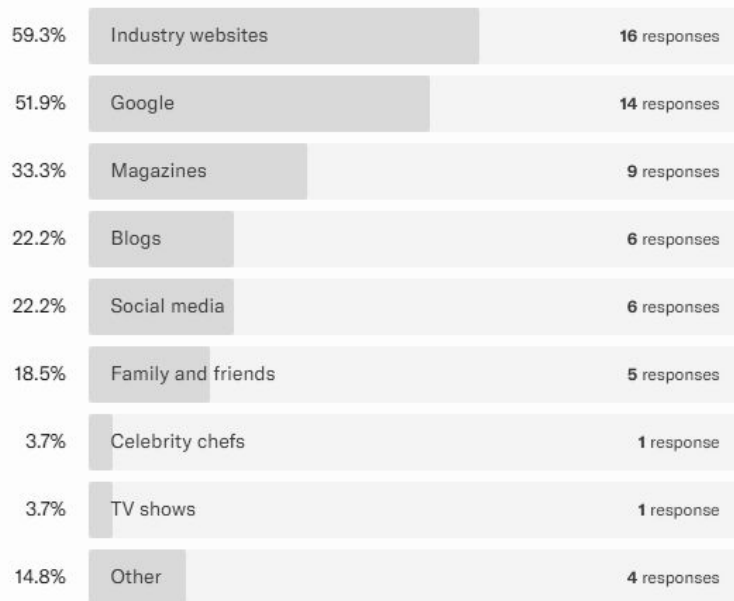
- **Knowledge of the Australian Mushrooms website is low** (74% have never visited the website)
- **Recipe sharing is not popular** among respondents who see patients/clients (nearly 60% do not give recipes or cooking materials)

## Part 7: Online resources?

### Q14. IF YES, WHERE DO YOU GENERALLY FIND INSPIRATION FOR RECIPES TO GIVE TO YOUR CLIENTS OR PATIENTS?

#### FINDINGS:

- **59.3% visit industry websites for inspiration**, showing a broader approach which is perhaps not specific to one vegetable may be effective
- Beyond industry websites, HCPs turn to google, magazines, blogs and social media (35 respondents)
- Of the 4 respondents who selected 'other', they named cookbooks, their own website and their own recipe ideas, rather than seeking it from external online resources



27/225 ANSWERED  
NON-MANDATORY

OPEN ENDED  
RESULTS

“Nutrition Books”  
(Dietitian)

“My own website as i  
post recipes”  
(Dietitian)

“My own cooking  
ideas” (Dietitian)

# Findings summarised + Recommendations

SLIDE	SUMMARY FINDINGS	RECOMMENDATIONS
<p><b>EDM and Paid social media</b> Slide 14/15</p>	<ul style="list-style-type: none"> <li>● Paid social was needed to boost numbers to reach targets</li> <li>● Low engagement with partner distribution</li> <li>● Difficult to track survey completions from which database or placement they came from. Majority came from the Australian Mushrooms, NRAUS databases and the Social Paid media campaign</li> </ul>	<ul style="list-style-type: none"> <li>● EDM placement and distributions with partner organisations needs to be managed more tightly with for optimum viewing and engagement. For example, one link to the survey in a partner EDM was at the bottom of a very long newsletter and could have been easily missed</li> <li>● Each partner placement to have its own unique link - we however will not be able to track completions inside the survey from the various sources. The data will be indicative so we can track success.</li> </ul>
<p><b>Part 1 Demographics and location</b> Slide 20 / 21</p>	<ul style="list-style-type: none"> <li>● Low proportion of males to females</li> <li>● High proportion of respondents from NSW and VIC</li> <li>● Large proportion of 'Other healthcare professionals'</li> <li>● All nutritionists were degree qualified</li> </ul>	<ul style="list-style-type: none"> <li>● Build up other Australian states and male quota</li> <li>● Split up 'Other healthcare professional' into subgroups in the survey</li> <li>● Other professions could indicate a strong new group to target that have access to patients to become advocates for Australian Mushrooms</li> </ul>
<p><b>Part 2: Health benefits and nutritional properties</b> Slide 22</p>	<ul style="list-style-type: none"> <li>● Despite familiarity by many, most could specify some properties and benefits but not many</li> <li>● Almost 10% of HCPs were not familiar at all with health or nutritional benefits</li> <li>● Dietitians and 'Other healthcare professionals' were the most familiar group with 'some' of the health and nutritional benefits of mushrooms</li> </ul>	<ul style="list-style-type: none"> <li>● If results continue to be familiar between nutritional and health benefits, and the SLR results don't show much difference between them, then questions may be merged</li> <li>● Need to target GPs, naturopaths with education</li> <li>● Target 'Other healthcare professionals' to 'recommend' as most familiar but least likely to recommend mushrooms</li> </ul>



# Findings summarised + Recommendations

SLIDE	FINDINGS	RECOMMENDATIONS
<p><b>Part 2: Health benefits and nutritional properties</b> Slide 23</p>	<ul style="list-style-type: none"> <li>• The vast majority (90.5%) of the 224 respondents were able to specify one nutritional property</li> <li>• Nearly 10% could not select a nutritional property</li> <li>• Dietary fibre, cholesterol free and vitamin D were the most commonly listed nutritional properties, respectively</li> <li>• Only half of the respondents selected vitamin D</li> </ul>	<ul style="list-style-type: none"> <li>• Create visual and interesting resources and info for GPs and Naturopaths as these were the least familiar with the nutritional properties i.e. Omega-3</li> <li>• Continue the focus the campaign year 1 on vitamin D being the most unique property of mushrooms</li> <li>• Need to educate HCPs on other nutritional properties not selected</li> </ul>
<p><b>Part 3: How valuable are mushrooms to HCPs?</b> Slide 24</p>	<ul style="list-style-type: none"> <li>• Almost 10% put none, or lower value on mushrooms compared to vegetables</li> <li>• HCP's trying to get their patients to even eat vegetables is a challenge</li> </ul>	<ul style="list-style-type: none"> <li>• Showcase the unique nutritional properties of mushrooms through scientific and educational material for GP's and healthcare professionals to show its importance</li> <li>• Focus on mushrooms as a 'super' and 'unique' vegetable and communicate ways to consume them</li> </ul>
<p><b>Part 4: What are the resources like?</b> Slide 25</p>	<ul style="list-style-type: none"> <li>• Resources were not well known</li> <li>• Reasons for not wanting or having were around time restraints, needing to encourage all vegetables, too much info and too many resources to manage</li> </ul>	<ul style="list-style-type: none"> <li>• Develop resources in conjunction with the overarching message of 'vegetables' where possible</li> <li>• Make resources easy to read, clear and readily available</li> </ul>

# Findings summarised + Recommendations

SLIDE	FINDINGS	RECOMMENDATIONS
<b>Part 6: Mushroom recommendations to clients</b> Slide 27	<ul style="list-style-type: none"> <li>• Among those who see patients/clients, many do not give out recipes</li> <li>• 40% recommend mushrooms regularly or occasionally</li> <li>• Main reason for not recommending was unfamiliar with all the nutritional properties</li> </ul>	<ul style="list-style-type: none"> <li>• Determine what area of work HCPs they are in (i.e. research, public health etc) to understand environment or how we would communicate materials</li> <li>• Materials and education specifically for GP's and other healthcare professionals are needed</li> </ul>
<b>Part 7: Online resources?</b> Slide 30	<ul style="list-style-type: none"> <li>• HCPs are not familiar with the Australian Mushrooms website (74% have never visited the website)</li> <li>• Recipe sharing is not popular among respondents who see patients/clients (nearly 60% do not give recipes or cooking materials)</li> </ul>	<ul style="list-style-type: none"> <li>• Need to drive more traffic to the Australian Mushrooms Health section of the website</li> <li>• Lean into paid media to create awareness and educate on Australian Mushrooms as we reached significant amount of GP's via this tactic</li> </ul>
<b>Part 7: Online resources?</b> Slide 31	<ul style="list-style-type: none"> <li>• Among those who use recipes, inspiration is found online: industry websites, google, etc.</li> </ul>	<ul style="list-style-type: none"> <li>• Develop partnerships with other vegetables and place recipe content on industry websites to either have links back to Australian Mushrooms or place content on these sites for increased amplification and coverage</li> </ul>

# Sentiment results against objectives



**Knowledge** of the nutritional properties and health benefits of mushrooms



Some good knowledge established  
59%

Ref: Q2. Result 1  
(Slide 22)



**Value** placed on mushrooms for their properties



Somewhat value placed on mushrooms  
57%

Ref: Q4. Result 1  
(Slide 24)



**Perception** of mushrooms for health



Med-low perception of mushrooms as very important for health  
33%

Ref: Q4. Result 2  
(Slide 24)



**Behaviour** around recommending mushrooms



24% of the respondents were undecided if mushrooms were as important as other vegetables

Ref: Q5. Result 2/3/4 added  
(Slide 24)



**Frequency** of recommendation or behaviour



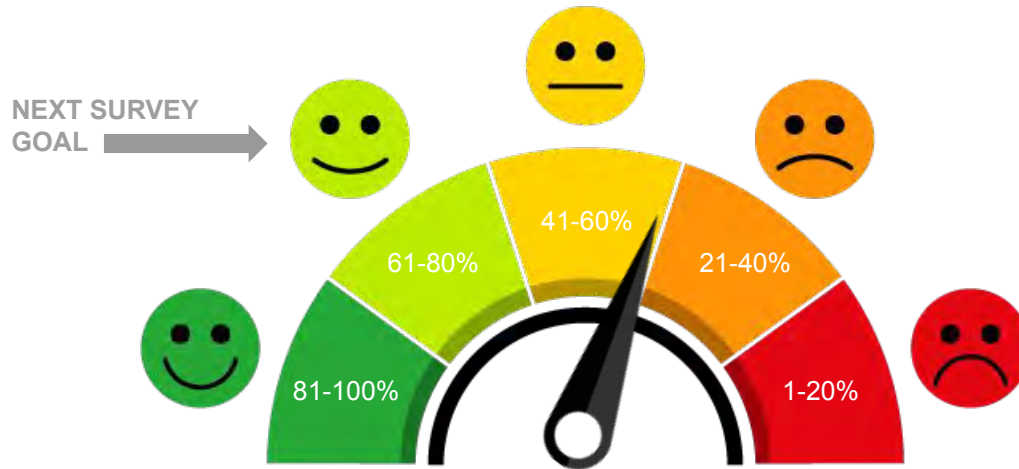
38% Regularly or occasionally recommend mushrooms

Ref: Q9. Result 2/4 added  
(Slide 27)

# Average sentiment KPI

Based on current research findings, we believe that we can use the campaign activity to improve knowledge levels and create more accessible and engaging resources to help shift the dial on a national scale.

The below scale indicates where we believe current knowledge levels and attitudes are currently sitting (41% sentiment), and our target for the 2020 survey so shift into the 61-80% sentiment band.



\* This has been calculated based on the percentages captured in slide 35 as an average value.

# Learnings & Opportunities

August 2019



# Strategy + Planning: What worked well

## **DETAILED DISTRIBUTION PLAN**

We considered timings, reminder emails and third party opportunities to maximise exposure

## **A NIMBLE APPROACH**

Allowed us to pivot and add the social paid element to ensure we collected a strong baseline sample

## **TAILORED EDMS**

Designed for the NRAUS and Hort Innovation database meant we could individualise and track performance across each database

## **ATTENTION GRABBING DESIGN**

Aligned with the consumer campaign look and feel was key for capturing attention and encouraging audiences to click through

# Strategy + Planning: Even better if we...

## PLAN THIRD PARTY EDMS

Are planned 4 weeks in advance.

This was all managed within the timeframes but should be built into planning for future EDMs

## COMBINE OUR EDMS

Now we have welcomed the NRAUS database, we recommend sending combined EDMs to maximise efficiencies

## USE PAID MEDIA

Given the small recognised number of GPs on Facebook, this is a limited job title to target. Consider upweighting future spend towards other HCPs

# Research Questions: What worked well

## QUICK COMPLETION

The research took just 4 minutes to complete and had an average completion rate of 70.5%

## SCREENING QUESTIONS

Have providing segmented data unique to each profession and region

## \$100 VOUCHERS

Was a cost effective way of incentivising the survey, whilst giving us a friendly reason to send the reminder email

## FLAV'S FUN FACTS

Provided interesting bitesize content to ensure all of our EDM content was engaging and useful, as well as serving to drive traffic to the research



# Research Questions: Even better if we...

## REMOVE OPEN ENDED Q'S

Did not provide quality responses. Recommend adjusting for phase 2

## STREAMLINE AMENDS

Streamlining the final changes to the questions would have helped build efficiencies into our ways of working

## MANDATORIES

Where possible, ensure it's a mandatory to give an answer when selecting 'other' in the survey, such as manually entering job titles

# Distribution plan: What worked well

## **SOCIAL AD CAMPAIGN**

Enabled us to reach new audiences quickly.  
Recommend using this as a key channel for upcoming campaigns

## **REMINDER EDM**

Generated a second wave of entries, allowing us to maximise opportunities with our hyper-engaged audience. Should be built into all EDM timelines

## **SUNDAY DISTRIBUTION**

Resulted in a particularly high open rate, showing this is a peak time for HCPs responding to their emails

## **EVENING EMAILS**

Tended result in more click throughs to the survey than morning emails. Recommend using this insight for upcoming EDMs

# Distribution plan: Even better if we...

## THIRD PARTY EDMS

Formats were information heavy, and did not drive traffic. Recommend working with them to post on their social channels in future and used tracked links

## TIMINGS FOR AD CAMPAIGN

This was a great way to bolster our respondents. We recommend using this mechanic from the start to maximise the opportunity

## LEVERAGING OUR ADVOCATES

Consider NRAUS and Flavia sharing the link from their owned assets and accounts to help reach new audiences

## GROWING OUR DATABASE

Consider using paid ads to promote upcoming activity - such as the webinar - to facilitate more sign ups to the database

# Takeaways: strategy + planning

## TAKEAWAY

**FOCUS ON BITESIZE,  
DIGESTIBLE  
CONTENT**

## FINDING

HCPs are time-poor and they want easy to understand, practical content and recipes which can be easily shared with patients.

**DRIVE TRAFFIC TO  
THE AUSTRALIAN  
MUSHROOMS  
WEBSITE**

74% of respondents have not visited the Australian Mushrooms website. Let's maximise opportunities to direct them to this platform.

**IDENTIFY  
OPPORTUNITIES TO  
WORK WITH THIRD  
PARTY PLATFORMS  
TO SHOWCASE OUR  
FINDINGS**

Industry websites, Google, magazines, blogs and social media were the top channels for finding inspiration and recipes.

**DIETARY FIBRE IS  
KNOWN - LET'S  
FOCUS ON OTHER  
PROPERTIES AND  
BIOACTIVES LESS  
KNOWN**

The general knowledge of Vitamin D in mushrooms was lower than expected, with dietary fibre rated as the most well known nutritional property.

# Takeaways: distribution plan

## TAKEAWAY

### LEVERAGE PAID SOCIAL ADS

## ACTION

Promote upcoming activity, including the webinar and GPCE events.

This will develop new potential audiences and enable us to retarget with new material developed.

### ALTERNATE THE EDM TIMINGS

Send our EDMs first thing in the morning, after work and on a Sunday enabled us to reach a broader audience. We should maintain this for next round of communications.

### INDUSTRY ORGANISATIONS

Sending our survey via key industry newsletters added credibility and exposure to the research, but did not drive a high volume of click throughs.

Recommend placement and leveraging their social channels where possible in future.

### OPEN ENDED QUESTIONS

Provided some data, however questions which offered a menu of options to select provided richer insight.

Recommend we use only quantitative style questions for the second wave of research.

# Setting Key Performance Indicators (KPIs)

August 2019



# Setting KPIs

ITEM year on year (YoY)	BENCHMARK SURVEY	KPI 2020 SURVEY			KPI 2021 SURVEY		
		MEETING	EXCEEDING	SMASHING	MEETING	EXCEEDING	SMASHING
Survey respondents	<b>225</b>	250	350	450	300	400	500
Database Growth YoY	<b>1,292</b>	1500	1700	2000	1500	1800	2500
Increase GP subscribers (of the pool)	<b>22%</b>	25%	30%	40%	28%	35%	45%
Increase Male subscribers/respondents	<b>16%</b>	20%	30%	35%	25%	30%	35%
SURVEY KPIs							
Q1. Can specify health benefits of mushrooms	<b>20%</b>	23%	26%	30%	25%	28%	32%
Q2. Can specify nutritional benefits of mushrooms	<b>17%</b>	20%	25%	30%	23%	28%	32%
Q3. Knowledge of Vitamin D as a nutritional property increases	<b>50%</b>	55%	60%	65%	TBC	TBC	TBC
Q4&5. Importance of mushrooms - Very Important	<b>33%</b>	38%	42%	46%	40%	44%	48%
Q6. Using resources and place value on them	<b>22%</b>	25%	26%	28%	28%	30%	34%

# Setting campaign goals

SURVEY KPIs	BENCHMARK SURVEY	KPI 2020 SURVEY			KPI 2021 SURVEY		
		MEETING	EXCEEDING	SMASHING	MEETING	EXCEEDING	SMASHING
Q7. <b>Increase</b> in 'Once per week' personal mushroom consumption	40%	43%	45%	50%	46%	50%	55%
Q9. <b>Decrease</b> in 'not recommending mushrooms'	18%	16%	14%	12%	14%	12%	10%
Q10. <b>Decrease</b> in 'I don't think about mushrooms'	50%	48%	46%	44%	45%	43	40%
Q11. <b>Increase</b> in recommending 'mushrooms for their nutritional properties	65%	68%	70%	75%	70%	75%	80%
Q12. <b>Increase</b> in respondents who have visited website	26%	30%	32%	34%	35%	40%	45%
Q13. <b>Increase</b> in offering patients healthy recipe materials	27%	30%	33%	35%	33%	35%	40%

\* These KPI's have been kept reasonably conservative and would be seen as 'Meeting Expectations'. We have also supplied a set of numbers for 'Exceeding Expectations' and 'Smashing Expectations' for stretch goals and inspiration.



# Next Steps

August 2019



# What's next?

- HORT Innovation to review and provide feedback or any additional requests
- Implement learnings into upcoming activity across webinar and GPCE activity for 2019
- Refine questions based on learnings for the next phase of the audience sentiment research in 2020
- Agree on KPI's for the next roll-out

# Thank you!

August, 2019



## **APPENDIX 3: MS121 AUDIENCE SENTIMENT RESEARCH 2**

**Hort  
Innovation**  
Strategic levy investment

**MUSHROOM  
FUND**

**Year 2 - Audience Sentiment Benchmark: Research Report - January 2021**



# Background:

**Project Code:** MU17002

**Project Name:** Educating health professionals about Australian mushrooms

**Project Leader:** Dr Flavia Fayet-Moore

**Delivery Partner:** Nutrition Research Australia Pty Ltd. (NRAUS)

**Report Author:** NRAUS, History Will be Kind (HWBK)

**Contact:** Flavia Fayet-Moore (e: [flavia@nraus.com](mailto:flavia@nraus.com) m: 0415 990 050)

# Contents:

- Objectives and Audience
- Approach
- Survey Results
- Learnings & Opportunities
- Key Performance Indicator Results
- Updating Key Performance Indicators
- Next Steps

# Objectives and audience

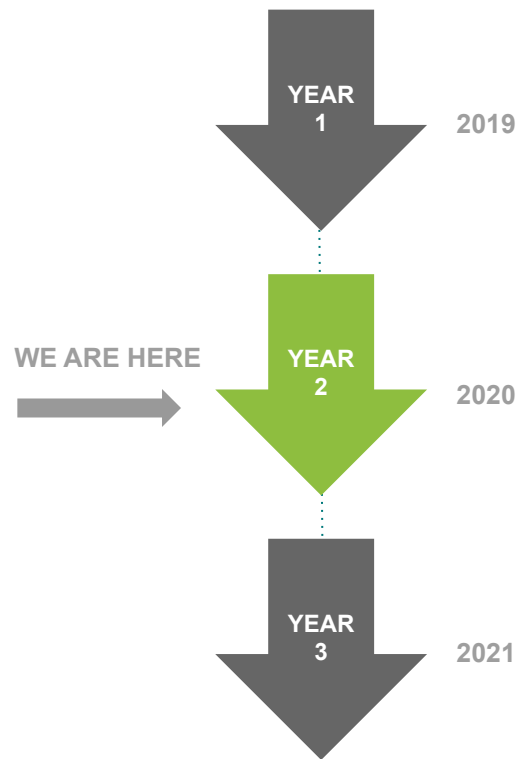




# Overview:

This report describes the findings from the 2020 Audience Sentiment Research. It is the second of three Audience Sentiment Surveys to be conducted throughout the project. The purpose of this survey is to:

1. Help measure the success of the program and developments year-on-year, through comparison to baseline data (2019).
2. Continue to gather insights that will help to tailor the communications program over the remainder of the project, in order to more strategically improve awareness and understanding of the nutritional and health benefits of mushrooms among healthcare professionals (HCPs).



# Objectives:

The aim of the survey is to measure awareness and attitudes across five areas:



**Knowledge** of the nutritional properties and health benefits of mushrooms.



**Value** placed on mushrooms for their properties.



**Perception** of mushrooms for health.



**Behaviour** around recommending mushrooms.



**Frequency** of recommendation or behaviour.

# Objectives:

For 2020, our goal was to measure understanding of the campaign messages to date, and any shift in sentiment. Sentiment shift is measured by tracking the overall sentiment results for each of the 5 core areas (**knowledge, perception, value, behaviour, frequency**). More detail on the specific questions used is provided in Slide 39.

While the pandemic in 2020 meant that some key activity was changed or postponed until 2021, we were still able to fulfil the majority of milestones during this period. **Below shows the overall sentiment in 2019 was 41.0%. The goal for 2020 was to be  $\geq 60\%$ :**



# Audiences:

## Core 2020 campaign audiences:

1. Dietitians
2. General Practitioners (GPs)
3. Nutritionists
4. Naturopaths
5. Other healthcare professionals (HCPs) (eg: physiotherapist, nurse)



# Approach



# Approach:

## STEP 1:

Continuously communicated to the database over the course of the program, using EDMs (Electronic Direct Mail/Newsletters) & paid social media. This highly targeted group was used as the basis for the response.

## STEP 2:

Questions and learnings from 2019's survey were reviewed and, where needed, questions adapted to suit 2020. Some additional questions were added or current ones rephrased.

## STEP 3:

Distributed our sentiment analysis questions to the NRAUS and Australian Mushrooms databases as a first stop.

## STEP 4:

Developed a paid social campaign targeting HCP audiences to reach new professionals across Facebook and LinkedIn.

## STEP 5:

Distributed a second follow up email to the database, to remind those who had not yet completed the survey.

## STEP 6:

Once the survey had closed, results were reviewed, analysed and compared to 2019 for tracking. Suggestions for 2021's survey and communications have been given within this report.

# Timeline:

## REWORKING 2019 QUESTIONS AND LEARNINGS

The 2019 audience sentiment survey report and questions were updated for 2020. A communications plan was agreed and dates aligned with the wider campaign.

## AUSTRALIAN MUSHROOMS AND NRAUS INVITATION EDM

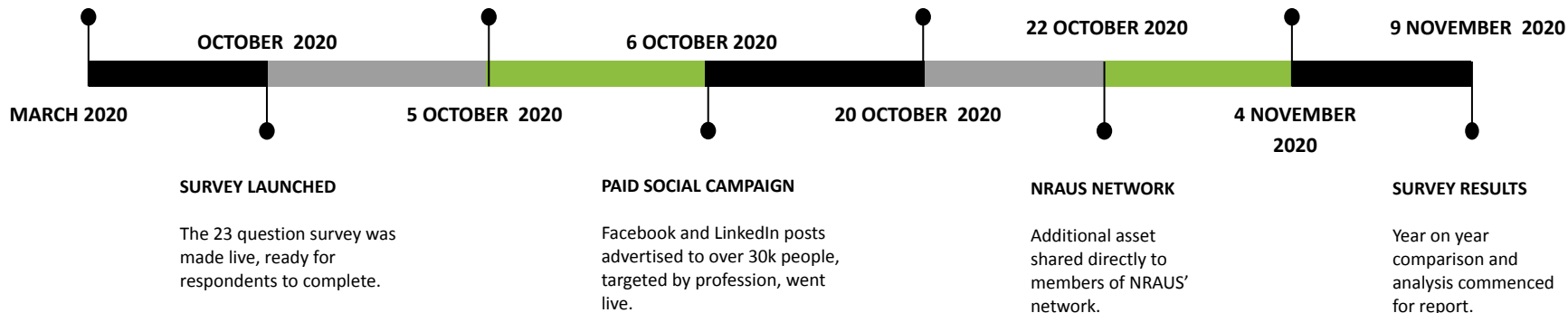
Delivered to a combined 1,271 contacts, including those carried over from the previous campaigns.

## REMINDER EDM

Delivered to a combined 1,261 contacts highlighting the survey was still open.

## SURVEY CLOSED

1 x voucher winner notified, with new contacts added into the master database.



# Distribution channels:

*Australian*  
**MUSHROOMS**

Australian  
Mushrooms  
database:  
1,033 contacts

**NRAUS Database:**  
238 contacts

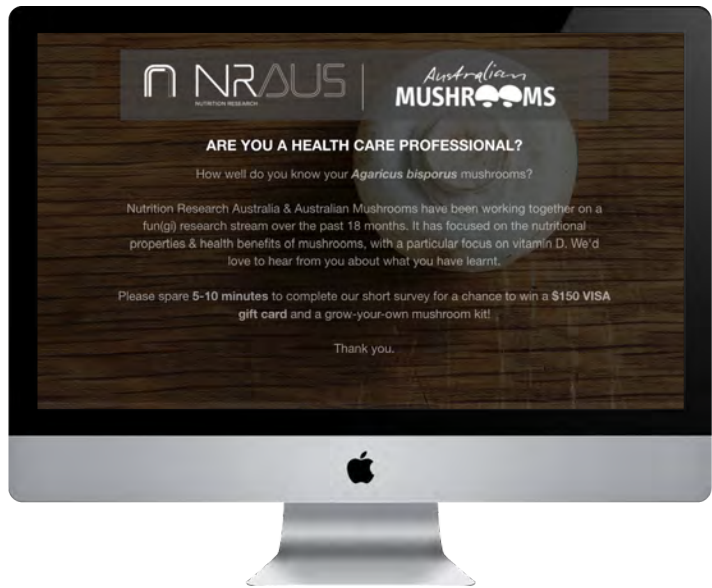


**Social Campaign:**  
31,767 reach

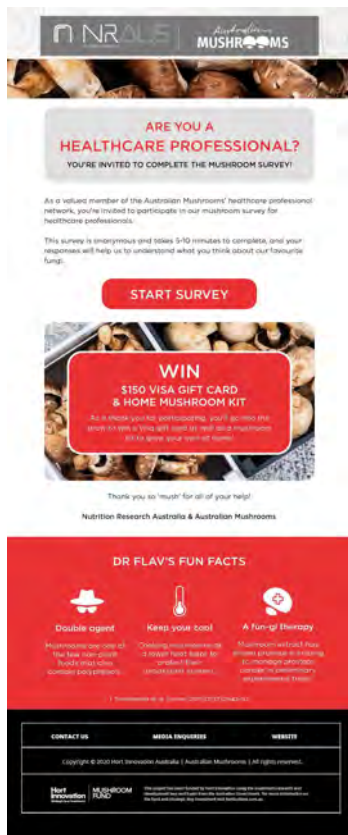
**TOTAL COMBINED REACH OF: 33,038 PEOPLE**



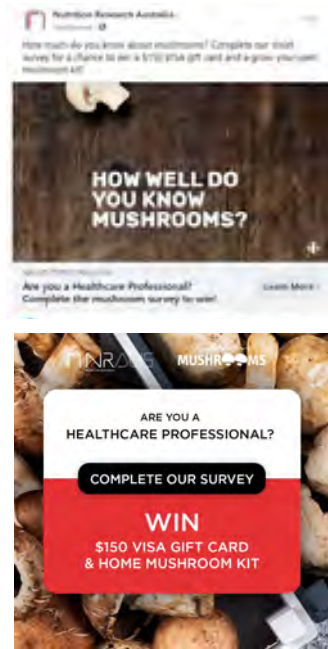
# Assets:



The survey used a state-of-the-art platform with a bespoke interface designed to maximise engagement and personalisation for owned branding.



A series of informative and engaging EDMs were designed to be consistent with project branding.



Additional social ads and campaign visuals were created for online audiences.

# EDM performance to existing databases

**OBJECTIVE:** To distribute the EDMs to the master HCP database created over the course of the campaign.

EDM	Database Size	Unique Opens	Open Rate	Clicked a Link	Unsubscribe Rate	Not Opened	Clicked the survey link
Survey invitation EDM	1,271	423	33.0%	22%	0.4% (6 people)	835	138
Survey reminder EDM	1,261	390	30.5%	12%	0.1% (2 people)	858	71
<b>TOTAL / AVERAGE</b>	<b>2,532 EDMs delivered</b>	<b>813 unique opens</b>	<b>31.8% open rate</b>	<b>17.0% clicked a link</b>	<b>0.2% opting out</b>	<b>1,693 unopened EDMs</b>	<b>209</b>

**31.8%**

average open rate  
(industry avg. 20-25%)

**76**

surveys completed via EDM link

# Paid social media

**OBJECTIVE:** To use targeted social ads to generate additional survey respondents, based on last year's learnings, whilst also growing the master HCP database.

Platform	Clicks to Site	Reach	Cost Per Click	Spend	Click Through Rate	Video Percentage Watched
Facebook	924	24,585	\$0.54	\$500	4.05%	30%
LinkedIn	200	7,182	\$5.00	\$1,000	2.78%	38.6%
<b>TOTAL / AVERAGE</b>	<b>1,124</b>	<b>31,767</b>	<b>\$2.77</b>	<b>\$1,500</b>	<b>3.41%</b>	<b>34.3%</b>

## RESULTS:

- Campaign ran for 15 days, drove 1,124 new visitors to the survey, and converted an additional **119 survey responses**.
- Click Through Rate was very high at an average of 3.41%, well above the industry average of 1%.
- **Over 100 additional HCP contacts** from the social strategy were added to the master database.
- In 2019, the Facebook only social campaign spent \$500 and drove 329 website visits, so all metrics have improved for 2020 when compared for investment.

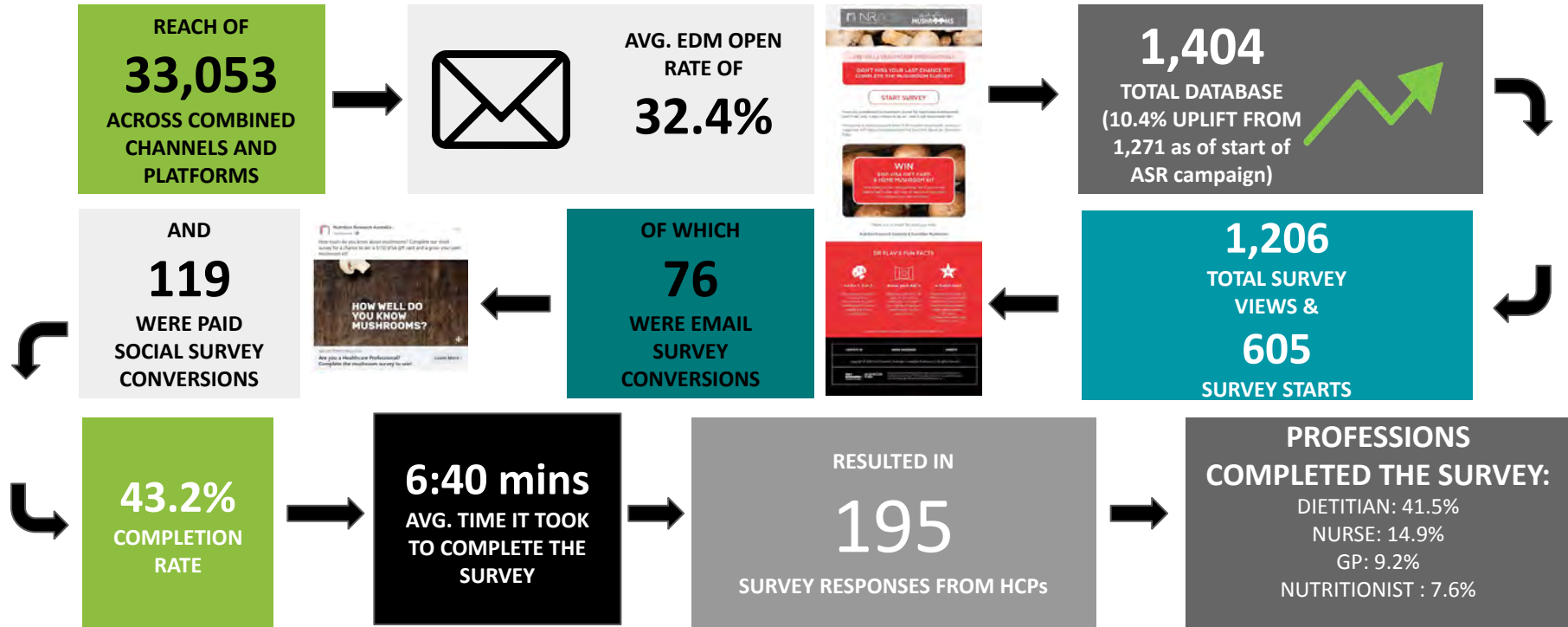


**119**  
surveys  
completed from  
paid activity

# Survey Results



# The approach in a snapshot:



# Survey Stats:

**605**

Survey starts of 1,206 total visits to the survey from all sources (email activity + paid)

**42.6%**

Completion rate of those that started the survey  
(n = 258)

**75.5%**

Health or food professionals. It is only these who are represented in the results  
(n = 195)

**61%**

Of our target audience took part from paid media activities  
(n = 119)

While there were 258 TOTAL SURVEY COMPLETIONS, this included ineligible responses from non-HCPs who were removed from the survey results in this report.  
Leaving 195 eligible HCPs who completed the survey.

# Survey structure:

The results have been set out in accordance with the overall survey structure:

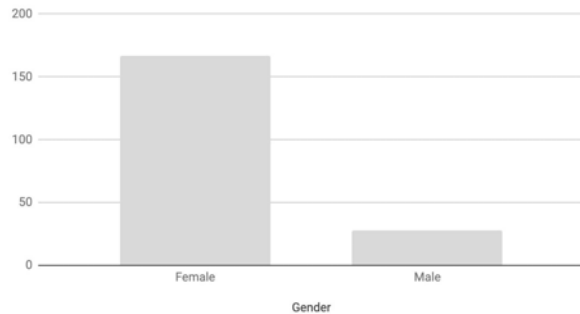
- **Part 1** - Audience segmentation
- **Part 2** - Knowledge of the health and nutritional properties of mushrooms
- **Part 3** - Value of mushrooms to HCPs
- **Part 4** - Knowledge of vitamin D properties (New for 2020)
- **Part 5** - Existing resources
- **Part 6** - Personal consumption habits and rationale
- **Part 7** - Mushroom recommendation to clients and rationale
- **Part 8** - Australian Mushrooms Website and additional comments

# Part 1: Audience Segmentation

## GENDER

85.6% of respondents were female

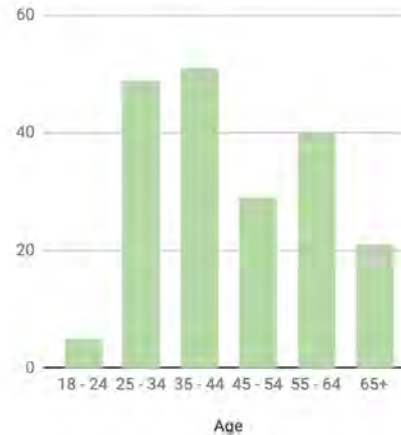
Gender Breakdown



## AGE

The age sample size were mostly evenly split

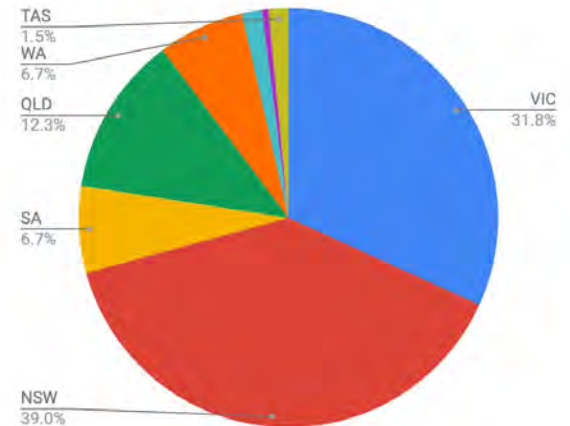
Age Breakdown



## LOCATION

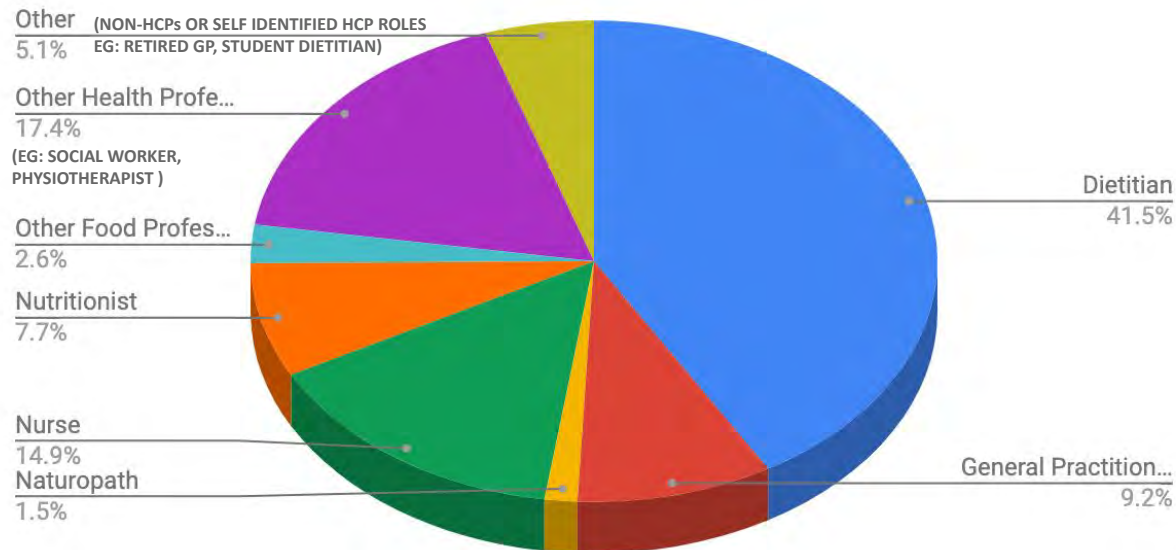
NSW and VIC were the most represented states

Location Breakdown





# Part 1: Audience Segmentation



49.2%

OF RESPONDENTS WERE  
DIETITIANS OR NUTRITIONISTS

5.1%

'OTHER' INCLUDED A RETIRED GP,  
A RESEARCHER AND AN  
ACADEMIC IN NUTRITIONAL  
BIOCHEMISTRY

195/195 ANSWERED  
MANDATORY

# Part 2: Knowledge of the health and nutritional properties of mushrooms

**Q1. How familiar are you with the health benefits of mushrooms (e.g. satiety, gut, heart health)?**

Response	2020	Dif. to 2019
Familiar with some health benefits but cannot specify them	48.2%	-14.8
Familiar and can specify their health benefits	27.7%	+7.7
Not familiar at all	11.8%	+3.8
Very familiar as I have attended events / webinars / read resources	8.2%	+4.2
Academic knowledge and actively seek more information	4.1%	+3.1

195/195 ANSWERED  
MANDATORY

**Q2. How familiar are you with the key nutritional properties of mushrooms (e.g. nutrient content, bioactive components)?**

Response	2020	Dif. to 2019
Familiar with some nutritional benefits but cannot specify them	51.3%	-8.7
Familiar and can specify their nutritional benefits	24.1%	+7.1
Not familiar at all	12.8%	-3.2
Academic knowledge and actively seek more information	6.2%	+4.2
Very familiar as I have attended events / webinars / read resources	5.6%	+1.6

195/195 ANSWERED  
MANDATORY

## FINDINGS:

- Overall familiarity of both the health and nutritional properties increased, in some cases increase could be attributed to events/webinars that have been attended (e.g. ‘When it comes to Vitamin D, two sources are best’ webinar).
- An increase (3.8%) in the number of respondents not familiar with health benefits points to an area to focus, however a decrease (3.2%) in unfamiliarity on nutritional properties is promising.
- Comparing year on year, we saw an increase in respondents who **both familiar and able to specify health benefits (27.7% in 2020 vs. 20.0% in 2019) and nutritional benefits (24.1% in 2020 vs. 17.0% in 2019).**

## Part 2: Knowledge of the health and nutritional properties of mushrooms

Q3. In your opinion, what are the key nutritional properties of mushrooms (e.g. nutrient content, bioactive components)?

### FINDINGS:

- **91.2%** of the respondents were **able to specify at least one nutritional property**, an increase **from 72% in 2019**.
- **9.7% could not select** a nutritional property.
- **Dietary fibre, vitamin D, cholesterol free** and **antioxidants** were the **most common** nutritional properties selected, respectively.
- **Vitamin D** saw the biggest increase in awareness, more than three times any others, showcasing the impact of the campaign focus.
- Four new options added for 2020, all which had 18.4% awareness or more.

Response	2020	Difference
Dietary fibre	74.3%	+2.0
Vitamin D	66.1%	+15.7
Cholesterol free	58.9%	-1.8
Antioxidants	58.4%	NEW
Potassium	32.8%	-2.5
Prebiotics	32.8%	+0.2
Folate	26.6%	-2.0
Selenium	25.6%	-4.6
Beta-glucans	22.5%	NEW
Chitin	18.4%	NEW
Ergosterol	18.4%	NEW
Ergothioneine	16.4%	+1.7
Don't Know	9.7%	+0.3
Vitamin E	7.6%	-2.7
Omega-3	7.1%	-0.5
Other	0%	-2.7

## Part 2: Knowledge of the health and nutritional properties of mushrooms

Response	2020
Increases and maintains vitamin D levels	65.1%
Improves gut health	62.5%
Increases fullness and reduces hunger	46.1%
Improves cardiometabolic markers (e.g. cholesterol, glucose, triglycerides)	44.6%
Strengthens the immune system	36.9%
Lowers the risk of some cancers	33.8%
Reduces inflammation	30.2%
Improves brain health and cognition	26.6%
Maintains strong bones	22.0%
Supports the nervous system	17.4%
Anti-aging	17.4%
Enhances physical performance (e.g. energy, muscle mass)	11.7%
Don't know	10.2%
Other	0.5%

Q4. In your opinion, what are the key health benefits of mushrooms? (New question).

### FINDINGS:

- This was a new question for 2020 so no comparisons are available.
- 10.2% **could not select** a health benefit.
- **Vitamin D levels**, as with the previous question, came out high, with about two-thirds being aware of its impact.
- Other health benefits that were well known included **gut health, satiety, and improvement of cardiometabolic markers**.
- Only one respondent submitted an 'other' response, and highlighted the low calorie properties of mushrooms.

## Part 3: Value of mushrooms to HCPs

Q5. How important do you think mushrooms are in supporting overall health?

Response	2020	Dif. to 2019
Very important	43.1%	+9.2
Somewhat important	49.7%	-7.4
Not important	3.1%	-1.4
Don't know	4.1%	-0.4

195/195 ANSWERED  
MANDATORY

Q6. State your opinion: "Mushrooms have unique health benefits and nutritional properties" (New question).

Response	2020
Strongly Agree	41.5%
Agree	42.6%
Neutral	15.9%
Disagree	0%
Strongly Disagree	0%

195/195 ANSWERED  
MANDATORY

### FINDINGS:

- A total of **92.8%** of respondents regarded mushrooms as 'Important' or 'Very Important' for health.
- Mushrooms being seen as '**Very Important**' increased from 2019 (33.9%) to 2020 (43.1%) for Q5, showing that **importance has increased**.
- **More than 84%** of respondents agreed that mushrooms have unique health benefits and nutritional properties. Not a single respondent disagreed with this statement.

## Part 3: Value of mushrooms to HCPs

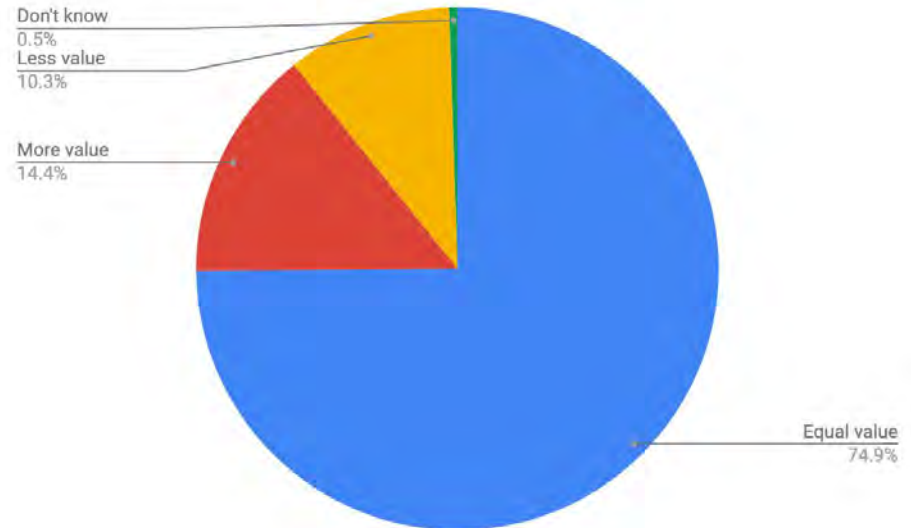
### Q7. How much value do you place on mushrooms compared to vegetables?

#### FINDINGS:

- The results for **2020 were very similar when compared to 2019**, with a slight drop in those who place more, equal and unknown value on mushrooms over vegetables.
- **89.3% of respondents**, over four fifths of those surveyed, still felt that mushrooms were either more or of equal value to vegetables.

195/195 ANSWERED  
MANDATORY

Response	2020	Dif. to 2019
More Value	14.4%	-0.3
Equal Value	74.9%	-1.0
Less Value	10.3%	+3.6
Don't know	0.5%	-2.2



## Part 4: Knowledge of vitamin D properties

Q8. What are the modifiable risk factors that increase a person's risk of vitamin D deficiency? (New question).

Response	2020
Limited sun exposure	96.4%
Clothing that covers entire body	86.1%
Low dietary vitamin D	80.5%
Where you live	65.1%
Wearing sunscreen	55.3%
Alcoholism	43.5%
Lack of physical activity	41.0%
Smoking	35.3%
Overweight or obesity	33.8%
High caffeine consumption	29.2%
Strict vegetarian diet	23.0%

### FINDINGS:

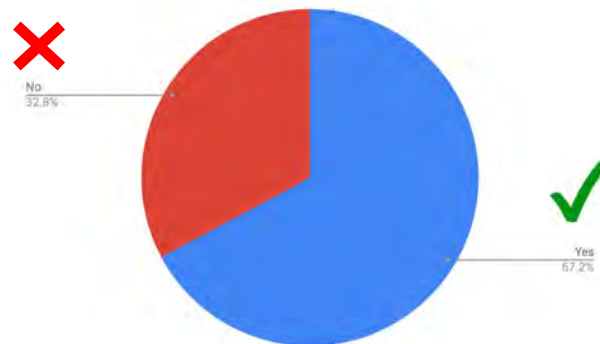
- This was a new question for 2020 so there is no comparative data to 2019.
- The top scoring known risk factors were **limited sun exposure, clothing that covers entire body, and low dietary vitamin D**, all scoring 80% or more.

## Part 4: Knowledge of vitamin D properties

Q9. Which of the following has the highest vitamin D content per serve? (New question).

Response	2020
2 eggs	13.8%
100g oily fish	25.0%
40g fortified breakfast cereal	11.2%
1 tablespoon margarine	3.0%
100g mushrooms	25.0%
100g UV-exposed mushrooms	62.5%
Other	0.5%

Q10. Can placing mushrooms in the sun increase their vitamin D content to 100% of your daily vitamin D needs? (New question).



### FINDINGS:

- Both were new questions for 2020 and therefore no comparative data to 2019.
- **62.5% said that UV-exposed mushrooms were the highest source of vitamin D**, which could show that the focus of the past activity is resonating.
- More than **two thirds of respondents** (67.2%) knew that placing mushrooms in the sun can increase their vitamin D content to 100% of daily needs.



## Part 5: Existing resources

Q11. Which statement best describes your opinion on the availability of resources to healthcare professionals on the health benefits and nutritional properties of mushrooms?

Response	2020	Dif. to 2019
I don't know of any resources	58.5%	-4.9
I have resources and they are useful	28.2%	+6.3
I have seen resources but they didn't interest me	9.7%	-2.8
I have resources and they are not very useful to me	3.6%	+1.4

195/195 ANSWERED  
MANDATORY

### FINDINGS:

- Across the board there has been a **slight increase in awareness of resources**.
- **58.5%** of respondents still claim to not know of any resources, compared to 63.4% in 2019.
- The usefulness of resources has seen a small positive increase (6.3%).
- Increasing awareness and access to mushroom resources remains a priority and opportunity.

## Part 6: Personal consumption habits and rationale

### Q12. How often do you personally consume mushrooms?

Response	2020	Dif. to 2019
Daily	3.6%	+0.9
A few times a week	34.4%	-3.5
Once per week	32.3%	-7.9
Once a month	21%	+7.2
Once every few months	5.6%	+2.0
Never	3.1%	+1.3

195/195 ANSWERED  
MANDATORY

### Q12a. Why don't you regularly consume mushrooms?

While six respondents picked 'Never' in Question 12, we received no responses for this question and therefore a comparison to 2019 is invalid.

0/195 ANSWERED  
NON-MANDATORY

#### FINDINGS:

- Almost all (96.9%) HCPs eat mushrooms, with the majority (70.3%) doing so **at least once a week**. This is a slight decrease (-10.5) from 2019 where 80.8% of HCPs reported eating mushrooms at least once per week.
- Consumption frequency is generally down since 2019.
- There is a small increase in the number consuming mushrooms **daily (+0.9%)**.

## Part 6: Mushroom recommendation to clients and rationale

Q13. How often do you specifically recommend mushrooms to your clients?

Response	2020	Dif. to 2019
Often/Always	21%	+7.7
Sometimes	25.6%	+7.3
Rarely	15.9%	+7.0
Never, as I don't see clients	22.6%	-11.3
Never, but I do see clients	7.7%	-10.6

195/195 ANSWERED  
MANDATORY

Q13a. Help us to understand why you do not recommend mushrooms to your clients.

Response (n=14 respondents)	2020	Dif. to 2019
I do not think about mushrooms specifically	28.5%	-21.5
I'm not familiar with their health benefits	42.8%	-1.6
I do not have time to discuss mushrooms specifically	21.4%	-11.9
I'm not familiar with their nutritional properties	21.4%	-11.9
My clients do not have cooking skills	7.1%	+1.5
I do not believe mushrooms are important to recommend	7.1%	NEW
My clients do not like mushrooms	7.1%	+4.3
Other	42.8%	+37.2

14/195 ANSWERED  
NON-MANDATORY

### FINDINGS:

- Overall there has been **an increase in the number of recommendations** taking place, with only 7.7% of those who see clients not recommending in 2020, a positive decrease on 2019 (18.3%).
- There was low responses to Q13a with only 14 responses, as this question was only mandatory for those who answered 'never, but I do see clients' to Q13. The majority who did not recommend mushrooms said that this is because they aren't familiar with the health benefits.

## Part 6: Mushroom recommendations to clients

**Q13b. Help us to understand why you recommend mushrooms to your clients.**

Response	2020	Dif. to 2019
For their nutritional properties (e.g. low in kj)	75.0%	+9.9
Vegetarian meal option	66.9%	+8.8
For their health benefits (e.g. heart health, gut health)	61.7%	+12.9
They are easy to cook	58.0%	+4.5
They add extra flavour to meals	57.3%	-10.1
To help increase vitamin D intake	49.2%	NEW
They make meals healthier	47.7%	-1.1
To add texture to meals	44.8%	NEW
To increase satiety	37.5%	NEW
Mushrooms are unique	19.8%	-8.1
Majority of my clients or patients like mushrooms	11.0%	+1.7
Other	0%	-4.7

### FINDINGS:

- The biggest change for 2020 was an **increase in recommending mushrooms** for their health benefits (+12.9) and nutritional properties (+9.9).
- **In 2019** the most popular reason for recommending mushrooms was that **they add extra flavour to meals**, however in **2020 four reasons overtook** it to become the most popular:
  - Nutritional properties (75%)
  - Vegetarian meal option (66.9%)
  - For their health benefits (61.7%)
  - They are easy to cook (58%)
- There were no responses to 'other' in 2020, while in 2019 4.7% (2 people) responded to 'other' with a manual input (eg: "Depends on the circumstances").
- The results for this question for 2020 include some additional answer options compared to 2019 to allow for more detailed responses.

## Part 8: Australian Mushrooms Website & Additional Comments

Q14. Have you visited the Australian Mushrooms website:  
[www.australianmushrooms.com.au](http://www.australianmushrooms.com.au) for health or nutritional  
information?

Response	2020	Dif. to 2019
Yes	27.6%	+1.6
No	72.4%	-1.6

195/195 ANSWERED  
MANDATORY

### FINDINGS:

- **Knowledge of the Australian Mushrooms website is still low** (72.4% have never visited the website).
- Whilst a slight increase from 2019 was seen, more can be done to drive the network to the website.

## Part 8: Australian Mushrooms Website & Additional Comments

Q15. Please provide any additional thoughts you have on the information that we are providing on mushrooms (New question for 2020, open ended response) - Refer to appendix for all responses.

105/195 ANSWERED  
NON-MANDATORY

Mushrooms are a powerhouse of nutritional benefits. They cannot be underestimated

Additional education material would be useful

We need an infographic

I personally can't stand mushrooms but I recommend and should learn more about them

There is very little clear health benefits campaign out there about mushrooms

I have never found UV mushrooms to buy

My clients and social media followers get very surprised when learn that sunbathing mushrooms increases their nutritional value!

I think a lot of health professionals just try and increase vegetable intake in general, but something as tangible as helping rectify the vitamin D issues can separate mushrooms as an individual recommendation

Quality, engaging communications, thank you

If Urea or other toxic poisons are used in the production process, the health benefits are negated

Love how you present your information. You're helping to make mushrooms more attractive to people

Is there mushroom juice?

Would love to learn more and have more consumer resources to provide to clients

# Findings summarised & recommendations

SLIDE	SUMMARY FINDINGS	RECOMMENDATIONS
<b>EDM and Paid social media</b> Slide 14/15	<ul style="list-style-type: none"> <li>• Taking the learnings from 2019, paid social was upweighted.</li> <li>• No partner activity was implemented due to learnings from 2019 and budget restrictions which yielded little results for a high expense.</li> <li>• Majority of survey responses came from social media.</li> <li>• Facebook was more cost effective than LinkedIn, but LinkedIn has tighter targeting capabilities.</li> <li>• Social also allowed us to extend our EDM database through competition mechanic submission.</li> </ul>	<ul style="list-style-type: none"> <li>• Increase social media further.</li> <li>• Keep the prize as something more generic to appeal to a wider HCP audience, the 'grow your own mushrooms' kit is more niche to the project than a solely cash prize.</li> </ul>
<b>Part 1 Demographics and location</b> Slide 20/21	<ul style="list-style-type: none"> <li>• As with 2019, low proportion of males to females.</li> <li>• High proportion of respondents from NSW and VIC.</li> <li>• 63 submissions dismissed who selected 'Not a healthcare professional'.</li> <li>• Lower number of GPs vs. 2019.</li> </ul>	<ul style="list-style-type: none"> <li>• Have the 'not a healthcare professional' as a qualifying question before progressing to the rest of the survey, so that these are automatically excluded in Q4 and all results can be included without manual deletion.</li> <li>• Upweight GP social paid targeting further or investigate another cost effective way such as website banners, social groups or other newsletters.</li> </ul>
<b>Part 2: Health benefits and nutritional properties</b> Slide 23	<ul style="list-style-type: none"> <li>• Both of these saw double digit percentage increases in familiarity.</li> <li>• Health benefits and nutritional properties both saw an increase in confidence on knowledge of these benefits.</li> <li>• There was a slight increase in those who weren't familiar with the health benefits, showing still room to improve.</li> </ul>	<ul style="list-style-type: none"> <li>• Continue to build on the educational program and resource distribution.</li> </ul>

# Findings summarised & recommendations

SLIDE	FINDINGS	RECOMMENDATIONS
<p><b>Part 2: Health benefits and nutritional properties</b> Slide 24</p>	<ul style="list-style-type: none"> <li>Majority of the 195 respondents could name one nutritional property (91.2%).</li> <li>Vitamin D responses increased the most significantly, with +15.7 increase to 66.1%.</li> <li>All nutritional properties highlighted consistently in the resources (ABCDE messaging) saw an increase from 2019.</li> </ul>	<ul style="list-style-type: none"> <li>The reinforced repetition of the vitamin D message throughout 2019/2020 is paying off, suggest continuing to expand on this in refreshed ways in 2021 to tailor to both new and current audience.</li> </ul>
<p><b>Part 2: Health benefits and nutritional properties</b> Slide 25</p>	<ul style="list-style-type: none"> <li>Only around 8% of respondents couldn't select a health benefit.</li> <li>Increase in vitamin D levels came out as the top response, similar to the above question.</li> <li>Nearly all respondents picked more than one health benefit.</li> </ul>	<ul style="list-style-type: none"> <li>Keep this question for 2021 to provide direct comparison.</li> <li>Similar to the above, vitamin D is dominating the sentiment, so maintain this with the consistent resource and education strategy currently employed.</li> </ul>
<p><b>Part 3: How valuable are mushrooms to HCPs?</b> Slide 26/27</p>	<ul style="list-style-type: none"> <li>Respondents view of mushrooms value and importance is very high.</li> <li>An increase by over 9% to them being very important.</li> <li>New question for 2020 showed that 84% believe mushrooms have unique properties.</li> </ul>	<ul style="list-style-type: none"> <li>Focusing on the specific benefits and properties is paying off and ensuring that the audience are seeing the value of mushrooms.</li> <li>Look at new ways of highlighting the unique benefits and importance of mushrooms to avoid repetition and provide new knowledge for owned audiences eg: EDM database.</li> </ul>



# Findings summarised & recommendations

SLIDE	FINDINGS	RECOMMENDATIONS
<b>Part 4: Knowledge of vitamin D properties</b> Slide 28/29	<ul style="list-style-type: none"> <li>The top scoring known risk factors were the obvious choices like clothing that covers entire body and limited sun exposure, alongside the lesser known low dietary vitamin D all scoring 80% or more.</li> <li>67.2% knew that placing mushrooms in the sun increased vitamin D.</li> </ul>	<ul style="list-style-type: none"> <li>Reinforced repetition of placing mushrooms in the sun for vitamin D message were well known, and the focus within the campaign shows the resonance of this.</li> <li>To avoid audience fatigue of repeated Vitamin D messaging, increase awareness of other key benefits in a similar approach alongside successful vitamin D messaging/hooks.</li> </ul>
<b>Part 5: What are the resources like?</b> Slide 30	<ul style="list-style-type: none"> <li>Resources are still not well known.</li> <li>A slight increase in respondents having the resources.</li> </ul>	<ul style="list-style-type: none"> <li>Continue to streamline the resources available.</li> <li>Keep pointing towards the newly created mushrooms hub, housing all historic and current assets, while also supporting with a consumer-facing resource that HCPs can share with their clients.</li> </ul>
<b>Part 6: Personal consumption habits and rationale</b> Slide 31	<ul style="list-style-type: none"> <li>Personal consumption of mushrooms was down slightly.</li> <li>Daily consumption, however, was up by a small amount.</li> <li>No one said why they didn't consume mushrooms.</li> </ul>	<ul style="list-style-type: none"> <li>Provide unique, easy and interesting ways to consume mushrooms.</li> <li>Whilst it would be good to see this improve, it is more valuable for long-term impact to focus on the recommendations to others to help spread awareness and wider consumption of mushrooms (which saw an increase, next slide).</li> </ul>

# Findings summarised & recommendations

SLIDE	FINDINGS	RECOMMENDATIONS
<p><b>Part 7: Mushroom recommendations to clients and rationale</b> Slide 32/33</p>	<ul style="list-style-type: none"> <li>● Overall there was an increase in mushroom recommendations to their clients.</li> <li>● Main reason for not recommending is the unfamiliarity with health benefits.</li> <li>● Being a strong vegetarian option was highlighted as one of the most popular reasons to recommend.</li> </ul>	<ul style="list-style-type: none"> <li>● Provide ways to consume mushrooms that are easy to achieve.</li> <li>● The fun facts provide an opportunity to do this in an appealing way.</li> <li>● Focus further on the health benefits to increase the awareness.</li> <li>● Keep the questions the same for 2021 for consistency and ease of comparison.</li> </ul>
<p><b>Part 8: Online resources?</b> Slide 34</p>	<ul style="list-style-type: none"> <li>● Only marginal gains on visits to the Australian Mushrooms website.</li> <li>● Still 72.4% haven't visited.</li> </ul>	<ul style="list-style-type: none"> <li>● Most of the time we are not driving to the Australian Mushrooms website in communications, as the content is for HCPs and the website is consumer facing only.</li> <li>● Consider removing this question in future as the activity doesn't drive to this site due to it being consumer facing and our assets not being able to sit there, or adding a consideration that HCPs send their clients to the Australian Mushrooms website for recipes and resources, noting that there will not be previous 2019/2020 data to compare.</li> </ul>

# Sentiment results against objectives



**Knowledge** of the nutritional properties and health benefits of mushrooms.



Knowledge and confidence in importance **increased** across the board  
**+12.9%**  
(59% in 2019)



**Perception** of mushrooms for health.



Place importance on mushrooms **increased** **+9.1%**  
(33% in 2019)



**Value** placed on mushrooms for their properties.



Mushrooms still viewed as **more of or equal** value to vegetables  
(57% in 2019)



**Behaviour** around recommending mushrooms.



Recommendations **increased** from 2019, with **10.6%** less who see clients but didn't recommend  
(24% in 2019)



**Frequency** of recommendation or behaviour.

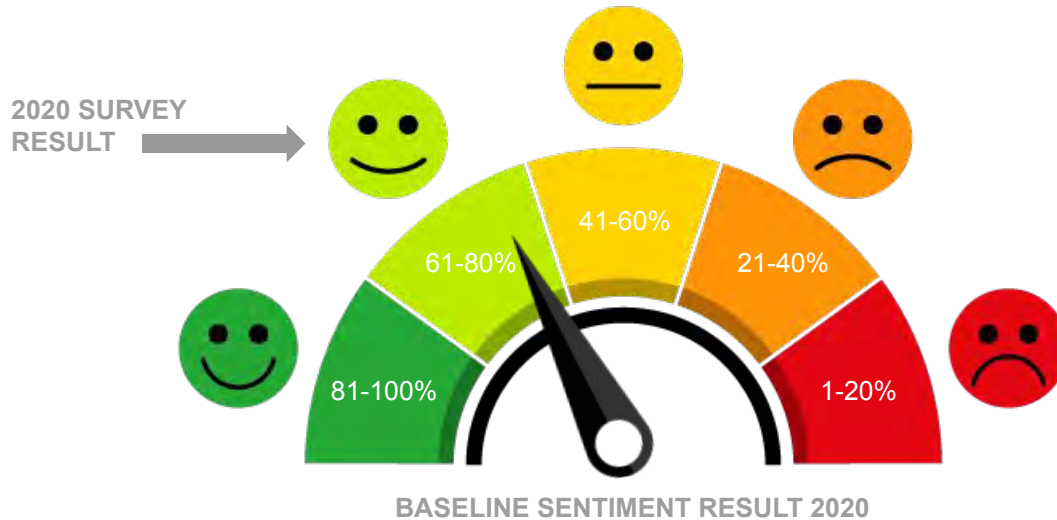


Always or often recommending mushrooms to their clients **decreased** to 27.1%  
(39% in 2019)

# Average sentiment KPI

Year on year (2019 to 2020) comparison on sentiment is very encouraging, with increases across the board in understanding, knowledge, recommendations and value of mushrooms.

The below scale indicates where current knowledge levels and attitudes are currently sitting (62.0%), with the aim to retain or improve this for 2021. **This has improved from 2019 which sat at 41.0% vs. the 2020 result of 62.0%:**



\* Calculated as an average value of the percentages captured in slide 39.

# Learnings & Opportunities



# Strategy & Planning: What worked well

## FORWARD PLANNING

With a long planning lead time from beginning of 2020 to now, we were able to map out timings to ensure all activity was considered ahead of time.

## TEST & LEARN

Remaining nimble which allowed us to pivot based on initial results, such as adding a paid social element where needed to bolster the responses.

## TAILORED EDMS

Templates created to make each campaign streamlined while also keeping it fresh and exciting, and ability to track performance over time.

## STANDOUT DESIGN

Maintained a consistent look and feel in terms of tone of voice and design principles, which helps to create a sense of familiarity and trust towards our marketing material.

# Strategy & Planning: Even better if we...

## **AFFORDABLE THIRD PARTY EDMS**

Investigate other industry newsletters ahead of time for possible placements that are targeted to HCPs, particularly GPs.

## **SOCIAL RETARGETING**

Using the audience results from all past social campaigns, retarget these previously engaged audiences with future spend for better uptake.

## **ALTERNATE MEDIA**

Research other advertising placements that are cost effective to reach other professionals beyond social ads or newsletters, such as display ads or industry networking groups on social.

# Research Questions: What worked well

## SENTIMENT INCREASE

Across the board positive sentiment among HCPs towards mushrooms has risen.

## PAID SOCIAL

This year paid social brought us the majority of our participants, whilst also adding over 100 emails to our database.

## PARTICIPATION PRIZE

This was a cost effective way of incentivising the survey, while giving us a friendly reason to send the reminder email.



# Research Questions: Even better if we...

## REDUCE AMOUNT OF QUESTIONS

Completion time increased by nearly two mins to 6 mins 40 secs, this could have lead to a 57% dropout rate. Under 5 mins is optimal.

## SIMPLIFY SOME LANGUAGE

Completion time could also be reduced by simplifying the wording of some of the questions.

## QUALIFYING QUESTION

Start survey with qualifying question about HCP status, and remove those who are not professionals automatically.

# Takeaways:

## TAKEAWAY

### THE WIDER CAMPAIGN IS WORKING

## FINDING

The sentiment amongst those who completed the 2020 survey have a solid understanding of mushrooms and their properties.

### DISCUSS WHICH WEBSITE SHOULD BE THE FOCUS

The website question may well be invalid if nothing continues to be driving to it for HCPs. Consider adding a specific HCP page to the website that we can drive traffic to, alternatively, HCPs can encourage their clients to visit it.

### KEEP SURVEY CONCISE AND TO THE POINT

We added several new questions this year, as well as more options to some questions, but as a consequence increasing the completion time and dropouts (6:40 average time and 43% completion rate in 2020, compared to 4:43 time and 51% completion rate in 2019).

# Limitations:

## Key limitations to consider when interpreting the data:

- The data from year 1 and 2 of the survey are cross-sectional, not longitudinal, with some participants differing from year to year.
- As a result, the tracked sentiment changes over time could be a result of a different set of people being surveyed, rather than a change in the knowledge base of the same group of people.
- In addition, some new survey questions were added or wordings updated from 2019 to 2020 in order to improve the readability or breadth of possible responses.
- Responses could have been influenced by the survey topic, preceding questions, and overall heavy mushrooms messaging. For example, in question 9, 62.5% said that UV-exposed mushrooms were the highest source of vitamin D, and in question 10, more than two thirds of respondents said they knew that placing mushrooms in the sun increases their vitamin D content.

# Key Performance Indicator Results



# Setting KPIs

ITEM Year on Year	2019 SURVEY	KPI 2020 SURVEY			2020 RESULT	PERFORMANCE
		MEETING	EXCEEDING	SMASHING		
Survey Respondents	225	250	350	450	195	MEETING
Database Growth YoY	1,292	1500	1700	2000	1,405	NOT MEETING
Increase GP subscribers (of the pool)	22%	100	150	200	129	MEETING
<b>SURVEY KPIs</b>						
Q1. Can specify health benefits of mushrooms	20%	23%	26%	30%	40%	SMASHING
Q2. Can specify nutritional benefits of mushrooms	17%	20%	25%	30%	35.9%	SMASHING
Q3. Knowledge of Vitamin D as a nutritional property increases	50%	55%	60%	65%	66.1%	SMASHING
Q4&5. Importance of mushrooms - Very Important	33%	38%	42%	46%	43.1%	EXCEEDING
Q6. Using resources and place value on them (now Q11)	22%	25%	26%	28%	28.2%	SMASHING

# Setting campaign goals

SURVEY KPIs	BENCHMARK SURVEY	KPI 2020 SURVEY			2020 RESULTS	PERFORMANCE
		MEETING	EXCEEDING	SMASHING		
Q7. <b>Increase</b> in 'Once per week' personal mushroom consumption	<b>40%</b>	43%	45%	50%	<b>32.3%</b>	DECREASING
Q9. <b>Decrease</b> in 'not recommending mushrooms'	<b>18%</b>	16%	14%	12%	<b>7.7%</b>	SMASHING
Q10. <b>Decrease</b> in 'I don't think about mushrooms'	<b>50%</b>	48%	46%	44%	<b>28.5%</b>	SMASHING
Q11. <b>Increase</b> in recommending 'mushrooms for their nutritional properties'	<b>65%</b>	68%	70%	75%	<b>75%</b>	SMASHING
Q12. <b>Increase</b> in respondents who have visited the Australia Mushrooms website	<b>26%</b>	30%	32%	34%	<b>27.6%</b>	NOT MEETING

# Updating Key Performance Indicators (KPIs)



# Setting KPIs for 2021

ITEM year on year (YoY)	BENCHMARK SURVEY	KPI 2020 SURVEY			KPI 2021 SURVEY		
		MEETING	EXCEEDING	SMASHING	MEETING	EXCEEDING	SMASHING
Survey Respondents	<b>225</b>	250	350	450	300	400	500
Database Growth (2020 to 2021)	<b>1,292</b>	1500	1700	2000	1500	1700	2000
SURVEY KPIs							
Q1. Can specify health benefits of mushrooms	<b>20%</b>	23%	26%	30%	25%	28%	32%
Q2. Can specify nutritional benefits of mushrooms	<b>17%</b>	20%	25%	30%	23%	28%	32%
Q3. Knowledge of Vitamin D as a nutritional property increases	<b>50%</b>	55%	60%	65%	60%	65%	70%
Q4&5. Importance of mushrooms - Very Important	<b>33%</b>	38%	42%	46%	40%	44%	48%
Q6. Using resources and place value on them	<b>22%</b>	25%	26%	28%	28%	30%	34%



# Setting campaign goals for 2021

SURVEY KPIs	BENCHMARK SURVEY	KPI 2020 SURVEY			KPI 2021 SURVEY		
		MEETING	EXCEEDING	SMASHING	MEETING	EXCEEDING	SMASHING
Q7. <b>Increase</b> in 'Once per week' personal mushroom consumption	40%	43%	45%	50%	46%	50%	55%
Q9. <b>Decrease</b> in 'not recommending mushrooms'	18%	16%	14%	12%	14%	12%	10%
Q10. <b>Decrease</b> in 'I don't think about mushrooms'	50%	48%	46%	44%	45%	43%	40%
Q11. <b>Increase</b> in recommending 'mushrooms for their nutritional properties	65%	68%	70%	75%	70%	75%	80%
Q12. <b>Increase</b> in respondents who have visited website	26%	30%	32%	34%	32%	34%	36%

## Footnotes:

- These KPIs have been kept reasonably conservative and would be seen as 'Meeting Expectations'. We have also supplied a set of numbers for 'Exceeding Expectations' and '**Smashing** Expectations' for stretch goals and inspiration.
- Q10: To note, as it's a non mandatory question, the respondent numbers will fluctuate much more than the rest of the survey.

# Next Steps



# What's next?

- HORT Innovation to review and provide feedback or any additional requests.
- Implement learnings into upcoming communications activity for 2021.
- Refine questions based on insights for the next phase of the audience sentiment research in 2021.
- Agree on KPIs for the next roll-out.

# Appendix



# Appendix: Commentary from survey question 15

RESPONSES BELOW AS RECEIVED FROM RESPONDENTS - SEE PAGE 34 FOR OVERVIEW.

“Question: Please provide any additional thoughts you have on the information that we are providing on mushrooms”

- We need an infographic
- Additional education material would be helpful
- Better information on how to enrich with Vit D
- I plan to look at more information
- Consumer friendly visual posters and factsheets to handout to people, with the key information
- Thank you, great to have this info
- It's great to raise awareness, would be beneficial to provide some studies as well or table re: tables about benefits of mushrooms
- Mushroom are good and add add variety for vegetarians
- Where we can purchase UV exposed mushrooms for dietary vitamin D?
- Great
- I personally can't stand mushrooms but I recommend and should learn more about them
- Delicious
- Haven't seen the resources yet
- Great way to promote this food as specially because Vitamin D deficiency is increasing day by day and this could make a difference
- Good protein source

# Appendix: Commentary from survey question 15

## (CONTINUED:)

- I think a lot of health professionals just try and increase vegetable intake in general, but something as tangible as helping rectify the vitamin D issues can separate mushrooms as an individual recommendation
- Would love to receive more emails with health benefits
- Wider marketing campaign needed
- It would be good to get the message about vitamin D to the general public. Better still, have UV-exposed mushrooms available in supermarkets and fruit and veg stores
- The vitamin D info is new to me
- It's interesting and good to be reminded of the unique benefits
- Mushrooms are great in all diets and particularly for the vegan diet
- Quality, engaging communications, thank you
- Apart from health they are a great culinary "vegetable"
- It's important for us all to keep abreast of new research as it comes to light not just of fruits and vegetables but also fungi
- Would love to learn more and have more consumer resources to provide to clients
- Materials are good if they are externally validated
- More on how they enhance the flavour of meals and can help replace meat
- I feel some of the health relationships could be overstated - foods can't boost our health beyond simply supporting general wellbeing
- It seems that consuming mushrooms may actually be very beneficial
- Best use if don't like the taste

# Appendix: Commentary from survey question 15

## (CONTINUED:)

- Not sure - it has been awhile
- I have many patients with irritable bowel syndrome and many need to avoid mushrooms it would be great to have better information on the mannitol content of different mushroom varieties and how this varies with cooking technique
- No specific suggestions - please continue your efforts
- Resources would be good for clients
- Love the info that's being provided. Would love to see more info that's specifically unique to mushrooms (aside from vitamin D benefits). Also more info on different types of mushrooms as varieties like Lions Mane etc are growing in popularity and a lot of health claims around them but would love more evidence to support or otherwise. Keep up the great work!
- I'm very happy that you are shining the spotlight on mushrooms. They are a fascinating plant/food source
- If possible can you provide informative pamphlets?
- I find the updates helpful
- We need more educational resources about the natural benefits of mushrooms
- I am not aware of information being provided on mushrooms
- It's made me realise how little I know about the nutritional properties of mushrooms
- I would like to understand more about the nutritional properties of mushrooms
- It would be useful if you listed quantities of nutrients and related factors
- Educate consumers on how to place in sun / increase via D

# Appendix: Commentary from survey question 15

## (CONTINUED:)

- How to help children learn to like them. Many people don't realise you can eat them raw
- A fact sheet for clients on increasing vit D with sun exposure would be helpful
- Would like to know more
- Need more information on benefits of mushroom
- I have never found UV exposed mushrooms to buy
- Excellent
- Would like further information on mushrooms for patient education in future
- As a GP, I would have thought that we would have been this information but we haven't
- Serving sizes
- Vegan rather than vegetarian diets do need mushrooms. Aged skin is another reason for less vit D production. Have a family member with a rare mushroom allergy which is a nuisance!
- Not sure if all kind of mushrooms contain vitamin D
- I wish there were more types of mushrooms readily available at supermarkets (from a consumer point of view)
- I would love more information on mushrooms
- Would like more information on Vit. D content
- Currently mushrooms are mainly seen for their value as a meat alternative for vegetarians. Good Umami flavour
- I love mushrooms, would love to grow and learn about it



# Appendix: Commentary from survey question 15

## (CONTINUED:)

- I would like to know more
- I don't know about the nutritional benefits of mushrooms other than they are "good for you"
- Very useful. Thank you
- Need much more promotion
- Can be eaten raw in salads or cooked in meals or as a separate vegetable dish
- I love the taste
- Encouraging
- Informative
- They are very good for you
- Very surprising, underestimated but realized it has lots of health benefits
- Can you put them in the sun to increase vitamin D at home?
- Mushrooms can be purchased all year round no matter what season, beginning, middle or end. Mushrooms can be grown at home and there are many tasty varieties. They can be eaten either cooked or raw, made into a dip. They also make an attractive garnish to be eaten with a healthy dip.
- It would be good if you provided some answers to these questions that I could access straight away eg: cardiac benefits/reference to an article to support this
- Thank you for providing this information

# Appendix: Commentary from survey question 15

## (CONTINUED:)

- I am happy with the current level of info
- Needs more exposure
- I'd eat mushrooms more often except they have a moderate level of salicylates to which I am sensitive to, sadly (causes gut and sinus issues)
- I do suggest my patients eat them, though
- More fundamental studies on the health benefits of mushrooms for human nutrition are needed
- I would like to see updated research on B12 content and immune factors apart from vitamin D content, especially in Asian and wild varieties
- Perhaps the brown bags at shops can state some of these facts for consumers. By the way I love how you present your information. You're helping to make mushrooms more attractive to people
- I am now more fascinated how incredibly nutritious mushrooms are. I will definitely increase my consumption of them and will expose them to the sun beforehand
- Much needed
- Lots of practitioner info on medicinal mushrooms
- My clients and social media followers get very surprised when learn that sunbathing mushrooms increases their nutritional value!
- Mushrooms are a powerhouse of nutritional benefits. They cannot be underestimated

# Appendix: Commentary from survey question 15

## (CONTINUED:)

- Keep up the good work!
- All the information you have given me is very helpful
- Nutritional information on the different varieties of mushrooms
- I have always thought of mushrooms as under the vegetable umbrella and never thought of them separately
- Some information about the difference in vitamin D from mushrooms compared to that from the sun is helpful
- I'd like a copy of this survey with the correct answers
- I love them, so tasty and easy to cook. We have been growing and cooking them for students at my children's school
- There is very little clear health benefits campaign out there about mushrooms
- Thank you
- Easy to find and navigate the website. Content is clear and understandable. Well presented
- They taste ok
- Website is informative and interesting for all - well done
- It can also enhance brain regrowth or modify for the better
- Useful
- Covers valuable information
- Is there any mushroom juice available or is there any good benefit in the mushroom juice?
- Personal taste I don't like them
- If UREA or other toxic poisons are used in the production process, the health benefits are negated

## **APPENDIX 4: MS129 AUDIENCE SENTIMENT RESEARCH 3**

**Hort  
Innovation**  
Strategic levy investment

**MUSHROOM  
FUND**

**Year 3 - Audience Sentiment Benchmark: Research Report - November 2021**



# Background:

**Project Code:** MU17002

**Project Name:** Educating health professionals about Australian mushrooms

**Project Leader:** Dr Flavia Fayet-Moore

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- Next Steps

# Objectives and audience

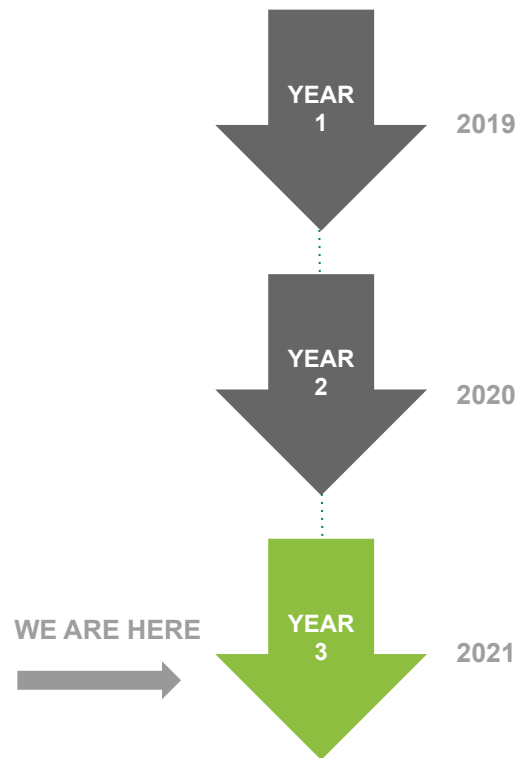




# Overview:

This report describes the findings from the 2021 Audience Sentiment Research. It is the third and final of three waves of Audience Sentiment Surveys conducted throughout the 3-year project. The purpose of this survey was to:

1. Help measure the impact of the program on changes in attitudes, knowledge and propensity to act, through comparison to baseline data.
2. Gather insights and learnings of the project in improving awareness and understanding of the nutritional and health benefits of mushrooms among healthcare professionals (HCPs).



# Objectives:

The aim of the survey was to measure the impact of mushroom activations on HCPs across 5 core areas:



**Knowledge** of the nutritional properties and health benefits of mushrooms.



**Value** placed on mushrooms for their properties.



**Perception** of mushrooms for health.



**Behaviour** around recommending mushrooms.



**Frequency** of recommendation or behaviour.

# Audiences:

## Core 2021 campaign audiences:

1. Dietitians
2. General Practitioners (GPs)
3. Nutritionists
4. Naturopaths
5. Other healthcare professionals (HCPs) (eg: physiotherapist, nurse)



# Approach



# Approach:

## STEP 1:

**Continuously communicated to database & wider HCP audience** over the course of the program, using EDMs (Electronic Direct Mail/Newsletter) & paid social media. This highly targeted group was used as the basis for the response.

## STEP 2:

**Questions and learnings from 2020's survey** were reviewed and, where needed, questions adapted. For 2021 questions were removed and an additional added, as well as additional options to some questions.

## STEP 3:

**Distributed our sentiment analysis questions** to the NRAUS and Australian Mushrooms databases as a first stop.

## STEP 4:

**Developed a paid social campaign** targeting HCP audiences to reach new professionals.

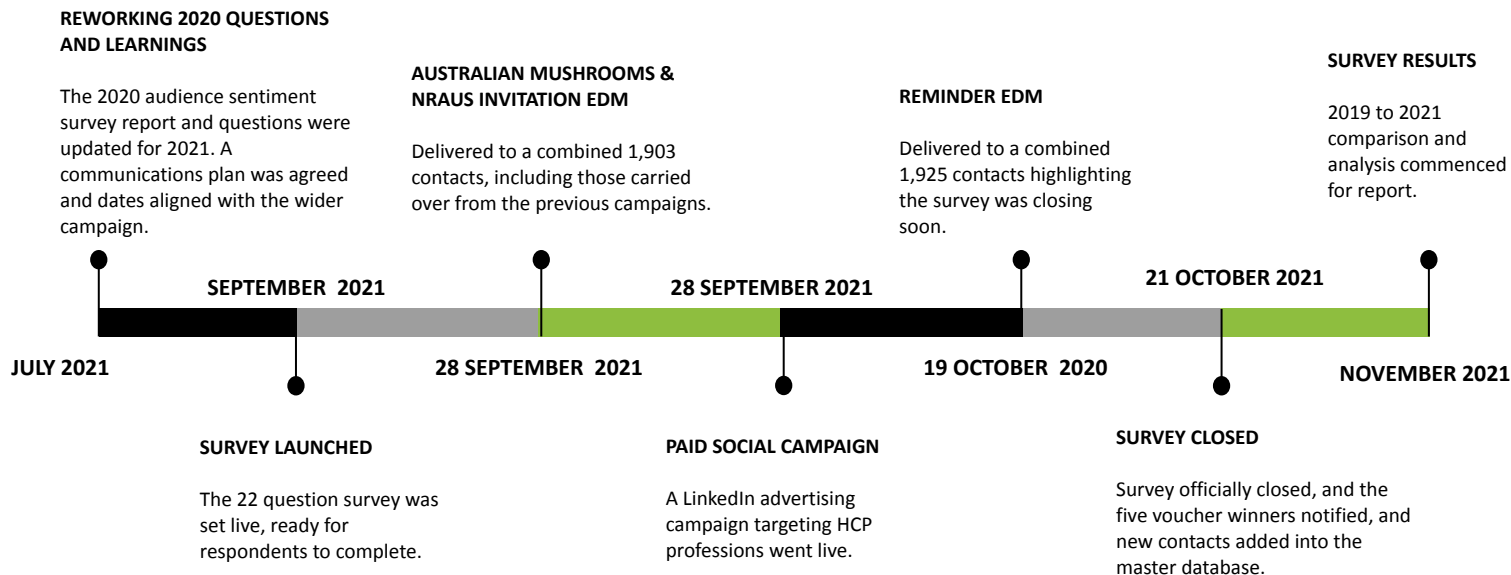
## STEP 5:

**Distributed a second follow up email** to the database, to remind those who had not yet completed the survey.

## STEP 6:

**Once the survey had closed,** results were reviewed, analysed and compared to the baseline of 2019 (and in some cases to 2020) for tracking. Learnings and overall insights were included.

# Timeline:



# Distribution channels:



Australian  
Mushrooms  
database:  
1,737 contacts

NRAUS Database:  
220 contacts



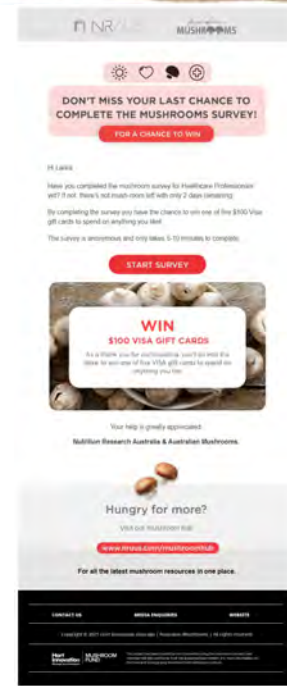
Social Campaign:  
101,160 reach

**TOTAL COMBINED REACH OF: 103,117 PEOPLE**

# Assets:



The survey used a custom interface designed to maximise engagement and personalisation for owned branding.



A series of informative and engaging EDMs were designed to entice and remind the audience.



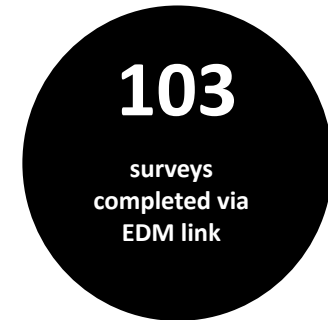
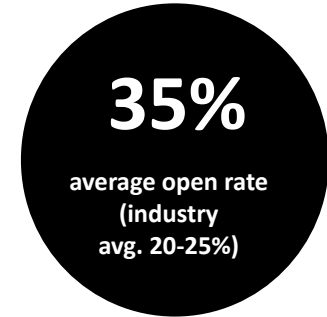
Additional social ads were created for online audiences to recruit further interest.



# EDM performance to existing databases

**OBJECTIVE:** To distribute the EDMs to the master HCP owned database built over the course of the campaign.

EDM	Database Size	Unique Opens	Open Rate	Clicked a Link	Unsubscribe Rate	Not Opened	Clicked the survey link
Survey invitation EDM	1,903	697	37.17%	28.98%	2.03% (38 people)	1,178	202
Survey reminder EDM	1,925	625	32.86%	15.2%	0.68% (13 people)	1,277	101
<b>TOTAL / AVERAGE</b>	<b>3,828 EDMs delivered</b>	<b>1,322 unique opens</b>	<b>35.0% open rate</b>	<b>22.09% clicked a link</b>	<b>1.35% opting out</b>	<b>2,455 unopened EDMs</b>	<b>303</b>



# Paid social media

**OBJECTIVE:** To use targeted social ads to generate additional survey respondents, based on last year's learnings, whilst also growing the master HCP database.

Platform	Clicks to Site	Reach	Cost Per Click	Spend	Click Through Rate	Video Percentage Watched
LinkedIn	290	101,160	\$11.06	\$3,000	0.29%	61.67%

## RESULTS:

- Campaign ran for 31 days, drove 290 visitors to the survey landing page and converted an additional **86 survey responses**.
- Key audiences targeted for this campaign was two-fold: HCP job titles and custom database targeting of our EDM database to capture the same audience also on LinkedIn.
- **29 additional HCP contacts** from the social strategy were added to the master database.
- In 2019 and 2020, Facebook spend was run to questionable responses, so 2021 implemented spend was placed on LinkedIn only to ensure the best possible result from higher quality candidates.

Nutrition Research Australia  
642 followers  
Promoted

Calling all Healthcare Professionals: We need you! How much do you know about mushrooms? Complete our short survey for a chance to win one of five \$100 VISA gift cards.

CALLING ALL HEALTHCARE PROFESSIONALS: **WE NEED YOU!**

You're invited to complete the mushroom survey

0:04 / 0:16

SURVEY: Complete the mushroom survey for a chance to WIN! [Sign Up](#)

16

Reactions

Like Comment

Add a comment...

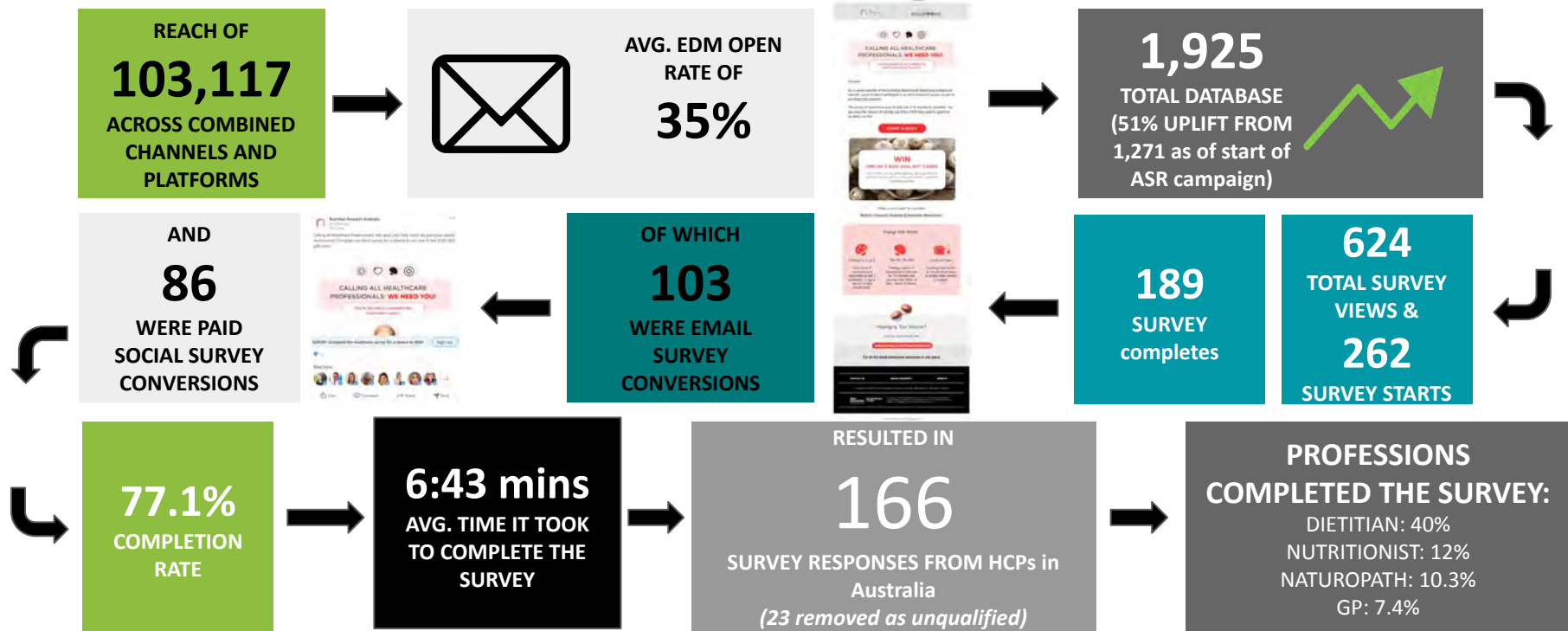
86

surveys  
completed from  
paid activity

# Survey Results



# The approach in a snapshot:



# Survey Stats:

**262**

Survey starts of 602 total visits to the survey from all sources (email activity + paid)

**77.1%**

Completion rate of those that started the survey (n = 202)

**82%**

Health or food professionals. It is only these who are represented in the results (n = 166)

**51%**

Of our target audience took part from paid media activities (n = 86)

# Survey structure:

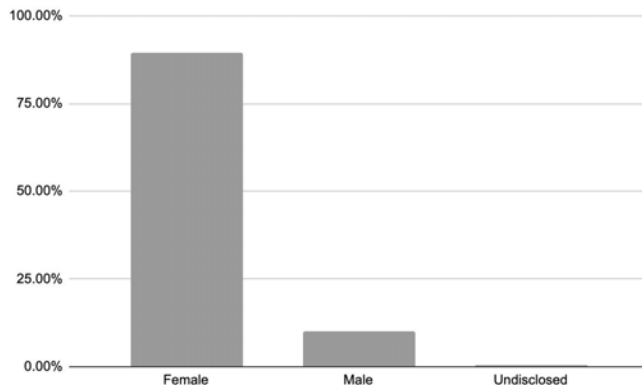
The results have been set out in accordance with the overall survey structure:

- **Part 1** - Audience segmentation
- **Part 2** - Knowledge of the health and nutritional properties of mushrooms
- **Part 3** - Value of mushrooms to HCPs
- **Part 4** - Knowledge of vitamin D properties
- **Part 5** - Existing resources
- **Part 6** - Personal consumption habits and rationale
- **Part 7** - Mushroom recommendation to clients and rationale
- **Part 8** - Perspective of mushrooms within dietary guidelines

# Part 1: Audience Segmentation

## GENDER

89.4% of respondents were female



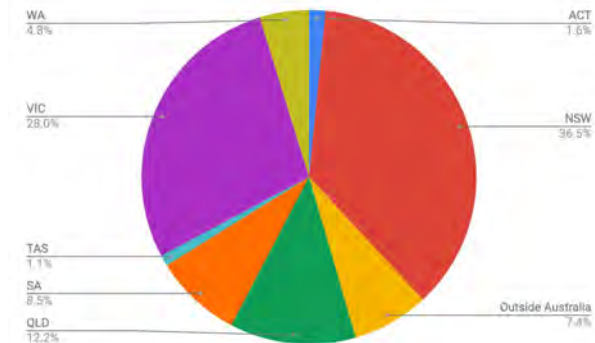
## AGE

The age sample size were mostly evenly split



## LOCATION

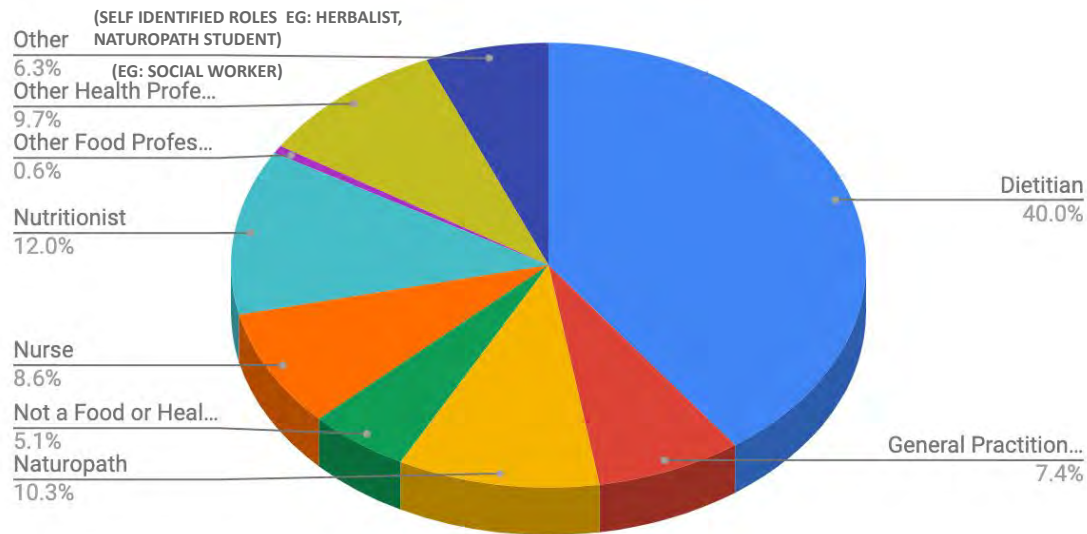
NSW and VIC were the most represented states



189/189 ANSWERED

MANDATORY \*those outside Australia removed from survey

# Part 1: Audience Segmentation



52%

OF RESPONDENTS WERE DIETITIANS OR NUTRITIONISTS

7.4%

OF RESPONDENTS WERE GPs

10.3%

OF RESPONDENTS WERE NATUROPATHS A KEY AUDIENCE FOR 2021

175/189 ANSWERED

MANDATORY\* Non Healthcare professional removed from survey



# Part 2: Knowledge of the health and nutritional properties of mushrooms

Q1. How familiar are you with the health benefits of mushrooms (e.g. satiety, gut, heart health)?

Response	2021	Dif. to 2019
Familiar with some health benefits but cannot specify them	38.6%	-24.4
Familiar and can specify their health benefits	34.9%	+14.9
Very familiar as I have attended events / webinars / read resources	17.5%	+13.5
Academic knowledge and actively seek more information	4.8%	+1.8
Not familiar at all	4.2%	-3.8

166/189 ANSWERED  
MANDATORY

Q2. How familiar are you with the key nutritional properties of mushrooms (e.g. nutrient content, bioactive components)?

Response	2021	Dif. to 2019
Familiar with some nutritional benefits but cannot specify them	42.2%	-16.8
Familiar and can specify their nutritional benefits	34.3%	+17.3
Very familiar as I have attended events / webinars / read resources	12.7%	+8.7
Not familiar at all	7.2%	-8.8
Academic knowledge and actively seek more information	3.6%	+1.6

166/189 ANSWERED  
MANDATORY

## FINDINGS:

- Overall knowledge in health benefits and nutritional properties of mushrooms has grown significantly in the past three years, with **over half of HCPs surveyed (57.2% & 50.6%) being familiar with each** (either being able to specify, very familiar or having academic knowledge) compared to around quarter at baseline (25% & 23%).
- This increase in familiarity, in some cases, could be attributed to events/webinars that have been attended.
- Four times more are **very familiar with the health benefits of mushrooms (17.5% vs 4%)** and three times more with the **key nutritional properties of mushrooms (12.7% vs 4%)** when comparing 2021 to 2019 potentially due to attending events and reading resources.
- **Unfamiliarity to nutrition and health benefits and being familiar but unable to specify dropped significantly** compared to baseline.

# Part 2: Knowledge of the health and nutritional properties of mushrooms

Q3. In your opinion, what are the key nutritional properties of mushrooms (e.g. nutrient content, bioactive components)?

## FINDINGS:

- **97.6%** of the respondents were **able to specify at least one nutritional property**, an increase **from 90.6% in 2019**.
- This year only **2.4% could not select** a nutritional property, a huge drop from 2019 (9.4%).
- **Vitamin D is the most commonly selected property** after being third in 2019 and second in 2020.
- **Beta-glucans** saw the biggest jump in knowledge with an almost 20 point increase from 2020 - this is one of the key attributes that has regularly been called out in campaign materials.
- The key nutritionals communicated throughout project, Antioxidants, Beta-glucan, Chitin, D, Ergosterol and Ergothioneine (ABCDE) all showed significant increases.

Response	Difference to 2019 or 2020	
	2021	or 2020
Vitamin D	74.1%	+23.7
Dietary fibre	72.3%	0
Antioxidants	65.1%	+6.7
Vegan friendly	65.1%	NEW
Low calorie	60.2%	NEW
B Vitamins	58.4%	NEW
Cholesterol free	57.8%	-2.9
Low sodium	52.4%	NEW
Beta-glucans	41.6%	+19.1
Prebiotics	34.9%	+2.3
Chitin	29.5%	+11.1
Potassium	29.5%	-5.8
Ergosterol	28.9%	+10.5
Ergothioneine	24.1%	+9.4
Folate	24.1%	-4.5
Selenium	23.5%	-7.7
Copper	15.7%	NEW
Omega-3	6.0%	-1.6
Vitamin E	5.4%	-4.9
Don't know	2.4%	-7
Other	0.0%	-2.7

## Part 2: Knowledge of the health and nutritional properties of mushrooms

Response	Difference	
	2021	to 2020
Increases and maintains vitamin D levels	76.5%	+11.4
Improves gut health	72.3%	+9.8
Strengthens the immune system	56.6%	+19.7
Increases fullness and reduces hunger	50.6%	+4.5
Improves cardiometabolic markers (e.g. cholesterol, glucose, triglycerides)	49.4%	+4.8
Lowers the risk of some cancers	43.4%	+9.6
Reduces inflammation	36.1%	+5.9
Improves brain health and cognition	35.5%	+8.9
Supports the nervous system	30.7%	+13.3
Anti-aging	24.1%	+6.7
Maintains strong bones	24.1%	+2.1
Enhances physical performance (e.g. energy, muscle mass)	18.1%	+6.4
Don't know	5.4%	-4.8
Other	1.2%	+0.7

Q4. In your opinion, what are the key health benefits of mushrooms? (new question in 2020)

### FINDINGS:

- Across the board there were between 2.1%-19.7% increase on knowledge of all health benefits.
- Only 5.4% **could not select** a health benefit, almost a 50% drop (4.8 point) from 2020.
- **Vitamin D levels**, as with the previous question, came out top response, with over three-quarters (76.5%) aware of its impact.
- Other health benefits that were well known included **gut health**, **satiety**, and **immune system support**.
- An almost **20 point increase**, compared to 2020, in knowledge of **mushrooms strengthening immune system**, after this was a focus in 2021.

## Part 3: Value of mushrooms to HCPs

Q5. How important do you think mushrooms are in supporting overall health?

Response	2021	Dif. to 2019
Very important	53%	+19.1
Somewhat important	45.8%	-11.3
Not important	0.6%	-3.9
Don't know	0.6%	-3.9

166/189 ANSWERED  
MANDATORY

Q6. State your opinion: "Mushrooms have unique health benefits and nutritional properties" (new question in 2020)

Response	2021	Dif. to 2020
Strongly Agree	58.4%	+16.9
Agree	34.9%	-7.7
Neutral	6.6%	-9.3
Disagree	0%	-
Strongly Disagree	0%	-

166/189 ANSWERED  
MANDATORY

### FINDINGS:

- A total of **98.8%** of respondents regarded mushrooms as 'Important' or 'Very Important' for health, 7.8 points more than in 2019.
- Mushrooms being seen as '**Very Important**' increased from 2019 (33.9%) to 2020 (43.1%) to 2021 (53%) for Q5, showing that **perception of importance has increased every year**.
- At the end of the project, **over half (53%) HCPs perceive mushrooms to be very important to health**, compared to only 1/3 (33.9%) of respondents at baseline.
- There has been over 16 point positive shift to **HCPs strongly agreeing that mushrooms have unique benefits and properties**.

## Part 3: Value of mushrooms to HCPs

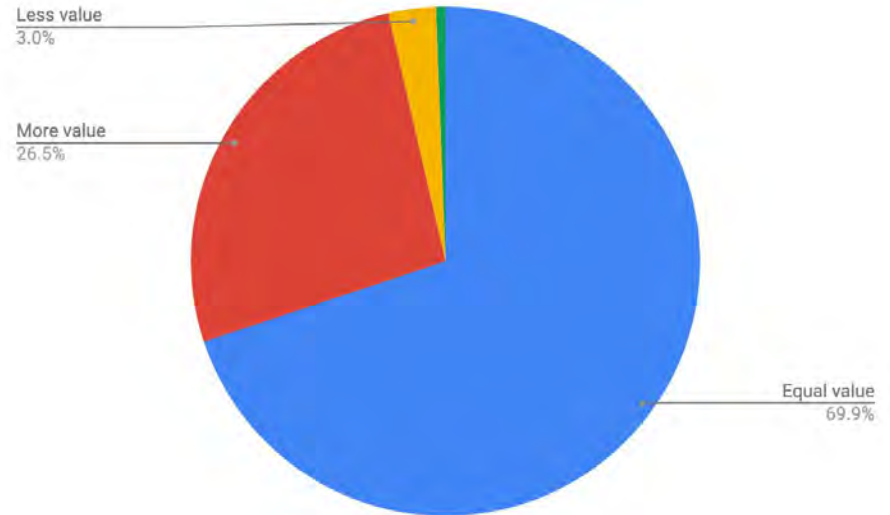
### Q7. How much value do you place on mushrooms compared to vegetables?

#### FINDINGS:

- For 2021 there was a significant increase in the number of respondents stating they placed 'More Value' on mushrooms, after a dip in 2020, **26.5%** in all for 2021.
- **96.4% of respondents** still felt that mushrooms were either more or of equal value to vegetables, an increase of 5.8 points since baseline.

166/189 ANSWERED  
MANDATORY

Response	2021	Dif. to 2019
More Value	26.5%	+11.8
Equal Value	69.9%	-6
Less Value	3%	-3.7
Don't know	0.6%	-2.1



## Part 4: Knowledge of vitamin D properties

Q8. Which of the following has the highest vitamin D content per serve? (new question for 2020)

Response	2021	Dif. to 2020
100g UV-exposed mushrooms	74.7%	+12.2
100g mushrooms	13.9%	-11.1
100g oily fish	6%	-19.0
2 eggs	2.4%	-11.4
40g fortified breakfast cereal	2.4%	-8.8
1 tablespoon margarine	0.6%	-2.4
Other	0%	-0.5

Q9. Can placing mushrooms in the sun increase their vitamin D content to 100% of your daily vitamin D needs? (new question for 2020)

Response	2021	Dif. to 2020
Yes	91.6%	+24.4
No	8.4%	-24.4

### FINDINGS:

- For the **second year running 100g of UV-exposed mushrooms came out as the option respondents mostly said had the highest source of vitamin D**, but with a 12.2 point increase since 2020.
- More than **nine tenths of respondents (91.6%)** knew that placing mushrooms in the sun can increase their vitamin D content to 100% of daily needs. This is a huge increase from 2020 of 24.4 points and reflects the consistency of this message within campaign communications.

## Part 5: Existing resources

Q10. Which statement best describes your opinion on the availability of resources to healthcare professionals on the health benefits and nutritional properties of mushrooms?

Response	2021	Dif. to 2019
I have resources and they are useful	41.6%	+19.7
I don't know of any resources	41.0%	-22.4
I have resources and they are not very useful to me	9.0%	+6.8
I have seen resources but they didn't interest me	8.4%	-4.1

166/189 ANSWERED  
MANDATORY

### FINDINGS:

- There was a significant increase in the awareness of the resources available, due to the project creating and promoting these assets.
- **Whilst 41%** of respondents claim to not know of any resources, this is a significant 22.5 point drop from 2019.
- The usefulness of resources has seen a **large positive increase** (19.7 points).
- Increase in awareness of resources was a learning from the 2020 survey and 2021's results show the focus here worked.

## Part 6: Personal consumption habits and rationale

### Q11. How often do you personally consume mushrooms?

Response	2021	Dif. to 2019
Daily	7.8%	+5.1
A few times a week	41.0%	+3.1
Once per week	34.3%	-5.9
Once a month	10.8%	-3
Once every few months	3.6%	0
Never	2.4%	+0.6

166/189 ANSWERED  
MANDATORY

### Q11a. Why don't you regularly consume mushrooms?

Response (n=28 respondents)	2021	Dif. to 2019
I forget to buy them	50.0%	N/A
I don't like the taste	17.9%	-82.1
I don't like the texture	14.3%	-60.7
They are too expensive	14.3%	N/A
I don't have any recipes with mushrooms	10.7%	N/A
I don't know how to cook mushrooms	3.6%	N/A
Other	25%	N/A

28/189 ANSWERED  
NON-MANDATORY

#### FINDINGS:

- **Almost all (94%) HCPs eat mushrooms at least once per month**, with the majority (83.2%) doing so **at least once a week**. Whilst consumption has remained fairly stable since 2019, frequency has increased over the past two years.
- Those that never ate mushrooms generally said they **forget to buy them (50%)**, highlighting some work possibly could be done at point of sale to drive top of mind awareness.
- Question 11a only had four respondents in 2019, and no respondents in 2020, hence the large drop in the differences here and lack of robust comparative insights.



## Part 6: Mushroom recommendation to clients and rationale

Q12. How often do you specifically recommend mushrooms to your clients?

Response	2021	Dif. to 2019
Always / Often*	48.8%	+28.3
Sometimes	23.5%	+5.2
Rarely	7.2%	-1.7
Never, as I don't see clients	14.5%	-19.4
Never, but I do see clients	6.0%	-12.3

166/189 ANSWERED  
MANDATORY

\*2019 this option was titled 'Regularly' so results from 2021, as with 2020 have combined Always and Often

Q12a. Help us to understand why you do not recommend mushrooms to your clients.

Response (n=61 respondents)	2021	Dif. to 2019
I do not think about mushrooms specifically	62.3%	+12.3
I do not have time to discuss mushrooms specifically	26.2%	-7.1
I'm not familiar with their health benefits	11.5%	-32.9
I'm not familiar with their nutritional properties	11.5%	-21.8
My clients do not like mushrooms	11.5%	+8.7
My clients do not have cooking skills	6.6%	+1
I do not believe mushrooms are important to recommend	0%	-7.1 (2020)
Other	6.6%	+1

61/189 ANSWERED  
NON-MANDATORY

### FINDINGS:

- **HCPs recommending mushrooms to their clients increased significantly** over the project (**47.7% to 79.5%**). At baseline only a fifth of HCPs were 'regularly' recommending to their clients. In 2021 this jumped to nearly 1 in 2 recommending 'always' or 'often'.
- The main reason for not recommending by nearly two-thirds of **respondents is that they do not think about mushrooms specifically**.
- **Unfamiliarity with nutrition and health benefits as reason has decreased significantly** from baseline with only 11.5% saying it was a reason compared to 33.3% and 44.4% in 2019.

## Part 6: Mushroom recommendations to clients

Q12b. Help us to understand why you recommend mushrooms to your clients.

Response	2021	Dif. to 2019
For their nutritional properties (e.g. low in kJ)	88.9%	+23.8
Vegetarian meal option	88.9%	+30.8
For their health benefits (e.g. heart health, gut health)	85.2%	+36.4
They add extra flavour to meals	75.3%	+7.9
They are easy to cook	72.8%	+19.3
To help increase vitamin D intake	71.6%	+22.4 (2020)
They make meals healthier	61.7%	+12.9
To add texture to meals	60.5%	+15.7 (2020)
Mushrooms are unique	51.9%	+24
To increase satiety	51.9%	+14.4 (2020)
To help decrease meat intake	50.6%	NEW
To help reduce sodium content meals	32.1%	NEW
Majority of my clients or patients like mushrooms	29.6%	+20.3
Other	0.0%	-4.7

### FINDINGS:

- Across the board **all options saw an increase in rationale of why mushrooms were recommended to clients** - as this is a multiple choice question, many answers can be selected.
- In 2019, the key reason for recommending was 'Adding flavour' but this is now in fourth place in 2021. Both the **nutritional properties** and **health benefits are driving recommendations**, alongside vegetarian properties which continues to grow in popularity generally.
- **In 2021**, the top five responses were the same as in 2020, with 'they add extra flavour' and 'they are easy to cook' switching places within the ranking.
- All but two options received 50% of respondents' votes or more, showing high engagement with several rationale points for recommending mushrooms.
- The 2021 results show that HCPs are **interested in what can be added to meals** (i.e. texture, flavour) rather than what is reduced by mushroom inclusion (i.e. meat intake, sodium).

## Part 8: Perspective of mushrooms within dietary guidelines

Q13. Given mushrooms are neither plant nor animal, and have unique nutritional properties, do you think mushrooms deserve to be given greater focus in the national dietary guidelines?

Response	2021
Yes definitely	50.6%
Maybe - Needs to be considered	40.4%
Unsure	6.0%
No	3.0%

166/189 ANSWERED  
MANDATORY

### FINDINGS:

- This was a new question for 2021 and therefore there is no comparative data.
- **Only 3% of HCPs don't not feel that mushrooms deserved to be given greater dietary guideline focus**, meaning that the community is either in favour or in favour of considering mushrooms as part of the dietary guidelines.

## Part 9: Additional Comments

Q14. Please provide any additional thoughts you have on the information that we are providing on mushrooms - Refer to appendix for all responses.

57/189 ANSWERED  
NON-MANDATORY

I'm aware of the benefits of mushrooms, but often forget to recommend them, they're not top of mind. It would be great to see a campaign like '2&5' or '30g nuts' (but) for mushrooms.

(I) really find the information/white paper etc very useful and informative. Great that research questions are being asked.

Very informative, well presented & easy to comprehend.

(Mushrooms are) very versatile - breakfast, lunch and dinner and all different kinds of cuisines e.g. Asian, European.

Visual resources and recipes for patients would be helpful.

More recipes to encourage intake, especially with non button mushroom types.

I recommend mushrooms as part of cooking mixed meals to clients when they want / need meal ideas, but often when I describe the veggies I use as part of meals, I hear 'I don't like mushrooms'. I think more work needs to be done to make mushrooms cool and for people to give them a go. I actually really like mushrooms personally.

You're doing a great job! Just need more exposure so both health professionals & consumers access your materials.

I received your excellent resource via LinkedIn on tanning - very insightful and also a very well presented resource - thank you!

# Findings summarised & recommendations

SLIDE	SUMMARY FINDINGS	RECOMMENDATIONS
<p><b>EDM and Paid social media</b> Slide 13/14</p>	<ul style="list-style-type: none"> <li>• Taking the learnings from 2020, paid social (LinkedIn campaign) was upweighted even further to target HCPs.</li> <li>• No partner activity was implemented due to learnings from 2019 and budget restrictions which yielded little results for a high expense.</li> <li>• Majority of survey responses came from the EDM send outs, which have steadily improved over time.</li> <li>• Following learnings from 2020, all social activity was moved to LinkedIn for better targeting which was reflected in the high calibre of respondents.</li> </ul>	<ul style="list-style-type: none"> <li>• Even though social media and EDM numbers increased, response rates dropped. This could be attributed to the external variables at play during the time the survey was in market (namely, uncertainty of lockdowns, fatigue with online activity and pandemic situation which is consistent in other reports).</li> <li>• While social wasn't as impactful as in previous years for driving numbers, quality of respondents was gained and important when considering future social KPIs.</li> </ul>
<p><b>Part 1 Demographics and location</b> Slide 19/20</p>	<ul style="list-style-type: none"> <li>• In line with the past two surveys, a much higher proportion of females to males took part.</li> <li>• High proportion of respondents from NSW and VIC, same as past surveys.</li> <li>• 262 started the survey, 202 submitted, 189 were valid and 23 were lost during for the below reasons.             <ul style="list-style-type: none"> <li>◦ 9 submissions dismissed who selected 'Not a healthcare professional'; 14 were based outside Australia.</li> </ul> </li> <li>• Higher number of nutritionists than previously (12% in 2021 vs 7.7% in 2020 vs 5.5% in 2019).</li> <li>• As a key target for 2021, Naturopath responses increase from 1.5% in 2020 to 10.3% in 2021</li> </ul>	<ul style="list-style-type: none"> <li>• With more prescriptive criteria the total number of responses is lower, but more targeted in the focus areas (i.e. Naturopath and Nutritionist). Recommend keeping this targeting - acknowledging it can affect quantity and future KPI setting.</li> </ul>

# Findings summarised & recommendations

SLIDE	FINDINGS	RECOMMENDATIONS
<p><b>Part 2: Health benefits and nutritional properties</b> Slide 21</p>	<ul style="list-style-type: none"> <li>Health benefits and nutritional properties both saw double digit increases in confidence of knowledge.</li> <li>Unfamiliarity decreased, showing that across the board understanding has increased due to the campaign.</li> </ul>	<ul style="list-style-type: none"> <li>Continue to build on the educational program and resource distribution.</li> </ul>
<p><b>Part 2: Health benefits and nutritional properties</b> Slide 22</p>	<ul style="list-style-type: none"> <li>Almost all (97.6%) of the respondents could identify at least one nutritional property of mushrooms, more than a six point increase from 2020 (91.2%).</li> <li>The reinforced repetition of the vitamin D message throughout 2019-2021 continues paying off. For the second year running, Vitamin D saw an increase in selection by 23.7 points (74.1% in 2021 vs 66.1% in 2020 vs 50.4% in 2019) to now be the most popular result with respondents.</li> <li>The majority of nutritional properties saw an increase in responses.</li> <li>Nominated benefits from respondents reflected the key communication messages. For example, this year we saw increase in immunity benefits which shows the messaging is having cut through (eg: 2021 the webinar hero-ed immunity).</li> </ul>	<ul style="list-style-type: none"> <li>Repetition and consistency of messages helps to build brands long-term. Hence continued on-going reinforcement of the strong resonating Vitamin D message would be beneficial.</li> <li>Opportunity to bring this out in consumer communications to amplify the HCP communication further.</li> </ul>

# Findings summarised & recommendations

SLIDE	FINDINGS	RECOMMENDATIONS
<p><b>Part 2: Health benefits and nutritional properties</b> Slide 23</p>	<ul style="list-style-type: none"> <li>• Across the board there was an increase of knowledge of all health benefits listed.</li> <li>• Vitamin D saw another massive increase with 76.5% of respondents selecting it.</li> <li>• Only 5.4% could not select a health benefit. This is less than in 2020, showing knowledge has improved YOY.</li> </ul>	<ul style="list-style-type: none"> <li>• Depending on key focus, either continue with the reinforced repetition of vitamin D or pivot to another benefit to increase awareness of it.</li> <li>• There is opportunity to further build on increasing awareness around immune benefits and associated bioactives of mushrooms which also provides a point of difference and is a key health trend.</li> </ul>
<p><b>Part 3: How valuable are mushrooms to HCPs?</b> Slide 24/25</p>	<ul style="list-style-type: none"> <li>• Highlighting the unique properties of mushrooms and their specific benefits and properties continues to pay off. The campaign's focus on the value of mushrooms is strong within respondents.</li> <li>• As with 2020, 2021 saw an increase by over 9% to them being very important.</li> <li>• The unique properties of mushrooms continues to be recognised with 93% of respondents viewing them as unique and the number viewing mushrooms as more valuable than vegetables has nearly doubled to around 1/4 since baseline.</li> </ul>	<ul style="list-style-type: none"> <li>• Continue to build on the unique benefits of mushrooms and pull apart from vegetables. This will likely be helpful to support conversion of those considering to agreeing mushrooms should be given greater focus within dietary guidelines (see later on slide 37)</li> </ul>

# Findings summarised & recommendations

SLIDE	FINDINGS	RECOMMENDATIONS
<b>Part 4: Knowledge of vitamin D properties</b> Slide 26	<ul style="list-style-type: none"> <li>Nearly three quarters of all respondents (74%) knew that 100g of UV-exposed mushrooms had the highest vitamin D.</li> <li>An increase of almost 25 points in knowledge that placing mushrooms in the sun increased vitamin D content.</li> </ul>	<ul style="list-style-type: none"> <li>The vitamin D message continues to be strong within the resources.</li> <li>Continue to maintain and build on this unique positioning of Vitamin D to further consolidate and build a unique story for mushrooms to set it apart from vegetables..</li> <li>With key top tier HCP being targeted, option to expand awareness with fitness professionals to help further drive ultimate consumer reach</li> </ul>
<b>Part 5: What are the resources like?</b> Slide 27	<ul style="list-style-type: none"> <li>A 13+ point uptick in respondents knowledge and use of resources showing that consistent and varied assets have been effective.</li> </ul>	<ul style="list-style-type: none"> <li>Resources served through social media channels seem to perform well, therefore continue to utilise this channel further to continue to drive reach of both materials and the resource hub</li> </ul>
<b>Part 6: Personal consumption habits and rationale</b> Slide 28	<ul style="list-style-type: none"> <li>HCPs who were personally consuming mushrooms increased after taking a slight dip in 2020. More than 12 points up in 2021 were consuming at least one a week.</li> <li>For those who didn't consumer mushrooms the key reasons with more than half the votes of those who don't consumer was that they forget to buy them.</li> </ul>	<ul style="list-style-type: none"> <li>Those who are not consuming mushrooms are not doing so consciously, they are simply forgetting when it comes to making purchase decision.</li> <li>Developing a simple dosage message for mushrooms may be a helpful strategy long term to help drive top of mind awareness message (i.e like one of your five day was for fruit and veg)</li> </ul>



# Findings summarised & recommendations

SLIDE	FINDINGS	RECOMMENDATIONS
<p><b>Part 7: Mushroom recommendations to clients and rationale</b> Slide 29/30</p>	<ul style="list-style-type: none"> <li>• There has been a significant shift in HCPs recommending mushrooms to their clients, with a 27+ point increase from 2020 in those recommending 'Always' or 'Often'.</li> <li>• The top reason those who didn't recommend them is that they're not thinking about mushrooms specifically.</li> <li>• Within those who do recommend all rationale options either increased YOY or were new to 2021's survey.</li> </ul>	<ul style="list-style-type: none"> <li>• Whilst across the board the results show a positive increase in mushroom recommendations, we are still losing some HCPs at the conversion stage. This means work continues to be needed in providing easy consumer materials for HCPs to pass on to their clients.</li> <li>• Feedback here, and in the open question, highlights the need for something simple to retain information. Further work could be to define a simple dosage amount for mushroom consumption, and keep communicating that simple message for both HCPs and consumers.</li> </ul>
<p><b>Part 8: Perspective of mushrooms within dietary guidelines</b> Slide 31</p>	<ul style="list-style-type: none"> <li>• A new question for 2021, more than half the respondents felt that mushrooms should be given more consideration when it comes to dietary guidelines.</li> <li>• A further 40% said that maybe they should and would need to consider it further.</li> <li>• Only 3% did not agree that mushrooms should be considered, showing limited resistance in the community to the benefits.</li> </ul>	<ul style="list-style-type: none"> <li>• The community seems to be behind supporting mushroom inclusion in dietary guidelines, however some further work could be done to convince those in the 'maybe' category.</li> <li>• Getting HCPs to see mushrooms as unique and valuable compared to vegetables will be a key part of converting the 'maybes' to 'yesses'</li> <li>• Wider consideration to the 3% who do not agree and understand why this is the case to help better shape future work.</li> </ul>

# Sentiment results against objectives



**Knowledge** of the nutritional properties and health benefits of mushrooms.

Confidence in knowledge of health benefits and nutritional properties both saw **double digit increases**  
**Health Benefits: +32.2**  
**Nutritional properties: +27.6**



**Perception** of mushrooms for health.

Respondents perception that mushrooms are very important **increased +19.1 to 53% (33.9% in 2019)**



**Value** placed on mushrooms for their properties.

Mushrooms still viewed as **more of or equal** value to vegetables for the third consecutive year  
**96.4% (90.6% in 2019)**



**Behaviour** around recommending mushrooms.

Recommendations of mushrooms to clients **increased** with +33.5 uplift to 72.3% **(38.8% at baseline)**



**Frequency** of recommendation or behaviour.

Always or often recommending mushrooms to their clients **increased to 48.8% (20.5% in 2019)**

# Learnings & Opportunities



# Strategy & Planning: What worked well

## **SOCIAL TARGETING**

Increased investment and tighter audience targeting with the social campaign meant that the quality of respondents was better than previous years.

## **CAMPAIGN PHASING**

The survey came right after several key milestones had been delivered, resulting in information being front of mind for participants.

## **TAILORED EDMS**

Once again the now recognisable designs were clear and direct, whilst also providing additional information. They had a high open rate.

# Strategy & Planning: Even better if we...

## IN MARKET FLEXIBILITY

The reduced number of respondents compared to previous years can be put down to external variables. Being able to shift the survey out by months could have negated this.

## INCENTIVISED SHARING

Respondent numbers may be increased by activating our existing database to engage their own network of relevant parties through incentives (i.e. money or prizes).

## REDUCED QUESTIONS FURTHER

Though there were less questions than 2020, survey response time was up on average by 3 seconds. Reducing questions further will increase engagement.

# Research Questions: What worked well

## SENTIMENT INCREASE

2021 saw another strong significant sentiment increase from 2019. This time the results were even stronger and a larger jump than in 2020.

## EDMs

Last year more respondents came from social, but this year it was EDMs. This shows that the assets have increased pertinence with the audience.

## QUALIFYING QUESTIONS

Having these questions allowed us to easily remove irrelevant responses, although it did reduce response numbers.

# Research Questions: Even better if we...

## UP THE PRIZE AMOUNT

Given the external variables, having an even more appealing prize could inspire more responses.

## SIMPLIFY SOME LANGUAGE

Completion time could also be reduced by simplifying the wording of some of the questions.

## REDUCE LEADING QUESTIONS

Some of the questions are very obvious in what they're asking of the respondents, removing prompts would allow for deeper knowledge.

# Takeaways:

## TAKEAWAY

**HCPs KNOWLEDGE  
OF MUSHROOMS  
BENEFITS  
INCREASED**

## FINDING

Across the board there was significant increase in knowledge of nutritional value and health benefits of mushrooms within the HCP community. More work can be done on both widening the communities engaged (i.e. fitness) and putting mushrooms front of mind further

**HCPs NOW MORE  
LIKELY TO  
RECOMMEND  
MUSHROOMS TO  
CLIENTS**

Since the campaign started, HCPs are now more likely than ever to recommend mushrooms to their clients. This can be continually built upon (i.e. with dosage messaging) to further increase consumption

**EXPLORING DIETARY  
GUIDELINES**

There is a significant appetite within the HCP community to see mushrooms given greater recognition in dietary guidance. This is something that could be explored further.



# Limitations:

## Key limitations to consider when interpreting the data:

- The data from year 1, 2 and 3 of the survey are cross-sectional, not longitudinal, with some participants differing from year to year.
- As a result, the tracked sentiment changes over time could be a result of a different set of people being surveyed, rather than a change in the knowledge base of the same group of people.
- In addition, some new survey questions were added or wordings updated from 2019 to 2020 to 2021, in order to improve the readability or breadth of possible responses.
- Responses could have been influenced by the survey topic, preceding questions, and overall heavy mushrooms messaging. For example, in question 9, 91.6% said that UV-exposed mushrooms were the highest source of vitamin D, which has been a hero topic in communications.

# Key Performance Indicator Results



# KPIs

ITEM Year on Year	2020 SURVEY	KPI 2021 SURVEY			2021 RESULTS	PERFORMANCE
		MEETING	EXCEEDING	SMASHING		
Survey Respondents	195	300	400	500	166	NOT MEETING
Database Growth YoY	1,405	1500	1700	2000	1,925	EXCEEDING
<b>SURVEY KPIs</b>						
Q1. Can specify health benefits of mushrooms	40%	25%	28%	32%	57.2%	SMASHING
Q2. Can specify nutritional benefits of mushrooms	35.9%	23%	28%	32%	50.6%	SMASHING
Q3. Knowledge of Vitamin D as a nutritional property increases	66.1%	60%	65%	70%	74.1%	SMASHING
Q5. Importance of mushrooms - Very Important	43.1%	40%	44%	48%	53%	SMASHING
Q6. Using resources and place value on them (now Q10)	28.2%	28%	30%	34%	41.6%	SMASHING

# Setting campaign goals

SURVEY KPIs	BENCHMARK SURVEY	KPI 2021 SURVEY			2021 RESULTS	PERFORMANCE
		MEETING	EXCEEDING	SMASHING		
Q7 (now Q.11). <b>Increase</b> in 'Once per week' personal mushroom consumption	<b>40%</b>	46%	50%	55%	<b>83.2%</b>	SMASHING
Q9 (now Q.12). <b>Decrease</b> in 'not recommending mushrooms'	<b>18%</b>	14%	12%	10%	<b>6%</b>	SMASHING
Q10 (now Q.12a). <b>Decrease</b> in 'I don't think about mushrooms'	<b>50%</b>	45%	43%	40%	<b>62.3%</b>	NOT MEETING
Q11 (now Q.12b). <b>Increase</b> in recommending 'mushrooms for their nutritional properties'	<b>65%</b>	70%	75%	80%	<b>88.9%</b>	SMASHING
Q12. <b>Increase</b> in respondents who have visited the Australia Mushrooms website	<b>26%</b>	32%	34%	36%	<b>N/A</b>	N/A

# Next Steps



# What's next?

- HORT Innovation to review and provide feedback or any additional requests.
- HORT Innovation to consider learnings for future projects outside of mushrooms activity.

# Thank You



# Appendix





# Appendix: Commentary from survey question 14

RESPONSES BELOW AS RECEIVED FROM RESPONDENTS - SEE PAGE 32 FOR OVERVIEW.

“Question: Please provide any additional thoughts you have on the information that we are providing on mushrooms”

- Would love to know more
- very versatile - breakfast, lunch and dinner and all different kinds of cuisines e.g. asian, european
- I recommend mushrooms as part of of cooking mixed meals to clients when they want / need meal ideas, but often when I describe the veggies I use as part of meals, I hear 'I don't like mushrooms!'; so I think more work needs to be done to make mushrooms cool and for people to give them a go. I actually really like mushrooms personally.
- I'm aware of the benefits of mushrooms, but often forget to recommend them, they're not top of mind; it would be great to see a campaign like 2&5; or 30g nuts for mushrooms.
- Appreciate the evidence and practical info from NRA and Aus Mushrooms
- I think it's important to highlight the fact that we can increase the vitamin D content of mushrooms at home
- You're doing a great job! Just need more exposure so both health professionals & consumers access your materials.
- more recipes to encourage intake esp with non button mushroom types
- Very informative, well presented & easy to comprehend.
- informing people that mushroom needs to be cooked not eaten raw
- The information about vitamin D is important esp for those following a plant-based diet
- i do enjoy them and agree they increase satiety and provide benefits. To be honest, i don't think of them separately and perhaps i need to start to consider
- I think it is key to distinguish them as diff from plant / animal.

# Appendix: Commentary from survey question 14

## (CONTINUED:)

- It's been great
- Need more and it needs to be more available to health care professionals
- Really find the information/white paper etc very useful and informative. Great that research questions are being asked
- Health professionals are generally well informed but the public needs further education especially in the current obesity crisis which is associated with increased inflammation and puts a population at an elevated risk for illnesses like Covid19.
- Visual resources and recipes for patients would be helpful
- Factsheets with recipes would be useful for patient information
- It could be helpful for instructions for people at the supermarket on sunning mushrooms for Vitamin D
- The Vitamin D info is helpful :)
- I received your excellent resource via LinkedIn on tanning - very insightful and also a very well presented resource - thank you!
- I am very keen on the Vitamin D status for bone health especially with my over 50's women and over 70's men that need higher vitamin D and calcium intakes and the Beta glucans content to help lower cholesterol
- perhaps easier meat free alternatives rather than adding to meat dishes?
- It's great
- Resources and information have been useful particularly given timely themes around immunity and Vit D deficiency over the last few years in lockdown. Although repetitive, it helps drive key messaging.
- It's anti-oxidant and cholesterol free

# Appendix: Commentary from survey question 14

## (CONTINUED:)

- It's great to have organisations leading the cause!
- The variety of mushrooms needs more attention and if they have different properties.
- I see mushrooms for most people to sit in the vegetable section- no need to confuse people otherwise too much
- many people don't like the flavour mushrooms, this barrier should be addressed
- Useful information
- Any ideas on improving intake would be helpful eg I recommend people grate them (when fresh and at their crispest) into other dishes. Recipes are good but other tips?
- I have not seen any resources provided by you all
- I don't know if you have a picture of available mushrooms in Australia markets with the nutrients contain that can help clients to learn more about different mushrooms and simple recipes on how to use them. Some of the newer mushrooms like lion mane is unknown to a lot of people and an understanding of the nutritional values will be helpful
- I am not sure where to get this information you are providing on mushrooms
- Great source of many dietary nutrients and taste great raw or cooked
- Mushrooms offer multiple health benefits to people are easy to cook and many varieties are available
- The information needs to be more precise and succinct for easy digestion.
- good but do not have much information.
- Knowledge of different types of mushrooms is needed. Different recipes also. The price of mushrooms needs to be considered
- I would love more resources, especially client handouts

# Appendix: Commentary from survey question 14

## (CONTINUED:)

- Further research into treating cancers
- focus more on immune support and nervous system support
- I have had access to great information from NRAUS through their recent webinar and resources via EDMs and website. very useful resources that should be shared across as many platforms as possible.
- it's great thanks. Would be great to get a summaries both for patient hands and practitioner reference
- I need to relisten to the latest webinar to absorb the information given. I think I may have sent a post seminar request for some recipes or where can be found. Would be a good motivator both to me and potential clients.I am in Melbourne and still in 6th lockdown. Thanks for seminars, are they on a website to relisten please?
- Consume daily!
- Huge and delicious edition to my tool kit
- Recipes are useful
- According to Dr. Kristi Funk woman should eat at least one mushroom per day to help reduce breast cancer risk
- Will Chinese mushrooms have same health benefit?
- The quiz has opened my eyes to place greater value on mushrooms
- More information for starting young children on mushrooms eg amounts, recipes.
- very useful and exciting information
- I have learned a lot about the unique benefits of mushrooms through the resources and information you provide. The information about vitamin d and mushrooms is especially helpful - thank you.

# Appendix: Commentary from survey question 14

## (CONTINUED:)

- I usually would not focus on recommending a specific type of food, but rather emphasising the benefits of having a varied diet and enjoy as many different types of vegetables as possible.
- Mushroom is an essential fungi with many health benefits. It's one of the most bio compound that you can enjoy freely for it's low in calories and full of minerals and more importantly vitamin D, especially when exposed to the sun.
- Mushroom is one of the main ingredients used in meat analogue manufacturing recently because of its great nutritional value and its meat-like taste
- My business is very small, however I greatly value the information you provide. Mushrooms are a terribly under-utilised and under valued food that will only become more important as food insecurity becomes a wider global issue, and the more information health professionals and the public have access to the better.
- more education to introduce the nutritional significance of mushrooms for human health is needed.
- The effect of UV exposure on the vitamin D content of mushrooms should be more widely known. More research on omega 3 and vitamin B12 content would also be helpful for the significant number of people adopting vegan diets
- Mushrooms are delicious
- Very succinct and useful information
- Can mushrooms cause allergy to some people?
- I don't really know much about mushrooms. More information for health professionals about the impact on mental illness would be appreciated.
- Very good

# Appendix: Commentary from survey question 14

## (CONTINUED:)

- I think repeating the message would help - advertise widely. I was not aware that you could increase vit D content
- It's very timely as anti inflammatory foods are becoming more recognised as being an important part of everyone's diet
- Mushrooms are great way to introduce less meat meals for children. They are easy for children to slice with a child friendly knife or be torn to pieces for a wild mushroom risotto.
- well thought
- delicious and healthy mushroom dishes easy to prepare
- Can't think of anything atm
- Super, super food
- Mushrooms indeed are valuable if only their accessibility (affordability) can somehow be addressed.
- I love what you guys are doing!
- This has reawakened me to the value of mushrooms.
- Try and get the contents of that webinar out to the general public - place it on YouTube - it was sensational
- Need information on scientific studies and evidence based research re: mushrooms

## **APPENDIX 5: MS108 SYSTEMATIC LITERATURE REVIEW SCOPE REPORT**



**Nutrition Research  
Australia**

## **The effect of edible mushrooms on health**

A scope for a systematic literature review

Prepared for Hort Innovation

March 2019

**Prepared by Nutrition Research Australia**





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## Executive Summary

### SLR Recommendations

Pursue a SLR on edible mushrooms and health outcomes on one of the following research areas, to be guided by Hort Innovation:

1. The effect of *Agaricus Bisporus* on all health outcomes, including all types of studies (human research studies, pre-clinical studies, and in vitro/cell line studies).
2. The effect of the top five most consumed edible mushrooms on all human health outcomes, including prospective cohort and intervention studies (**NRA preferred option**).

Hort Innovation commissioned Nutrition Research Australia to conduct a systematic literature review (SLR) on the health effects of edible mushrooms.

To identify the best approach and the most up-to-date literature, a scientific database was searched for studies on edible mushrooms (including extract) and health outcomes. PROSPERO (a register of ongoing systematic literature reviews), and clinical trial registry databases were both searched to identify ongoing studies. We identified gaps in the existing systematic review literature to generate options for the commissioned SLR, evaluating the pros and cons of each option.

### Existing systematic literature reviews

No existing SLR was identified which examined effect of edible mushrooms on a broad range of health outcomes in humans. There were three SLRs identified which assessed the effect of edible mushrooms on specific health outcomes in humans: cancer, cardiovascular risk factors, and vitamin D status. Additionally, one SLR was found which examined the effect of edible mushrooms in animal studies. There were two unpublished ongoing SLRs registered on PROSPERO which also examine specific health outcomes: colorectal cancer and vitamin D status. No review was identified which examined the nutritional composition and bioactive components of mushrooms.

There were over 300 narrative reviews (i.e. discussion papers which do not use rigorous scientific methods to evaluate the literature) on mushrooms and health outcomes, most of which were published since 2013, which reveals there is substantial interest in this topic. The only health



## Nutrition Research Australia

outcome that there are sufficient studies available to complete a SLR is on vitamin D, but one SLR has been recently published (2016), and no new primary research studies have been published since that time. Based on this research, Hort Innovation may pursue a nutrient content or health claim for UV-irradiated mushrooms on vitamin D with Food Standards Australia New Zealand but this would require further research outside the scope of this project.

### **Agaricus bisporus only scope**

As *Agaricus bisporus* (which includes white button mushrooms, crimini, flat and portabello mushrooms) is the main mushroom grown and sold in Australia, a scoping search was done to determine whether there are sufficient human research studies to perform a SLR on the effect of only *Agaricus bisporus* on health outcomes. In the brief scope of the literature, eight human research studies were identified; two were on bioavailability of particular components in the mushroom, and the remainder were on a variety of health outcomes. It is unlikely there are enough original human research studies examining the health effects of *Agaricus bisporus* alone. Therefore, a SLR reviewing only *Agaricus bisporus* would need to be supported with pre-clinical and *in vitro* studies (i.e. animal studies) to generate enough data to draw conclusions.

### **Human studies among the top five edible mushrooms**

A basic scoping search was used to identify human research studies using the top five edible mushrooms: *Agaricus bisporus*, *Pleurotus ostrateus* (oyster mushroom), *Lentinus edodes* (shiitake mushroom), *Auricularia polytricha* (black fungus) and *Flammulina velutipes* (enoki mushroom). Together with *Agaricus bisporus*, 22 primary research articles were identified examining the effect of mushrooms on inflammation, cancer risk, satiety, gastro-intestinal health, skeletal muscle function, and vitamin D levels.

### **Summary of recommended options for the commissioned SLR**

The recommended SLR option would examine the effect of the top five edible mushrooms or *Agaricus bisporus* alone. There are sufficient original research studies in humans to examine the top five edible mushrooms, which will ensure relevance of the results in the communications messages. There are not sufficient original research studies in humans to examine the effect of only *Agaricus bisporus*, and therefore if the choice is to focus the SLR on *Agaricus bisporus* only, then all study types (i.e. non-human studies) would need to be included. This approach would ensure alignment of the communications messages to the most commonly consumed edible mushrooms available in Australia (i.e. *Agaricus bisporus*), but would limit the relevance and translatability of the evidence to the Australian public.



## Background

Nutrition Research Australia (NRA) was commissioned by Hort Innovation to conduct a systematic literature review (SLR) to summarise the health effects of edible mushrooms. This document provides a brief summary of the current evidence for the effect of edible mushrooms on human health, and proposes options for how the SLR may be conducted.

### Edible mushrooms

Although commonly consumed as a vegetable, mushrooms are both botanically and nutritionally unique. Botanically, mushrooms are members of the *Fungi* kingdom, offering a nutritional profile that is distinct to that offered by both plants and animals (1). Nutritionally, they are low in energy and rich in micronutrients (Table 1). Unlike plants, mushrooms lack chlorophyll and are therefore unable to generate energy through photosynthesis, instead obtaining sustenance from complex organic materials from dead or living tissues of plants or animals (1). 'Edible mushrooms' refers to fungi which bear fruiting structures large enough to be seen with the naked eye, which do not have a poisonous effect in humans, and are perceived to have a desirable taste and aroma (2). There are many edible mushrooms grown and sold globally (Table 2), however the most commonly consumed mushroom worldwide is the *Agaricus bisporus* (1), accounting for approximately 40% of all mushroom sales globally. Most mushrooms grown and consumed in Australia are the white button mushrooms (*Agaricus bisporus*), with a small number of exotic species grown and sold (3). This group of mushrooms includes the common white button, flat, crimini, and portabello mushrooms, which represent the single mushroom species at various parts of its life stage. Other commonly consumed mushrooms worldwide include *Lentinus edodes* (common name: shiitake mushroom), *Pleurotus Ostreatus* (common name: oyster mushroom), *Auricularia polytricha* (common name: black fungus mushroom), and *Flammulina velutipes* (common name: enoki mushroom). Together, these five species account for 85% of the global sales of edible mushrooms (4).

**Table 1.** Macro- and micronutrient composition of common edible mushrooms (4) according to Australian and US databases

	Agaricus Bisporus, fresh, raw (/100g) <sup>1</sup>	Shitake, raw (/100g) <sup>2</sup>	Oyster, raw (/100g) <sup>2</sup>	Fungi, Cloud ears, dried (/100g) <sup>2</sup>
Total energy (kJ)	86	141	138	1187
Available energy (kJ)	75			
Protein (g)	2.3	2.2	3.31	9.25
Fat (g)	0.4 g	0.49	0.41	0.73
Saturated Fat (g)	0.08		0.06	
Monounsaturated Fat (g)	0.01		0.03	
Polyunsaturated Fat (g)	0.22		0.12	
Omega-3 Polyunsaturated Fat (g)	0.00			
Omega-6 Polyunsaturated Fat (g)	0.22			
Carbohydrate, total (g)	2.7	6.79	6.09	73.01
Starch (g)	0.0			
Sugar (g)	0.0	2.38	1.11	
Mannitol (g)	1.3			
Dietary Fibre (g)	1.4	2.5	2.3	7.01
<b>Vitamins</b>				
Thiamin (B1) (mg)	0.06	0.015	0.125	0.015
Niacin (B3) (mg)	3.2			
Niacin Equivalents (mg)	3.82	3.877	5.0	6.267
Pantothenic Acid (B5) (mg)	1.2	1.5		
Biotin (B7) (µg)	8.5			
Folate (B9) (µg)	22	13	38	38
Ergocalciferol (µg)	2	0.4		
Vitamin D <sub>3</sub> equivalents (µg)	2.14	18 IU	29 IU	0 IU
*Ergocalciferol, Vit D enhanced (µg)	24			
*Vitamin D <sub>3</sub> equivalents, Vit D Enhanced (µg)	24.18			
<b>Minerals</b>				
Calcium (mg)	3	2		159



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Copper (mg)	0.37	0.142	
Iron (mg)	0.45	0.41	5.88
Magnesium (mg)	11	20	83
Phosphorus (mg)	110	112	184
Potassium (mg)	360	304	754
Sodium (mg)	9	9	35
Zinc (mg)	0.06	1.03	1.32

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<sup>1</sup>Data obtained from Food Standards Australia and New Zealand, Australian Food Composition Database (5)

<sup>2</sup>Data obtained from United States Department of Agriculture National Nutrient Database (6)

**Table 2.** Select commonly consumed edible mushroom species consumed globally (4).

Scientific Name	Common Names
<b>Agaricus bisporus</b>	<b>Common, button, flat, cultivated, champignon, crimini, portabello</b>
<b>Pleurotus ostreatus</b>	<b>Oyster, pleurotus, pleurote, abalone</b>
<b>Lentinus edodes</b>	<b>Shiitake, oak, oak brown, golden oak, Chinese black, black winter, oriental black, black forest, foret, danko, shiang ku</b>
<b>Auricularia polytricha</b>	<b>Black fungus, cloud ear, tree ear</b>
<b>Flammulina velutipes</b>	<b>Enoki , enok, enokitake, enokidake, golden needle, golden, snow puff, velvet foot, velvet stem, winter</b>
Tremella fuciformis	White fungus, snow fungus
Agaricus sylvaticus	Scaly wood, blushing wood, pinewood
Lyophyllum shimeji	Pioppini, beech, hon-shimenji
Pholliota nameko	Butterscotch, namerako
Pleurotus eryngii	King brown, king oyster, king trumpet, royal trumpet, erungii
Agrocybe aegerita	Chestnut, cinnamon cap , brick top
Lepista nuda	Blewitt, blewit, blu
Coriolus versicolour	Yun zhi, Turkey tail
Ganoderma lucidum	Lingzhi
Agaricus blazei	Almond , of the sun, of life, royal sun agaricus
Leucopaxillus giganteus	Giant leucopax
Inonotus obliquus	Chaga

The most commonly consumed edible mushrooms globally indicated by bold text.

### Edible mushrooms and health outcomes

Mushrooms have been revered throughout history for their medicinal and therapeutic benefits, and mushrooms or extracts from mushrooms play a prominent role in traditional medicines (7). These bioactive properties in mushrooms as well as their unique nutritional profile (Table 1) mean that edible mushrooms may offer additional health benefits compared to vegetables alone.

There are many narrative reviews, which suggest there are a range of health benefits of consuming mushrooms. These reviews claim mushrooms aid glycaemic control in diabetes (8, 9), weight management (9), hypertension, and reduce the risk of cardiovascular disease (10, 11). In addition, mushrooms are one of the few vegetarian sources of vitamin B12 (12), and after exposure to one hour of sunlight, one serve of mushrooms can produce up to 100% of the daily requirements for vitamin D (from the conversion of ergosterol to ergocalciferol) (13). The reviews also claim that mushrooms provide non-nutritive benefits, including polysaccharides which act as prebiotics (14), beta-glucans which aid in the management of hyperlipidaemia and blood glucose control (15), melatonin which can help regulate the sleep-wake cycle (16), and multiple bioactive nutrients which are thought to have anti-inflammatory (17) and anti-tumour (18) properties. The health benefits associated with mushrooms have been attributed to anti-microbial, immune-modulatory, anti-



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carcinogenic, and hypocholesterolemic effects, with some evidence that effects may also be mediated through the gastrointestinal microbiota (19). The latest narrative review that attempts to combine all health outcomes (Roupas 2012) examined the role of edible mushrooms in human health (20). The authors proposed that compounds from mushrooms, most notably polysaccharides (beta-glucans or protein-polysaccharide complexes) and/or bioactive proteins modulate host immune responses and are directly or indirectly associated with a myriad of health effects. Roupas et al reported potential benefits in cancer, immune function, diabetes, cognition, cardiovascular risk markers, asthma, hepatitis and constipation, with lower levels of evidence derived from pre-clinical and *in vitro* studies also supporting a role for mushrooms in rheumatoid arthritis, bone health, wound healing and eye health (20). Most of the reported health benefits in Roupas et al were derived from *in vitro* and *in vivo* animal studies, with only a few human intervention studies available at the time for inclusion (20).

Given the vast claims of mushrooms' health benefits and a lack of systematic evidence on edible mushrooms and health, Nutrition Research Australia was commissioned by Hort Innovation to conduct a systematic literature review on the health benefits of edible mushrooms. This research will be used to make evidence-based educational messages to healthcare professionals, and provide the best available evidence for the current mushrooms marketing campaign. The aim of this document is to scope and identify gaps in the literature to determine the best approach for the currently commissioned SLR.





## Methods

The literature was scoped across two main areas of research and no date restrictions were set for the searches:

1. What is the available evidence on the nutritional and bioactive components of edible mushrooms?
2. What is the available evidence on the health effects of edible mushrooms?

### Nutritional and bioactive components

Medline, Pubmed and Google Scholar were searched to identify systematic or narrative reviews related to the nutritional composition (macro-, micro-, and phytonutrients) and/or bioactive components of edible mushrooms.

Medline search terms included (Agaricales OR mushroom OR agaricus bisporus OR white button mushroom OR common mushroom OR champignon OR flat mushroom OR crimini OR Portobello OR agaricus) and (nutritional OR nutrient OR vitamin OR mineral OR polysaccharide OR bioactive OR nutraceutical OR functional food), and searches were limited to 'review'.

### Health Outcomes

Medline, Pubmed, and Google Scholar were searched for systematic reviews and primary human research studies relating to mushrooms (edible and medicinal) and health outcomes. As *Agaricus Bisporus* is the primary mushroom produced and sold by Australian Mushrooms, the funding for this research, the search strategy was specific to capture all studies with these mushrooms.

Medline search terms included (Agaricales OR mushroom OR agaricus bisporus OR white button mushroom OR common mushroom OR champignon OR flat mushroom OR crimini OR Portobello OR agaricus) AND (cancer or cardiovascular disease OR diabetes mellitus OR stroke OR hypertension OR obesity OR non-alcoholic fatty liver disease OR body weight OR waist circumference OR body composition OR cholesterol OR dislipidemia OR triglycerides OR glucose OR glucose intolerance OR insulin resistance OR insulin OR inflammation OR interleukins OR monocytes OR macrophages OR neutrophils OR microbiota OR gastrointestinal microbiome OR short chain fatty acids OR chronic kidney failure OR kidney OR glomerular filtration rate OR liver OR liver disease OR liver enzymes OR liver function).



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The search was then limited to “review” articles to identify articles relevant to this scoping review. Titles and abstracts of the review articles were searched for keywords to broadly categorise the reviews by health outcomes.

To identify any completed or ongoing systematic reviews, the PROSPERO database was searched using “mushroom”, “agaricale” and “fungi” as keywords. Clinical Trials.gov, the Australian and New Zealand Clinical Trials Registry, and the European Union Clinical Trials register were used to identify past or ongoing clinical human research trials.

Further scoping of Medline for the top five most common mushrooms among human research studies (randomised controlled trials or prospective cohort studies) was also conducted. The top five were chosen as they account for 85% of total global edible mushroom sales, and thus have a higher capacity for translation to Australia.

Medline search terms included (Agaricus bisporus OR Pleurotus ostreatus OR Lentinus edodes OR Auricularia polytricha OR Flammulina velutipes) AND (randomised controlled trial OR clinical trial OR cohort OR intervention), and results were limited to ‘human’. Intervention studies with the top five most common mushrooms (whole mushroom or extract) and measures of intermediate health markers (e.g. cholesterol, blood pressure, inflammatory markers etc), or cohort studies which measured dietary intake of mushrooms and health outcomes (e.g. diabetes, cancer, cardiovascular disease) were included.

## Results

### 1. Nutritional and bioactive components

#### Systematic Literature Reviews

There were no SLRs identified that incorporated the nutritional and bioactive profile of edible mushrooms.

#### Narrative Reviews

One narrative review published in 2013 reported on the chemical composition and nutritional components of wild-growing and cultivated edible mushrooms, including macronutrients, vitamins and provitamins, minerals, flavour and taste compounds, pigments, phenolic compounds, and other constituents (21). There are also several narrative reviews published between 2003 and 2017 that report on bioactive ingredients in mushrooms (22-26). These focus on either a single mushroom species: *Agaricus bisporus* (27), *Agaricus blazei* (22), *Hericium erinaceus* (23), *Letina edodes* (25), genus: *Agaricus* (26), or a single bioactive ingredient: fungal polysaccharides (24).

Although one narrative review included mushrooms of the *Agaricus* genus, it included only *Agaricus blazei*, *Agaricus sylvaticus*, and *Agaricus brasiliensis*. The review that focused on *Agaricus bisporus* (27) was older and published in 2003, whereas all other review articles were published more recently (between 2012 and 2017). The reviews on *Agaricus bisporus* (27) *Hericium erinaceus* (23) fungal polysaccharides (24) and *Agaricus* (26) focused primarily on the bioactive components and ingredients, with some support of bioactive roles in *in vivo* studies. The more recently published review article on *Agaricus blazei* (22) and *Lentinula edodes* (25) provided linkage between bioactive ingredients and outcomes in human research studies, providing a higher level of evidence for those particular mushrooms and greater translatability for those mushrooms.

A strong area of research interest and publications is the potential for mushrooms as a significant source of vitamin D. Two recent narrative reviews (published in 2016 and 2018) provide evidence that UV-irradiated mushrooms contain a significant amount of vitamin D (28, 29). One 100g serve of UV-irradiated mushrooms have the capacity to deliver 50-100% of daily vitamin D requirements (29).

## 2. Edible Mushrooms and Health Outcomes

### Systematic Reviews

No existing SLR was identified which examined effect of edible mushrooms on a broad range of health outcomes in humans. There were three SLRs identified which assessed the effect of edible mushrooms on specific health outcomes in humans: cancer, cardiovascular risk factors, and vitamin D status respectively. Additionally, one SLR was found which examined the effect of edible mushrooms in animal studies. There were two unpublished ongoing SLRs registered on PROSPERO which also examine specific health outcomes: colorectal cancer and vitamin D status. No systematic review was identified which examined the nutritional composition of mushrooms.

Two Cochrane Reviews have been published, assessing *Genoderma lucidum* (Lingzhi or reishi mushroom) as a powder or extract for the treatment of cardiovascular risk factors (2014) (30) and cancer treatment (2015) (31). The first review determined there was currently insufficient evidence to support the use of *Genoderma lucidum* for the treatment of cardiovascular risk factors in people with type 2 diabetes mellitus (30). The second review found that *Genoderma lucidum* has the potential to be used as an adjunct treatment to conventional cancer treatments, and may enhance tumour response and stimulate host immune responses; however, it noted that higher quality studies with longer term follow-up are required (31). Both Cochrane SLRs were limited by there being few high quality human intervention studies available that met the inclusion criteria (30, 31). One Cochrane review is registered on PROSPERO as ongoing, investigating *Coriolus versicolor* mushroom for colorectal cancer treatment.

One systematic review and meta-analysis of animal studies assessed the effect of *Sparrasis crispa* in rat, mice, and cancer cell lines (n=33 studies) and found beneficial effects on insulin resistance and glucose control in diabetic models, as well as antifungal, anti-inflammatory, and antioxidant activity. No human studies were included in the analysis (32).

One systematic review published in 2016 investigated the effects of UV-irradiated mushrooms on human serum vitamin D levels in interventions ranging from 3 – 6 weeks (33). This showed that irradiated mushrooms increased Vitamin D levels in people who had low levels of vitamin D at baseline (at the beginning of the study) due to an increase in vitamin D<sub>2</sub> (ergocalciferol). In participants with adequate vitamin D at baseline there was an increase in vitamin D<sub>2</sub> and concomitant decrease in serum vitamin D<sub>3</sub> (cholecalciferol), thus overall vitamin D levels were

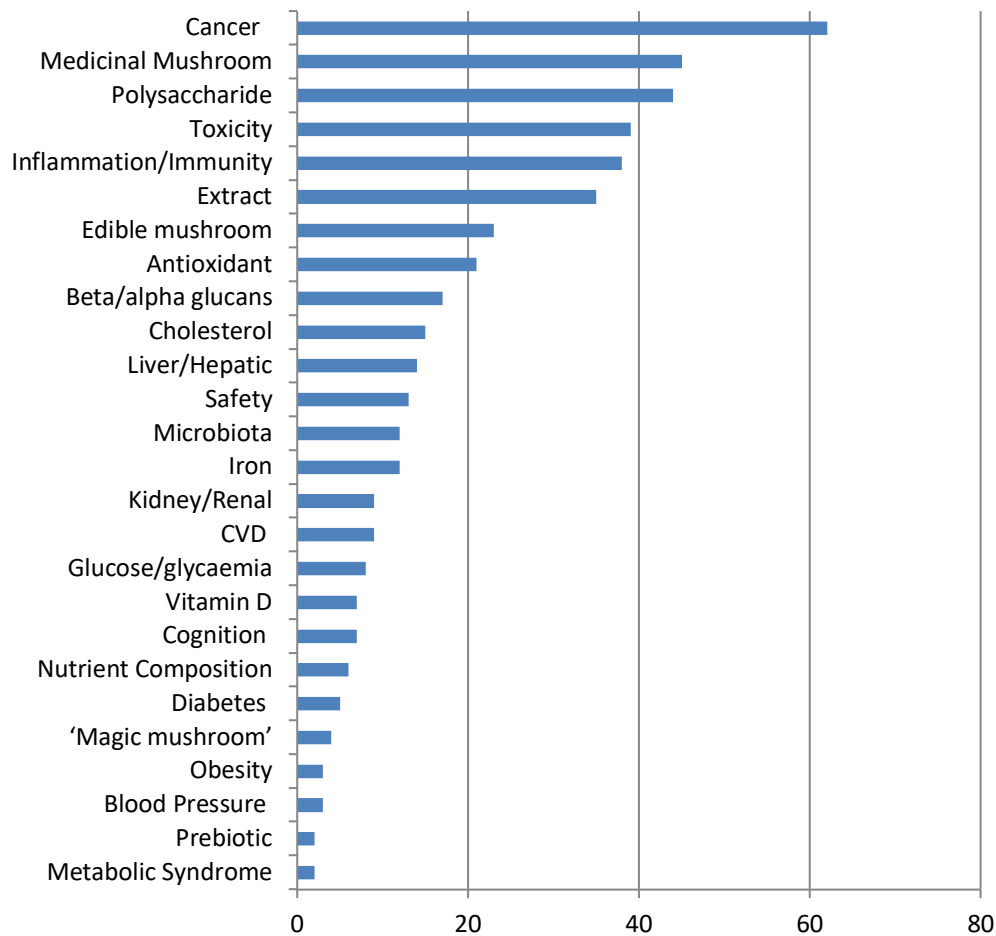


unaffected. A second systematic review on whether vitamin D<sub>2</sub> from irradiated mushrooms affects vitamin D status in humans is listed on PROSPERO as 'ongoing' (last updated February 2018).

### Narrative Reviews

There are a large number of narrative literature reviews available, which discuss the literature with no systematic or clear methodology applied. Narrative reviews are not considered to provide high level evidence of a health effect and have been scoped to determine the areas which have the most academic interest. The literature search identified 361 review articles published between 1968 and 2018, with the majority (53.2%) of these published from 2013 onwards. Few of these reviews (14 of 361, 3.9%) were published in high-ranking journals (define as the top 50 journals in Nutrition or Medicine), and many were noted to have poor use of the English language. Abstracts of the review articles were searched for keywords to broadly categorise the papers into subject areas. The majority of review articles have been published in the area of cancer (n=62) and inflammation/immune function (n=38 papers) (**Figure 1**). The majority of papers published in the area of cancer were focused on medicinal mushrooms (n=25) consumed via supplementation or polysaccharide extracts (e.g. beta-glucans) (n=26), therefore failing to address the impact of edible mushrooms on human health. Many of the reviews also focused on either medicinal mushrooms (e.g. *Ganoderma lucidum*, *Coriolus versicolor*) or mushrooms not commonly consumed within Australia (e.g. *Araricus blazei*).

## Number of review articles identified



**Figure 1.** Overview of included topics in review articles focused on mushrooms. Topics identified by searching for keywords in abstracts of papers. Individual papers may be included more than once if there were multiple relevant keywords identified.

Two narrative reviews focusing specifically on edible mushrooms and several human health outcomes were published in 2012 (20) and 2014 (34), and have been highlighted for this scope due to their relevance to this project. The first, a narrative review by Roupas et al, provided a detailed summary of associations between all types of edible mushrooms and any health outcome. The main focus of this review was human research studies, although animal and *in vivo* evidence was included to support mechanisms. The review outlined benefits or potential benefits of mushrooms in areas of cancer, immune function, diabetes, cognition, asthma, hepatitis and constipation. The searches and methodology followed in the review were not described and thus are not replicable, and it is unclear how studies were decided to be included or not included in the review, or if study quality assessment was performed.



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The review article by Feeny et al (1) provides a more general overview, including some health outcomes (oral health, disease risk, cognition, cancer, and obesity), but with additional information regarding nutritional composition and bioactive compounds, sensory properties of mushrooms and future research needs. Similar to Roupas et al the methodology was not specified, therefore is not replicable. Furthermore, both articles were published five or more years earlier, and thus an update of the literature is warranted.

Overall there was a broad range of topics included in the review articles, and a broad range of publication quality. The most commonly reviewed health outcome was cancer, of which the majority of research was conducted using medicinal mushrooms or polysaccharide extracts (e.g. beta-glucan).



## Gaps in the Literature

Based on our scoping search, we identified the following gaps in the existing published systematic review literature:

- No SLRs were identified which evaluated the effect of all *Agaricus bisporus* varieties on health related outcomes
- No SLRs were identified which evaluated the effect of the top five most commonly consumed mushrooms on health related outcomes
- No SLRs were identified which examined the nutritional and bioactive profile of edible mushrooms
- Existing SLRs examining mushrooms in humans are limited to the effect of a single mushroom species, which are not commonly consumed in Australia (e.g. *Genoderma lucidum*, *Sparrasis crispa*), and on a specific health outcome: cancer, cardiovascular risk factors, and vitamin D status
- Existing SLRs are limited by small numbers of high quality human intervention studies with short term follow-up
- Existing SLRs are limited by failing to include prospective observational cohort studies in humans, which examine the effect of mushrooms consumed as part of the normal diet, on long term health outcomes (i.e. prognosis evidence)
- The published SLR on vitamin D did not identify the UV exposure necessary for mushrooms to meet vitamin D requirements

Based on the gaps in the literature, two potential systematic literature reviews were further scoped to determine the feasibility of each review:

1. Focus on *Agaricus bisporus* only and health outcomes including all study types
2. Focus on the top five most consumed edible mushrooms and health outcomes including human prospective and intervention studies only





## Further Scope

### 1. *Agaricus Bisporus* only

- A scoping search was conducted in Medline keywords “agaricus bisporus OR white button mushroom OR common mushroom OR champignon OR flat mushroom OR crimini OR portobello”.
- Only eight intervention studies using *Agaricus bisporus* as either whole mushroom or its extract were identified (**Table 3**). Two of these studies assessed bioavailability of components in mushrooms (vitamin D and ergothioneine) (35, 36), and the remainder investigated health effects across a variety of conditions.
- The majority of studies are in healthy adults, thus would be broadly generalisable to the general public.
- There are insufficient human research studies to include only human studies using *Agaricus bisporus* in a SLR, therefore this option will need to be supported with *in vitro* and pre-clinical evidence. There are numerous animal and *in vitro* studies using *Agaricus bisporus* or components derived from *Agaricus bisporus*. A random sample of identified animal studies is summarised in **Table 4** to demonstrate the range of health outcomes studied.
- Due to a wide variety of health outcomes measured, there is no one area with enough information to be the sole focus of the review, therefore all health outcomes would need to be included.

**Table 3.** Human studies using *Agaricus bisporus* or extracts derived from *Agaricus bisporus*

Reference	Health effect/disease	Population	Study Design	Mushroom Product	Outcomes	Effect of mushrooms
Nutrients. 2018;10:1402 (37).	Gut health	Health Adults (n=32)	Randomised open-label cross-over trial	Mushrooms ( <i>A.bisporus</i> ) vs meat daily for 10 days	SCFA production Laxation Fecal microbiota Fecal pH	↑ stool weight ↑ bacteroidetes ↓ firmicutes
Appetite. 2017;117:179-85 (38)	Appetite and Satiety	Healthy Adults (n=32)	Randomised open-label cross-over trial	226g <i>Agaricus bisporus</i> vs 28g meat/day for 10 days	Hunger Fullness Ad libitum energy intake	↓ hunger ↑ fullness ↔ energy intake
Applied Nutritional Investigation. 2012;28(5):527-31 (34)	Mucosal immunity	Healthy Adults (n=24)	Parallel RCT	Normal diet + 100g blanched WBM/day vs control diet for 1 week	Salivary Immunoglobulin A (SIgA) secretion	↑ SIgA secretion at 1 and 2 weeks post intervention
European Journal of Clinical Nutrition. 2010;64:720-6 (39)	Immunity	Hypercholesterolemic adults (n=57)	Parallel RCT	Fruit juice enriched with α-glucans (5g) derived from <i>Agaricus bisporus</i> vs control juice for 5wks	IL-1β, TNF-α & IL-6 production <i>ex vivo</i> (LPS-stimulated in PBMC cells)	↓ TNF-α production ↔ IL-6 ↔ IL-1β
Plant Foods for Human Nutrition. 2016;71(3):245-51 (40)	Metabolic risk factors	Adults with metabolic syndrome (n=37)	Single-arm study	100g WBM consumed daily	Oxidative stress Antioxidant levels Glucose metabolism Insulin resistance	↑ ergothioneine ↑ adiponectin ↓ oxidative stress ↔ insulin resistance ↔ glucose metabolism
Journal of Sports Sciences. 32(7):670-9, 2014. (41)	Skeletal muscle function	High school athletes with low Vit D (n=34)	RCT	Portabello mushroom powder (600IU/day Vit D <sub>2</sub> or placebo for 6 weeks	Skeletal Muscle Function Exercise induced muscle damage	↑ serum 25(OH)D <sub>2</sub> ↓ serum 25(OH)D <sub>3</sub> ↔ muscle function



						↔ exercise-induced muscle damage
Journal of Nutrition 142(7): 1246-1252. (36)	Serum vitamin D	Healthy Adults (n=38)	RCT	Untreated mushrooms, untreated mushrooms + ergocalciferol supplement, UV-treated mushrooms, or control for 6 weeks	Serum vitamin D	UV treated mushrooms and ergocalciferol: ↑ serum 25(OH)D <sub>2</sub> ↓ serum 25(OH)D <sub>3</sub> ↔ vitamin D status
Preventive Medicine 54 Suppl: S75-78. (35)	Bioavailability of ergothioneine	Healthy Men (n=10)	Cross-over RCT	Test meal containing 8 or 16g mushroom powder ( <i>Agaricus bisporus</i> )	Red blood cell (RBC) ergothioneine  Postprandial lipemia	↑ RBC ergothioneine  ↓ postprandial triglycerides

WBM: White button mushroom. RCT: Randomised controlled trial.

**Table 4.** A selection of animal studies using *Agaricus bisporus* or extracts derived from *Agaricus bisporus*

Reference	Health effect/disease	Bioactive/extract	Animal model	Summary effect
Nutrients. 2018;10(11):1721 (42)	Gut health	3 or 6 serves freeze-dried WBM for 6 weeks	Pig	↓ LPS-induced IL1-β expression ↑ abundance of clostridiales taxa (microbiota)
Journal of Physiology & Biochemistry. 2018;74(4):635-46. (43)	Obesity/NAFLD	High fat diet + <i>Agaricus bisporus</i> supplementation (10% - Ab unclear whether this is energy or g)	C57BL/6J mice	↓ HFD-induced weight gain ↓ liver steatosis ↓ expression of CD36
Diabetes. 1975;24(8):705-14. (43)	Diabetes	Lectins derived from <i>Agaricus bisporus</i> & <i>Agaricus campestris</i>	Rat	Lectins in concentrations above 58µg/mL stimulates insulin & glucagon release in 2mM glucose from isolated pancreatic islet cells
International Journal of Medicinal Mushrooms. 2018;20(7):695-704. (44)	Immune	White button mushroom powder +/- lactobacillus casei for 60 days	Zebrafish	WM+LC ↑ growth-related genes ↑ antioxidant genes (SOD, CAT)
International Journal of Biological Macromolecules.2018; 118(Pt B):1488-1493. (45)	Liver	<i>Agaricus</i> Bus Polysachharide (FPS) ispor	Mice	↓ liver index ↓ liver enzymes ↑ glutathione & SOD capacity ↓ CCl <sub>4</sub> induced hepatic injury
International Journal of Medicinal Mushrooms. 2018;20(4):337-347. (46)	Mucosal immunity and growth	WBM Powder for 8 weeks	Trout	↔ growth
Journal of Experimental Therapeutics & Oncology. 12(3):231-237, 2018 May. (47)	Progression of carcinogenesis	<i>Agaricus bisporus</i> extracts	Mice	↓ progression of chemically induced carcinogenesis

WBM: White Button Mushroom, NAFLD: Non-alcoholic fatty liver disease, LPS: Lipopolysaccharide, SOD: Superoxide dismutase, CAT: Catalase, CCl<sub>4</sub>:

Carbon tetra-chloride.

## 2. Top five most consumed edible mushrooms and health outcomes in human studies

The literature scope for *Agaricus bisporus* demonstrated that there are insufficient human intervention studies specifically using *Agaricus bisporus* to warrant a systematic literature review. A second option would be to expand the scope to include primary human research studies using whole or extract of the top five most commonly consumed mushrooms (i.e. *Agaricus bisporus*, *Pleurotus ostreatus*, *Lentinus edodes*, *Auricularia polytricha*, and *Flammulina velutipes*). A similar search strategy to Option 1 was conducted in Medline with the scientific and common names of the mushrooms of interest used as keywords, the search was limited to 'humans' and review articles were excluded.

- This search identified an additional 14 published human research studies ([Table 5](#)), giving a total of n=22 human research studies (including *Agaricus bisporus*):
  - 2 case-control study
  - 1 cohort study study
  - 17 randomised controlled trials
  - 1 single arm intervention study
  - 1 phase I/II study
- The main mushrooms used in these studies were *Agaricus bisporus* (n=8), *Pleurotus ostreatus* (n=5), *Lentinula edodes* (n=7), or the mushroom type was unspecified.
- There are a limited number of cohort studies reporting on mushroom intake and health outcomes.
- The majority of studies are in healthy adults, and thus would be generalisable to the Australian public.
- The majority of identified studies used extracts, and a limited number used whole mushroom interventions.

**Table 5.** Human research studies on the top five most commonly consumed mushrooms\* (**excluding *Agaricus bisporus***) and health outcomes

Reference	Mushroom	Study Design	Whole mushroom/extract	Population	Duration/follow-up	Health Outcome
Bergendiova, K., et al. (2011) (48)	Pleurotus Ostreatus	Double-blind RCT	Extract (beta-glucans)	Athletes (n=50)	3 months	Immune responses Upper respiratory tract infections
Bobovcak, M., et al. (2010) (49)	Pleurotus Ostreatus	Double-blind RCT	Extract (beta-glucans)	Athletes (n=20)	2 months	Post-exercise immune response
Boels, D., et al. (2014) (50)	Lentinula edodes	Retrospective case study	Whole mushroom	French Adults	Jan 2000 – Dec 2013	Shiitake dermatitis
Choi, J.-Y., et al. (2014) (51)	Lentinula edodes	Double blind RCT	Rice bran fermented with Lentinula edodes	Healthy adults (n=80)	8 weeks	Inflammatory Markers
Gaullier, J.-M., et al. (2011) (52)	Lentinula edodes	Cross-over RCT	Extract (beta-glucans)	Elderly caucasian adults (n=42)	6 weeks	Inflammatory Markers
Gordon, M., et al. (1998) (53)	Lentinula edodes	Phase I/II trial	Extract (Lentinan [1,3-beta glucan])	HIV-positive adults (n=50)	8 weeks/12 weeks	
Jayasuriya, W. J. A. B. N., et al. (2015) (54)	Pleurotus Ostreatus/ Pleurotus cystidiosus	RCT	Freeze-dried powdered mushroom suspensions	Healthy adults/adults with type 2 diabetes (n=44)	Acute postprandial study	Postprandial glucose control
Jesenak, M., et al. (2014) (55)	Pleurotus Ostreatus	Double-blind RCT	Extract (Pleuran [s-glucan])	Children with recurrent respiratory infections (n=175)	6 months	Allergic inflammation
Jesenak, M., et al. (2013) (56)	Pleurotus Ostreatus	Double-blind RCT	Extract (Pleuran [s-glucan])	Children with recurrent respiratory infections (n=175)	6 months	Respiratory Symptoms
Lee, A. H., et al. (2013) (57)	Unspecified	Case-control	Mushroom intake measured by retrospective food frequency questionnaire	Women with (n=500) and without (n=500) epithelial ovarian cancer	N/A	Incident of cancer risk



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Lingstrom, P., et al. (2012) (58)	Lentinula edodes	Double-blind three-arm crossover RCT	Edible mushroom extract in a mouthwash solution		2 weeks (2 weeks washout)	Dental caries
Nöthlings, U., et al. (2008). (59)	Unspecified	Prospective cohort	Mushroom intake measured by food frequency questionnaire	Adults with diabetes (n=10,449)	Mean 9 years	All cause mortality
Signoretto, C., et al. (2011) (60)	Lentinula edodes	Double-blind three-arm crossover RCT	Edible mushroom extract in a mouthwash solution	Young adults (n=30)	11 days	Oral bacterial count Oral pathogens
Zembron-Lacny, A., et al. (2013) (61)	Lentinula edodes	Cross-over RCT	Shiitake extract	Healthy men (n=14)	10 days	Exercise-induced inflammation

\* *Agaricus bisporus*, *Pleurotus ostreatus*, *Lentinus edodes*, *Auricularia polytricha*, and *Flammulina velutipes*. RCT: Randomised controlled trial.

## Discussion

The aim of this literature scope is to identify and summarise the current evidence base for edible mushrooms and human health, to identify gaps in the literature and determine the best approach for the commissioned SLR.

No recent systematic literature reviews have been conducted describing the nutritional macro- and micro-nutrient profile or bioactive components of *Agaricus bisporus*, the most commonly consumed mushroom globally and in Australia. As the nutritional composition of mushrooms is not directly informative of health effects, this area was not further scoped beyond the review articles. However, if this is an area Hort Innovation is interested in, it could be incorporated into the SLR. In particular, inclusion of bioactive properties may help to communicate the health effects to health professionals and dietitians, to highlight biological plausible mechanisms for effects, and become a point of reference for other researchers on the latest evidence of their bioactive and nutritional composition. If not included in the SLR, aspects of these may instead be included in the 'Fun Facts' document, although it may not be a comprehensive summary of the evidence.

There are less than five systematic literature reviews published on mushrooms and specific health outcomes. The largest area of research to date among over 300 narrative reviews has been in the area of cancer and immunology, with a greater number of reviews reporting on medicinal mushrooms than edible mushrooms. There is a need for high quality reviews using systematic methods to elucidate the role of mushrooms in human health using the latest available evidence. Furthermore, research should be conducted using commonly consumed mushrooms that are readily available and have a strong history of culinary use.

There is strong interest in the vitamin D content of mushrooms as vitamin D deficiency and insufficiency becomes a greater health burden in Australia (62). The literature scope identified that there is a 2016 published systematic review (33), with no new research papers identified that would give new information beyond these reviews. As reported by Cardwell et al (29), one 100g serve of mushrooms exposed to UVB radiation can provide 50-100% of daily vitamin D requirements, therefore there may be sufficient evidence to pursue a nutrient or a general level health claim for mushrooms through Food Standards Australia and New Zealand. This would require further research and is out of scope of this project.





## Options for a systematic literature review

Based on the identified literature gaps and subsequent literature scope of primary research studies, we propose two feasible options for the current SLR which are proposed in detail in Table 6.

**Option 1:** The effect of *Agaricus bisporus* on all human health outcomes, including all types of studies (human research studies, pre-clinical studies, and in vitro/cell line studies).

This includes only *Agaricus Bisporus* on all health outcomes and all types of studies (human research studies, pre-clinical studies and in vitro/cell line studies).

**Option 2:** The effect of the top five most consumed edible mushrooms on all human health outcomes, including prospective cohort and intervention studies (**NRA preferred option**).

### Additional Considerations

- There are currently no SLRs reporting on the nutritional or bioactive components of the most commonly consumed mushrooms. This information could be included in the SLR as a secondary research question.
- There may be sufficient evidence to pursue a nutrient or general level health claim for vitamin D in UV-irradiated mushrooms, but would require further research beyond the scope of this project.
  - One 100g serve of mushrooms exposed to 60 minutes of sunlight can generate 50-100% of daily vitamin D requirements.
  - Recent 2016 SLR published in this area with no new primary studies identified since that publication.
- Future research could also focus on establishing a relationship between vitamin D from mushrooms and health outcomes (e.g. bone health).

The advantages and disadvantages of each option are outlined below.

**Table 6.** Recommendations for a systematic literature review on edible mushrooms and health outcomes

Population(s)	Study Design	Exposure/ Intervention	Comparator/s	Outcomes	Duration/ follow-up
<b>Option 1</b>					
Pre-clinical studies including animal models, <i>In vitro</i> and <i>ex vivo</i> studies using animal or human cell lines  Human adults (aged ≥ 18 years)	All study designs included	Edible mushrooms ( <i>Agaricus bisporus</i> ) or extracts derived from <i>Agaricus bisporus</i> mushrooms	All comparators will be included	<p>Health Outcomes</p> <ul style="list-style-type: none"> <li>• Cancer (all types)</li> <li>• Cardiovascular disease</li> <li>• Diabetes</li> </ul> <p>Intermediate health outcomes</p> <ul style="list-style-type: none"> <li>• Anthropometry (e.g. body weight, BMI, waist circumference)</li> <li>• Blood Pressure</li> <li>• Blood Lipids (e.g. cholesterol, LDL, HDL, TG, lipoproteins)</li> <li>• Glucose control (e.g. fasting glucose, insulin sensitivity)</li> <li>• Inflammation markers</li> <li>• Gut health (e.g. fecal stool weight, pH, microbial composition)</li> <li>• Liver &amp; Renal function</li> </ul>	Any duration or follow-up
<b>Option 2</b>					
Human adults (aged ≥ 18 years)	Prospective cohort  Randomized controlled trials  Non-randomised	Exposure measured as dietary intake (g/day or serves/day) of mushrooms*  Any interventions using the top	All comparators will be included	<p>Health Outcomes</p> <ul style="list-style-type: none"> <li>• Cancer (all types)</li> <li>• Cardiovascular disease</li> <li>• Diabetes</li> <li>• Gastrointestinal disease</li> <li>• Diseases of the bone</li> </ul> <p>Intermediate health outcomes</p> <ul style="list-style-type: none"> <li>• Anthropometry (e.g. body weight, BMI, waist circumference)</li> <li>• Blood Pressure</li> </ul>	Any duration or follow-up



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controlled trials  
Single arm intervention studies  
five edible mushrooms OR extracts derived from mushrooms\*

- Blood Lipids (e.g. cholesterol, LDL, HDL, TG, lipoproteins)
- Glucose control (e.g. fasting glucose, insulin sensitivity)
- Inflammation markers
- Gut health (e.g. fecal stool weight, pH, microbial composition)
- Liver & Renal function
- Immunity

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\* *Agaricus bisporus*, *Pleurotus ostreatus*, *Lentinus edodes*, *Auricularia polytricha*, and *Flammulina velutipes*

### Option 1: *Agaricus bisporus*, all study types

#### Advantages:

- All research outcomes will be applicable to *Agaricus bisporus*, being highly recognised by Australian consumers and the primary mushroom species produced by mushroom growers in Australia
- Inclusion of the pre-clinical and *in vitro* studies may offer guidance for future research and development

#### Disadvantages:

- There are limited human research studies available and they are across a broad range of health outcomes
- Communication on the *in vitro* and pre-clinical findings may not be directly translatable

### Option 2: Top 5 globally consumed edible mushrooms, only human studies

#### Advantages:

- Only human intervention studies included, which are highly translatable
- Majority of studies in healthy adults – applicable to the general population
- Randomised controlled trials allow for establishment of causal pathways, providing a higher level of scientific evidence
- The top five edible mushrooms the message will be highly applicable globally
- The top five mushrooms are highly recognisable and readily available to the Australian public

#### Disadvantages:

- Includes mushrooms other than *Agaricus Bisporus*, and findings will relate to all mushrooms species included, irrespective if they are widely consumed or available in Australia
- The health outcomes of one type of mushroom may not be applicable to other types of mushrooms



## **NRA Recommendation**

**Option 2:** A systematic review is undertaken that examines the effect of the top five most commonly consumed mushrooms on human health, including prospective cohort and intervention studies.

There is sufficient scope in the literature to support either option, therefore the option that best aligns with Hort Innovation's research and development objectives and communications plan should be selected. Based on the scientific appraisal of the evidence, NRA recommend the second approach, including prospective cohort studies, randomised controlled trials, and single-arm intervention studies in humans which use any of the top five consumed mushrooms and includes all human health outcomes. This will ensure findings are directly translatable to dietary recommendations for an Australian audience.

A systematic review of the nutritional and bioactive compounds of mushrooms could be included as a secondary research question within the systematic review.

## Questions for discussion with Hort Innovation

If the recommendations by NRA are accepted, we ask that Hort Innovation consider the following queries:

	Question	Rationale	Recommendation
1	Does Hort Innovation agree with the decision to limit the SLR to studies using the top five most commonly consumed mushrooms?	<p>We have limited the edible mushrooms to the top five most popular globally as these mushrooms are highly recognised by the Australian public. Many studies have been conducted on mushrooms not commonly consumed in Australia.</p> <p>Results of one mushroom species may not be directly translatable to different mushroom species, particularly those grown in different geographical conditions. The top 5 mushrooms account for ~85% of edible mushroom sales globally, thus would remain a) highly relevant to an Australian Audience and b) still relevant globally.</p>	Limit to top five most consumed edible mushrooms as listed in Option 2 and in Table 6
2	Is Hort Innovation interested in including the nutritional composition and bioactive compounds of mushrooms in the SLR?	<p><i>Pros:</i></p> <ul style="list-style-type: none"> <li>• May provide a point-of-difference for mushrooms from vegetable or animal foods</li> <li>• May improve interest amongst health professionals by proving a biologically plausible link between bioactive components and health outcomes</li> <li>• May increase citations of the paper</li> </ul> <p><i>Cons:</i></p> <ul style="list-style-type: none"> <li>• May not be strictly relevant to the health outcomes included in the review</li> <li>• Will take more time to complete, but within scope of the commissioned SLR</li> </ul>	To be guided by Hort Innovation
3	Do you have a preference for including whole mushrooms vs extracts in the SLR?	It is our understanding that Hort Innovation is primarily interested in the role of whole mushrooms in human health. Studies using whole mushrooms will be directly translatable to	If the bioactive components of mushrooms are to be included in the SLR, then including

	<p>the Australian public, but the small number of available studies may limit the scope of the review.</p> <p>Options would be to include:</p> <ul style="list-style-type: none"> <li>a) <b>Whole mushrooms only (fresh or dried)</b>  <i>Pros:</i> Direct translation to dietary recommendations  <i>Cons:</i> Many studies will be excluded</li> <li>b) <b>Whole and processed mushrooms (e.g. powdered mushroom, mushroom suspension)</b>  <i>Pros:</i> No changes to mushroom composition, therefore, findings may still be applicable to whole mushrooms  <i>Cons:</i> Some studies excluded</li> <li>c) <b>Include whole and processed mushrooms and mushroom extracts (e.g. beta-glucans derived from mushrooms)</b>  <i>Pros:</i> Greatest number of studies for inclusion            If bioactive compounds are included in the SLR then this could provide a plausible link between components and health outcomes  <i>Cons:</i> Extracts are often in much higher doses than can be obtained from whole mushrooms, limiting applicability of findings</li> </ul>	<p>extract studies would provide a logical link between mushrooms and health effects and should be included</p> <p>If the focus of the SLR is to remain only on human health outcomes without the secondary question of bioactive compounds, then only whole or processed mushrooms should be included</p>
<p>4 Does pre-clinical or <i>in vitro</i> evidence have any value for Hort Innovation in terms of future research and development?</p>	<p>If pre-clinical (i.e. animal studies) are of interest to the R&amp;D goals of Hort Innovation, they could be added to the inclusion criteria of the SLR and be reported separately. However, this would substantially add to the time required to complete and publish the SLR and would not be translatable to the Australian public.</p>	<p>Do not include in the current SLR.</p> <p>If of interest to the R&amp;D goals of Hort Innovation, a second SLR focusing specially on pre-clinical</p>



and in vitro evidence could be considered.

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## **APPENDIX 6: SYSTEMATIC LITERATURE REVIEW ADDITIONAL SCOPE**

## Background

Hort Innovation commissioned Nutrition Research Australia (NRA) to conduct a systematic literature review (SLR) on the health effects of edible mushrooms. As part of this process, a scope of the literature was undertaken to determine the best approach. Two options were provided to Hort Innovation in the scope report. Conduct a SLR on:

1. The effect of *Agaricus bisporus* on all health outcomes, including all types of studies (human research studies, pre-clinical studies, and in vitro/cell line studies).
2. The effect of the top five\* most consumed edible mushrooms on all human health outcomes, including prospective cohort and intervention studies (NRA preferred option).

\**Agaricus bisporus*, *Pleurotus ostrateus* (oyster mushroom), *Lentinus edodes* (shiitake mushroom), *Auricularia polytricha* (black fungus) and *Flammulina velutipes* (enoki mushroom).

Hort Innovation was concerned that option 2 would be dominated by studies that do not include *Agaricus bisporus*, and that the scientific communications would not apply to Australian Mushrooms, who is funding this project. Option 1 is the most relevant to Australian Mushrooms, but since most studies are not in humans, the scientific communications on the findings would need to reflect the level of evidence. Hort Innovation requested for a quote to do both SLRs, but publish only the relevant one (likely option 1).

The purpose of this document is to perform a further scope and determine the proportion of human research studies on *Agaricus bisporus* versus the other edible mushrooms in option 2 to have an idea if most of the science will be applicable to Australian Mushrooms (*A. bisporus*) or to the other mushrooms.

A quote with the additional cost to conduct both SLRs is included.

## Methods

First, we determined whether additional human research studies are likely to be available for *Agaricus bisporus* in other databases. SCOPUS, which is one of the largest scientific databases available, was searched using “agaricus bisporus” or “white button mushroom” as a keyword, in titles, or in abstracts. This was then limited to “human” “humans” “adult” “male” or “female”. This identified **297** potentially relevant articles. This was further narrowed by searching for keywords “rct” or “randomised” or “randomized” or “intervention” or “trial”, which identified **59** potentially relevant papers. Titles and abstracts were then screened to determine if there were additional human research studies. All identified papers from the previous scope and from this search were compared to determine how many human research studies were available for each of the top five mushrooms consumed worldwide.

## Results

Screening of titles and abstracts revealed the addition of only one paper using *Agaricus bisporus* as an intervention in a human research study that was not in our scope report. This study investigated changes to serum vitamin D levels with UV-B irradiated mushrooms; Appendix 1), and suggests that the Medline search strategy used in the initial scope is likely to be reflective of the proportion of human research studies available.

The top three mushrooms had roughly similar proportions of human studies: eight studies using *Agaricus bisporus*, five studies using oyster mushrooms, and seven studies using shiitake mushrooms. There were no human studies on enoki or black fungus mushrooms found. It is likely there will be a few more studies identified using a more thorough search strategy and screening method during the full systematic literature review. However, as only one additional study was located in Scopus that was not in Medline, it is likely that the proportion of studies using each mushroom will be similar to that identified in the original scoping search.

## Discussion

- If the purpose of the review is to provide evidence only on *Agaricus bisporus*, then option 1 would be the choice.
  - Preclinical and cell line studies will not be directly translatable to humans, but it will assist in supporting the human studies found, explaining mechanisms of action and in providing guidance for future research and development.
  - For example, you may be able to say “White button mushrooms are a great source of glucans, which might help lower cholesterol”. This can be supported from the nutrient content literature and animal studies, but the claim will be more tentative than if there were studies in humans to support it.
- If the purpose of the SLR is to provide evidence for “mushrooms” as a category, being unique and different to other foods and vegetables, then option 2 would be beneficial as evidence from human research studies is directly applicable, can be communicated on (pending findings across human studies are consistent) and as the main mushroom grown and sold in Australia, it would likely benefit the sales of *Agaricus bisporus* mushrooms. The scientific communications may or may not be specific to each type of mushrooms, and may be executed as a whole category (as it has been previously done). The extent of specificity of type of mushroom could depend on the extent and similarity of the evidence found for each.

## Quote

The additional cost to conduct both SLRs is **\$25,000**. This includes a combined search strategy to obtain human and non-human studies on the top five mushrooms consumed worldwide, screening and full text selection. This quote is dependent on the number of non-human studies found, but it should cover data extraction for all studies. We may choose to further select certain types of non-human studies (like animal only and excluding in vitro) if there are too many studies included for data extraction.



### Summary

It is unlikely that there are enough well designed RCTs with strong evidence for the effect of mushrooms (of any kind) on anything except bioavailability of vitamin D. There are no studies that show vitamin D has a clear 'health benefit' either. Further, it is difficult to demonstrate a clear health benefit without at least a few studies of decent sample size, methodology and comparable interventions/outcomes, so you can have confidence in the findings and your communications messages. For this reason, the communications will likely be nutrient focused and/or include animal studies to support the findings. With this in mind, we are in agreement that option 1 is the better option to be pursued.

## Appendix 1

The additional study on *Agaricus bisporus* mushrooms identified through the SCOPUS database search.

Urbain, P., Singler, F., Ihorst, G., Biesalski, H.-K., Bertz, H.

### **Bioavailability of vitamin D<sub>2</sub> from UV-B-irradiated button mushrooms in healthy adults deficient in serum 25-hydroxyvitamin D: A randomized controlled trial**

(2011) *European Journal of Clinical Nutrition*, 65 (8), pp. 965-971.

#### **Abstract**

**Background/Objectives:** Mushrooms contain very little or any vitamin D<sub>2</sub> but are abundant in ergosterol, which can be converted into vitamin D<sub>2</sub> by ultraviolet (UV) irradiation. Our objective was to investigate the bioavailability of vitamin D<sub>2</sub> from vitamin D<sub>2</sub>-enhanced mushrooms by UV-B in humans, and comparing it with a vitamin D<sub>2</sub> supplement.

**Subjects/Methods:** Fresh mushrooms were irradiated with an UV-B dose of 1.5 J/cm<sup>2</sup>, increasing vitamin D<sub>2</sub> content from <math>\leq 1</math> to 491  $\mu\text{g}/100\text{ g}$  and made to an experimental soup. In this 5-week, single-blinded, randomized, placebo-controlled trial, 26 young subjects with serum 25-hydroxyvitamin D (25OHD)  $\leq 50\text{ nmol/l}$  were randomly assigned into three groups ((a) mushroom, (b) supplement and (c) placebo). They received during winter (a) 28 000 IU (700 g) vitamin D<sub>2</sub> via the experimental soup, or (b) 28 000 IU vitamin D<sub>2</sub> via a supplement or (c) placebo, respectively. **Results:** After 2 weeks, serum 25OHD was significantly higher in the mushroom than in the placebo group ( $P=0.001$ ). The serum 25OHD concentrations in the mushroom and supplement groups rose significantly and similarly over the study period by 3.9 nmol/l (95% confidence interval (95% CI): 2.9, 4.8) and by 4.7 nmol/l per week (95% CI: 3.8, 5.7), respectively. **Conclusions:** We are the first to demonstrate in humans that the bioavailability of vitamin D<sub>2</sub> from vitamin D<sub>2</sub>-enhanced button mushrooms via UV-B irradiation was effective in improving vitamin D status and not different to a vitamin D<sub>2</sub> supplement. This trial was registered at <http://germanctr.de> as DRKS00000195. © 2011 Macmillan Publishers Limited All rights reserved.

## **APPENDIX 7: SYESTEMATIC LITERATURE REVIEW NEXT STEPS**



# *Agaricus bisporus* systematic literature review: next steps

Hort Innovation  
**September 2019**

Nutrition Research Australia Pty Ltd

## Summary

Over 500 studies were identified for the SLR. There are too many animal and cell studies to be included, but enough human studies were found (20) to warrant its own SLR.

Including key bioactives (flavonoids and glucans) in addition to human studies will provide extra key messages for the project and novel information for the SLR. The 500 papers database will be used to inform project communications.

We recommend a SLR on **the health effects of *Agaricus bisporus* mushrooms in humans** including its flavonoid and glucan properties.

## Background

Hort Innovation commissioned Nutrition Research Australia (NRAUS) to conduct a systematic literature review (SLR) on health and nutrition related outcomes of the mushroom *Agaricus bisporus* (white button mushrooms, crimini, flat and portabello mushrooms).

A literature scope was previously conducted to determine whether there are sufficient human research studies alone to perform a SLR on the health effects of *Agaricus bisporus*. In the brief scope of the literature, eight human research studies were identified; two were on bioavailability of particular components in the mushroom, and the remainder on a variety of health outcomes. The scope concluded that it is unlikely that there are enough original human research studies examining the health effects of *Agaricus bisporus* alone. Therefore, a SLR reviewing only *Agaricus bisporus* would need to be supported with pre-clinical (i.e. animal studies) and in vitro studies (i.e. cell studies) to generate enough data to draw conclusions.

Upon discussion with Hort Innovation, we agreed to pursue the option of conducting a SLR on the effect of *Agaricus bisporus* on all health and nutrient outcomes, including all types of studies (human research studies, pre-clinical and in vitro studies).

## Preliminary SLR results

Following a comprehensive literature search, **501 papers** were identified that met the predetermined inclusion criteria.

1. **5795** references were identified and imported for screening. Of these, 85 were duplicates and removed
2. **5710** studies were screened against title and abstract, and 4673 studies were excluded
3. **1037** studies assessed for full-text eligibility, and 536 studies were excluded
4. A total of **501** studies were included

The average number of papers in a SLR is about 20-30. As the ~500 papers are an unfeasible number of papers to include in a SLR, the inclusion criteria for this SLR will need to be further refined.

To facilitate the decision-making process for the inclusion criteria refinement, we have classified each of the 501 papers into categories and subcategories of interest. The **categories** (and subcategories) are: 92 **bioactives** (phenolics, flavonoids, glucans); 57 **macronutrients** (sugars, amino acids, fatty acids); 67 **micronutrients** (vitamin D, heavy metals); 20 **human studies** (inflammation, immunological, cholesterol, cancer, gastrointestinal, glycaemic/insulin, halitosis (body odour), satiety, vitamin D); 85 **animal studies** (agaritine, cytotoxic/antitumour/anticancer, angiogenesis, body composition, carcinogenesis, cholesterol, cognition, glycaemic/insulin, gastrointestinal, haematological, inflammation, immunological, skin healing, vitamin D); 105 **cell line** studies (antihypertensive, anti-bacterial, -fungal, -microbial, cytotoxic/anti-tumour/anticancer, cytogenic, carcinogenic, cholesterol, endocrinological, genoprotective, immunological, inflammation, gastrointestinal, melanogenesis, wound healing); and 30 **other studies** (agaritine, residues, microbes, indoles) Note that each study could be classified across multiple categories.

### Human studies:

- 20 studies reported on varying health outcomes including inflammation (4 papers), immunological function (6 papers), the effect of mushrooms on Vitamin D status (4 papers) blood lipids (3 papers), glycaemic control (2 papers), satiety (2 papers), and isolated studies on cancer, gastro-intestinal function, and halitosis/body odour
- Still to date, there are no published SLRs on the health effect *Agaricus bisporus* mushrooms in humans

### **Bioactive components:**

- 92 papers measured bioactive substances including 74 papers on phenolics
  - Flavonoids, a sub-category of phenols which have been established as beneficial to human health, were reported in 22 studies
- Seven papers measured glucans
- Some isolated papers reported other bioactive components including melatonin and indole compounds

### **Nutrient studies:**

- 57 papers reported on macronutrient content (i.e. fats, sugars, and/or carbohydrate content)
- 67 papers reported on micronutrient content
  - **Vitamin D:** 35 papers reported on the vitamin D content of mushrooms (i.e. ergosterol)
  - **Heavy metals:** 40 papers reported on heavy metal concentrations
    - These included papers which measured and reported heavy metal concentrations in cultivated and wild grown mushrooms, as well as mushrooms grown in metal-rich compost
- Although this information will provide some new and updated information, it is unlikely to have significant novelty value, as macro- and micronutrient profile of mushrooms are readily available in publicly accessible databases

### **Animal studies:**

- 85 studies that most commonly reported on inflammation (15 studies) and immunological function (15 studies)

### **Cell line/in vitro studies:**

- 105 studies that most commonly investigated outcomes related to anti-bacterial and anti-tumour/cytotoxicity/anticancer properties (20 studies for each), and immunology (18 studies)

The NRAUS team has assessed the possible options to deliver a systematic review that:

- ✓ is novel
- ✓ is relevant to the Australian population
- ✓ is translatable to humans
- ✓ adds value to the current area of mushroom research
- ✓ will provide the maximum number of key messages for communication and educational components of the project

#### Options not recommended:

Including all vitamin D studies in the SLR

- A large number of studies were identified (34 studies)
- There is already a recent systematic literature review assessing Vitamin D in human research studies, and a recent narrative review summarizing evidence of Vitamin D in mushrooms
- We will combine all vitamin D papers into one library and use them to inform the development of the upcoming communications content (webinar, GPCE) and potentially using it for a health claim for mushrooms

Including animal and cell studies

- There are too many studies to be included and these can be still be utilised to support the discussion of the outcomes of the human studies

## Recommendations

#### The SLR approach

- Focus of the SLR to be **human studies**
  - Best evidence to assess health effects
  - There are 20 studies in humans with varying health outcomes- more than was identified in the initial scope
  - Sufficient for a SLR.
  - Will provide a good overview of where more research should be directed
  - While there will be limited firm conclusions on each health outcome given the broad range of health outcomes reported, animal and cell line studies can be used to support



the findings from human research studies and provide mechanistic insights to inform future research and development.

- Include an 'add on' component of interest: **flavonoids and glucans**
  - These bioactive compounds can help support a health effect of mushrooms and may be able to distinguish them from either plants or animals as an independent food group
  - Relevant messaging for our communications.

### The *Agaricus bisporus* scientific database update

We now have a complete and up-to-date database of every study published on the *Agaricus bisporus* mushroom and health related outcome or nutritional/bioactive component. It will be used during this project to inform the SLR, for communications, for Flav's Fun Facts, and to inform future research. We have also ensured that it remains updated with every relevant paper published beyond the end date for the SLR and throughout the duration of the campaign by applying our NutritioniQ service to this database.

## NUTRITIONiQ

### ABOUT THE SCIENTIFIC UPDATE SERVICE

- ✓ Set up an automated research publication alert for the search strategy utilised
- ✓ We will collate papers across the databases that are relevant
- ✓ This service allows updates to the database to be streamlined and for any internal or external communications to be based on the latest science, while providing insights for R&D

### Next Steps

1. Review and discuss what has been done
2. Hort Innovation to confirm the recommended approach
3. NRAUS to update expected SLR completion timelines
4. Begin data extraction for the human studies concurrently with data extraction on the vitamin D studies to support webinar and GPCE communications

## **APPENDIX 8: MS110/111 SYSTEMATIC LITERATURE REVIEW & KEY POINTS**



# Examining the health effects and bioactive components in *Agaricus bisporus* mushrooms: A scoping literature review

Prepared for Hort Innovation  
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Nutrition Research Australia Pty Ltd.

**Journal:** The Journal of Nutritional Biochemistry

**Examining the health effects and bioactive components in *Agaricus bisporus* mushrooms: A scoping review**

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**Manuscript words:** 4994 (excluding references)

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**Prospero:** This study was prospectively registered (still awaiting processing).

**Disclaimer:** Horticulture Innovation provided topline suggestions on the proposed review methodology; but had no contribution to the draft analysis, interpretation of results or drafting of the manuscript.

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**Running heading:** Health effects of *Agaricus bisporus* mushrooms.

**Abbreviations:** 25(OH)D<sub>2</sub>, 25-Hydroxyvitamin D<sub>2</sub>, 25(OH)D, 25-Hydroxyvitamin D; BBM, brown button mushrooms; CE, catechin equivalents; CG, comparator group; CGEs, cyanidin-3-glucoside equivalents; d, days; f, female; GAE, gallic acid equivalents; g, grams; Hb, haemoglobin; HDL, high density lipoprotein cholesterol; HMW, high molecular weight; H<sub>2</sub>, hydrogen; IgA, immunoglobulin A; IgG, immunoglobulin G; IL, interleukin; IU, international units; IG, intervention group; kcal, kilocalorie; LDL, low density lipoprotein cholesterol; LMW, low molecular weight; MetS, metabolic syndrome; µg, micrograms; mg, milligrams; m, months; NA, not applicable; OR, odds ratio; ORAC, oxygen radical absorbance capacity; PCV, packed cell volume; iPTH, parathyroid hormone; PSA, prostate specific antigen; QE, quercetin equivalents; Qct, quercetin; RCT, randomised controlled trial; RBC, red blood cells; RE, rutin equivalents; sIgA, secretory immunoglobulin A; sCML, serum carboxymethyl-lysine; sMG, serum methylglyoxal; TNF, tumour necrosis factor; USA, United States of America; UV, ultraviolet; UVB, ultraviolet B; w, weeks; WBC, white blood cells; w/w, weight per weight; WBM, white button mushrooms; y, years.

**Keywords:** Systematic review, *Agaricus bisporus*, mushroom, health, human, bioactive

1 **Abstract**

2 There is evidence from both *in vitro* and animal models that the consumption of edible mushrooms  
3 has beneficial effects on health. It is unclear whether similar effects exist in humans and which  
4 bioactive compounds are present. This review synthesizes the evidence on the world's most  
5 commonly consumed mushroom, *Agaricus bisporus* to (i) examine its effect on human health  
6 outcomes; and (ii) determine the nutrient density of its bioactive compounds, which may explain  
7 their health effects. A systematic literature search was conducted on the consumption of *Agaricus*  
8 *bisporus*, without date and study design limits. Bioactive compounds included ergosterol,  
9 ergothioneine, flavonoids, glucans and chitin. Two authors independently identified studies for  
10 inclusion and assessed methodological quality. Beneficial effects of *Agaricus bisporus* on metabolic  
11 syndrome, immune function, gastrointestinal health and cancer, with the strongest evidence for the  
12 improvement in Vitamin D status in humans, were found. Ultraviolet B (UVB) exposed mushrooms  
13 may increase and maintain serum 25(OH)D levels to a similar degree as vitamin D supplements.  
14 *Agaricus bisporus* contain beta-glucans, ergosterol, ergothioneine, vitamin D and an antioxidant  
15 compound usually reported as flavonoids; with varying concentrations depending on the type of  
16 mushroom, cooking method and duration, and UVB exposure. Further research is required to fully  
17 elucidate the bioactive compounds in mushrooms using vigorous analytical methods and expand the  
18 immunological markers being tested. To enable findings to be adopted into clinical practice and  
19 public health initiatives, replication of existing studies in different population groups is required to  
20 confirm the impact of *Agaricus bisporus* on human health.

## 21 1. Introduction

22 Although commonly regarded and consumed as a vegetable, mushrooms are members of the *Fungi*  
23 kingdom and offer a unique nutritional profile. Biologically distinct to both plants and animals,  
24 mushrooms are rich in micronutrients that are normally found in vegetables, meats and grains [1].  
25 These include riboflavin, niacin, pantothenic acid, copper, phosphorus, selenium, fibre-associated  
26 monosaccharides and polysaccharides, and the sulphur-containing amino acid ergothioneine [1, 2].  
27 Mushrooms are one of the only natural vegetarian sources of both vitamin B<sub>12</sub>, which is bacteria-  
28 derived [3], and vitamin D, which is produced by the conversion of ergosterol to ergocalciferol after  
29 exposure to ultraviolet (UV) light [4].

30

31 There is a growing body of evidence that suggests consuming several mushroom species, either as a  
32 food or as extracts, may improve physical and mental health [5, 6]. Mushrooms are rich in bioactive  
33 compounds, particularly ergothioneine, ergosterol, vitamin D, beta-glucan and selenium, and these  
34 bioactive compounds have been favourably linked to immune function [7, 8], glycaemic control [9,  
35 10], weight management [11], lipid profile [12, 13], blood pressure [14], bone density [15], gut  
36 health [16], cancer [17, 18] and cognitive function [19]. These health benefits are thought to be  
37 largely a result of the enhancement of cellular immunity to produce immunomodulatory, anti-  
38 carcinogenic, anti-microbial and hypocholesterolemic effects [5], and due to their effects on the  
39 gastrointestinal microbiota (19).

40

41 Despite the growing body of evidence linking mushrooms' nutritional uniqueness to beneficial health  
42 effects, existing narrative reviews have found limited evidence in human studies. In 2012, Roupas et  
43 al. [5] concluded that while mushrooms of many different species demonstrated numerous health  
44 benefits within *in vitro* and *in vivo* animal models, there was insufficient evidence to confirm similar  
45 effects in humans due to limitations in study design, sample size and the indirectness of the  
46 evidence [5]. Other narrative reviews investigating the role of beta-glucans in mushrooms [20] and

47 immunomodulatory activities of mushroom polysaccharides [21] have also found limited research in  
48 humans. Since these narrative reviews were published, interest into the therapeutic properties of  
49 edible mushrooms in human models has grown. Therefore, a broad systematic synthesis of the  
50 evidence reporting the health effects of edible mushrooms in humans and their bioactive  
51 compounds that support these effects is warranted.

52

53 Due to the large variety of mushroom species available for human consumption, a focus on those  
54 that are most abundant and frequently consumed by humans will have the greatest translational  
55 value. The most commonly consumed mushrooms worldwide belong to the *Agaricus bisporus*  
56 species, which includes white button mushrooms (WBM), brown button mushrooms (BBM),  
57 portobello and cremini mushrooms [1]. Therefore, the aim of this scoping literature review was to  
58 synthesize the evidence on *Agaricus bisporus* mushrooms to (i) examine its effect on human health  
59 outcomes; and (ii) determine the nutrient density of its bioactive compounds, which may explain  
60 their health effects.

61

## 62 **2. Methods**

63 The review protocol was developed using the Preferred Reporting Items for Systematic Reviews and  
64 Meta-Analyses (PRISMA) guidelines [22], PRISMA Extension for Scoping Reviews (PRISMA-ScR) [23]  
65 and was prospectively registered at PROSPERO (still awaiting processing).

66

### 67 **2.1. Eligibility criteria**

68 **Table 1** highlights the eligibility criteria for the study selection. Studies were deemed eligible if they  
69 were original primary research articles conducted in human populations, reported on whole or  
70 processed (e.g. dried extract) mushrooms from the *Agaricus bisporus* species, were consumed orally,  
71 and reported a health outcome. All physical and mental health outcomes were considered for  
72 inclusion. Prospective cohort and cross-sectional studies on health outcomes in humans were



73 considered if the dietary intake from mushrooms was measured, even if the mushroom type (e.g.  
74 whole mushroom or extract) was unspecified. Studies reporting on bioactive compounds were also  
75 included if they reported on *Agaricus bisporus* mushrooms and measured ergosterol, ergothioneine,  
76 flavonoids, glucans (alpha- or beta-glucans) or chitin.

77

## 78 **2.2. Search strategy**

79 A systematic search for publications was conducted (25<sup>th</sup> June 2019), using the electronic databases  
80 MEDLINE, EMBASE, Scopus, CINHALL and The Cochrane Library, without date limits (**Table S1**). To  
81 identify publications that reported on the consumption of *Agaricus bisporus* mushrooms, the  
82 following keywords were searched (with special features in parentheses): Agaricus (exp/), Agaricus  
83 bisporus (exp/), A bisporus (exp/), white button mushroom (exp/), button mushroom (exp/),  
84 common mushroom (exp/), cultivated mushroom (exp/), champignon (exp/), cremini (exp/), cremini  
85 (exp/), portobello (exp/) (**Table S1**). Keywords were searched for as free text in the title, abstract and  
86 subject headings. Study population and outcomes records were combined using the Boolean  
87 operator “AND”. Additional publications were identified from references in original papers.

88

## 89 **2.3 Selection process**

90 All records identified were first assessed for eligibility based on information contained in the title,  
91 abstract, and description/MeSH heading by two independent reviewers (KA, ED, TC or FFM), after  
92 which the inclusion and exclusion criteria were applied (**Table 1**). This process was completed using  
93 Covidence systematic literature review software [Veritas Health Innovation, Melbourne, Australia]  
94 [24]. The full text of all studies that appeared to meet the eligibility screening were retrieved and  
95 subjected to a second assessment for relevance by the same two reviewers (**Table 1**). Any difference  
96 in assessments that arose between reviewers was discussed in the first instance or resolved by a  
97 third independent reviewer (FFM).

98

99 Human research studies were then assessed for methodological quality in duplicate by two  
100 independent reviewers (KA and ED) using the Quality Criteria Checklist for Primary Research in the  
101 Academy of Nutrition and Dietetics Evidence Analysis Manual [25]. The Quality Criteria Checklist  
102 included four relevance questions that addressed applicability to practice and ten validity questions  
103 that addressed scientific reliability, including confounding, study quality and heterogeneity. The  
104 Quality Criteria Checklist enabled a systematic, objective rating (positive, negative or neutral) to be  
105 given to each study and was used to confirm agreement among independent reviewers. 'Positive'  
106 studies were of the highest quality, with most answers to the validity questions being positive,  
107 followed by 'neutral' studies. 'Negative' studies were of the lowest quality, with most of the answers  
108 to the validity questions being negative. Once again, any difference in assessments were resolved, if  
109 necessary, by a third independent reviewer (FFM). The internal validity of studies which reported  
110 biochemical analysis of mushrooms was not performed as critical appraisal tools do not exist for this  
111 study design.

112

#### 113 **2.4 Data extraction**

114 Data were extracted from all included studies into a Microsoft Excel [Version 1908; Excel for Office  
115 365] spreadsheet by one investigator (KA or ED) and checked for accuracy by another investigator  
116 (KA or ED). Data extracted were study and participant characteristics, baseline, follow-up, washout  
117 period, run-in period, test product, control product, dosage, measurement method, change in  
118 outcome, and p-value for between group comparisons. Data extracted for bioactive studies included  
119 source of mushrooms, whether mushrooms were cultivated or wild, storage conditions, extraction  
120 and measurement technique used, amount of the bioactive reported and units of measurement. For  
121 studies reporting ergosterol, vitamin D was also extracted if reported. Original authors were  
122 contacted to confirm any missing data [26-28]. If original authors could not be contacted, data were  
123 retrieved using manuscript figures [27] or excluded [26, 28].

124

## 125 **3. Results**

### 126 **3.1. Description of studies**

127 The systematic search strategy identified 9,811 records, of which 68 were eligible for inclusion (n=15  
128 human studies, n=53 biochemical studies; **Figure 1**).

129

#### 130 *3.1.1. Health outcomes*

131 A total of 15 human trials reported on consumption of *Agaricus bisporus* mushrooms and physical  
132 health outcomes [29-43], and none reported on mental health or cognitive function. The study  
133 characteristics and methodological quality of these included studies are shown in **Table 2**. The  
134 majority (73%) of studies were randomised controlled trials (RCTs) [29-36, 39, 40, 43]). Other study  
135 designs included a non-RCT [41], a secondary analysis of a RCT which presented pooled data from  
136 two intervention groups in a pre-post study design format [42], a Phase 1 Clinical trial [38], and a  
137 retrospective case-control study [37]. The reported health outcomes were vitamin D status (4  
138 studies) [29-32], inflammation (2 studies) [33, 34], satiety (2 studies) [35, 40], cancer (2 studies) [37,  
139 38], gastrointestinal health (2 studies) [39, 40], cholesterol [34, 41], diabetes risk factors [42], and  
140 immunology [43]. Studies were mainly conducted in the United States of America (USA) (10 studies)  
141 [29, 30, 32, 34-36, 38, 39, 42], and others were from Germany [31], Netherlands [33], China [37],  
142 Japan [40], Iraq [41], and Australia [43]. Only one study reported minor adverse effects (abdominal  
143 bloating), but had no participant withdraw.

144

145 Studies were mainly conducted in adults, with one study on male teenage athletes [32]. Most of the  
146 intervention studies used 'healthy' populations (8 studies) [29-31, 34-36, 39, 43], with the remaining  
147 conducted in adults with hypercholesterolemia [33], metabolic syndrome [42], insufficient Vitamin D  
148 levels [32], older adults with problematic halitosis and body odour [40], and cancer [37, 38] (**Table**  
149 **2**).

150

151 Using the Quality Criteria Checklist for Primary Research (**Table S2**), six studies received a positive  
152 quality rating (i.e. defined as having a high level of internal validity and low risk of bias across the  
153 study) [29, 31, 37, 38, 42, 43], six studies received a neutral rating (i.e. unclear levels of internal  
154 validity and bias) [32-36, 39], and three studies received a negative rating [30, 40, 41]. Interventions  
155 were generally well described with clearly defined outcomes. Objective biomarkers were utilised  
156 across studies, with the exception of studies that had self-reported measures of satiety [35, 36] and  
157 gastrointestinal health outcomes [39, 40].

158

### 159 *3.1.2. Bioactive compounds*

160 A total of 41 studies reported the concentration of bioactive antioxidant compounds (ergosterol, 16  
161 studies [44-59]; ergothioneine, 4 studies [48, 60-62]; flavonoids, 22 studies [63-84]) and 16 reported  
162 concentrations of polysaccharides (glucans, 9 studies [27, 80, 84-90]; chitin, 7 studies [27, 87, 90-94])  
163 in *Agaricus bisporus* mushrooms (**Table 3**). From the 16 papers that reported ergosterol, five also  
164 reported Vitamin D<sub>2</sub> (25(OH)D<sub>2</sub>) [46, 48-51]. Mushroom varieties included WBM (47 studies) [27, 46-  
165 56, 59-66, 68-87, 89-94], portobello (8 studies) [49, 57, 58, 60, 61, 85, 87, 88], BBM (7 studies) [47,  
166 48, 54, 55, 67, 79, 89], and cremini (6 studies) [49, 60, 61, 85, 87, 88] mushrooms. The majority of  
167 studies (79%) reported only one mushroom type, with WBM being the most common (68%), and  
168 two studies did not specify the type of mushroom used [44, 45]. Mushrooms were mainly cultivated  
169 (51 studies) and sourced from Europe (24 studies) [27, 44, 45, 50, 52, 53, 55-58, 64, 67, 69, 73, 74,  
170 78, 79, 86, 88-90, 92-94] and Asia (19 Studies) [51, 59, 62, 63, 65, 66, 68, 71, 72, 75-77, 80-84, 87].  
171 Other regions included the Americas (6 studies) [48, 49, 60, 61, 70, 85], Canada (3 studies) [46, 47,  
172 54] and the United Kingdom (1 study) [91].

173

## 174 **3.2. Impact of *Agaricus bisporus* mushroom intake on human health**

### 175 *3.2.1. Serum vitamin D*

176 Studies that reported on the bioavailability of vitamin D from UVB-exposed mushrooms used fresh  
177 mushrooms [29, 31], dried mushroom extract [30] and mushroom powder [32]. Doses of vitamin D  
178 ranged from 8.8µg/day (352 IU/day) [29], up to 28,000 IU/day (700 µg/day) [31], and study  
179 durations ranged from 5 to 12 weeks. A significant increase in serum 25(OH)D<sub>2</sub> was reported in all  
180 four RCT studies [29-32], alongside a decrease in serum 25(OH)D<sub>3</sub> reported in two studies [29, 32],  
181 (p<.001 for all). Three studies showed a significant increase in total serum 20(OH)D (p<0.001 for all)  
182 [30-32], and only one study specifically screened people for low levels of vitamin D at baseline [32].  
183 When UVB-exposed mushroom extracts were compared to a daily vitamin D<sub>2</sub> or D<sub>3</sub> supplement  
184 (2000IU/day; 50µg/day) across a 12-week intervention, no significant differences in overall 25(OH)D  
185 levels between the groups were found [30]. At doses of 2000IU/day, UVB-exposed mushrooms were  
186 equivalent to a supplement at increasing total 25(OH)D levels.

187

### 188 3.2.2. *Inflammatory markers*

189 Three studies reported on inflammatory markers [33, 34, 42]. In healthy young women, both 8g and  
190 16g doses of mushroom powder increased serum ergothioneine and decreased oxygen radical  
191 absorbance capacity (ORAC) [34]. Alternatively, in a 16-week uncontrolled pre-post study using a  
192 cooked mushrooms intervention (100g/day), both serum ergothioneine and ORAC increased  
193 (p=0.03) [42]. When cytokine production was measured after 5g/day of α-glucans from mushroom  
194 extract consumed across a 5-week intervention, tumour necrosis factor (TNF)-alpha decreased  
195 compared to the control (p=0.017) [33]. However, there were no effects on any other inflammatory  
196 markers measured (i.e. interleukin (IL)-1β, IL-2, IL-4, IL-6, IL-10, IL-12, IL-13, IL-17, interferon-γ, serum  
197 creatinine).

198

### 199 3.2.3. *Satiety*

200 Two studies assessed the impact of dietary mushrooms on satiety, and findings were inconsistent  
201 [35, 36]. In 35 young adults (age 23±4 years), mushroom consumption was associated with lower

202 hunger ( $p=0.045$ ), greater fullness ( $p=0.05$ ) and decreased prospective food consumption ( $p=0.03$ )  
203 compared with a protein-matched beef portion [35]. However, no change in energy intake was  
204 observed [35]. Alternatively, in a different sample of mixed-race adults from the USA ( $n=47$ ; age  
205 mean (range) 35.5 (18-62) years) mushroom intake was not associated with changes in subjective  
206 satiety when compared to a volume-matched, rather than energy-matched, portion of beef [36]. The  
207 replacement of mushrooms for beef resulted in a decrease in the total fat and energy intake (total  
208 fat  $41.1\pm 0.4\text{g}$  vs.  $10.2\pm 0.2\text{g}$ ,  $p<.001$ ; energy  $2012\pm 70\text{kcal}$  vs.  $1640\pm 65\text{kcal}$ ,  $p<.001$ ) of the meal, and  
209 the lower energy intake from the meal was only partially compensated for at the other eating  
210 occasions ( $11.4\pm 12.0\%$  energy;  $7.4\pm 7.7\%$  total fat) [36].

211

#### 212 3.2.4. Gastrointestinal health

213 Consumption of fresh mushrooms [39] and a mushroom extract [40] both showed beneficial effects  
214 on stool weight, microbiota, bowel strain, faecal odour and halitosis (**Table 2**). No changes were  
215 observed in markers of bacterial fermentation (breath  $\text{H}_2$ , faecal pH and faecal short chain fatty  
216 acids) [39] or bowel regularity [40], compared to the control.

217

#### 218 3.2.5. Cancer

219 The association between human consumption of *Agaricus bisporus* mushrooms and cancer was  
220 assessed in a case control study [37] and a Phase 1 Clinical Trial [38]. In the case-control study of  
221 1000 females from China (age  $59\pm 6$  years), consumption of more than 2g per day of WBM reduced  
222 the odds of ovarian cancer by 32% (adjusted OR 0.68 (95% CI, 0.52-0.89) [37]. In a sample of prostate  
223 cancer patients, mushroom extract at increased doses (4g to 14g extract daily; equivalent to 40g to  
224 14g fresh WBM) was associated with decreased prostate specific antigen (PSA) levels in 36% of  
225 patients, with stable PSA levels or no effect in the remaining patients [38]. Minimal side effects were  
226 reported and mostly limited to Grade 1 abdominal bloating [38].

227

### 228 3.2.6. *Metabolic Markers*

229 Two studies reported on metabolic markers of health [41, 42]. WBM cooked in olive oil (2g/kg body  
230 weight/day) were associated with significantly lower glucose, total cholesterol, low-density  
231 lipoprotein, triglycerides and body weight, and higher high-density lipoprotein, compared to the  
232 control ( $p < 0.05$  for all) [41]. However, baseline values were not reported and the olive oil was only  
233 delivered to the treatment group. In a second sample of adults with at least two features of the  
234 metabolic syndrome, adiponectin increased after daily consumption of 100g of cooked mushrooms  
235 over the 16-week intervention ( $7.9 \pm 3.2 \mu\text{g/mL}$  baseline;  $8.8 \pm 3.5 \mu\text{g/mL}$  16 weeks,  $p = 0.03$ ) [42].

236

### 237 3.2.7. *Immune Function*

238 The effect of cooked WBM (100g/day for 7 days) on salivary IgA secretion was measured in 24  
239 healthy adults (age  $41.4 \pm 11.3$  years) [43]. Compared to their usual diet, 100g of cooked WBM intake  
240 for seven days was associated with increased serum IgA osmolarity ( $p < .0001$ ), secretion rate  
241 ( $p < .0005$ ), and concentration ( $p < .0005$ ) [43]. These findings indicate a potential benefit for mucosal  
242 immunity.

243

## 244 **3.3. Concentration of bioactive compounds in *Agaricus bisporus***

### 245 3.3.1. *Flavonoids*

246 The majority (95%) of studies reported the total flavonoid content of whole mushrooms, and one  
247 study reported individual flavonoids [64] (**Table 3**). Two studies measured the cap and stipe (i.e. the  
248 stalk) separately for WBM [63, 79] and BBM [79], and five studies investigated the effect of cooking  
249 on flavonoid content [69, 71, 76, 77, 81]. WMB had the highest concentration of catechins  
250 ( $396.00 \mu\text{g/g}$ ) and myricetins ( $11.75 \mu\text{g/g}$ ), and low to negligible quantities of quercetin, kaempferol,  
251 naringenin and resveratrol present ( $0.25\text{-}1.75 \mu\text{g/g}$ ) [64]. Cooking mushrooms reduced flavonoid  
252 concentrations and flavonoid concentration for raw mushrooms was the highest across all studies  
253 [69, 71, 76, 77, 81]. Cooking methods assessed included blanching [69], frying [71, 76], boiling [76,

254 77, 81], microwaving [76, 77], steaming [76, 77] and pressure cooking [76, 77]. Only two studies  
255 measured the effect of cooking time, on flavonoid content [71, 76]. For both boiling and frying,  
256 flavonoid content was reduced with cooking time (6 minutes) [71, 76]. For shorter cooking times (1.5  
257 minutes), microwaving retained the most flavonoids compared to boiling or steaming (70.8%, 60.4%  
258 and 55.4% respectively) [76]. When cooking time was extended to six minutes, microwaving retained  
259 the least flavonoids compared to other cooking methods (20.8% microwaving, 48.5% boiling, 68.3%  
260 steaming) [76].

261

262 The mushroom cap had a greater concentration of flavonoids than the stipe. Four out of five  
263 analyses from two studies reported a mean of 28.1% greater flavonoid concentration in the WBM  
264 cap (range: 4.5 – 58.4%), compared to the stipe [63, 79]. For BBM, the difference between the cap  
265 and stipe differed according to the solvent used for the analysis, with the water solvent showing a  
266 greater concentration in the cap, and the 50% water-ethanol showing a greater concentration in the  
267 stipe [79]. Only one study reported on flavonoids in both WBM and BBM, with the water solvent  
268 showing higher concentrations of flavonoids in the BBM, and water-ethanol solvent showing a  
269 greater concentration in WBM [79]. Majority of studies (75%) used colorimetric assays [63, 65-68,  
270 70-76, 78, 79, 81], while the remainder used spectrometry (15%) [69, 77, 80], high performance  
271 liquid chromatography (5%) [64] or an unspecified method (10%) [82, 83]. None of the studies  
272 reported on flavonoid concentrations by mushroom maturity (e.g. WBM compared to Portobello).

273

### 274 3.3.2. Ergosterol and Vitamin D

275 Ergosterol was measured in 16 studies [44-59]. In addition to ergosterol, vitamin D<sub>2</sub> was also  
276 measured in five of those studies [46, 48-51]. Most studies (67%) that reported on ergosterol and  
277 vitamin D content used UVB-exposed mushrooms [46, 48-50]. The range of ergosterol  
278 concentrations in UVB-exposed whole WBM and BBM were 579.5mg/100g – 633.4mg/100g [46, 54]  
279 and 722.0mg/100g – 769.0mg/100g [54], respectively (**Table 3**). No studies reported ergosterol in



280 UVB-exposed extracts. In non-UV-exposed whole WBM and BBM, the average ergosterol  
281 concentration was 714.3mg/100g (range 56.3 – 1740mg/100g) [45-47, 49-51, 53, 54, 56] and  
282 334.5mg/100g (range 203.0 – 466.0mg/100g) [47, 54], respectively. In non-UV-exposed WBM and  
283 BBM extracts, the range of ergosterol concentration was 4 – 3672mg/100g [44, 48, 52, 55] and 26.4  
284 – 620mg/100g [48, 55], respectively. Exposure to UVB light over time consistently increased vitamin  
285 D<sub>2</sub> content and decreased ergosterol concentrations [49, 54].

286

287 Both BBM and cremini mushrooms had a marginally higher quantity of ergosterol compared to WBM  
288 in two studies (BBM 466mg/100g vs. WBM 341mg/100g [47]; cremini 61.4mg/100g vs. WBM  
289 56.3mg/100g [49]). None of the studies investigated the effect of cooking method or mushroom  
290 maturity on ergosterol content. Except one study which compared the portobello cap against whole  
291 WBM [49] and found a marginally higher concentration of ergosterol in the portobello cap  
292 (62.1mg/100g) compared to the WBM (56.3mg/100g) [49].

293

### 294 3.3.3. Ergothioneine

295 Four studies measured ergothioneine content [48, 60-62]. One used both WBM and BBM extracts  
296 [48], while the remaining studies used whole mushrooms [60-62]. Whole mushrooms contained an  
297 average ergothioneine content of 0.43±0.25mg/g. There were no clear trends among the two studies  
298 that compared the ergothioneine content by type of whole mushroom (whole WBM, cremini and  
299 portobello mushrooms) [60, 61]. However, WBM extract had a greater concentration of  
300 ergothioneine (0.81-0.92mg/g) than BBM extract (0.37-0.48mg/g) [48]. None of the studies reported  
301 on the effect of cooking method or the part of the mushroom body (i.e. cap vs. stipe) on  
302 ergothioneine concentrations.

303

### 304 3.3.4. Glucans

305 Eight papers measured and reported on glucans as either total [80, 84, 87-89], alpha- [27, 80, 84, 87-  
306 89], and/or beta- [27, 80, 84-89]. Glucans were reported using a variety of methods (%w/w, %, and  
307 g/100g), making direct comparisons across studies difficult. When total, alpha- and beta-glucans  
308 were compared across the cap and stipe of WBM and BBMs, a higher concentration of glucans was  
309 reported in the stipe [89]. Studies which measured both alpha and beta-glucans reported that the  
310 most prevalent glucans present in mushrooms are beta-glucans, which account for (mean  $\pm$  SD)  
311 75.0 $\pm$ 17.8% of the total glucan concentration [80, 84, 89]. BBM had a marginally higher  
312 concentration of glucans than WBM [89]. No differences in beta-glucan concentration was reported  
313 by mushroom maturity or cooking method [85], and all studies used whole mushrooms.

314

### 315 3.3.5. Chitin

316 Chitin was measured in seven studies using WBM [27, 87, 90-94], with high variability in reported  
317 values. Chitin content ranged from 0.005g/100g to 1.2g/100g for whole mushroom [27, 87, 90], 6.4%  
318 to 42% in the stipe [91, 92, 94], 7.2% to 7.4% in the cap [92, 94], 5.9% gills [92] and 0.005g/100g for  
319 the extract [93]. Cooking increased chitin content regardless of preparation technology, with  
320 comparable values in fresh and canned samples (fresh: raw 0.6 $\pm$ 0.04g/100g vs. cooked  
321 0.7 $\pm$ 0.04g/100g; deep frozen: raw 0.34 $\pm$ 0.01g/100g vs. cooked 0.52 $\pm$ 0.02g/100g; canned: raw  
322 0.61 $\pm$ 0.05g/100g vs. cooked 0.74 $\pm$ 0.06g/100g) [90]. No studies measured chitin in other mushroom  
323 types.

324

## 325 4. Discussion

326 This scoping literature review systematically summarised the evidence from human intervention  
327 trials and biochemical studies that reported on the health effects and bioactive compounds in  
328 *Agaricus bisporus* mushrooms. Results confirmed that *Agaricus bisporus* mushrooms are a rich  
329 source of beta-glucans, antioxidants and vitamin D, with a wide variability in values reported by  
330 mushroom type, cooking time and method, and exposure to UVB across studies. Several beneficial

331 effects of *Agaricus bisporus* consumption exist for metabolic syndrome, gastrointestinal health and  
332 cancer, with the strongest evidence of a health effect on improving vitamin D status of individuals.  
333 All studies reported that the consumption of UVB-exposed mushrooms was as effective at increasing  
334 and maintaining total serum 25(OH)D levels as vitamin D supplements, in individuals with and  
335 without vitamin D deficiency at baseline. Despite the wide range of health benefits reported, the  
336 evidence is still quite limited and further research is warranted, specifically for inflammatory and  
337 immune function where results are promising.

338

339 The biologically distinct and nutritionally unique properties of mushrooms make them a powerful  
340 food choice to improve human health. Unlike plants, mushrooms have high concentrations of  
341 ergosterol in their cell walls [4], and when both fresh and dried varieties of mushrooms are exposed  
342 to UVB radiation, ergosterol is transformed to pre-vitamin D<sub>2</sub>, then converted to vitamin D<sub>2</sub> [30, 95].  
343 Findings confirm UVB-exposed mushrooms contain vitamin D<sub>2</sub> in a very bioavailable form that is  
344 relatively stable during storage and cooking, making them an ideal non-animal food source of  
345 vitamin D. Mushrooms also contain significant proportions of beta-glucans. We found that beta-  
346 glucans accounted for approximately 75% of total glucan concentrations in *Agaricus bisporus*  
347 mushrooms with a volume of 8-12g/100g dry weight, which is substantially higher than the 3-  
348 8g/100g dry weight found in oats, 1.3-2.7g/100g dry weight in rye, and 2-20g/100g dry weight in  
349 barley. A number of international food governing bodies (including Food Standards Australia New  
350 Zealand, U.S. Food and Drug Administration, European Food Safety Authority, Health Canada's Food  
351 Directorate, and Singapore Food Agency) have approved a high level health claim based on the  
352 relationship between the consumption of 3g of beta-glucans (from oats or barley) and blood  
353 cholesterol, with no such claim available for mushrooms. Given the significant proportions of beta-  
354 glucans reported in mushrooms, further research in this area is warranted to confirm the potential  
355 health effects induced by beta-glucans from mushrooms specifically.

356

357 Studies identified by this review suggest that the consumption of *Agaricus bisporus* mushrooms may  
358 improve both components of the metabolic syndrome and gastrointestinal health. However, the  
359 only study that measured markers of metabolic syndrome provided mushrooms alongside olive oil,  
360 which exerts its own beneficial effect on human health [96]. The impact of mushrooms on satiety  
361 was inconsistent, which is likely a result of the lack of consistent comparator groups used (i.e.  
362 volume matched vs. energy matched portion of beef). While whole mushrooms and extracts were  
363 associated with bowel function, further research is required to explore if these effects are linked to  
364 any further health improvement as existing research did not identify any change in short chain fatty  
365 acids or bacterial fermentation.

366

367 Two included studies reported that *Agaricus bisporus* mushrooms reduced the risk and progression  
368 of ovarian and prostate cancers, respectively. This suggests that these mushrooms may have a role  
369 as adjuvant therapy for cancer treatment. The mechanism of action for this effect may be related to  
370 the immunomodulating and anti-tumour effects of beta-glucans, ergothioneine and ergosterol [5].  
371 Beta-glucans have been shown to have immune-stimulating effects [20, 21], and ergothioneine is an  
372 immune modifier with antioxidant and cytoprotective properties [97, 98]. This review found that  
373 consumption of whole WBM improved mucosal immunity via increased serum IgA osmolarity and  
374 adiponectin [42], which may have a role in the prevention of malignancy and improved prognosis  
375 [99]. Decreased levels of ergothioneine in both blood and plasma have been observed in  
376 neurodegenerative, cardiovascular and kidney diseases [98], while increased ergothioneine  
377 concentrations may beneficially modulate the tumour microenvironment [100]. Similarly, ergosterol  
378 is an immunologically active lipid that can induce pyroptosis [101]. Although included studies  
379 regarding the effect of human *Agaricus bisporus* mushroom consumption on immunity and cancer  
380 had high internal validity, further robust RCTs are required to confirm their cancer preventative and  
381 treatment effects in diverse samples alongside traditional therapies.

382

383 A large number of published studies reported the presence of flavonoids in *Agaricus bisporus*  
384 mushrooms. These highlight large variability in the measurement of total flavonoids, ranging from as  
385 little as 5.68 mg rutin equivalents per 100g [80], up to 1,636 mg per 100g [83] in whole WBM.  
386 Estimates of daily flavonoid intake from across USA, European and Australian databases range from  
387 209mg to 1,017mg per day [102]. Recent evidence suggests that mushrooms may not contain  
388 flavonoids at all due to (i) the absence of genes required for their biosynthesis, and (ii) the lack of  
389 flavonoids detected when using analytic methods with higher levels of sensitivity and specificity such  
390 as high-performance liquid chromatography versus colorimetric assays [103]. Currently, there are no  
391 validated methods for the identification and quantification of flavonoids in foods and plants, and  
392 thus quantification of flavonoids has been inconsistent between studies [104]. Gil Raminez et al.  
393 (2016) provide convincing evidence to suggest that another compound is being detected by assays  
394 claiming to detect flavonoids [103]. They showed that ergosterol demonstrated cross-reactivity with  
395 quercetin in a colorimetric assay, giving a positive reading in the detectable range when no quercetin  
396 was present [103]. As the majority (75%) of studies in this review measured flavonoids using  
397 colorimetric assays, caution is required when interpreting these values. Although flavonoids may or  
398 may not be present in mushrooms, a strong correlation between total flavonoids and antioxidant  
399 activity has been found [61]. Therefore, whatever the measured compound/s is, it has biological  
400 activity similar to that of flavonoids *in vitro*. If not a flavonoid, the compound could be ergosterol, as  
401 ergosterol from BBM and WBM has been highly correlated with total antioxidant activity ( $R^2=0.89$ )  
402 [47] and could account for the antioxidant activity previously observed [61]. In turn, it may further  
403 contribute to the cancer preventative effects of *Agaricus bisporus* mushrooms.

404

#### 405 **4.1. Implications for future research**

406 Opportunities exist for future research to confirm the causative relationship between the  
407 consumption of whole WBM versus extracts on human inflammatory and immune function, and its  
408 anti-cancer effects. Prior to being adopted into clinical practice and public health initiatives,

409 replication of existing studies in other population groups is required to confirm the impact of  
410 *Agaricus bisporus* mushrooms on human health including satiety, gastrointestinal function including  
411 its effect on the microbiota, and metabolic syndrome. Initial human studies are required to replicate  
412 findings from *in vitro* and animal studies which suggest *Agaricus bisporus* mushrooms may improve  
413 mental health and cognitive function, as none conducted in humans have reported on these health  
414 outcomes. Further research is required to fully elucidate the bioactive compounds in mushrooms  
415 using vigorous analytical methods, such as nuclear magnetic resonance spectroscopy, and expand  
416 the immunological markers and bioactive compounds being tested.

417

#### 418 **4.2. Limitations**

419 The strengths of this review relate to the broad systematic literature search strategy used to identify  
420 the available evidence to answer the research question. This is the first review to systematically  
421 synthesize the evidence from published human trials on *Agaricus bisporus* mushroom specifically,  
422 and its consumption on health outcomes, while further reporting on the bioactive compounds that  
423 may explain these effects. This review is further strengthened by the development of and adherence  
424 to an evidenced based protocol and comprehensive evaluation of the methodological quality of  
425 included human studies. It is limited by many studies that reported inadequate details related to  
426 sample size or power calculations. The lack of such details may confound data particularly relating to  
427 the reliability of effect sizes. There was large variability in bioactive measurements reported in  
428 mushrooms, which may be due to differing analytic methods with varying degrees of sensitivity and  
429 specificity. Lastly, despite a growing interest in the relationship between mushrooms and health,  
430 only a small number of studies (< 4 studies) have been published for each health outcome, despite  
431 over 300 narrative reviews having been published on mushrooms and health using *in vitro* and  
432 animal models. This reduces confidence in the reported effects and limits the generalisability of the  
433 conclusions to the general population.

434

435 **5. Conclusion**

436 *Agaricus bisporus* mushrooms are sources of beta-glucans, ergosterol, ergothioneine, vitamin D and  
437 an antioxidant compound usually reported as flavonoids; with varying concentrations depending on  
438 the type of mushroom, cooking method and duration, and UVB exposure. UVB-exposed mushrooms  
439 increase and maintain serum 25(OH)D levels to a similar degree as vitamin D supplements. Further,  
440 the evidence shows it lowers risk of cancer, and improves metabolic syndrome, immune function  
441 and gastrointestinal health. Due to the small number of studies examining each health outcome and  
442 the lack of replication of reported results, further research is required to confirm these effects on  
443 health to enable findings to be adopted into clinical practice.

444

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452

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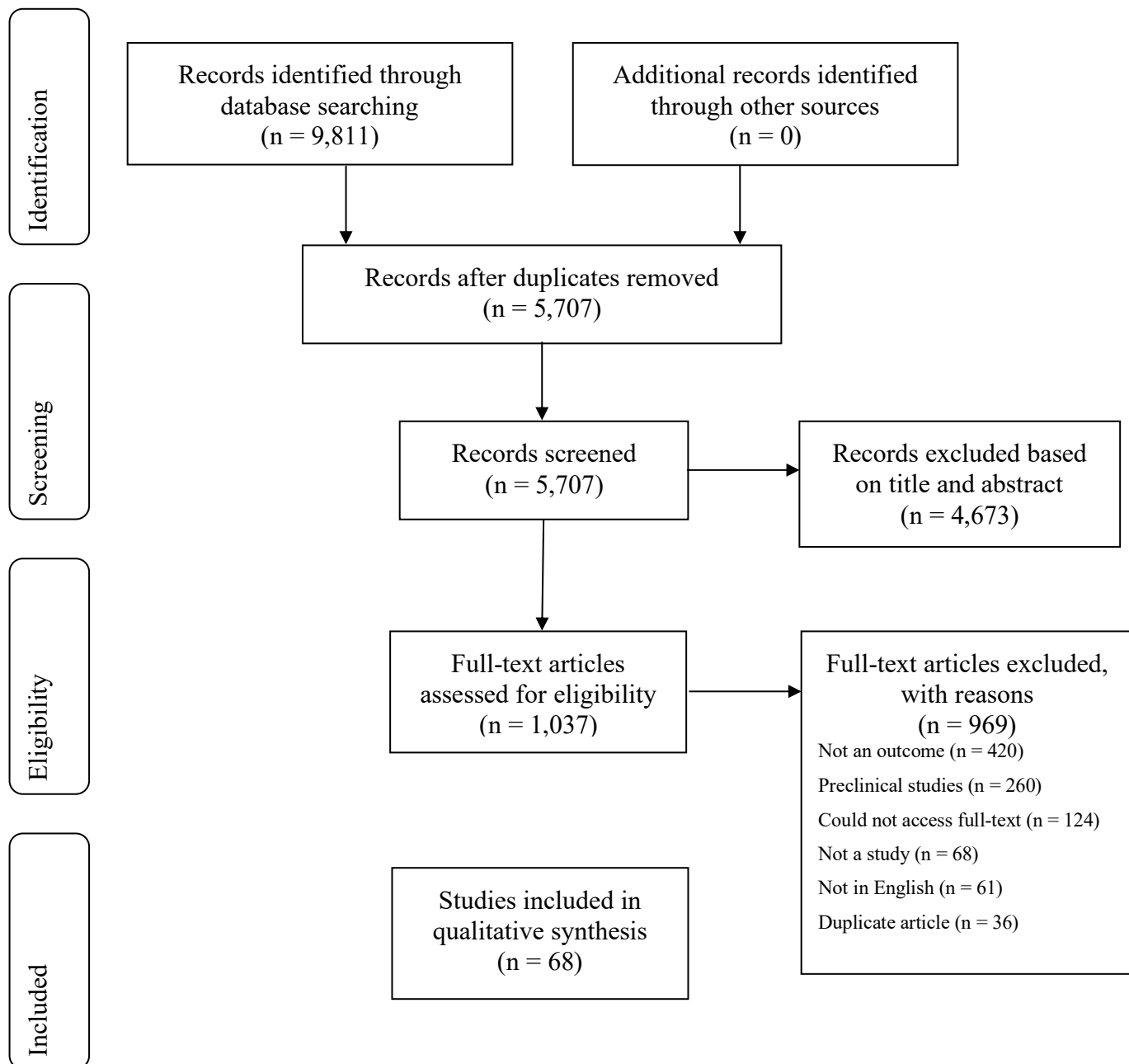
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**Table 1.** Inclusion and exclusion criteria for the selection of studies

Inclusion criteria	Exclusion criteria
Studies on <i>Agaricus bisporus</i> mushrooms in human populations of any age and health effect, without date limits	Studies published in languages other than English
Studies using <i>Agaricus bisporus</i> mushrooms in whole or processed (e.g. dried extract) form	Studies where <i>Agaricus bisporus</i> mushrooms were not consumed orally
Studies conducted in any country	Studies in animals
Any study design	Studies in duplicate populations
Studies reporting data in a format that enabled data specific to mushrooms to be extracted	Lack of a random sample
Studies reporting ergosterol, ergothioneine, flavonoids, bioactive polysaccharides (alpha and beta glucans) and chitin in <i>Agaricus bisporus</i> mushrooms	Studies solely reporting other bioactive compounds in <i>Agaricus bisporus</i> mushrooms



**Figure 1.** PRISMA study flow chart

**Table 2.** Studies using *Agaricus bisporus* mushrooms or extracts derived from *Agaricus bisporus* mushrooms and measuring health outcomes in humans

Author, year, country	Study aim	Study Design, sample size (n: IG/CG)	Study duration	Population (age, %female, health condition)	Exposure	Outcome/s Measured	Results (↑↓↔)	Adverse effects/ limitations	Conclusions	Study quality (+ ∅ -)
Vitamin D										
Stephensen, 2012, USA	To evaluate the effects of consuming UV-exposed white button mushrooms ( <i>Agaricus bisporus</i> ) on the vitamin D status of healthy adults.	Parallel, double-blind n: 9/10/10 (8.8µg D2/17.1µg D2/control) (3% attrition)	6w	31 ± 11y 58% f Healthy	<b>Intervention:</b> UV-exposed cooked mushrooms (87.9g/day) delivering 8.8µg OR 17.1µg D2/day <b>Comparator:</b> Non UV-exposed cooked mushrooms (87.9g/day)	<i>8.8µg D2/day:</i> <b>Serum 25(OH)D2</b> Serum 25(OH)D3 Serum 25(OH)D (total) Serum 24,25(OH)D3 <hr/> <i>17.1µg D2/day:</i> <b>Serum 25(OH)D2</b> <b>Serum 25(OH)D3</b> Serum 25(OH)D (total) Serum 24,25(OH)D3	↑ (p<0.05) ↔ ↔ ↔ <hr/> ↑ (p<0.05) ↓ (p<0.05) ↔ ↔	No adverse effects.  No significant difference in the vitamin D2 content of raw vs. cooked mushrooms (p=0.41)	Ergocalciferol was absorbed and metabolised to 25(OH)D2 but did not affect vitamin D status, because 25OHD3 decreased proportionally.	+
Keegan, 2013, USA	To compare effectiveness at increasing and maintaining vitamin D status of dried white mushroom extract and supplemental vitamin D3 and vitamin D2.	Parallel, 3-arm (1IG, 2CG) n: 14/8/3 (17% attrition)	12w	35y 75% f Healthy	<b>Intervention:</b> Dried white button mushroom extract (2000 IU D2/day) <b>Comparator:</b> Supplement 2000 IU D2/day OR 2000 IU D3/day	<b>Serum 25(OH)D (total)</b> <b>Serum 25(OH)D2</b> Serum 25(OH)D3	↑ (p<0.001) <sup>a</sup> ↑ (p<0.001) <sup>a</sup> Not reported	No adverse effects.	Consumption of mushrooms containing D2 was as effective at increasing and maintaining total serum 25(OH)D levels as supplemental vitamin D2 and D3.	-
Urban, 2011, Germany	To investigate the bioavailability of vitamin D2 from UV-exposed mushrooms in humans, in comparison to a vitamin D2 supplement.	Parallel, single-blind, 3-arm (2IG, 1CG) n: 8/9/9 (8% attrition)	5w	31 ± 6y 65% f Healthy	<b>Intervention:</b> UV-exposed cooked mushrooms (28,000 IU D2/day) OR Non-UV-exposed cooked mushrooms (60 IU D2/day + 28,000 IU D2/day supplement)	<i>28,000 IU D2/day:</i> <b>Serum 25(OH)D (total)</b> Serum Calcium Serum iPTH	↑ (p<0.001) ↔ ↔	No adverse effects.	Vitamin D2-enhanced button mushrooms via UV exposure was effective in improving vitamin D status	+

					<b>Comparator:</b> Non-UV-exposed cooked mushrooms (60 IU D2/day + placebo supplement)	<i>60 + 28,000IU D2/day:</i> <b>Serum 25(OH)D (total)</b> Serum Calcium Serum iPTH	<b>↑ (p&lt;0.001)</b> ↔ ↔		in young, healthy adults.	
Shanely, 2014, USA	To determine if supplementation with mushroom powder would enhance skeletal muscle function and attenuate exercise-induced muscle damage in low vitamin D status high school athletes.	Parallel, double-blind, 2-arm (1IG, 1CG) n: 17/17 (3% attrition)	6w	16 ± 0y 0% f Vitamin D insufficient athletes	<b>Intervention:</b> UV-exposed powdered mushroom (600 IU D2/day) <b>Comparator:</b> Placebo	<b>Serum 25(OH)D (total)</b> <b>Serum 25(OH)D2</b> <b>Serum 25(OH)D3</b>	<b>↑ (p=0.004)</b> <b>↑ (p&lt;0.0001)</b> <b>↓ (p&lt;0.0001)</b>	No adverse effects.	600 IU/d vitamin D2 increased 25(OH)D2 with a concomitant decrease in 25(OH)D3, with no effect on muscular function or exercise-induced muscle damage in high school athletes.	∅
<b>Inflammation</b>										
Calvo, 2016, USA	To estimate the impact of adding white button mushrooms to daily diet on known T2D risk factors.	Parallel, 4-arm*** n: 37	16w	48y 65% f MetS	<b>Intervention:</b> UV-exposed cooked mushrooms (100g/day) <b>Comparator:</b> Supplement 1242 IU D3/day OR 7320 IU D3/day	<b>Serum ergothioneine</b> <b>ORAC</b> 8-isoprostane <b>Adiponectin</b> Leptin <b>sCML</b> <b>sMG</b>	<b>↑ (p≤0.01)</b> <b>↑ (p=0.03)</b> ↔ <b>↑ (p=0.03)</b> ↔ <b>↓ (p≤0.01)</b> <b>↓ (p≤0.01)</b>	No adverse effects.	Consuming white button mushrooms was associated with increased ergothioneine, lower circulating oxidative stress factors and higher serum adiponectin and ORAC.	+

Volman, 2010, Netherlands	To evaluate the effects of consuming $\alpha$ -glucans in hypercholesterolemic subjects.	Parallel, double-blind n: 26/30 (0% attrition)	5w (2w run-in)	57 $\pm$ 8y 42.9% f Hypercholesterolemic	<b>Intervention:</b> 200mL juice/day containing 5g/day $\alpha$ -glucans extracted from white button mushrooms <b>Comparator:</b> 200mL juice/day with 0g $\alpha$ -glucans	*IL-1 $\beta$ *IL-6 <b>*TNF<math>\alpha</math></b> *IL-10 *IL-17  <i>Th1 cytokines:</i> **IFN $\gamma$ **IL-12 **IL-2  <i>Th2 cytokines:</i> **IL-13 **IL-4  Serum creatinine Serum ALT Serum AST Serum GGT Serum APT Serum Bilirubin	$\leftrightarrow$ $\leftrightarrow$ <b><math>\downarrow</math> (p=0.017)</b> $\leftrightarrow$ $\leftrightarrow$  $\leftrightarrow$ $\leftrightarrow$ $\leftrightarrow$ $\leftrightarrow$ $\leftrightarrow$ $\leftrightarrow$ $\leftrightarrow$ $\leftrightarrow$ $\leftrightarrow$ $\leftrightarrow$	No adverse effects.	Consumption of <i>A. bisporus</i> $\alpha$ -glucans lowered LPS-induced TNF $\alpha$ production, whereas no effect on IL-1 $\beta$ and IL-6 was observed. No obvious Th1–Th2 skewing by PHA-stimulated PBMCs was observed. However, we observed a trend towards a decreased production of IL-12 and IL-10. No significant changes in kidney or liver function.	$\emptyset$
Weigand-Heller, 2012, USA	To evaluate the bioavailability of ergothioneine using a dose–response, postprandial time-course design.	Cross-over, 2-arm (1IG, 1CG) n: 10/10 (0% attrition)	3d (3d washout)	27 $\pm$ 3y 0% f Healthy	<b>Intervention:</b> Powdered mushroom (8g/day OR 16g/day) <b>Comparator:</b> Placebo	CRP Cholesterol HDL LDL Triglycerides Glucose <b>ORAC (total)</b> <b>Ergothioneine</b>	$\leftrightarrow$ $\leftrightarrow$ $\leftrightarrow$ $\leftrightarrow$ $\leftrightarrow$ $\leftrightarrow$ <b><math>\downarrow</math> (p&lt;0.05)</b> <b><math>\uparrow</math> (p&lt;0.05)</b>	No adverse effects.	Ergothioneine was bioavailable after consuming mushrooms and a trend in the postprandial triglyceride response indicated that there was a blunting effect after both the 8g and 16g doses. ORACtotal	$\emptyset$

										values decreased after the 8g and 16g mushroom meal.
Satiety										
Hess, 2017, USA	To compare satiety and food intake differences between mushroom and meat consumption.	Cross-over, 2-arm (1IG, 1CG) n: 35/35 (9% attrition)	10d (10d washout)	23 ± 4y 53% f Healthy	<b>Intervention:</b> Cooked mushroom meal (226g/day) <b>Comparator:</b> Cooked beef meal (28g/day)	<b>Satiety</b> Energy intake	↑ (p=0.05) ↔	No adverse effects.	Mushroom meal had a positive effect on satiety, but no effect on energy intake.	∅
Cheskin, 2008, USA	To investigate how substituting mushrooms for beef in a test lunch affected energy intake, fat intake, palatability, appetite, satiety and satiety in normal weight, overweight and obese adults.	Cross-over, 2-arm n: 76/76 (29% attrition)	4d (3d washout)	36y 67% f Healthy	<b>Intervention:</b> Cooked mushroom meal (339 kcal/day) <b>Comparator:</b> Cooked beef meal (783 kcal/day)	Satiety Satiation <b>Fat intake</b> <b>Energy intake</b> Appetite	↔ ↔ ↓ (p<0.0001) ↓ (p<0.0001) ↔	No adverse effects.	Energy intakes were higher during meat lunches than mushroom lunches. Total daily energy and fat intake were greater in the meat than in the mushroom condition. Palatability, appetite, satiety and satiety did not differ.	∅
Cancer										
Lee, 2013, China	To investigate the association between mushroom consumption and risk of epithelial ovarian cancer.	Case-control, retrospective n: 500/500	2y	59 ± 6y 100% f Healthy (controls) Ovarian cancer (cases)	<b>Exposure:</b> White button mushroom consumption	Ovarian cancer	↓ (OR=0.68)	N/A	Ovarian cancer patients consumed less mushrooms than controls. Apparent	+

									reductions in cancer risk were found at high levels of intake, especially for white button mushroom for women consuming >2g/day.	
Twardoski, 2015, USA	To evaluate the effects of white button mushroom powder on serum PSA levels and determine the tolerability.	Phase I, clinical dose-escalation n: 36	10m (1-58m)	68y 0% f Elevated PSA	<b>Treatment:</b> Powdered mushroom (4,6,8,10,12,14g/day)	<b>Serum PSA</b> Androgens MDSCs IL-15	<b>↓ (n=13, 36%)</b>	Abdominal bloating	White button mushroom powder therapy was associated with declining PSA levels in some patients.	+
<b>Gastrointestinal</b>										
Hess, 2018, USA	To assess mushroom consumption compared to meat on gastrointestinal tolerance, short chain fatty acid (SCFA) production, laxation, and fecal microbiota.	Cross-over, 2-arm (1IG, 1CG) n: 35/35 (9% attrition)	10d (10d washout)	23 ± 4y 53% f Healthy	<b>Intervention:</b> Cooked mushroom meal (226g/day) <b>Comparator:</b> Cooked beef meal (28g/day)	Breathe hydrogen Stool frequency Stool consistency Fecal pH <b>Fecal wet weight</b> SCFA	↔ ↔ ↔ ↔ <b>↑ (p=0.002)</b> ↔	No adverse effects.	The mushroom diet resulted in higher average stool weight and a different fecal microbiota composition compared to the meat diet, with greater abundance of Bacteroidetes lower abundance of Firmicutes.	∅



Nishihira, 2017, Japan	To investigate whether ingesting champignon extract daily improved halitosis and body and fecal odor.	Parallel, double-blind, 4-arm (3IG, 1CG) n: 20/20/20/20 (4% attrition)	4w	64 ± 7y 51% f Problematic halitosis, body or fecal odor	<b>Intervention:</b> Champignon extract (50mg/day OR 500mg/day OR 1000mg/day) <b>Comparator:</b> 0mg/day	<p><i>50mg/day:</i></p> <p>Halitosis ↔</p> <p><b>Pillow odor ↓ (p=0.003)</b></p> <p>Pajama odor ↔</p> <p><b>Fecal odor ↓ (p=0.001)</b></p> <p>Bowel movement regularity ↔</p> <p><b>Strain during bowel movements ↓ (p=0.005)</b></p> <p>Sensation of residual stools ↔</p> <hr/> <p><i>500mg/day:</i></p> <p><b>Halitosis ↓ (p=0.001)</b></p> <p><b>Pillow odor ↓ (p=0.003)</b></p> <p><b>Pajama odor ↓ (p=0.004)</b></p> <p><b>Fecal odor ↓ (p=0.001)</b></p> <p>Bowel movement regularity ↔</p> <p><b>Strain during bowel movements ↓ (p=0.005)</b></p> <p>Sensation of residual stools ↔</p> <hr/> <p><i>100mg/day:</i></p> <p><b>Halitosis ↓ (p=0.001)</b></p> <p>Pillow odor ↔</p> <p><b>Pajama odor ↓ (p=0.004)</b></p> <p><b>Fecal odor ↓ (p=0.001)</b></p> <p>Bowel movement regularity ↔</p> <p><b>Strain during bowel movements ↓ (p=0.005)</b></p> <p>Sensation of residual stools ↔</p>	No adverse effects.	Ingesting champignon extract improved halitosis and body and fecal odor. Results suggest the effectiveness of champignon extract in alleviating odors is dose-dependent, i.e., it increases with the dosage.	-
Cholesterol									

Abd-alwahad, 2018, Iraq	To investigate the physiological and biological effects of eating mushrooms cooked in olive oil.	Parallel, non-randomised, 2-arm n: 25/25	30d	Not reported.	<b>Intervention:</b> Cooked mushroom (2g/kg body weight/day) <b>Comparator:</b> Usual diet	<b>Glucose</b> <b>Cholesterol</b> <b>HDL</b> <b>LDL</b> <b>Triglycerides</b> <b>Body weight</b> Urea Uric acid <b>WBC</b> <b>RBC</b> Hb PCV	↓ (p<0.05) ↓ (p<0.05) ↑ (p<0.05) ↓ (p<0.05) ↓ (p<0.05) ↓ (p<0.05) ↔ ↔ ↔ ↑ (p<0.05) ↑ (p<0.05) ↔ ↔	No adverse effects.	Agaricus bisporus cooked in olive oil reduces harmful lipids, glucose and enhances the blood cells.	-
Weigand-Heller, 2012, USA	To evaluate the bioavailability of ergothioneine using a dose-response, postprandial time-course design.	Cross-over, 2-arm (1IG, 1CG) n: 10/10 (0% attrition)	3d (3d washout)	27 ± 3y 0% f Healthy	<b>Intervention:</b> Powdered mushroom (8g/day OR 16g/day) <b>Comparator:</b> Placebo	Cholesterol HDL LDL Triglycerides	↔ ↔ ↔ ↔	No adverse effects.	Ergothioneine was bioavailable after consuming mushrooms and a trend in the postprandial triglyceride response indicated that there was a blunting effect after both the 8g and 16g doses.	∅
T2D risk management										
Calvo, 2016, USA	To estimate the impact of adding white button mushrooms to daily diet on known T2D risk factors.	Parallel, 4-arm*** n: 37	16w	48y 65% f MetS	<b>Intervention:</b> UV-exposed cooked mushrooms (100g/day) <b>Comparator:</b> Supplement 1242 IU D3/day OR 7320 IU D3/day	Serum 25(OH)D (total) <b>Serum ergothioneine</b> <b>ORAC</b> 8-isoprostane <b>Adiponectin</b> Leptin <b>sCML</b> <b>sMG</b>	↔ ↑ (p≤0.01) ↑ (p=0.03) ↔ ↑ (p=0.03) ↔ ↓ (p≤0.01) ↓ (p≤0.01)	No adverse effects.	Consuming white button mushrooms was associated with increased ergothioneine, lower circulating oxidative stress factors and higher serum adiponectin and ORAC and thus	+

improved risk markers of diabetes.

Immunological										
Jeong, 2012, Australia	To investigate the effect of dietary intake of white button mushrooms on salivary IgA (sIgA) secretion in healthy subjects.	Parallel, 2-arm (1IG, 1CG) n: 12/8 (20% attrition)	7d	42 ± 12y 50% f Healthy	<b>Intervention:</b> Cooked mushrooms (100g/day) <b>Comparator:</b> Usual diet	<b>sIgA:osmality</b> <b>sIgA secretion rate</b> <b>sIgA concentration</b> IgG secretion rate IgG concentration	<b>↑ (p=0.0012)</b> <b>↑ (p&lt;0.0005)</b> <b>↑ (p&lt;0.0005)</b> ↔ ↔	No adverse effects.	Consuming white button mushrooms accelerates SIgA secretion, thereby indicating its potential health benefits for improving mucosal immunity.	+

IG: intervention group. CG: comparator group. UV: ultraviolet. PSA: serum prostate-specific antigen. MetS: metabolic syndrome. 25(OH)D: 25-hydroxyvitamin D. IL: interleukin. iPTH: parathyroid hormone. TNF $\alpha$ : tumour necrosis factor alpha. HDL: high density lipoprotein cholesterol. LDL: low density lipoprotein cholesterol. WBC: white blood cells. RBC: red blood corpuscles. Hb: haemoglobin. PCV: packed cell volume. ORAC: oxygen radical absorbance capacity. sCML: serum carboxymethyl-lysine. sMG: serum methylglyoxal. sIgA: secretory immunoglobulin A. IgG: immunoglobulin G. d: days. w: weeks. m: months. y: years. f: female. IU: international unit.  $\uparrow$ : significant increase compared with control.  $\downarrow$ : significant decrease compared with control.  $\leftrightarrow$ : no significant change compared with control. Study quality +: positive.  $\emptyset$ : neutral. -: negative. \* *ex-vivo* LPS-stimulated cytokine production in peripheral mononuclear blood cells (PBMC). \*\* PHA-induced T-cell proliferation in PBMC. \*\*\* 4-arm pooled analysis. a: significant from baseline.

**Table 3.** Bioactive components in *Agaricus Bisporus* mushrooms

Reference	Type	Mushroom source (wild/cultivated, country)	Mushroom part	Compound (glucan/flavonoid/ ergosterol etc)	Amount
Babu, 2013	WBM	Cultivated, India	Cap	Flavonoids	2.173 ± 0.0007 µg/g
			Stipe	Flavonoids	1.533 ± 0.005 µg/g
Akyüz, 2012	WBM	Cultivated, Turkey	Whole	Myricetin	11.75 µg/g
				Quercetin	0.25 µg/g
				Kaempferol	0.25 µg/g
				Catechin	396.00 µg/g
				Naringenin	1.75 µg/g
				Resveratrol	0.50 µg/g
Tajalli, 2015	WBM	Cultivated/wild, Iran	Whole (wild)^	Flavonoids	3.72 (0.0020) mg CE/g
				Anthocyanins	4.7 (1.2) mg CGEs/100g
				Flavonoids	4.24 (0.0016) mg CE/g
				Anthocyanins	7.7 (0.5) mg CGEs/100g
				Flavonoids	2.78 (0.0004) mg CE/g
				Anthocyanins	1.13 (0.2) mg CGEs/100g
				Flavonoids	5.11 (0.0044) mg CE/g
			Whole (cultivated)	Anthocyanins	0.15 (0.01) mg CGEs/100g
				Flavonoids	3.98 (0.0004) mg CE/g
				Anthocyanins	1.7 (0.2) mg CGEs/100g
				Flavonoids	4.12 (0.0020) mg CE/g
				Anthocyanins	0.087 (0.1) mg CGEs/100g
				Flavonoids	4.15 (0.0016) mg CE/g
				Anthocyanins	'very low' (almost 0) mg CGEs/100g
Singla, 2010	WBM	Cultivated, India	Whole (raw)	Flavonoids (free)	37.12 mg/100g
				Flavonoids (bound)	64.69 mg/100g
			Whole (processed)	Flavonoids (free)	35.42 mg/100g
				Flavonoids (bound)	63.72 mg/100g
				Flavonoids	1.09 (0.02) mg CE/g
				Flavonoids	0.97 (0.01) mg CE/g
Mircea, 2015	BBM	Cultivated, Romania	Whole	Flavonoids	1.09 (0.02) mg CE/g
					0.97 (0.01) mg CE/g

					1.52 (0.01) mg CE/g
Guizani, 2012	WBM	Cultivated, Oman	Whole	Flavonoids	0.76 (0.05) mg
Jaworska, 2014	WBM	Cultivated, Poland	Whole (fresh)	Flavonoids	142 (8) mg/100g
			Whole (blanched)	Flavonoids	53 (3) mg/100g
			Whole (culinary treated)	Flavonoids	35 (5) mg/100g
Gan, 2013	WBM	Cultivated, Malaysia, Brazil	Extract (60% ethanol)	Flavonoids	1.75 (0.26) mg GAE/g
			Extract (aqueous)	Flavonoids	1.36 (0.11) mg GAE/g
Ganguli, 2006	WBM	Cultivated, India	Whole (raw)	Flavonoids	0.079% (0.004)
			Whole (fried 4min)	Flavonoids	0.050% (0.002)
			Whole (fried 5min)	Flavonoids	0.041% (0.004)
			Whole (fried 6min)	Flavonoids	0.038% (0.006)
Singla, 2012	WBM	Cultivated, India	Whole (raw)	Flavonoids	37.12 mg/100g
			Whole (2% treated)	Flavonoids	31.54 mg/100g
			Whole (4% treated)	Flavonoids	31.53 mg/100g
Öztürk, 2011	WBM	Cultivated, Turkey	Whole	Flavonoids	5.12 (0.55) µg QE/mg
Ozen, 2010	WBM	Cultivated, Turkey		Flavonoids	0.106 (0.006) mg QE/g
				Anthocyanins	0.17 (0.01) mg/ml
Rezaeian, 2015	WBM	Cultivated/wild, Iran	Whole (cultivated)	Flavonoids	6.46 (0.13) mg CE/g
			Whole (cultivated)	Flavonoids	1.11 (0.24) mg CE/g
			Whole (wild)^	Flavonoids	4.48 (0.05) mg CE/g
Ng, 2019	WBM	Cultivated, India	Whole (raw)	Flavonoids	78.67 (8.80) mg QE/100g
			Whole (boiled)	Flavonoids	46.89 (1.25) mg QE/100g
			Whole (microwaved)	Flavonoids	43.39 (4.66) mg QE/100g
			Whole (steamed)	Flavonoids	32.83 (4.51) mg QE/100g
			Whole (pressure-cooked)	Flavonoids	59.11 (10.30) mg QE/100g
Ng, 2017	WBM	Cultivated, Malaysia	Whole (raw)	Flavonoids	20.2 (2.9) mg Qct/100g
			Whole (boiled 1.5min)	Flavonoids	12.2 (2.8) mg Qct/100g
			Whole (boiled 3min)	Flavonoids	11.3 (2.7) mg Qct/100g
			Whole (boiled 4.5min)	Flavonoids	10.7 (0.7) mg Qct/100g
			Whole (boiled 6min)	Flavonoids	9.8 (0.4) mg Qct/100g
			Whole (microwaved 1.5min)	Flavonoids	14.3 (2.4) mg Qct/100g
			Whole (microwaved (3min)	Flavonoids	7.5 (1.0) mg Qct/100g

			Whole (microwaved 4.5min)	Flavonoids	6.1 (1.1) mg Qct/100g
			Whole (microwaved 6min)	Flavonoids	4.2 (0.5) mg Qct/100g
			Whole (steamed 1.5min)	Flavonoids	11.2 (3.4) mg Qct/100g
			Whole (steamed 3min)	Flavonoids	14.4 (5.0) mg Qct/100g
			Whole (steamed 4.5min)	Flavonoids	12.0 (1.0) mg Qct/100g
			Whole (steamed 6min)	Flavonoids	13.8 (1.0) mg Qct/100g
			Whole (pressure-cooked 15min)	Flavonoids	12.7 (0.3) mg Qct/100g
Barros, 2018	WBM	Cultivated/wild, Portugal	Whole <sup>^</sup>	Flavonoids	1.73 (0.11) mg/g
Buruleanu, 2018	WBM	Cultivated, Romania	Cap	Flavonoids	6.54 (0.00) mg QE/g
				Flavonoids	7.83 (4.18) mg QE/g
			Stipe	Flavonoids	5.23 (0.02) mg QE/g
				Flavonoids	3.26 (0.04) mg QE/g
	BBM	Cultivated, Romania	Cap	Flavonoids	8.43 (0.02) mg QE/g
				Flavonoids	3.5 (0.14) mg QE/g
			Stipe	Flavonoids	8.05 (0.04) mg QE/g
				Flavonoids	5.22 (0.06) mg QE/g
Khan, 2016	WBM	Cultivated, India	Whole	Flavonoids	56.76 µg RE/g
Jagadish, 2009	WBM	Cultivated, India	Whole (raw)	Flavonoids	16.4 (0.5) mg QE/g
			Whole (boiled)	Flavonoids	15.2 (0.2) mg QE/g
Dhamodhara, 2013	WBM	Cultivated, India	Whole	Flavonoids	10.3 (1.0) mg QE/g
Um, 2014	WBM	Cultivated, South Korea	Whole	Flavonoids	1636.8 (17.5) mg naringin/100g
Palansiamy, 2014	WBM	Cultivated, Spain	Whole (25°C)*	α-glucan	27% <sup>a</sup>
				β-glucan	25% <sup>a</sup>
			Whole (50°C)*	α-glucan	26% <sup>a</sup>
				β-glucan	27% <sup>a</sup>
			Whole (100°C)*	α-glucan	32% <sup>a</sup>
				β-glucan	29% <sup>a</sup>
			Whole (150°C)*	α-glucan	35% <sup>a</sup>
				β-glucan	0% <sup>a</sup>
Whole (200°C)*	α-glucan	50% <sup>a</sup>			

				$\beta$ -glucan	44% <sup>a</sup>
			Whole	Chitin	4.9 mg/100g
Choi, 2010	WBM	Korea	Whole	Total glucan	8.97 (0.21) % w/w
				$\alpha$ -glucan	1.13 (0.52) % w/w
				$\beta$ -glucan	7.83 (0.74) % w/w
			LMW	Catechin	15.07 (0.83) mg/g
				Tannic acid	11.58 (0.65) mg/g
				Gallate	9.51 (0.52) mg/g
			HMW	Catechin	14.98 (0.34) mg/g
				Tannic acid	11.50 (0.27) mg/g
				Gallate	9.45 (0.22) mg/g
Dikeman, 2005	WBM	Cultivated, USA	raw immature	$\beta$ -glucan	0.1%
			cooked immature	$\beta$ -glucan	0.1%
			raw mature	$\beta$ -glucan	0.1%
			cooked mature	$\beta$ -glucan	0.1%
	Crimini		raw immature	$\beta$ -glucan	0.1%
			cooked immature	$\beta$ -glucan	0.1%
			raw mature	$\beta$ -glucan	0.1%
			cooked mature	$\beta$ -glucan	0.1%
	Portabella		raw immature	$\beta$ -glucan	0.1%
			cooked immature	$\beta$ -glucan	0.1%
			raw mature	$\beta$ -glucan	0.0%
			cooked mature	$\beta$ -glucan	0.2%
Nitschke, 2011a	WBM	Cultivated, Germany	Whole	$\beta$ -glucan	2.60 g/100g
Khan, 2017	WBM	Cultivated, India	Whole	Total glucan	10.045 (0.21) g/100g
				$\alpha$ -glucan	1.534 (1.56) g/100g
				$\beta$ -glucan	8.511 (2.45) g/100g
Singh, 2017	WBM	Cultivated, India	Whole	Total glucan	0.78 g/10g
				Chitin	0.12 g/10g
				Chitin-glucan complex	1.8 g/10g
	Portobello			Total glucan	3.96 (0.64)
	Crimini			Total glucan	3.94 (0.08)
				$\beta$ -glucan	19.20%

Mirończuk-Chodakowska, 2017	Portobello	Cultivated, Poland	Whole	Total glucan	3.96 (0.64)
	Crimini			Total glucan β-glucan	3.94 (0.08) 19.2%
Sari, 2017	WBM	Cultivated, Germany	Cap	Total glucan	10.051 ± 2.228 g/100g
				α-glucan	1.547 ± 0.378 g/100g
				β-glucan	8.605 ± 2.373 g/100g
	Stipe	Total glucan	14.963 (4.979) g/100g		
		α-glucan	2.667 (1.224) g/100g		
		β-glucan	12.296 (4.077) g/100g		
BBM	Cap	Total glucan	12.348 (4.514) g/100g		
		α-glucan	3.511 (2.383) g/100g		
Stipe	Total glucan	14.647 (4.874) g/100g			
	α-glucan	4.568 (2.845) g/100g			
β-glucan	10.079 (2.230) g/100g				
Taofiq, 2016	Unknown	Portugal	Extract	Ergosterol	44.79 ± 0.37 mg/g
Stojkovic, 2014	Unknown	Netherlands	Cap	Ergosterol	138.74 ± 0.61 mg/100g
Simon, 2011	WBM	Cultivated, Canada	Whole	Ergosterol	578.2 ± 29.8 mg/100g
				Vitamin D	5.5 ± 4.6 µg/100g
			Whole (UV light exposed)	Ergosterol	579.5 ± 20.7 mg/100g
				Vitamin D	579.5 ± 20.7 µg/100g
			Whole (sunlight exposed)	Ergosterol	633.4 ± 17.4 mg/100g
				Vitamin D	633.4 ± 17.4 µg/100g
Shao, 2010	WBM	Canada	Stage 1	Ergosterol	3.41 mg/g
			Stage 2	Ergosterol	3.32mg/g
			Stage 3	Ergosterol	3.01mg/g
			Cap (Stage 3)	Ergosterol	3.30mg/g
			Stipe (Stage 3)	Ergosterol	2.33mg/g
	BBM	Canada	Stage 1	Ergosterol	4.66mg/g
			Stage 2	Ergosterol	2.93mg/g
			Stage 3	Ergosterol	2.49mg/g



Sapozhnikova, 2014	WBM	Cultivated, USA	Cap (Stage 3)	Ergosterol	2.71mg/g	
			Stipe (Stage 3)	Ergosterol	2.03mg/g	
			Extract	Ergothioneine	0.81-0.92mg/g	
				Ergosterol	4.6-5.2mg/g	
				Vitamin D	179 ± 5IU/g	
	BBM	Cultivated, USA	Extract	Vitamin D	2156 ± 43IU/g	
				Vitamin D	4739 ± 61IU/g	
				Ergothioneine	0.37-0.48mg/g	
			Extract (Low UV)	Vitamin D	1942 ± 30IU/g	
				Extract (High UV)	Vitamin D	6292 ± 109IU/g
Phillips, 2011	WBM	Cultivated, USA	Whole	Ergosterol	56.3mg/100g	
				Vitamin D	0.11ug/100g	
	Crimini	Cultivated, USA	Whole	Ergosterol	61.4mg/100mg	
				Vitamin D	0.06ug/100g	
	Portabella	Cultivated, USA	Cap	Ergosterol	62.1mg/100g	
				Vitamin D	0.25ug/100g	
			Cap (UV treated)	Ergosterol	51.1mg/100g	
				Vitamin D	11.2ug/100g	
	Mattila, 2002	WBM	Cultivated, Finland	Whole	Ergosterol	654mg/100g
					Vitamin D	0mg/100g
Wild, Finland			Whole <sup>^</sup>	Vitamin D	4.7-194ug/100g	
Jasinghe, 2005	WBM	Cultivated, Singapore	Whole	Ergosterol	7.80 ± 0.35mg/g	
				Vitamin D	12.48 ± 0.28ug/g	
Heleno, 2017	WBM	Cultivated, Portugal	Extract	Ergosterol	36.72 ± 0.01mg/g	
Hammann, 2016	WBM	Cultivated, Germany	Whole	Ergosterol	443 ± 44mg/100g; 90% free sterols	
Guan, 2016	WBM	Cultivated, Canada	Cap	Ergosterol	6.12 ± 0.09mg/g	
					<i>UV dose:</i>	
					0.5kj/m <sup>2</sup>	6.05 ± 0.37mg/g
					1.0kj/m <sup>2</sup>	6.11 ± 0.20mg/g
			2.0kj/m <sup>2</sup>	5.96 ± 0.16 mg/g		
		Stem	Ergosterol	5.2 ± 0.13mg/g		

			<i>UV dose:</i>		
			0.5kj/m <sup>2</sup>		5.4 ± 0.29mg/g
			1.0kj/m <sup>2</sup>		5.25 ± 0.22mg/g
			2.0kj/m <sup>2</sup>		5.2 ± 0.18mg/g
	BBM		Cap	Ergosterol	7.59 ± 0.13 mg/g
			<i>UV dose:</i>		
			0.5kj/m <sup>2</sup>		7.61 ± 0.61 mg/g
			1.0kj/m <sup>2</sup>		7.64 ± 0.31 mg/g
			2.0kj/m <sup>2</sup>		7.69 ± 0.19mg/g
			Stem	Ergosterol	7.56 ± 0.41mg/g
			<i>UV dose:</i>		
			0.5kj/m <sup>2</sup>		7.22 ± 41mg/g
			1.0kj/m <sup>2</sup>		7.35 ± 0.29mg/g
			2.0kj/m <sup>2</sup>		7.60 ± 0.18mg/g
Gasecka, 2018	BBM	Cultivated, Poland	Extract (Hollander Spawn C9)	Ergosterol	26.4 ± 1.5mg/100g
	WBM		Extract (Sylvan 767)	Ergosterol	9.5 ± 1.2mg/100g
			Extract (Amycel 2600)	Ergosterol	21.7 ± 1.2mg/100g
			Extract (Kanmycel 3-1)	Ergosterol	36.1 ± 3mg/100g
			Extract (Italspawn F599)	Ergosterol	4 ± 0.7mg/100g
			Extract (Kanmycel K2)	Ergosterol	18.4mg/100g
			Extract (Sylvan A15)	Ergosterol	1.1 ± 0.2mg/100g
Cardoso, 2017	WBM	Cultivated, Portugal	Cap	Ergosterol	17.4 ± 0.1mg/g
Cardoso, 2019	Portobello	Cultivated, Portugal	Whole	Ergosterol	216-250mg /100g
Barreira, 2014	Portobello	Cultivated, Portugal	Extract	Ergosterol	352 ± 1 mg/100g
					77 ± 1 mg/100g
Alshammaa, 2017	WBM	Wild, Iraq	Extract <sup>^</sup>	Ergosterol	27.6675% (w/w)
Chung, 1998	WBM	Cultivated, UK	Stipe	Chitin	42%
Hassainia, 2018	WBM	Cultivated, France	Cap	Chitin	7.4 ± 1.2%
			Stipe	Chitin	6.4 ± 1.4%
			Gills	Chitin	5.9 ± 1.2%
Manzi, 2001	WBM	Cultivated, Italy	Whole (fresh, raw)	β-glucan	1.4 ± 0.2 mg/100g

				Chitin	0.6 ± 0.04 g/100g
			Whole (fresh, cooked)	β-glucan	4.2 ± 0.3 mg/100g
				Chitin	0.7 ± 0.04 g/100g
			Whole (deep frozen, raw)	β-glucan	1.2 ± 0.6 mg/100g
				Chitin	0.34 ± 0.01 g/100g
			Whole (deep frozen, cooked)	β-glucan	3.2 ± 0.8 mg/100g
				Chitin	0.52 ± 0.02 g/100g
			Whole (canned, raw)	β-glucan	1.7 ± 0.2 mg/100g
				Chitin	0.61 ± 0.05 g/100g
			Whole (canned, cooked)	β-glucan	0.8 ± 0.4 mg/100g
				Chitin	0.74 ± 0.06 g/100g
Nitschke, 2011b	WBM	Cultivated, Germany	Extract	Chitin	4.69 ± 0.90 mg/100g
Vetter, 2007	WBM	Cultivated, Germany	Cap (1 <sup>st</sup> flush)	Chitin	7.21 ± 0.51%
			Cap (2 <sup>nd</sup> flush)	Chitin	7.16 ± 1.0%
			Cap (3 <sup>rd</sup> flush)	Chitin	5.63 ± 1.02%
			Stipe (1 <sup>st</sup> flush)	Chitin	7.61 ± 0.90%
			Stipe (2 <sup>nd</sup> flush)	Chitin	7.29 ± 1.34%
			Stipe (3 <sup>rd</sup> flush)	Chitin	6.94 ± 2.23%
Kalaras, 2017	WBM	Cultivated, USA	Whole	Ergothioneine	0.41 ± 0.18 mg/g
	Crimini				0.47 ± 0.16 mg/g
	Portobello				0.15 mg/g
Dubost, 2007	WBM	Cultivated, USA	Whole	Ergothioneine	0.21 ± 0.01 mg/g
	Crimini				0.40 ± 0.03 mg/g
	Portobello				0.45 ± 0.03 mg/kg
Chen, 2012	WBM	Cultivated, Taiwan	Whole	Ergothioneine	932.7 ± 5.0 mg/kg

WBM: white button mushroom. BBM: brown button mushroom. LMW: low molecular weight. HMW: high molecular weight. \* pressurized-water extraction temperatures. ^ wild mushrooms may naturally receive UV exposure from sunlight compared to cultivated mushrooms unless otherwise specified. a: values estimated from figures. µg: micrograms. CGEs: cyanidin-3-glucoside equivalents. CE: catechin equivalents. QE: quercetin equivalents. GAE: gallic acid equivalents. Qct: quercetin. RE: rutin equivalents. w/w: weight per weight.

## Supplementary Material

**Table S1:** Search terms

### Medline & Embase (Ovid)

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- 1 "agaricus".ti,ab.
  - 2 Agaricus/
  - 3 (button adj3 mushroom\*).ti,ab.
  - 4 "common mushroom\*".ti,ab.
  - 5 champignon\*.ti,ab.
  - 6 (cremini\* or crimini\*).ti,ab.
  - 7 (portobello\* or portabello\* or portabella\* or portobella\*).ti,ab.
  - 8 1 or 2 or 3 or 4 or 5 or 6 or 7
  - 9 (review or editorial or letter or comment).pt.
  - 10 8 not 9
- 

### CINHAL

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- S9 S1 OR S3 OR S4 OR S5 OR S6 OR S7 OR S8
- S8 TI ( portobello\* or portabello\* or portabella\* or portobella\* ) OR AB ( portobello\* or portabello\* or portabella\* or portobella\* )
- S7 TI ( cremini\* or crimini\* ) OR AB ( cremini\* or crimini\* )
- S6 TI agaricus OR AB agaricus
- S5 TI champignon\* OR AB champignon\*
- S4 TI "common mushroom\*". OR AB "common mushroom\*".
- S3 TI "button mushroom\*" OR AB "button mushroom\*"
- S2 TI button adj3 mushroom\* OR AB button adj3 mushroom\*
- S1 "agaricus"
- 

### Scopus

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( TITLE-ABS-KEY ( agaricus ) OR TITLE-ABS-KEY ( "button mushroom\*" ) OR TITLE-ABS-KEY ( champignon\* ) OR TITLE-ABS-KEY ( ( crimini\* OR cremini\* ) ) OR TITLE-ABS-KEY ( ( portabello\* OR portobella\* OR portobello\* ) ) AND NOT TITLE ( review ) ) AND DOCTYPE ( ar )

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## Cochrane Library

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- 1 agaricus
  - 2 button NEAR/3 mushroom\*
  - 3 (portabello\* or portabella\* or portobello\* or portobella)
  - 4 champignon\*
  - 5 (crimini\* or cremini\*)
  - 6 ("Agaricus"):ti,ab,kw
  - 7 MeSH descriptor: [Agaricus] explode all trees
  - 8 (button mushroom\*):ti,ab,kw
  - 9 (portabello\* or portabella\* or portobello\* or portobella):ti,ab,kw
  - 10 (champignon\*):ti,ab,kw
  - 11 ((crimini\* or cremini\*)):ti,ab,kw
-

**Table S2.** Quality Criteria Checklist for Primary Research

Study reference	R/v	Relevance				Validity										Overall
		q 1	q 2	q 3	q 4	q 1	q 2	q 3	q 4	q 5	q 6	q 7	q 8	q 9	q 10	
Volman et al, 2010	1	Yes	Yes	Yes	Yes	Yes	Yes	?	?	?	Yes	Yes	?	Yes	?	⊖
	2	Yes	Yes	Yes	Yes	Yes	Yes	?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	
Stephensen et al, 2012	1	Yes	Yes	Yes	Yes	Yes	Yes	Yes	?	Yes	Yes	Yes	Yes	Yes	Yes	+
	2	Yes	Yes	Yes	Yes	Yes	Yes	Yes	?	Yes	Yes	Yes	?	Yes	Yes	
Urbain et al, 2011	1	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	?	Yes	Yes	?	Yes	Yes	+
	2	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	
Shanely et al, 2014	1	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	?	Yes	Yes	?	No	No	⊖
	2	Yes	Yes	Yes	Yes	Yes	Yes	?	Yes	Yes	Yes	?	Yes	Yes	?	
Jeong et al, 2012	1	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	?	Yes	Yes	?	Yes	Yes	+
	2	Yes	Yes	Yes	Yes	Yes	Yes	Yes	?	Yes	Yes	Yes	Yes	Yes	?	
Nishihira et al, 2017	1	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	?	Yes	Yes	No	No	-
	2	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	?	?	?	?	
Cheskin et al, 2008	1	Yes	Yes	Yes	Yes	Yes	Yes	Yes	?	?	?	Yes	Yes	Yes	Yes	⊖
	2	Yes	Yes	Yes	Yes	Yes	Yes	Yes	?	?	?	Yes	Yes	Yes	Yes	
Hess et al, 2018	1	Yes	Yes	Yes	?	Yes	Yes	?	Yes	No	Yes	Yes	Yes	No	Yes	⊖
	2	Yes	Yes	Yes	?	Yes	Yes	?	Yes	Yes	Yes	?	Yes	Yes	Yes	
Hess et al, 2017	1	Yes	Yes	Yes	?	Yes	Yes	?	Yes	No	Yes	Yes	Yes	Yes	Yes	⊖
	2	Yes	Yes	Yes	?	Yes	Yes	?	Yes	No	Yes	?	Yes	Yes	?	
Weigand-Heller et al, 2012	1	Yes	Yes	Yes	Yes	Yes	?	Yes	Yes	No	Yes	Yes	No	No	Yes	⊖
	2	Yes	Yes	Yes	Yes	Yes	Yes	?	Yes	Yes	Yes	No	Yes	?	Yes	
Keegan et al, 2013	1	Yes	Yes	Yes	Yes	Yes	Yes	No	No	?	No	?	Yes	No	No	-
	2	Yes	Yes	Yes	Yes	Yes	Yes	No	?	?	Yes	?	?	?	?	
Twardowski et al, 2015	1	Yes	Yes	Yes	Yes	Yes	Yes	Yes	n/a	Yes	n/a	Yes	Yes	Yes	Yes	+
	2	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	n/a	?	Yes	Yes	Yes	Yes	
Calvo et al, 2016	1	Yes	Yes	Yes	Yes	Yes	Yes	Yes	n/a	n/a	n/a	Yes	Yes	?	Yes	+
	2	Yes	Yes	Yes	Yes	Yes	Yes	n/a	n/a	n/a	n/a	?	?	Yes	Yes	
Lee et al, 2013	1	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	?	+
	2	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	

Abd-Alwahab et al, 2018	1	Yes	Yes	Yes	Yes	Yes	No	No	?	?	?	No	No	No	?	-
	2	Yes	Yes	Yes	Yes	Yes	No	?	?	?	?	No	?	?	?	

R/v: Reviewer. ?: Unclear. +: Positive. 0: Neutral. -: Negative. n/a: not applicable.

### Relevance

1. **Would implementing the studied intervention or procedure (if found successful) result in improved outcomes for the patients/clients/population group? (NA for some epidemiological studies)**
2. **Did the authors study an outcome (dependent variable) or topic that the patients/clients/population group would care about?**
3. **Is the focus of the intervention or procedure (independent variable) or topic of study a common issue of concern to dietetics practice?**
4. **Is the intervention or procedure feasible? (NA for some epidemiological studies)**

### Validity

#### 1. Was the research question clearly stated?

- 1.1 Was the specific intervention(s) or procedure (independent variable(s)) identified?
- 1.2 Was the outcome(s) (dependent variable(s)) clearly indicated?
- 1.3 Were the target population and setting specified?

#### 2. Was the selection of study subjects/patients free from bias?

- 2.1 Were inclusion/exclusion criteria specified (e.g., risk, point in disease progression, diagnostic or prognosis criteria), and with sufficient detail and without omitting criteria critical to the study?
- 2.2 Were criteria applied equally to all study groups?
- 2.3 Were health, demographics, and other characteristics of subjects described?
- 2.4 Were the subjects/patients a representative sample of the relevant population?

#### 3. Were study groups comparable?

- 3.1 Was the method of assigning subjects/patients to groups described and unbiased? (Method of randomization identified if RCT)
- 3.2 Were distribution of disease status, prognostic factors, and other factors (e.g., demographics) similar across study groups at baseline?
- 3.3 Were concurrent controls used? (Concurrent preferred over historical controls.)
- 3.4 If cohort study or cross-sectional study, were groups comparable on important confounding factors and/or were preexisting differences accounted for by using appropriate adjustments in statistical analysis?
- 3.5 If case control study, were potential confounding factors comparable for cases and controls? (If case series or trial with subjects serving as own control, this criterion is not applicable. Criterion may not be applicable in some cross-sectional studies.)
- 3.6 If diagnostic test, was there an independent blind comparison with an appropriate reference standard (e.g., "gold standard")?

#### **4. Was method of handling withdrawals described?**

- 4.1 Were follow up methods described and the same for all groups?
- 4.2 Was the number, characteristics of withdrawals (i.e., dropouts, lost to follow up, attrition rate) and/or response rate (cross-sectional studies) described for each group? (Follow up goal for a strong study is 80%.)
- 4.3 Were all enrolled subjects/patients (in the original sample) accounted for?
- 4.4 Were reasons for withdrawals similar across groups?
- 4.5 If diagnostic test, was decision to perform reference test not dependent on results of test under study?

#### **5. Was blinding used to prevent introduction of bias?**

- 5.1 In intervention study, were subjects, clinicians/practitioners, and investigators blinded to treatment group, as appropriate?
- 5.2 Were data collectors blinded for outcomes assessment? (If outcome is measured using an objective test, such as a lab value, this criterion is assumed to be met.)
- 5.3 In cohort study or cross-sectional study, were measurements of outcomes and risk factors blinded?
- 5.4 In case control study, was case definition explicit and case ascertainment not influenced by exposure status?
- 5.5 In diagnostic study, were test results blinded to patient history and other test results?

#### **6. Were intervention/therapeutic regimens/exposure factor or procedure and any comparison(s) described in detail? Were intervening factors described?**

- 6.1 In RCT or other intervention trial, were protocols described for all regimens studied?
- 6.2 In observational study, were interventions, study settings, and clinicians/provider described?
- 6.3 Was the intensity and duration of the intervention or exposure factor sufficient to produce a meaningful effect?
- 6.4 Was the amount of exposure and, if relevant, subject/patient compliance measured?
- 6.5 Were co-interventions (e.g., ancillary treatments, other therapies) described?
- 6.6 Were extra or unplanned treatments described?
- 6.7 Was the information for 6.4, 6.5, and 6.6 assessed the same way for all groups?
- 6.8 In diagnostic study, were details of test administration and replication sufficient?

#### **7. Were outcomes clearly defined and the measurements valid and reliable?**

- 7.1 Were primary and secondary endpoints described and relevant to the question?
- 7.2 Were nutrition measures appropriate to question and outcomes of concern?
- 7.3 Was the period of follow-up long enough for important outcome(s) to occur?
- 7.4 Were the observations and measurements based on standard, valid, and reliable data collection instruments/tests/procedures?



- 7.5 Was the measurement of effect at an appropriate level of precision?
- 7.6 Were other factors accounted for (measured) that could affect outcomes?
- 7.7 Were the measurements conducted consistently across groups?

**8. Was the statistical analysis appropriate for the study design and type of outcome indicators?**

- 8.1 Were statistical analyses adequately described the results reported appropriately?
- 8.2 Were correct statistical tests used and assumptions of test not violated?
- 8.3 Were statistics reported with levels of significance and/or confidence intervals?
- 8.4 Was “intent to treat” analysis of outcomes done (and as appropriate, was there an analysis of outcomes for those maximally exposed or a dose-response analysis)?
- 8.5 Were adequate adjustments made for effects of confounding factors that might have affected the outcomes (e.g., multivariate analyses)?
- 8.6 Was clinical significance as well as statistical significance reported?
- 8.7 If negative findings, was a power calculation reported to address type 2 error?

**9. Are conclusions supported by results with biases and limitations taken into consideration?**

**9.1 Is there a discussion of findings?**

**9.2 Are biases and study limitations identified and discussed?**

**10. Is bias due to study’s funding or sponsorship unlikely?**

- 10.1 Were sources of funding and investigators’ affiliations described?
- 10.2 Was there no apparent conflict of interest?



# What are the health benefits and bioactive components found in *Agaricus bisporus* mushrooms? Key findings from a world-first systematic literature review

Prepared for Hort Innovation  
**March 2020**

Prepared by Nutrition Research Australia



## Executive Summary

This is the first ever systematic review on the health benefits of the world's most commonly consumed mushroom, *Agaricus bisporus*, using human studies. This systematic review also explores the amount of key bioactive compounds found in mushrooms, which may explain their health effects.

### Health benefits:

- Eating mushrooms exposed to ultraviolet (UV) light increases vitamin D levels and decreases vitamin D precursor ergosterol concentration. The effect on vitamin D levels is the same as taking a supplement.
- Eating cooked mushrooms can increase ergothioneine (an antioxidant) and reduce inflammation.
- A mushroom-based meal can increase fullness and reduce subsequent hunger compared to eating a meat-based meal with the same amount of protein.
- Including mushrooms (either fresh or extract) in the diet can improve markers of gut health, specifically, an increase faecal stool weight, a reduction in strain during bowel movements, a reduction in faecal odour, improved gut microbiota, and can also minimise bad breath.
- Eating more than 2g per day of white button mushrooms can lower the risk of ovarian cancer by 32%.
- Eating 100g of cooked mushrooms daily can strengthen the immune system and increase adiponectin, a protein hormone which improves insulin sensitivity, protects against atherogenesis, promotes anti-inflammatory effects, and can even decrease body weight.

### Bioactive compounds:

- White button mushrooms have more ergothioneine (an antioxidant) than brown button mushrooms.
- White button mushrooms have 28% more antioxidants in the cap compared to the stipe (or stem).
- There are 8-12g/100g of beta-glucans in mushrooms, more than oats (3-8g/100g). The beta-glucan content is higher in the stipe (10-12g/100g) compared to the cap (8-9g/100g).
- Cooking decreases the number of antioxidants found in mushrooms. The greater the cooking time, the greater the loss.

- Cooking increases chitin, a naturally occurring fibre that is similar to cellulose, regardless of how the mushroom is prepared and stored (e.g. fresh, frozen or canned).

## Background

It has been reported from laboratory experiments and research conducted in animals that eating edible mushrooms can improve health. These studies show that mushrooms are a rich source of bioactive compounds including ergothioneine, ergosterol, vitamin D, beta-glucan and selenium, which can:

- Strengthen the immune system.
- Help control blood sugar levels, cholesterol, and blood pressure.
- Help manage body weight.
- Improve gut health.
- Promote strong bones.
- Improve brain function.

However, it is unknown whether similar effects also occur in humans.

There is a large variety of mushrooms on the market today. The mushrooms most commonly eaten by humans worldwide belong to the *Agaricus bisporus* species, which includes white button, brown button, portobello, and cremini mushrooms. A systematic review that focuses on these types of mushrooms is therefore most generalisable to the Australian population and will provide the most relevant key messages for communication and educational purposes.

This is the first systematic review ever conducted on the effects of the world's most commonly consumed mushroom, *Agaricus bisporus*, on human health outcomes. This review also explores the amount of each bioactive compound found in mushrooms, which may explain their health effects.

## What was done

A systematic literature search of the five electronic databases (MEDLINE, EMBASE, Scopus, CINAHL, and The Cochrane Library) was conducted. No restrictions were placed on the type of study that could be included or the date when it was published.

To be included in this review, a study needed to meet the following criteria:

- ✓ Be conducted in humans of any age,
- ✓ Use *Agaricus bisporus* mushrooms in whole or processed (e.g. dried extract) form, and
- ✓ Report effects on any health outcome OR report on one or more of the following bioactive compounds: ergosterol, ergothioneine, vitamin D, flavonoids, glucans, and/or chitin.

To decide if a study should be included in this review, two investigators independently checked each study for eligibility. Any differences between the two authors were decided by a third independent investigator. Studies that reported on human health outcomes were also assessed for methodological quality by two different investigators using the Quality Criteria Checklist for Primary Research in the Academy of Nutrition and Dietetics Evidence Analysis Manual.

The systematic literature search found 9,811 studies. Of these, 501 studies that investigated *Agaricus bisporus* mushrooms were identified. These 501 studies represent a complete and up-to-date database of every study published on the *Agaricus bisporus* mushroom and health related outcome or nutritional/bioactive compound. The evidence is current to December 2019 and is being continuously monitored for newly published papers that also meet the eligibility criteria.

Of the 501 studies which investigated *Agaricus bisporus*, 68 studies met the eligibility criteria and were examined to answer the research questions. Fifteen studies reported the effect of mushroom consumption on human health, and 53 studies reported the amount of one or more bioactive compounds.

## Key results

### Health outcomes

Studies reported on the following health outcomes:

- Vitamin D absorption (**4 studies**).
- Inflammation (e.g. cytokines, antioxidant capacities; **3 studies**).
- Satiety (e.g. hunger and fullness; **2 studies**).
- Gut health (e.g. microbiota, stool weight, bowel strain, faecal odour, bad breath; **2 studies**).
- Cancer (**2 studies**).
- Cardio-metabolic markers (e.g. glucose, cholesterol, triglycerides, body weight; **2 studies**).
- Immune function (**1 study**).

Most research (80%) has been conducted with medium to high methodological quality. Studies were mainly conducted in the USA (67%), and intervention studies mainly used 'healthy' people (57%). There were no significant side effects reported with eating mushrooms.

We found that eating *Agaricus bisporus* mushrooms can:

### *Increase and maintain vitamin D levels*

- The strongest evidence of any health benefit was found for improving vitamin D status.
- All studies showed UVB-exposed mushrooms increased vitamin D<sub>2</sub> levels.
- Eating UVB-exposed mushrooms had the same efficacy at increasing total vitamin D levels as taking a vitamin D supplement.

### *Reduce inflammation*

- Cooked mushrooms (100g per day) increased both ergothioneine (an antioxidant) and increased oxygen radical absorbance capacity (antioxidant activity) in a high quality randomised controlled trial.
- Eating 5g per day of  $\alpha$ -glucans from mushroom extract over 5 weeks led to a decrease in tumour necrosis factor (TNF)-alpha (a pro-inflammatory cytokine), compared to the control.
- No effects were found on other inflammatory markers measured (e.g. interleukin (IL)-1 $\beta$ , IL-2, IL-4, IL-6, IL-10, IL-12, IL-13, IL-17, interferon- $\gamma$ , serum creatinine).

### *Increase satiety*

- Eating mushrooms was associated with increased feelings of fullness, reduced hunger, and a lower food intake during the rest of the day, compared with a protein-matched beef meal without mushrooms.
- No differences in hunger or fullness were found when a mushroom meal was compared to a volume-matched, rather than calorie matched beef meal, but total calorie intake was substantially lower.

### *Improve gut health*

- Mushrooms (either fresh or extract) increased faecal stool weight, reduced strain during bowel movements, reduced faecal odour, improved gut microbiota, and minimised bad breath, compared to control.
- No changes were found in markers of bacterial fermentation (breath H<sub>2</sub>, faecal pH and faecal short chain fatty acids) or bowel regularity, compared to the control.

### *Lower the risk of cancer*

- Regularly consuming mushrooms reduced the risk of ovarian and prostate cancers.
- Eating more than 2g per day of white button mushrooms was associated with a 32% reduced risk of ovarian cancer.

- Mushroom extract was associated with decreased prostate specific antigen levels in 36% of prostate cancer patients. Prostate specific antigen levels are used by doctors to help detect prostate cancer or other prostate abnormalities.

#### *Improve metabolic markers*

- Levels of adiponectin increased after eating 100g of cooked white button mushrooms daily over 16 weeks. By increasing adiponectin, mushrooms may improve insulin sensitivity, protect against atherogenesis, promote anti-inflammatory effects, and even decrease body weight.
- Eating white button mushrooms cooked in olive oil (2g/kg body weight/day) for 30 days were associated with lower glucose, total cholesterol, low-density lipoprotein, triglycerides, and body weight, and higher high-density lipoprotein, compared to the control.

#### *Strengthen the immune system*

- Compared to usual diet, eating 100g of cooked white button mushrooms for 7 days was associated with increased serum IgA osmolarity, secretion rate, and concentration, which are markers of immune function.
- Findings show that white button mushrooms may improve mucosal immunity. The mucosal immune system protects the body from pathogens than can enter the body's surfaces through gas exchange (lungs), food absorption (the gut), sensory activities (eyes, nose, mouth, throat), and reproduction (uterus and vagina).

#### **Bioactive compounds**

Studies reported on the following bioactive compounds:

- Flavonoids (**22 studies**).
- Ergosterol (**16 studies**).
- Vitamin D (**5 studies**).
- Ergothioneine (**4 studies**).
- Glucans (**9 studies**).
- Chitin (**7 studies**).

*Agaricus bisporus* mushrooms contain beta-glucans, ergosterol, ergothioneine, vitamin D, and an antioxidant compound usually reported as flavonoids. The concentration of these bioactive compounds will vary depending on the type of mushroom, cooking method and duration, and level



of UVB exposure. Research have been mainly conducted using cultivated white button mushrooms from Europe or Asia.

### *Flavonoids*

- The greatest concentration of flavonoids was catechin (~396ug/g), followed by myricetin (11.75ug/g).
- Cooking decreased flavonoid concentration, therefore raw is best for flavonoid content. The greater the cooking time, the greater the loss.
- More flavonoids were found in the cap compared to the stipe (approximately 28% greater in cap of white button mushrooms).
- It is unknown if any differences in flavonoids exist by mushroom type.

### *Ergosterol and vitamin D*

- Exposure to UVB light (e.g. in a lab or sunlight) after harvesting increased vitamin D and decreased ergosterol (vitamin D precursor) concentration.
- Brown button and cremini mushrooms reported greater ergosterol concentrations compared to white button mushrooms.
- Portebello mushrooms reported higher concentrations of ergosterol in the cap, compared to white button mushrooms.
- No study has tested the effect of cooking method or mushroom maturity on ergosterol concentration.

### *Ergothioneine*

- White button mushrooms had a greater concentration of the antioxidant ergothioneine compared to brown button mushroom extract.
- No study has tested the effect of cooking method or mushroom part on ergothioneine.

### *Glucans*

- The main glucans in mushrooms are beta-glucans, which account for approximately 75% of total glucan concentrations.
- A greater concentration of glucans can be found in the stipe than the cap.
- The volume of beta-glucans in mushrooms is approximately 8-12g [8-9g/100g cap; 10-12g/100g stipe], which is more than oats (3-8g/100g).

- Brown button mushrooms have slightly higher concentrations of glucans compared to white button mushrooms.
- No differences in beta-glucan concentration was found with maturity or cooking method.

### Chitin

- Cooking increases chitin, a naturally occurring fibre that is similar to cellulose, regardless of how the mushroom is prepared and stored (e.g. fresh, frozen or canned).

## The bottom line

*Agaricus bisporus* mushrooms contain beta-glucans, ergosterol, ergothioneine, vitamin D, and unknown antioxidants usually reported as flavonoids. The amount of these nutrients can differ depending on the type of mushroom, cooking method, cooking length, part of the mushroom, and amount of sun exposure pre- and post-harvest. Eating UV-exposed mushrooms have the same ability as vitamin D supplements at increasing and maintaining a person's vitamin D levels. *Agaricus bisporus* mushrooms have also been shown to reduce the risk of cancer, and improve metabolic health, immune function, and gastrointestinal function. However, more human studies are needed before these findings can be confidently adopted into clinical practice.

## Further research opportunities

*Create a Practice-based Evidence in Nutrition (PEN) professional resource.*

**Background:** The PEN System is an online tool that gives nutrition professionals worldwide access to a trusted source of evidence-based information that they can use to improve their practice. PEN has partnered with the Dietitians Association of Australia, Dietitians of Canada, and the British Dietetic Association.

**What is required:** To create a PEN guideline for mushrooms we will need to apply either (i) the Grading of Recommendations Assessment, Development and Evaluation (GRADE) approach to the key findings of this systematic review, or (ii) apply the PEN System Evidence-based Process (i.e. non-GRADE approach) to grade the levels of evidence, similar to the NHMRC levels of evidence process. This is a PEN requirement.

**Benefit:** Creating a PEN professional resource that focuses on the health benefits of *Agaricus bisporus* mushrooms will help promote the key results from this review to a wide audience of nutrition professionals globally through the PEN platform.

*Conduct a randomised controlled trial to investigate the cholesterol lowering effect of beta-glucans in mushrooms: Are mushrooms as effective as oats?*

**Background:** Mushrooms contain a substantially higher concentration of beta-glucans compared to oats, rye, and barley. FSANZ and other international food governing bodies have approved a high-level health claim based on the link between eating 3g of beta-glucans (from oats or barley) and blood cholesterol. However, no claim has been approved for mushrooms.

**What is required:** The higher amounts of beta-glucans in mushrooms, compared to oats and barley, present an exciting opportunity to confirm the health effects induced by beta-glucans in mushrooms using a clinical trial.

**Benefit:** This could help to provide the evidence required to support the submission for a health claim for the ability of mushrooms to lower cholesterol.

*Conduct a randomised controlled trial of the effect of sun exposed mushrooms on vitamin D within the Australian context.*

**Background:** This systematic review found the strongest evidence of a health effect for UVB-exposed mushrooms on the improvement of vitamin D status. However, no study has investigated this relationship in the Australian population. Due to the Earth's orbit, Australians are exposed to up to 15% more ultraviolet (UV) radiation than Europeans during summer, and some of the highest levels of UV radiation in the world during the year because of our close proximity to the equator.

**What is required:** Conducting the same study in Australia to test whether we find different results.

**Benefit:** Finding out whether stronger health effects can be achieved from mushrooms that are exposed to higher levels of UV radiation from the Australian sun will give us the direct evidence needed to support a health claim for mushroom's and the improvement of vitamin D in Australia.

*Conduct a clinical trial of the effect of sun exposed mushrooms on vitamin D status in vulnerable population groups*

**Background:** In Australia, 98% of bariatric surgery patients are deficient in vitamin D before they have surgery, cancer patients are advised to avoid sun exposure during chemotherapy

and in aged care there is a strong push to avoid medicalisation and focus on food and quality of life, despite a high rate of vitamin D deficiency.

**What is required:** Replicate the randomised controlled trial mentioned above in vulnerable groups of people who are at high risk of vitamin D deficiency (e.g. bariatric surgery patients, cancer patients and the elderly in aged care)

**Benefit:** Findings would be of high clinical relevance.

*Conduct further research to strengthen the evidence of a link between mushrooms and health*

**Background:** This review found that only a small number of studies have looked at the effect of eating *Agaricus bisporus* mushrooms on each health outcome (1-4 studies for each health outcome). This lack of replication in studies lowers the confidence, or strength of the evidence, for each key result.

**What is required:** Similar studies to be conducted in different groups of people (e.g. the elderly, children, specific disease states).

**Benefit:** Findings can be translated into clinical practice guidelines and public health initiatives.

*Examine different types of cooking methods and the effects they have on mushroom flavour and texture profile.*

**Background:** The effect of different types of cooking methods on mushroom flavour and texture profile remains unknown.

**What is required:** Understand these effects through new research.

**Benefit:** Will enhance the culinary versatility of mushrooms and provide exciting new ways for health professionals to promote the use of mushrooms to their clients.

*Deep dive into umami and combining foods to help inform culinary professionals.*

**Background:** Research that explains what happens when umami foods are combined is needed to understand the full potential of this flavour profile. Umami, as a fifth taste, can elevate food by providing richness and complexity while increasing satiety. Umami-rich foods bring a meaty and salty essence to plant-based and low sodium dishes, while they can further enhance digestion and stimulate saliva and digestive juices.

**What is required:** Understand the science behind this unique flavour profile and especially how mushrooms can be combined with other umami-rich foods to increase their flavour and digestive properties.

**Benefit:** This research would significantly enhance the education of culinary professionals and introduce them to new and innovative ways to use mushrooms in their dishes.

*Do an updated analysis of the bioactive and nutrient composition using Australian mushrooms (including Agaricus bisporus mushrooms), similar to what has recently been completed for potatoes.*

**Background:** FSANZ has recently undertaken a small analytical program to update their food composition data holdings. Foods were chosen if they had either no data, or if data were outdated and no longer reflected the products available for consumption. Vegetables that have recently been updated are cauliflower, carrot, corn and potatoes. Differences in nutrient composition were found for some vegetables (e.g. potatoes) which has led FSANZ to refine their records and results will also feed into future releases of the FSANZ reference database: the Australian Food Composition Database.

**What is required:** An updated nutrient analysis of mushrooms consumed in Australian. Such an analysis has not been completed.

**Benefit:** Could potentially fill some important data gaps and provide an improved level of confidence about the nutrient composition of mushrooms consumed in Australia.

*Measure the time-exposure relationship for vitamin D in Agaricus bisporus mushrooms (gills exposed/cap exposed/sliced) for 10- or 15-minute intervals in the Australian sun.*

**Background:** The amount of vitamin D that mushrooms can absorb from the Australian sun is unknown. For example, we don't understand what happens to vitamin D concentrations when you accidentally leave your mushrooms out in the sun for an extended period of time. Also, do differences exist in the vitamin D content of UV-exposed mushrooms depending on how they are placed outside (e.g. gills exposed, or cap exposed) or whether they are sliced?

**What is required:** Conduct a study that measures the vitamin D content of three different groups of UV-exposed mushrooms (e.g. group 1: gills exposed; group 2: cap exposed; group 3 sliced) at 10- or 15-minute intervals over 8 hours.

**Benefit:** Will help us answer to these questions and provide data to inform clinical practice guidelines for the use of mushrooms to treat vitamin D deficiency in Australia.

*Determine if your genes influence whether you like or dislike mushrooms?*

**Background:** We don't know if taste preferences for umami foods, like mushrooms, are influenced by genetics. Research shows that there are genes related to taste sensitivity (our likes or dislikes to bitter, sweet, umami and even fat flavours). In particular, vegetable

preferences are strongly influenced by genetics. However, very few genetic studies have looked at specific foods and results have not been consistent. For some tastes (e.g. sweet, salty and fat) research shows genes partially control our preferences to these foods, this means our preferences for these foods could be modified based on diet.

**What is required:** Undertake research to understand if a consumers preference to mushrooms could be modified by environmental exposures.

**Benefit:** Will provide important insight when strategising ways to increase consumer intakes.

*Investigate if organic mushrooms differ to non-organic mushrooms with regards to ergosterol content. Is there such a thing as organic mushrooms?*

**Background:** Limited research has looked at the effect of farming practices on the nutrient content of mushrooms. Some research suggests that organic vegetables have more of the antioxidant compounds linked to better health than regular food, and lower levels of toxic metals and pesticides. However, any differences in the ergosterol content of mushrooms remains unknown. Mushrooms are rich in ergosterol, which is converted to vitamin D with UV light.

**What is required:** Research that helps us to understand if there are any differences in the ergosterol content of organic mushrooms compared to cultivated mushrooms.

**Benefit:** Will help to refine the health messages that are given to clients seeking to improve their vitamin D status through eating mushrooms.

**APPENDIX 9: MS113 SYSTEMATIC LITERATURE REVIEW MANUSCRIPT**



# Examining the health effects and bioactive components in *Agaricus bisporus* mushrooms: a scoping review<sup>☆</sup>

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## Abstract

There is evidence from both *in vitro* and animal models that the consumption of edible mushrooms has beneficial effects on health. It is unclear whether similar effects exist in humans and which bioactive compounds are present. This review synthesises the evidence on the world's most commonly consumed mushroom, *Agaricus bisporus* to (i) examine its effect on human health outcomes; and (ii) determine the nutrient density of its bioactive compounds, which may explain their health effects. A systematic literature search was conducted on the consumption of *A. bisporus*, without date and study design limits. Bioactive compounds included ergosterol, ergothioneine, flavonoids, glucans and chitin. Two authors independently identified studies for inclusion and assessed methodological quality. Beneficial effects of *A. bisporus* on metabolic syndrome, immune function, gastrointestinal health and cancer, with the strongest evidence for the improvement in Vitamin D status in humans, were found. Ultraviolet B (UVB) exposed mushrooms may increase and maintain serum 25(OH)D levels to a similar degree as vitamin D supplements. *A. bisporus* contain beta-glucans, ergosterol, ergothioneine, vitamin D and an antioxidant compound usually reported as flavonoids; with varying concentrations depending on the type of mushroom, cooking method and duration, and UVB exposure. Further research is required to fully elucidate the bioactive compounds in mushrooms using vigorous analytical methods and expand the immunological markers being tested. To enable findings to be adopted into clinical practice and public health initiatives, replication of existing studies in different population groups is required to confirm the impact of *A. bisporus* on human health.

**Keywords:** Systematic review; *Agaricus bisporus*; Mushroom; Health; Human; Bioactive

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**Abbreviations:** 25(OH)D<sub>2</sub>, 25-Hydroxyvitamin D<sub>2</sub>; 25(OH)D, 25-Hydroxyvitamin D; BBM, brown button mushrooms; CE, catechin equivalents; CG, comparator group; CGEs, cyanidin-3-glucoside equivalents; d, days; f, female; GAE, gallic acid equivalents; g, grams; Hb, haemoglobin; HDL, high density lipoprotein cholesterol; HMW, high molecular weight; H<sub>2</sub>, hydrogen; IgA, immunoglobulin A; IgG, immunoglobulin G; IL, interleukin; IU, international units; IG, intervention group; kcal, kilocalorie; LDL, low density lipoprotein cholesterol; LMW, low molecular weight; MetS, metabolic syndrome; NA, not applicable; OR, odds ratio; ORAC, oxygen radical absorbance capacity; PCV, packed cell volume; iPTH, parathyroid hormone; PSA, prostate specific antigen; QE, quercetin equivalents; Qct, quercetin; RCT, randomised controlled trial; RBC, red blood cells; RE, rutin equivalents; sIgA, secretory immunoglobulin A; sCML, serum carboxymethyl-lysine; sMG, serum methylglyoxal; TNF, tumour necrosis factor; UV, ultraviolet; UVB, ultraviolet B; WBC, white blood cells; w/w, weight per weight; WBM, white button mushrooms

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## 1. Introduction

Although commonly regarded and consumed as a vegetable, mushrooms are members of the *Fungi* kingdom and offer a unique nutritional profile. Biologically distinct to both plants and animals, mushrooms are rich in micronutrients that are normally found in vegetables, meats and grains [1]. These include riboflavin, niacin, pantothenic acid, copper, phosphorus, selenium, fibre-associated monosaccharides and polysaccharides, and the sulphur-containing amino acid ergothioneine [1,2]. Mushrooms are one of the only natural vegetarian sources of both vitamin B<sub>12</sub>, which is bacteria-derived [3], and vitamin D, which is produced by the conversion of ergosterol to ergocalciferol after exposure to ultraviolet (UV) light [4].

There is a growing body of evidence that suggests consuming several mushroom species, either as a food or as extracts, may improve physical and mental health [5,6]. Mushrooms are rich in bioactive compounds, particularly ergothioneine, ergosterol, vitamin D, beta-glucan and selenium, and these bioactive compounds have been favourably linked to immune function [7,8], glycaemic control [9,10], weight management [11], lipid profile [12,13], blood pressure [14], bone density [15], gut health [16], cancer [17,18] and cognitive function [19]. These health benefits are thought to be largely a result of the enhancement of cellular immunity to produce immunomodulatory, anti-carcinogenic, antimicrobial and hypocholesterolemic effects [5], and due to their effects on the gastrointestinal microbiota [19].

Despite the growing body of evidence linking mushrooms' nutritional uniqueness to beneficial health effects, existing narrative reviews have found limited evidence in human studies. In 2012, Roupas et al. [5] concluded that while mushrooms of many different species demonstrated numerous health benefits within *in vitro* and *in vivo* animal models, there was insufficient evidence to confirm similar effects in humans due to limitations in study design, sample size and the indirectness of the evidence [5]. Other narrative reviews investigating the role of beta-glucans in mushrooms [20] and immunomodulatory activities of mushroom polysaccharides [21]

have also found limited research in humans. Since these narrative reviews were published, interest into the therapeutic properties of edible mushrooms in human models has grown. Therefore, a broad systematic synthesis of the evidence reporting the health effects of edible mushrooms in humans and their bioactive compounds that support these effects is warranted.

Due to the large variety of mushroom species available for human consumption, a focus on those that are most abundant and frequently consumed by humans will have the greatest translational value. The most commonly consumed mushrooms worldwide belong to the *Agaricus bisporus* species, which includes white button mushrooms (WBM), brown button mushrooms (BBM), portobello and cremini mushrooms [1]. Therefore, the aim of this scoping literature review was to synthesise the evidence on *A. bisporus* mushrooms to (i) examine its effect on human health outcomes; and (ii) determine the nutrient density of its bioactive compounds, which may explain their health effects.

## 2. Methods

The review protocol was developed using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines [22], PRISMA Extension for Scoping Reviews (PRISMA-ScR) [23] and was prospectively registered at PROSPERO (still awaiting processing).

### 2.1. Eligibility criteria

Table 1 highlights the eligibility criteria for the study selection. Studies were deemed eligible if they were original primary research articles conducted in human populations, reported on whole or processed (e.g. dried extract) mushrooms from the *A. bisporus* species, were consumed orally, and reported a health outcome. All physical and mental health outcomes were considered for inclusion. Prospective cohort and cross-sectional studies on health outcomes in humans

Table 1  
Inclusion and exclusion criteria for the selection of studies

Inclusion criteria	Exclusion criteria
Studies on <i>A. bisporus</i> mushrooms in human populations of any age and health effect, without date limits	Studies published in languages other than English
Studies using <i>A. bisporus</i> mushrooms in whole or processed (e.g. dried extract) form	Studies where <i>A. bisporus</i> mushrooms were not consumed orally
Studies conducted in any country	Studies in animals
Any study design	Studies in duplicate populations
Studies reporting data in a format that enabled data specific to mushrooms to be extracted	Lack of a random sample
Studies reporting ergosterol, ergothioneine, flavonoids, bioactive polysaccharides (alpha and beta glucans) and chitin in <i>A. bisporus</i> mushrooms	Studies solely reporting other bioactive compounds in <i>A. bisporus</i> mushrooms

were considered if the dietary intake from mushrooms was measured, even if the mushroom type (e.g. whole mushroom or extract) was unspecified. Studies reporting on bioactive compounds were also included if they reported on *A. bisporus* mushrooms and measured ergosterol, ergothioneine, flavonoids, glucans (alpha- or beta-glucans) or chitin.

2.2. Search strategy

A systematic search for publications was conducted (25th June 2019), using the electronic databases MEDLINE, EMBASE, Scopus, CINHAL and The Cochrane Library, without date limits (Table S1). To identify publications that reported on the consumption of *A. bisporus* mushrooms, the following keywords were searched (with special

features in parentheses): Agaricus (exp/), Agaricus bisporus (exp/), A bisporus (exp/), white button mushroom (exp/), button mushroom (exp/), common mushroom (exp/), cultivated mushroom (exp/), champignon (exp/), cremini (exp/), cremini (exp/), portobello (exp/) (Table S1). Keywords were searched for as free text in the title, abstract and subject headings. Study population and outcomes records were combined using the Boolean operator “AND”. Additional publications were identified from references in original papers.

2.3. Selection process

All records identified were first assessed for eligibility based on information contained in the title, abstract, and description/MeSH heading by two independent reviewers (KA, ED, TC or FFM), after

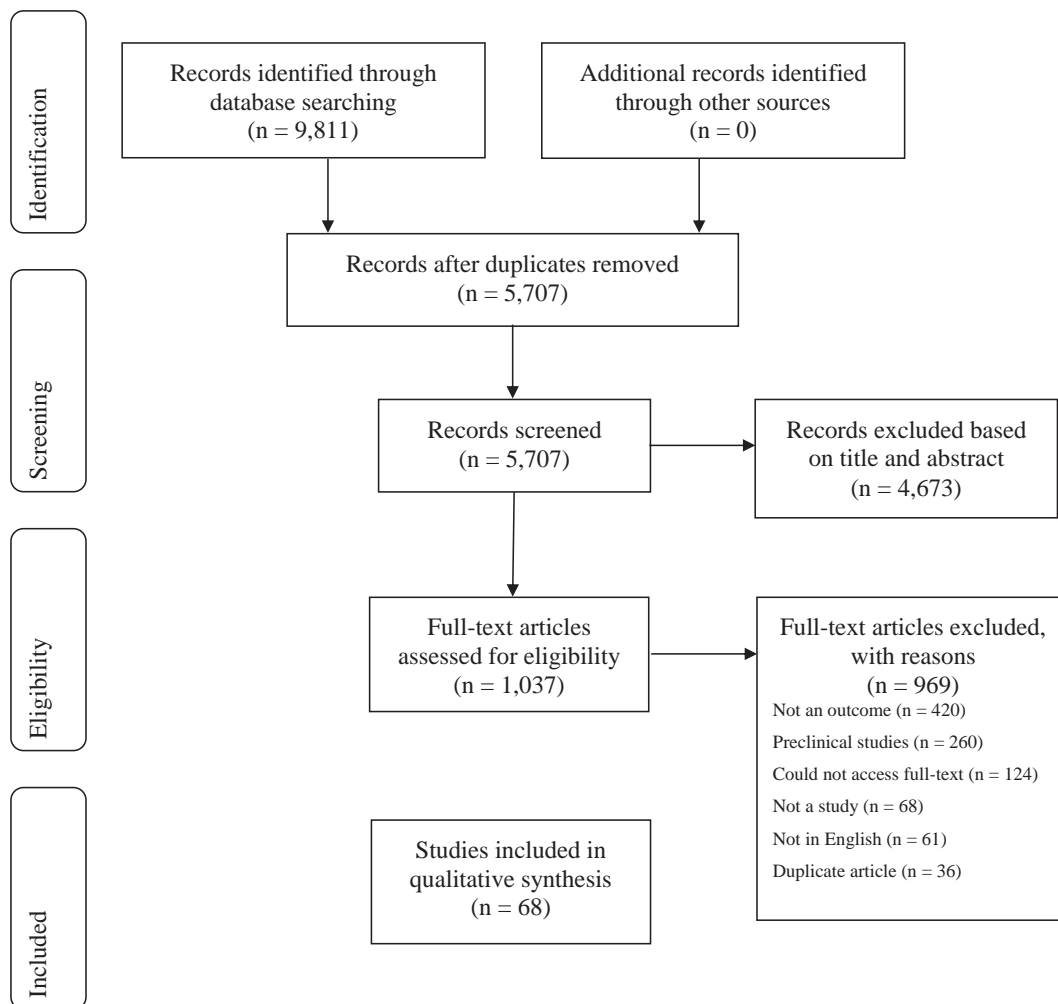


Fig. 1. PRISMA study flow chart.

Table 2  
Studies using *Agaricus bisporus* mushrooms or extracts derived from *Agaricus bisporus* mushrooms and measuring health outcomes in humans

Author, year, country	Study aim	Study Design, sample size (n: IG/CG)	Study duration	Population (age, %female, health condition)	Exposure	Outcome/s Measured	Results (↑↓↔)	Adverse effects/ limitations	Conclusions	Study quality (+ 0 -)
<b>Vitamin D</b>										
Stephensen, 2012, USA	To evaluate the effects of consuming UV-exposed white button mushrooms ( <i>A. bisporus</i> ) on the vitamin D status of healthy adults.	Parallel, double-blind n: 9/10/10 (8.8 µg D <sub>2</sub> /17.1 µg D <sub>2</sub> /control) (3% attrition)	6 w	31±11 y 58% f Healthy	<b>Intervention:</b> UV-exposed cooked mushrooms (87.9 g/day) delivering 8.8 µg OR 17.1 µg D <sub>2</sub> /day <b>Comparator:</b> Non UV-exposed cooked mushrooms (87.9 g/day)	8.8 µg D <sub>2</sub> /day: <b>Serum 25(OH)D<sub>2</sub></b> Serum 25(OH)D <sub>3</sub> Serum 25(OH)D (total) Serum 24,25 (OH)D <sub>3</sub> 17.1 µg D <sub>2</sub> /day: <b>Serum 25(OH)D<sub>2</sub></b> <b>Serum 25(OH)D<sub>3</sub></b> Serum 25(OH)D (total) Serum 24,25 (OH)D <sub>3</sub>	↑ (P<.05) ↔ ↔ ↔ ↔ ↑ (P<.05) ↓ (P<.05) ↔ ↔	No adverse effects.  No significant difference in the vitamin D <sub>2</sub> content of raw vs. cooked mushrooms (P=.41)	Ergocalciferol was absorbed and metabolised to 25 (OH)D <sub>2</sub> but did not affect vitamin D status, because 25OHD <sub>3</sub> decreased proportionally.	+
Keegan, 2013, USA	To compare effectiveness at increasing and maintaining vitamin D status of dried white button mushroom extract and supplemental vitamin D <sub>3</sub> and vitamin D <sub>2</sub> .	Parallel, 3-arm (1IG, 2CG) n: 14/8/3 (17% attrition)	12 w	35 y 75% f Healthy	<b>Intervention:</b> Dried white button mushroom extract (2000 IU D <sub>2</sub> /day) <b>Comparator:</b> Supplement 2000 IU D <sub>2</sub> /day OR 2000 IU D <sub>3</sub> /day	<b>Serum 25(OH)D (total)</b> <b>Serum 25(OH)D<sub>2</sub></b> Serum 25(OH)D <sub>3</sub>	↑ (P<.001) <sup>a</sup> ↑ (P<.001) <sup>a</sup> Not reported	No adverse effects.	Consumption of mushrooms containing D <sub>2</sub> was as effective at increasing and maintaining total serum 25(OH)D levels as supplemental vitamin D <sub>2</sub> and D <sub>3</sub> .	-
Urbain, 2011, Germany	To investigate the bioavailability of vitamin D <sub>2</sub> from UV-exposed mushrooms in humans, in comparison to a vitamin D <sub>2</sub> supplement.	Parallel, single-blind, 3-arm (2IG, 1CG) n: 8/9/9 (8% attrition)	3-5 w	31 ± 6 y 65% f Healthy	<b>Intervention:</b> UV-exposed cooked mushrooms (28,000 IU D <sub>2</sub> /day) OR Non-UV-exposed cooked mushrooms (60 IU D <sub>2</sub> /day + 28,000 IU D <sub>2</sub> /day supplement) <b>Comparator:</b> Non-UV-exposed cooked mushrooms (60 IU D <sub>2</sub> /day + placebo supplement)	28,000 IU D <sub>2</sub> /day: <b>Serum 25(OH)D (total)</b> Serum Calcium Serum iPTH  60 + 28,000 IU D <sub>2</sub> /day: <b>Serum 25(OH)D (total)</b> Serum Calcium Serum iPTH	↑ (P<.001) ↔ ↔  ↑ (P<.001) ↔ ↔	No adverse effects.	Vitamin D <sub>2</sub> -enhanced button mushrooms via UV exposure was effective in improving vitamin D status in young, healthy adults.	+
Shanely, 2014, USA	To determine if supplementation with mushroom powder would enhance skeletal muscle function and attenuate exercise-induced muscle damage in low vitamin D status high school athletes.	Parallel, double-blind, 2-arm (1IG, 1CG) n: 17/17 (3% attrition)	6 w	16± 0 y 0% f Vitamin D insufficient athletes	<b>Intervention:</b> UV-exposed powdered mushroom (600 IU D <sub>2</sub> /day) <b>Comparator:</b> Placebo	<b>Serum 25(OH)D (total) Serum 25 (OH)D<sub>2</sub></b> <b>Serum 25(OH)D<sub>3</sub></b>	↑ (P=.004) ↑ (P<.0001) ↓ (P<.0001)	No adverse effects.	600 IU/d vitamin D <sub>2</sub> increased 25 (OH)D <sub>2</sub> with a concomitant decrease in 25(OH)D <sub>3</sub> , with no effect on muscular function or exercise-induced muscle damage in high school athletes.	0

Table 2  
(continued)

Author, year, country	Study aim	Study Design, sample size (n: IG/CG)	Study duration	Population (age, %female, health condition)	Exposure	Outcome/s Measured	Results (↑↓↔)	Adverse effects/ limitations	Conclusions	Study quality (+ 0 -)
<b>Inflammation</b>										
Calvo, 2016, USA	To estimate the impact of adding white button mushrooms to daily diet on known T2D risk factors.	Parallel, 4-arm*** n: 37	16 w	48 y 65% f MetS	<b>Intervention:</b> UV-exposed cooked mushrooms (100 g/day) <b>Comparator:</b> Supplement 1242 IU D <sub>3</sub> /day OR 7320 IU D <sub>3</sub> /day	<b>Serum ergothioneine</b> <b>ORAC</b> 8-isoprostane <b>Adiponectin</b> Leptin <b>sCML</b> <b>sMG</b>	↑ ( <b>P≤.01</b> ) ↑ ( <b>P= .03</b> ) ↔ ↑ ( <b>P= .03</b> ) ↔ ↓ ( <b>P≤.01</b> ) ↓ ( <b>P≤.01</b> )	No adverse effects.	Consuming white button mushrooms was associated with increased ergothioneine, lower circulating oxidative stress factors and higher serum adiponectin and ORAC.	+
Volman, 2010, Netherlands	To evaluate the effects of consuming α-glucans in hypercholesterolemic subjects.	Parallel, double-blind n: 26/30 (0% attrition)	5 w (2 w run-in)	57± 8 y 42.9% f	Hypercholesterolemic  Ø <i>Th1 cytokines:</i> **IFNγ **IL-12 **IL-2 <i>Th2 cytokines:</i> **IL-13 **IL-4	<b>Intervention:</b> 200 mL juice/day containing 5 g/day α-glucans extracted from white button mushrooms <b>Comparator:</b> 200 mL juice/day with 0 g α-glucans	*IL-1β *IL-6 *TNFα *IL-10 *IL-17  ↔ ↔ ↔ ↔ ↔  ↔ ↔ ↔ ↔ ↔	↔ ↔ ↓ ( <b>P= .017</b> ) ↔ ↔	No adverse effects.	Consumption of <i>A. bisporus</i> α-glucans lowered LPS-induced TNFα production, whereas no effect on IL-1β and IL-6 was observed. No obvious Th1–Th2 skewing by PHA-stimulated PBMCs was observed. However, we observed a trend towards a decreased production of IL-12 and IL-10. No significant changes in kidney or liver function.
Serum creatinine	↔									
Serum ALT	↔									
Serum AST	↔									
Serum GGT	↔									
Serum APT	↔									
S e r u m Bilirubin	↔									
Weigand-Heller, 2012, USA	To evaluate the bioavailability of ergothioneine using a dose–response, postprandial time-course design.	Cross-over, 2-arm (1IG, 1CG) n: 10/10 (0% attrition)	3 d (3 d washout)	27± 3 y 0% f Healthy	<b>Intervention:</b> Powdered mushroom (8 g/day OR 16 g/day) <b>Comparator:</b> Placebo	CRP Cholesterol HDL LDL Triglycerides Glucose <b>ORAC (total)</b> <b>Ergothioneine</b>	↔ ↔ ↔ ↔ ↔ ↔ ↓ ( <b>P&lt;.05</b> ) ↑ ( <b>P&lt;.05</b> )	No adverse effects.	Ergothioneine was bioavailable after consuming mushrooms and a trend in the postprandial triglyceride response indicated that there was a blunting effect after both the 8 g and 16 g doses. ORAC total values decreased after the 8 g and 16 g mushroom meal.	Ø

T a b l e 2  
(continued)

Author, year, country	Study aim	Study Design, sample size (n: IG/CG)	Study duration	Population (age, %female, health condition)	Exposure	Outcome/s Measured	Results (↑↓↔)	Adverse effects/ limitations	Conclusions	Study quality (+ 0 -)
<b>Satiety</b>										
Hess, 2017, USA	To compare satiety and food intake differences between mushroom and meat consumption.	Cross-over, 2-arm (1IG, 1CG) n: 35/35 (9% attrition)	10 d (10 d washout)	23± 4 y 53% f Healthy	<b>Intervention:</b> Cooked mushroom meal (226 g/day) <b>Comparator:</b> Cooked beef meal (28 g/day)	<b>Satiety</b> Energy intake	↑ ( <b>P=.05</b> ) ↔	No adverse effects.	Mushroom meal had a positive effect on satiety, but no effect on energy intake.	0
Cheskin, 2008, USA	To investigate how substituting mushrooms for beef in a test lunch affected energy intake, fat intake, palatability, appetite, satiation and satiety in normal weight, overweight and obese adults.	Cross-over, 2-arm n: 76/76 (29% attrition)	4 d (3 d washout)	36 y 67% f Healthy	<b>Intervention:</b> Cooked mushroom meal (339 kcal/day) <b>Comparator:</b> Cooked beef meal (783 kcal/day)	Satiety Satiation <b>Fat intake</b> <b>Energy intake</b> Appetite	↔ ↔ ↓ ( <b>P&lt;.0001</b> ) ↓ ( <b>P&lt;.0001</b> ) ↔	No adverse effects.	Energy intakes were higher during meat lunches than mushroom lunches. Total daily energy and fat intake were greater in the meat than in the mushroom condition. Palatability, appetite, satiation and satiety did not differ.	0
<b>Cancer</b>										
Lee, 2013, China	To investigate the association between mushroom consumption and risk of epithelial ovarian cancer.	Case-control, retrospective n: 500/500	2 y	59 ± 6 y 100% f H e a l t h y (controls) Ovarian cancer (cases)	<b>Exposure:</b> White button mushroom consumption	Ovarian cancer	↓ ( <b>OR=0.68</b> )	N/A	Ovarian cancer patients consumed less mushrooms than controls. Apparent reductions in cancer risk were found at high levels of intake, especially for white button mushroom for women consuming >2 g/day.	+
Twardoski, 2015, USA	To evaluate the effects of white button mushroom powder on serum PSA levels and determine the tolerability.	Phase I, clinical dose-escalation n: 36	10 m (1–58 m)	68 y 0% f Elevated PSA	<b>Treatment:</b> Powdered mushroom (4,6,8,10,12,14 g/day)	<b>Serum PSA</b> Androgens MDSCs IL-15	↓ ( <b>n=13, 36%</b> )	Abdominal bloating	White button mushroom powder therapy was associated with declining PSA levels in some patients.	+
<b>Gastrointestinal</b>										
Hess, 2018, USA	To assess mushroom consumption compared to meat on gastrointestinal tolerance, short chain fatty acid (SCFA) production, laxation, and faecal microbiota.	Cross-over, 2-arm (1IG, 1CG) n: 35/35 (9% attrition)	10 d (10 d washout)	23± 4 y 53% f Healthy	<b>Intervention:</b> Cooked mushroom meal (226 g/day) <b>Comparator:</b> Cooked beef meal (28 g/day)	Breathe hydrogen Stool frequency Stool consistency Faecal pH <b>F a e c a l w e i g h t</b> SCFA	↔ ↔ ↔ ↔ ↑ ( <b>P=.002</b> ) ↔	No adverse effects.	The mushroom diet resulted in higher average stool weight and a different faecal microbiota composition compared to the meat diet, with greater abundance of Bacteroidetes lower abundance of Firmicutes. Ingesting champignon extract improved halitosis and body and	0
Nishihira, 2017, Japan	To investigate whether ingesting champignon extract daily improved	Parallel, double-blind, 4-arm (3IG, 1CG) n: 20/20/20/20	4 w	64 ± 7 y 51% f Problematic	<b>Intervention:</b> Champignon extract (50 mg/day OR 500	50 mg/day: Halitosis <b>Pillow odour</b>	↔ ↔ ↓ ( <b>P=.003</b> )	No adverse effects.		-



Table 2  
(continued)

Author, year, country	Study aim	Study Design, sample size (n: IG/CG)	Study duration	Population (age, %female, health condition)	Exposure	Outcome/s Measured	Results (↑↓↔)	Adverse effects/ limitations	Conclusions	Study quality (+ 0 -)
Weigand-Heller, 2012, USA	To evaluate the bioavailability of ergothioneine using a dose-response, postprandial time-course design.	Cross-over, 2-arm (1IG, 1CG) n: 10/10 (0% attrition)	3 d (3 d washout)	27±3 y 0% f Healthy	<b>Intervention:</b> Powdered mushroom (8 g/day OR 16 g/day) <b>Comparator:</b> Placebo	Uric acid WBC RBC Hb PCV Cholesterol HDL LDL Triglycerides	↔ ↑ (P<.05) ↑ (P<.05) ↔ ↔ ↔ ↔ ↔ ↔ ↔	No adverse effects.	Ergothioneine was bioavailable after consuming mushrooms and a trend in the postprandial triglyceride response indicated that there was a blunting effect after both the 8 g and 16 g doses.	0
T2D risk management Calvo, 2016, USA	To estimate the impact of adding white button mushrooms to daily diet on known T2D risk factors.	Parallel, 4-arm*** n: 37	16 w	48 y 65% f MetS	<b>Intervention:</b> UV-exposed cooked mushrooms (100 g/day) <b>Comparator:</b> Supplement 1242 IU D <sub>3</sub> /day OR 7320 IU D <sub>3</sub> /day	Serum 25(OH)D (total) Serum ergothioneine ORAC 8-isoprostane Adiponectin Leptin sCML sMG	↔ ↑ (P≤.01) ↑ (P=.03) ↔ ↑ (P=.03) ↔ ↓ (P≤.01) ↓ (P≤.01) ↔	No adverse effects.	Consuming white button mushrooms was associated with increased ergothioneine, lower circulating oxidative stress factors and higher serum adiponectin and ORAC and thus improved risk markers of diabetes.	+
Immunological Jeong, 2012, Australia	To investigate the effect of dietary intake of white button mushrooms on salivary IgA (sIgA) secretion in healthy subjects.	Parallel, 2-arm (1IG, 1CG) n: 12/8 (20% attrition)	7 d	42 ± 12 y 50% f Healthy	<b>Intervention:</b> Cooked mushrooms (100 g/day) <b>Comparator:</b> Usual diet	sIgA: osmality sIgA secretion rate s I g A concentration IgG secretion rate I g G concentration	↑ (P=.0012) ↑ (P<.0005) ↑ (P<.0005) ↔ ↔	No adverse effects.	Consuming white button mushrooms accelerates sIgA secretion, thereby indicating its potential health benefits for improving mucosal immunity.	+

IG, intervention group; CG, comparator group; UV, ultraviolet; PSA, total serum prostate-specific antigen; MetS, metabolic syndrome; 25(OH)D, 25-hydroxyvitamin D; IL, interleukin; iPTH, parathyroid hormone; TNF $\alpha$ , tumour necrosis factor alpha; HDL, high density lipoprotein cholesterol; LDL, low density lipoprotein cholesterol; WBC, white blood cells; RBC, red blood corpuscles; Hb, haemoglobin; PCV, packed cell volume; ORAC, oxygen radical absorbance capacity; sCML, serum carboxymethyl-lysine; sMG, serum methylglyoxal; sIgA, secretory immunoglobulin A; IgG, immunoglobulin G; d, days; w, weeks; m, months; y, years; f, female; IU, international unit; ↑, significant increase compared with control; ↓, significant decrease compared with control; ↔, no significant change compared with control; Study quality +, positive; 0, neutral; -, negative; \* *ex-vivo* LPS-stimulated cytokine production in peripheral mononuclear blood cells (PBMC); \*\* PHA-induced T-cell proliferation in PBMC; \*\*\* 4-arm pooled analysis; a, significant from baseline.

which the inclusion and exclusion criteria were applied (Table 1). This process was completed using Covidence systematic literature review software [Veritas Health Innovation, Melbourne, Australia] [24]. The full text of all studies that appeared to meet the eligibility screening were retrieved and subjected to a second assessment for relevance by the same two reviewers (Table 1). Any difference in assessments that arose between reviewers was discussed in the first instance or resolved by a third independent reviewer (FFM).

Human research studies were then assessed for methodological quality in duplicate by two independent reviewers (KA and ED) using the Quality Criteria Checklist for Primary Research in the Academy of Nutrition and Dietetics Evidence Analysis Manual [25]. The Quality Criteria Checklist included four relevance questions that addressed applicability to practice and 10 validity questions that addressed scientific reliability, including confounding, study quality and heterogeneity. The Quality Criteria Checklist enabled a systematic, objective rating (positive, negative or neutral) to be given to each study and was used to confirm agreement among independent reviewers. 'Positive' studies were of the highest quality, with most answers to the validity questions being positive, followed by 'neutral' studies. 'Negative' studies were of the lowest quality, with most of the answers to the validity questions being negative. Once again, any difference in assessments were resolved, if necessary, by a third independent reviewer (FFM). The internal validity of studies which reported biochemical analysis of mushrooms was not performed as critical appraisal tools do not exist for this study design.

#### 2.4. Data extraction

Data were extracted from all included studies into a Microsoft Excel [Version 1908; Excel for Office 365] spreadsheet by one investigator (KA or ED) and checked for accuracy by another investigator (KA or ED). Data extracted were study and participant characteristics, baseline, follow-up, washout period, run-in period, test product, control product, dosage, measurement method, change in outcome, and *P*-value for between group comparisons. Data extracted for bioactive studies included source of mushrooms, whether mushrooms were cultivated or wild, storage conditions, extraction and measurement technique used, amount of the bioactive reported and units of measurement. For studies reporting ergosterol, vitamin D was also extracted if reported. Original authors were contacted to confirm any missing data [26–28]. If original authors could not be contacted, data were retrieved using manuscript figs. [27] or excluded [26,28].

### 3. Results

#### 3.1. Description of studies

The systematic search strategy identified 9811 records, of which 68 were eligible for inclusion ( $n=15$  human studies,  $n=53$  biochemical studies; Fig. 1).

##### 3.1.1. Health outcomes

A total of 15 human trials reported on consumption of *A. bisporus* mushrooms and physical health outcomes [29–43], and none reported on mental health or cognitive function. The study characteristics and methodological quality of these included studies are shown in Table 2. The majority (73%) of studies were randomised controlled trials (RCTs) [29–36,39,40,43]. Other study designs included a non-RCT [41], a secondary analysis of a RCT which presented pooled data from two intervention groups in a pre-post study design format [42], a Phase 1 Clinical trial [38], and a retrospective case-control study [37]. The reported health outcomes were vitamin D status (4 studies) [29–32], inflammation (2 studies) [33,34], satiety (2 studies) [35,40], cancer (2 studies) [37,38], gastrointestinal health (2 studies) [39,40],

cholesterol [34,41], diabetes risk factors [42], and immunology [43]. Studies were mainly conducted in the United States of America (USA) (9 studies) [29,30,32,34–36,38,39,42], and others were from Germany [31], Netherlands [33], China [37], Japan [40], Iraq [41], and Australia [43]. Only one study reported minor adverse effects (abdominal bloating), but had no participant withdraw.

Studies were mainly conducted in adults, with one study on male teenage athletes [32]. Most of the intervention studies used 'healthy' populations (8 studies) [29–31,34–36,39,43], with the remaining conducted in adults with hypercholesterolemia [33], metabolic syndrome [42], insufficient Vitamin D levels [32], older adults with problematic halitosis and body odour [40], and cancer [37,38] (Table 2).

Using the Quality Criteria Checklist for Primary Research (Table 2), six studies received a positive quality rating (*i.e.* defined as having a high level of internal validity and low risk of bias across the study) [29,31,37,38,42,43], six studies received a neutral rating (*i.e.* unclear levels of internal validity and bias) [32–36,39], and three studies received a negative rating [30,40,41]. Interventions were generally well described with clearly defined outcomes. Objective biomarkers were utilised across studies, with the exception of studies that had self-reported measures of satiety [35,36] and gastrointestinal health outcomes [39,40].

##### 3.1.2. Bioactive compounds

A total of 41 studies reported the concentration of bioactive antioxidant compounds (ergosterol, 16 studies [44–59]; ergothioneine, 4 studies [48,60–62]; flavonoids, 22 studies [63–84]) and 16 reported concentrations of polysaccharides (glucans, 9 studies [27,80,84–91]; chitin, 7 studies [27,87,90,92–95]) in *A. bisporus* mushrooms (Table 3). From the 16 papers that reported ergosterol, five also reported Vitamin D<sub>2</sub> (25(OH)D<sub>2</sub>) [46,48–51]. Mushroom varieties included WBM (47 studies) [27,46–56,59–66,68–87,89–95], portobello (8 studies) [49,57,58,60,61,85,87,88], BBM (7 studies) [47,48,54,55,67,79,89], and cremini (6 studies) [49,60,61,85,87,88] mushrooms. The majority of studies (79%) reported only one mushroom type, with WBM being the most common (68%), and two studies did not specify the type of mushroom used [44,45]. Mushrooms were mainly cultivated (51 studies) [27,46,48–58,60–83,86–95] and sourced from Europe (24 studies) [27,44,45,50,52,53,55–58,64,67,69,73,74,78,79,86,88–90,93–95] and Asia (19 Studies) [51,59,62,63,65,66,68,71,72,75–77,80–84,87,91]. Other regions included the Americas (6 studies) [48,49,60,61,70,85], Canada (3 studies) [46,47,54] and the United Kingdom (1 study) [92].

#### 3.2. Impact of *A. bisporus* mushroom intake on human health

##### 3.2.1. Serum vitamin D

Studies that reported on the bioavailability of vitamin D from UVB-exposed mushrooms used fresh mushrooms [29,31], dried mushroom extract [30] and mushroom powder [32]. Doses of vitamin D ranged from 8.8 µg/day (352 IU/day) [29], up to 28,000 IU/day (700 µg/day) [31], and study durations ranged from 5 to 12 weeks. A significant increase in serum 25(OH)D<sub>2</sub> was reported in all four RCT studies [29–32], alongside a decrease in serum 25(OH)D<sub>3</sub> reported in two studies [29,32], ( $P<.001$  for all). Three studies showed a significant increase in total serum 20(OH)D ( $P<.001$  for all) [30–32], and only one study specifically screened people for low levels of vitamin D at baseline [32]. When UVB-exposed mushroom extracts were compared to a daily vitamin D<sub>2</sub> or D<sub>3</sub> supplement (2000 IU/day; 50 µg/day) across a 12-week intervention, no significant differences in overall 25(OH)D levels between the groups were found [30]. At doses of 2000 IU/day, UVB-exposed mushrooms were equivalent to a supplement at increasing total 25(OH)D levels.

##### 3.2.2. Inflammatory markers

Three studies reported on inflammatory markers [33,34,42]. In healthy young women, both 8 g and 16 g doses of mushroom powder



Table 3  
Bioactive components in *Agaricus Bisporus* mushrooms

Reference	Type	Mushroom source (wild/cultivated, country)	Mushroom part	Compound (glucan/flavonoid/ergosterol etc.)	Amount
Babu, 2013	WBM	Cultivated, India	Cap	Flavonoids	2.173±0.0007 µg/g
			Stipe	Flavonoids	1.533±0.005 µg/g
Akyüz, 2012	WBM	Cultivated, Turkey	Whole	Myricetin	11.75 µg/g
				Quercetin	0.25 µg/g
				Kaempferol	0.25 µg/g
				Catechin	396.00 µg/g
				Naringenin	1.75 µg/g
				Resveratrol	0.50 µg/g
Tajalli, 2015	WBM	Cultivated/wild, Iran	Whole (wild) <sup>^</sup>	Flavonoids	3.72 (0.0020) mg CE/g
				Anthocyanins	4.7 (1.2) mg CGEs/100 g
				Flavonoids	4.24 (0.0016) mg CE/g
				Anthocyanins	7.7 (0.5) mg CGEs/100 g
				Flavonoids	2.78 (0.0004) mg CE/g
				Anthocyanins	1.13 (0.2) mg CGEs/100 g
				Flavonoids	5.11 (0.0044) mg CE/g
				Anthocyanins	0.15 (0.01) mg CGEs/100 g
			Whole (cultivated)	Flavonoids	3.98 (0.0004) mg CE/g
				Anthocyanins	1.7 (0.2) mg CGEs/100 g
				Flavonoids	4.12 (0.0020) mg CE/g
				Anthocyanins	0.087 (0.1) mg CGEs/100 g
				Flavonoids	4.15 (0.0016) mg CE/g
				Anthocyanins	'very low' (almost 0) mg CGEs/100 g
				Flavonoids	4.94 (0.0028) mg CE/g
				Anthocyanins	4.6 (0.9) mg CGEs/100 g
Singla, 2010	WBM	Cultivated, India	Whole (raw)	Flavonoids (free)	37.12 mg/100 g
				Flavonoids (bound)	64.69 mg/100 g
			Whole (processed)	Flavonoids (free)	35.42 mg/100 g
				Flavonoids (bound)	63.72 mg/100 g
Mircea, 2015	BBM	Cultivated, Romania	Whole	Flavonoids	1.09 (0.02) mg CE/g
					0.97 (0.01) mg CE/g
					1.52 (0.01) mg CE/g
Guizani, 2012	WBM	Cultivated, Oman	Whole	Flavonoids	0.76 (0.05) mg
Jaworska, 2014	WBM	Cultivated, Poland	Whole (fresh)	Flavonoids	142 (8) mg/100 g
			Whole (blanched)	Flavonoids	53 (3) mg/100 g
			Whole (culinary treated)	Flavonoids	35 (5) mg/100 g
Gan, 2013	WBM	Cultivated, Malaysia, Brazil	Extract (60% ethanol)	Flavonoids	1.75 (0.26) mg GAE/g
			Extract (aqueous)	Flavonoids	1.36 (0.11) mg GAE/g
Ganguli, 2006	WBM	Cultivated, India	Whole (raw)	Flavonoids	0.079% (0.004)
			Whole (fried 4 min)	Flavonoids	0.050% (0.002)
			Whole (fried 5 min)	Flavonoids	0.041% (0.004)
			Whole (fried 6 min)	Flavonoids	0.038% (0.006)
Singla, 2012	WBM	Cultivated, India	Whole (raw)	Flavonoids	37.12 mg/100 g
			Whole (2% treated)	Flavonoids	31.54 mg/100 g
			Whole (4% treated)	Flavonoids	31.53 mg/100 g
Öztürk, 2011	WBM	Cultivated, Turkey	Whole	Flavonoids	5.12 (0.55) µg QE/mg
Ozen, 2010	WBM	Cultivated, Turkey		Flavonoids	0.106 (0.006) mg QE/g
				Anthocyanins	0.17 (0.01) mg/mL
Rezaeian, 2015	WBM	Cultivated/wild, Iran	Whole (cultivated)	Flavonoids	6.46 (0.13) mg CE/g
			Whole (cultivated)	Flavonoids	1.11 (0.24) mg CE/g
			Whole (wild) <sup>^</sup>	Flavonoids	4.48 (0.05) mg CE/g
Ng, 2019	WBM	Cultivated, India	Whole (raw)	Flavonoids	78.67 (8.80) mg QE/100 g
			Whole (boiled)	Flavonoids	46.89 (1.25) mg QE/100 g
			Whole (microwaved)	Flavonoids	43.39 (4.66) mg QE/100 g
			Whole (steamed)	Flavonoids	32.83 (4.51) mg QE/100 g
			Whole (pressure-cooked)	Flavonoids	59.11 (10.30) mg QE/100 g
Ng, 2017	WBM	Cultivated, Malaysia	Whole (raw)	Flavonoids	20.2 (2.9) mg Qct/100 g
			Whole (boiled 1.5 min)	Flavonoids	12.2 (2.8) mg Qct/100 g
			Whole (boiled 3 min)	Flavonoids	11.3 (2.7) mg Qct/100 g
			Whole (boiled 4.5 min)	Flavonoids	10.7 (0.7) mg Qct/100 g
			Whole (boiled 6 min)	Flavonoids	9.8 (0.4) mg Qct/100 g
			Whole (microwaved 1.5 min)	Flavonoids	14.3 (2.4) mg Qct/100 g
			Whole (microwaved 3 min)	Flavonoids	7.5 (1.0) mg Qct/100 g
			Whole (microwaved 4.5 min)	Flavonoids	6.1 (1.1) mg Qct/100 g
			Whole (microwaved 6 min)	Flavonoids	4.2 (0.5) mg Qct/100 g
			Whole (steamed 1.5 min)	Flavonoids	11.2 (3.4) mg Qct/100 g
			Whole (steamed 3 min)	Flavonoids	14.4 (5.0) mg Qct/100 g
			Whole (steamed 4.5 min)	Flavonoids	12.0 (1.0) mg Qct/100 g
			Whole (steamed 6 min)	Flavonoids	13.8 (1.0) mg Qct/100 g
			Whole (pressure-cooked 15 min)	Flavonoids	12.7 (0.3) mg Qct/100 g
Barros, 2018	WBM	Cultivated/wild, Portugal	Whole <sup>^</sup>	Flavonoids	1.73 (0.11) mg/g
Buruleanu, 2018	WBM	Cultivated, Romania	Cap	Flavonoids	6.54 (0.00) mg QE/g
				Flavonoids	7.83 (4.18) mg QE/g
			Stipe	Flavonoids	5.23 (0.02) mg QE/g

Table 3 (continued)

Reference	Type	Mushroom source (wild/cultivated, country)	Mushroom part	Compound (glucan/flavonoid/ ergosterol etc.)	Amount	
Khan, 2016 Jagadish, 2009	BBM		Cap	Flavonoids	3.26 (0.04) mg QE/g	
			Stipe	Flavonoids	8.43 (0.02) mg QE/g	
	WBM		Whole	Flavonoids	3.5 (0.14) mg QE/g	
			Whole (raw)	Flavonoids	8.05 (0.04) mg QE/g	
			Whole (boiled)	Flavonoids	5.22 (0.06) mg QE/g	
			Whole	Flavonoids	56.76 µg RE/g	
			Whole	Flavonoids	16.4 (0.5) mg QE/g	
			Whole	Flavonoids	15.2 (0.2) mg QE/g	
			Whole	Flavonoids	10.3 (1.0) mg QE/g	
			Whole	Flavonoids	1636.8 (17.5) mg naringin/100 g	
Dhamodhara, 2013 Um, 2014 Palanisamy, 2014	WBM	Cultivated, India	Whole	α-Glucan	27% <sup>a</sup>	
			Whole	β-Glucan	25% <sup>a</sup>	
	WBM		Whole (25 °C)*	α-Glucan	26% <sup>a</sup>	
			Whole (50 °C)*	β-Glucan	27% <sup>a</sup>	
			Whole (100 °C)*	α-Glucan	32% <sup>a</sup>	
			Whole (150 °C)*	β-Glucan	29% <sup>a</sup>	
			Whole (200 °C)*	α-Glucan	35% <sup>a</sup>	
			Whole (200 °C)*	β-Glucan	0% <sup>a</sup>	
			Whole (200 °C)*	α-Glucan	50% <sup>a</sup>	
			Whole (200 °C)*	β-Glucan	44% <sup>a</sup>	
Choi, 2010	WBM	Korea	Whole	Chitin	4.9 mg/100 g	
			Whole	Total Glucan	8.97 (0.21) % w/w	
			LMW	α-Glucan	1.13 (0.52) % w/w	
				β-Glucan	7.83 (0.74) % w/w	
				Catechin	15.07 (0.83) mg/g	
			HMW	Tannic acid	11.58 (0.65) mg/g	
				Gallate	9.51 (0.52) mg/g	
				Catechin	14.98 (0.34) mg/g	
				Tannic acid	11.50 (0.27) mg/g	
			Dikeman, 2005	WBM	Cultivated, USA	Raw immature
Cooked immature	β-Glucan	0.1%				
Raw mature	β-Glucan	0.1%				
Crimini	Cooked mature	β-Glucan				0.1%
	Raw immature	β-Glucan				0.1%
Portabella	Cooked immature	β-Glucan				0.1%
	Raw mature	β-Glucan				0.1%
Portabella	Cooked mature	β-Glucan				0.1%
	Raw immature	β-Glucan				0.1%
Portabella	Cooked immature	β-Glucan				0.1%
	Raw mature	β-Glucan	0.0%			
Portabella	Cooked mature	β-Glucan	0.2%			
	Cooked mature	β-Glucan	0.2%			
Nitschke, 2011a Khan, 2017	WBM	Cultivated, Germany	Whole	β-Glucan	2.60 g/100 g	
			Whole	Total glucan	10.045 (0.21) g/100 g	
Singh, 2017	WBM	Cultivated, India	Whole	α-Glucan	1.534 (1.56) g/100 g	
				β-Glucan	8.511 (2.45) g/100 g	
				Total glucan	8.511 (2.45) g/100 g	
Singh, 2017	WBM	Cultivated, India	Whole	Total glucan	0.78 g/10 g	
				Chitin	0.12 g/10 g	
				Chitin-glucan complex	1.8 g/10 g	
				Total glucan	3.96 (0.64)	
Singh, 2017	WBM	Cultivated, India	Whole	Total glucan	3.94 (0.08)	
				Total glucan	3.94 (0.08)	
				β-Glucan	19.20%	
Mirończuk-Chodakowska, 2017	Portobello Crimini	Cultivated, Poland	Whole	Total glucan	3.96 (0.64)	
				Total glucan	3.94 (0.08)	
Sari, 2017	WBM	Cultivated, Germany	Cap	β-Glucan	19.2%	
				Total glucan	10.051±2.228 g/100 g	
			Stipe	α-Glucan	1.547±0.378 g/100 g	
				β-Glucan	8.605±2.373 g/100 g	
				Total glucan	14.963 (4.979) g/100 g	
	BBM		Cap	α-Glucan	2.667 (1.224) g/100 g	
				β-Glucan	12.296 (4.077) g/100 g	
			Stipe	Total glucan	12.348 (4.514) g/100 g	
				α-Glucan	3.511 (2.383) g/100 g	
				β-Glucan	8.837 (3.046) g/100 g	
BBM	Cap	Total glucan	14.647 (4.874) g/100 g			
		α-Glucan	4.568 (2.845) g/100 g			
	Stipe	β-Glucan	10.079 (2.230) g/100 g			
		Total glucan	44.79±0.37 mg/g			
		Ergosterol	138.74± 0.61 mg/100 g			
Taofiq, 2016 Stojkovic, 2014 Simon, 2011	Unknown Unknown WBM	Portugal Netherlands Cultivated, Canada	Extract Cap Whole	Ergosterol Ergosterol Ergosterol Vitamin D	578.2±29.8 mg/100 g 5.5±4.6 µg/100 g	

(continued on next page)

Table 3 (continued)

Reference	Type	Mushroom source (wild/cultivated, country)	Mushroom part	Compound (glucan/flavonoid/ergosterol etc.)	Amount		
Shao, 2010	WBM	Canada	Whole (UV light exposed)	Ergosterol	579.5±20.7 mg/100 g		
			Whole (sunlight exposed)	Vitamin D	579.5±20.7 µg/100 g		
			Stage 1	Ergosterol	633.4±17.4 mg/100 g		
			Stage 2	Vitamin D	633.4±17.4 µg/100 g		
			Stage 3	Ergosterol	3.41 mg/g		
			Cap (Stage 3)	Ergosterol	3.32 mg/g		
			Stipe (Stage 3)	Ergosterol	3.01 mg/g		
			BBM	Canada	Stage 1	Ergosterol	3.41 mg/g
					Stage 2	Ergosterol	3.32 mg/g
					Stage 3	Ergosterol	3.01 mg/g
Cap (Stage 3)	Ergosterol	3.30 mg/g					
Stipe (Stage 3)	Ergosterol	2.33 mg/g					
Stipe (Stage 3)	Ergosterol	2.33 mg/g					
Sapozhnikova, 2014	WBM	Cultivated, USA	Extract	Ergosterol	4.66 mg/g		
			Extract	Ergosterol	4.66 mg/g		
			Extract	Ergosterol	2.93 mg/g		
			Extract	Ergosterol	2.93 mg/g		
			Extract	Ergosterol	2.49 mg/g		
			Extract	Ergosterol	2.49 mg/g		
			Extract	Ergosterol	2.71 mg/g		
			Extract	Ergosterol	2.71 mg/g		
			Extract	Ergosterol	2.03 mg/g		
			Extract	Ergosterol	2.03 mg/g		
Phillips, 2011	WBM	Cultivated, USA	Extract (Low UV)	Ergothioneine	0.81–0.92 mg/g		
			Extract (High UV)	Ergosterol	4.6–5.2 mg/g		
			Extract	Vitamin D	179 ± 5 IU/g		
			Extract	Vitamin D	2156± 43 IU/g		
			Extract	Vitamin D	4739± 61 IU/g		
			Extract	Ergothioneine	0.37–0.48 mg/g		
			Extract	Ergosterol	4.6–6.2 mg/g		
			Extract	Vitamin D	179± 4 IU/g		
			Extract	Vitamin D	1942± 30 IU/g		
			Extract	Vitamin D	6292±109 IU/g		
Mattila, 2002	WBM	Cultivated, Finland	Whole	Ergosterol	56.3 mg/100 g		
			Whole	Vitamin D	0.11 µg/100 g		
			Whole	Ergosterol	61.4 mg/100 mg		
			Whole	Vitamin D	0.06 µg/100 g		
			Whole	Ergosterol	62.1 mg/100 g		
			Whole	Vitamin D	0.25 µg/100 g		
Jasinghe, 2005	WBM	Cultivated, Singapore	Whole	Ergosterol	51.1 mg/100 g		
			Whole	Vitamin D	11.2 µg/100 g		
			Whole	Ergosterol	654 mg/100 g		
			Whole	Vitamin D	0 mg/100 g		
			Whole	Ergosterol	4.7–194 µg/100 g		
			Whole	Vitamin D	4.7–194 µg/100 g		
Heleno, 2017	WBM	Cultivated, Portugal	Whole	Ergosterol	7.80±0.35 mg/g		
			Whole	Vitamin D	12.48±0.28 µg/g		
			Whole	Ergosterol	36.72±0.01 mg/g		
			Whole	Ergosterol	443± 44 mg/100 g; 90% free sterols		
			Whole	Ergosterol	443± 44 mg/100 g; 90% free sterols		
			Whole	Ergosterol	6.12±0.09 mg/g		
			Whole	Ergosterol	6.12±0.09 mg/g		
			Whole	Ergosterol	6.05±0.37 mg/g		
			Whole	Ergosterol	6.11±0.20 mg/g		
			Whole	Ergosterol	5.96±0.16 mg/g		
Hammann, 2016	WBM	Cultivated, Germany	Whole	Ergosterol	5.2±0.13 mg/g		
			Whole	Ergosterol	5.2±0.13 mg/g		
			Whole	Ergosterol	5.2±0.13 mg/g		
			Whole	Ergosterol	5.2±0.13 mg/g		
			Whole	Ergosterol	5.2±0.13 mg/g		
			Whole	Ergosterol	5.2±0.13 mg/g		
			Whole	Ergosterol	5.2±0.13 mg/g		
			Whole	Ergosterol	5.2±0.13 mg/g		
			Whole	Ergosterol	5.2±0.13 mg/g		
			Whole	Ergosterol	5.2±0.13 mg/g		
Guan, 2016	WBM	Cultivated, Canada	Whole	Ergosterol	5.4±0.29 mg/g		
			Whole	Ergosterol	5.25±0.22 mg/g		
			Whole	Ergosterol	5.2±0.18 mg/g		
			Whole	Ergosterol	5.2±0.18 mg/g		
			Whole	Ergosterol	5.2±0.18 mg/g		
			Whole	Ergosterol	5.2±0.18 mg/g		
			Whole	Ergosterol	5.2±0.18 mg/g		
			Whole	Ergosterol	5.2±0.18 mg/g		
			Whole	Ergosterol	5.2±0.18 mg/g		
			Whole	Ergosterol	5.2±0.18 mg/g		
Gasecka, 2018	BBM	Cultivated, Poland	Cap	Ergosterol	7.59±0.13 mg/g		
			Cap	Ergosterol	7.59±0.13 mg/g		
			Cap	Ergosterol	7.59±0.13 mg/g		
			Cap	Ergosterol	7.59±0.13 mg/g		
			Cap	Ergosterol	7.59±0.13 mg/g		
			Cap	Ergosterol	7.59±0.13 mg/g		
			Cap	Ergosterol	7.59±0.13 mg/g		
			Cap	Ergosterol	7.59±0.13 mg/g		
			Cap	Ergosterol	7.59±0.13 mg/g		
			Cap	Ergosterol	7.59±0.13 mg/g		
Cardoso, 2017	WBM	Cultivated, Portugal	Cap	Ergosterol	7.61± 0.61 mg/g		
			Cap	Ergosterol	7.64±0.31 mg/g		
			Cap	Ergosterol	7.69±0.19 mg/g		
			Cap	Ergosterol	7.69±0.19 mg/g		
			Cap	Ergosterol	7.69±0.19 mg/g		
			Cap	Ergosterol	7.69±0.19 mg/g		
			Cap	Ergosterol	7.69±0.19 mg/g		
			Cap	Ergosterol	7.69±0.19 mg/g		
			Cap	Ergosterol	7.69±0.19 mg/g		
			Cap	Ergosterol	7.69±0.19 mg/g		
Cardoso, 2019	Portobello	Cultivated, Portugal	Whole	Ergosterol	7.72± 41 mg/g		
			Whole	Ergosterol	7.35±0.29 mg/g		
Barreira, 2014	Portobello	Cultivated, Portugal	Whole	Ergosterol	7.60±0.18 mg/g		
			Whole	Ergosterol	7.60±0.18 mg/g		
Alshammaa, 2017	WBM	Wild, Iraq	Extract	Ergosterol	26.4± 1.5 mg/100 g		
			Extract	Ergosterol	9.5± 1.2 mg/100 g		
			Extract	Ergosterol	21.7± 1.2 mg/100 g		
			Extract	Ergosterol	21.7± 1.2 mg/100 g		
			Extract	Ergosterol	36.1± 3 mg/100 g		
			Extract	Ergosterol	36.1± 3 mg/100 g		
			Extract	Ergosterol	4± 0.7 mg/100 g		
			Extract	Ergosterol	4± 0.7 mg/100 g		
			Extract	Ergosterol	18.4 mg/100 g		
			Extract	Ergosterol	18.4 mg/100 g		
Chung, 1998	WBM	Cultivated, UK	Stipe	Ergosterol	1.1±0.2 mg/100 g		
			Stipe	Ergosterol	1.1±0.2 mg/100 g		
Hassainia, 2018	WBM	Cultivated, France	Cap	Ergosterol	17.4±0.1 mg/g		
			Cap	Ergosterol	17.4±0.1 mg/g		
Hassainia, 2018	WBM	Cultivated, France	Cap	Ergosterol	216–250 mg/100 g		
			Cap	Ergosterol	216–250 mg/100 g		
Hassainia, 2018	WBM	Cultivated, France	Cap	Ergosterol	352 ± 1 mg/100 g		
			Cap	Ergosterol	352 ± 1 mg/100 g		
Hassainia, 2018	WBM	Cultivated, France	Cap	Ergosterol	77 ± 1 mg/100 g		
			Cap	Ergosterol	77 ± 1 mg/100 g		
Hassainia, 2018	WBM	Cultivated, France	Cap	Ergosterol	27.6675% (w/w)		
			Cap	Ergosterol	27.6675% (w/w)		
Hassainia, 2018	WBM	Cultivated, France	Cap	Chitin	42%		
			Cap	Chitin	42%		
Hassainia, 2018	WBM	Cultivated, France	Cap	Chitin	7.4± 1.2%		
			Cap	Chitin	7.4± 1.2%		

Table 3 (continued)

Reference	Type	Mushroom source (wild/cultivated, country)	Mushroom part	Compound (glucan/flavonoid/ergosterol etc.)	Amount
Manzi, 2001	WBM	Cultivated, Italy	Stipe	Chitin	6.4±1.4%
			Gills	Chitin	5.9± 1.2%
			Whole (fresh, raw)	β-Glucan	1.4±0.2 mg/100 g
				Chitin	0.6±0.04 g/100 g
			Whole (fresh, cooked)	β-Glucan	4.2± 0.3 mg/100 g
				Chitin	0.7±0.04 g/100 g
			Whole (deep frozen, raw)	β-Glucan	1.2± 0.6 mg/100 g
				Chitin	0.34±0.01 g/100 g
			Whole (deep frozen, cooked)	β-Glucan	3.2±0.8 mg/100 g
				Chitin	0.52±0.02 g/100 g
Nitschke, 2011b Vetter, 2007	WBM	Cultivated, Germany	Extract	Chitin	4.69±0.90 mg/100 g
			Cap (1st flush)	Chitin	7.21±0.51%
	WBM	Cultivated, Germany	Cap (2nd flush)	Chitin	7.16±1.0%
			Cap (3rd flush)	Chitin	5.63±1.02%
			Stipe (1st flush)	Chitin	7.61±0.90%
			Stipe (2nd flush)	Chitin	7.29±1.34%
			Stipe (3rd flush)	Chitin	6.94±2.23%
			Whole	Ergothioneine	0.41±0.18 mg/g
					0.47±0.16 mg/g
					0.15 mg/g
Kalaras, 2017	WBM	Cultivated, USA	Whole	Ergothioneine	0.21±0.01 mg/g
					0.40±0.03 mg/g
					0.45±0.03 mg/kg
Dubost, 2007	WBM	Cultivated, USA	Whole	Ergothioneine	932.7±5.0 mg/kg
Chen, 2012	WBM	Cultivated, Taiwan	Whole	Ergothioneine	

WBM, white button mushroom; BBM, brown button mushroom; LMW, low molecular weight; HMW, high molecular weight; \* pressurised-water extraction temperatures; ^ wild mushrooms may naturally receive UV exposure from sunlight compared to cultivated mushrooms unless otherwise specified; a, values estimated from figures; µg, micrograms; CGEs, cyanidin-3-glucoside equivalents; CE, catechin equivalents; QE, quercetin equivalents; GAE, gallic acid equivalents; Qct, quercetin; RE, rutin equivalents; w/w, weight per weight.

increased serum ergothioneine and decreased oxygen radical absorbance capacity (ORAC) [34]. Alternatively, in a 16-week uncontrolled pre-post study using a cooked mushrooms intervention (100 g/day), both serum ergothioneine and ORAC increased ( $P=.03$ ) [42]. When cytokine production was measured after 5 g/day of α-glucans from mushroom extract consumed across a 5-week intervention, tumour necrosis factor (TNF)-α decreased compared to the control ( $P=.017$ ) [33]. However, there were no effects on any other inflammatory markers measured (i.e. interleukin (IL)-1β, IL-2, IL-4, IL-6, IL-10, IL-12, IL-13, IL-17, interferon-γ, serum creatinine).

### 3.2.3. Satiety

Two studies assessed the impact of dietary mushrooms on satiety, and findings were inconsistent [35,36]. In 35 young adults (age 23±4 years), mushroom consumption was associated with lower hunger ( $P=.045$ ), greater fullness ( $P=.05$ ) and decreased prospective food consumption ( $P=.03$ ) compared with a protein-matched beef portion [35]. However, no change in energy intake was observed [35]. Alternatively, in a different sample of mixed-race adults from the USA ( $n=47$ ; age mean (range) 35.5 (18–62) years) mushroom intake was not associated with changes in subjective satiety when compared to a volume-matched, rather than energy-matched, portion of beef [36]. The replacement of mushrooms for beef resulted in a decrease in the total fat and energy intake (total fat 41.1±0.4 g vs. 10.2±0.2 g,  $P<.001$ ; energy 2012±70 kcal vs. 1640±65 kcal,  $P<.001$ ) of the meal, and the lower energy intake from the meal was only partially compensated for at the other eating occasions (11.4±12.0% energy; 7.4±7.7% total fat) [36].

### 3.2.4. Gastrointestinal health

Consumption of fresh mushrooms [39] and a mushroom extract [40] both showed beneficial effects on stool weight, microbiota, bowel

strain, faecal odour and halitosis (Table 2). No changes were observed in markers of bacterial fermentation (breath H<sub>2</sub>, faecal pH and faecal short chain fatty acids) [39] or bowel regularity [40], compared to the control.

### 3.2.5. Cancer

The association between human consumption of *A. bisporus* mushrooms and cancer was assessed in a case control study [37] and a Phase 1 Clinical Trial [38]. In the case-control study of 1000 females from China (age 59±6 years), consumption of more than 2 g per day of WBM reduced the odds of ovarian cancer by 32% (adjusted OR 0.68 (95% CI, 0.52–0.89) [37]. In a sample of prostate cancer patients, mushroom extract at increased doses (4–14 g extract daily; equivalent to 40–140 g fresh WBM) was associated with decreased total prostate specific antigen (PSA) levels in 36% of patients, with stable PSA levels or no effect in the remaining patients [38]. Minimal side effects were reported and mostly limited to Grade 1 abdominal bloating [38].

### 3.2.6. Metabolic markers

Two studies reported on metabolic markers of health [41,42]. WBM cooked in olive oil (2 g/kg body weight/day) were associated with significantly lower glucose, total cholesterol, low-density lipoprotein, triglycerides and body weight, and higher high-density lipoprotein, compared to the control ( $P<.05$  for all) [41]. However, baseline values were not reported, and the olive oil was only delivered to the treatment group. In a second sample of adults with at least two features of the metabolic syndrome, adiponectin increased after daily consumption of 100 g of cooked mushrooms over the 16-week intervention (7.9±3.2 µg/mL baseline; 8.8±3.5 µg/mL 16 weeks,  $P=.03$ ) [42].

### 3.2.7. Immune function

The effect of cooked WBM (100 g/day for 7 days) on salivary IgA secretion was measured in 24 healthy adults (age  $41.4 \pm 11.3$  years) [43]. Compared to their usual diet, 100 g of cooked WBM intake for 7 days was associated with increased serum IgA osmolarity ( $P < .0001$ ), secretion rate ( $P < .0005$ ), and concentration ( $P < .0005$ ) [43]. These findings indicate a potential benefit for mucosal immunity.

## 3.3. Concentration of bioactive compounds in *A. bisporus*

### 3.3.1. Flavonoids

The majority (95%) of studies reported the total flavonoid content of whole mushrooms, and one study reported individual flavonoids [64] (Table 3). Two studies measured the cap and stipe (*i.e.* the stalk) separately for WBM [63,79] and BBM [79], and five studies investigated the effect of cooking on flavonoid content [69,71,76,77,81]. WBM had the highest concentration of catechins (396.00  $\mu\text{g/g}$ ) and myricetins (11.75  $\mu\text{g/g}$ ), and low to negligible quantities of quercetin, kaempferol, naringenin and resveratrol present (0.25–1.75  $\mu\text{g/g}$ ) [64]. Cooking mushrooms reduced flavonoid concentrations and flavonoid concentration for raw mushrooms was the highest across all studies [69,71,76,77,81]. Cooking methods assessed included blanching [69], frying [71,76], boiling [76,77,81], microwaving [76,77], steaming [76,77] and pressure cooking [76,77]. Only two studies measured the effect of cooking time, on flavonoid content [71,76]. For both boiling and frying, flavonoid content was reduced with cooking time (6 min) [71,76]. For shorter cooking times (1.5 min), microwaving retained the most flavonoids compared to boiling or steaming (70.8%, 60.4% and 55.4% respectively) [76]. When cooking time was extended to 6 min, microwaving retained the least flavonoids compared to other cooking methods (20.8% microwaving, 48.5% boiling, 68.3% steaming) [76].

The mushroom cap had a greater concentration of flavonoids than the stipe. Four out of five analyses from two studies reported a mean of 28.1% greater flavonoid concentration in the WBM cap (range: 4.5–58.4%), compared to the stipe [63,79]. For BBM, the difference between the cap and stipe differed according to the solvent used for the analysis, with the water solvent showing a greater concentration in the cap, and the 50% water-ethanol showing a greater concentration in the stipe [79]. Only one study reported on flavonoids in both WBM and BBM, with the water solvent showing higher concentrations of flavonoids in the BBM, and water-ethanol solvent showing a greater concentration in WBM [79]. Majority of studies (75%) used colorimetric assays [63,65–68,70–76,78,79,81], while the remainder used spectrometry (15%) [69,77,80], high performance liquid chromatography (5%) [64] or an unspecified method (10%) [82,83]. None of the studies reported on flavonoid concentrations by mushroom maturity (*e.g.* WBM compared to Portobello).

### 3.3.2. Ergosterol and vitamin D

Ergosterol was measured in 16 studies [44–59]. In addition to ergosterol, vitamin D<sub>2</sub> was also measured in five of those studies [46,48–51]. Most studies (67%) that reported on ergosterol and vitamin D content used UVB-exposed mushrooms [46,48–50]. The range of ergosterol concentrations in UVB-exposed whole WBM and BBM were 579.5 mg/100 g–633.4 mg/100 g [46,54] and 722.0 mg/100 g – 769.0 mg/100 g [54], respectively (Table 3). No studies reported ergosterol in UVB-exposed extracts. In non-UV-exposed whole WBM and BBM, the average ergosterol concentration was 714.3 mg/100 g (range 56.3–1740 mg/100 g) [45–47,49–51,53,54,56] and 334.5 mg/100 g (range 203.0–466.0 mg/100 g) [47,54], respectively. In non-UV-exposed WBM and BBM extracts, the range of ergosterol concentration was 4–3672 mg/100 g [44,48,52,55] and 26.4–620 mg/100 g [48,55], respectively. Exposure to UVB light over time consistently increased vitamin D<sub>2</sub> content and decreased ergosterol concentrations [49,54].

Both BBM and cremini mushrooms had a marginally higher quantity of ergosterol compared to WBM in two studies (BBM 466 mg/100 g vs. WBM 341 mg/100 g [47]; cremini 61.4 mg/100 g vs. WBM 56.3 mg/100 g [49]). None of the studies investigated the effect of cooking method or mushroom maturity on ergosterol content. Except one study which compared the portobello cap against whole WBM [49] and found a marginally higher concentration of ergosterol in the portobello cap (62.1 mg/100 g) compared to the WBM (56.3 mg/100 g) [49].

### 3.3.3. Ergothioneine

Four studies measured ergothioneine content [48,60–62]. One used both WBM and BBM extracts [48], while the remaining studies used whole mushrooms [60–62]. Whole mushrooms contained an average ergothioneine content of  $0.43 \pm 0.25$  mg/g. There were no clear trends among the two studies that compared the ergothioneine content by type of whole mushroom (whole WBM, cremini and portobello mushrooms) [60,61]. However, WBM extract had a greater concentration of ergothioneine (0.81–0.92 mg/g) than BBM extract (0.37–0.48 mg/g) [48]. None of the studies reported on the effect of cooking method or the part of the mushroom body (*i.e.* cap vs. stipe) on ergothioneine concentrations.

### 3.3.4. Glucans

Nine papers measured and reported on glucans as either total [80,84,87–89,91], alpha- [27,80,84,87–89,91], and/or beta- [27,80,84–89,91]. Glucans were reported using a variety of methods (% w/w, %, and g/100 g), making direct comparisons across studies difficult. When total, alpha- and beta-glucans were compared across the cap and stipe of WBM and BBMs, a higher concentration of glucans was reported in the stipe [89]. Studies which measured both alpha and beta-glucans reported that the most prevalent glucans present in mushrooms are beta-glucans, which account for (mean  $\pm$  SD)  $75.0 \pm 17.8\%$  of the total glucan concentration [80,84,89,91]. BBM had a marginally higher concentration of glucans than WBM [89]. No differences in beta-glucan concentration were reported by mushroom maturity or cooking method [85], and all studies used whole mushrooms.

### 3.3.5. Chitin

Chitin was measured in seven studies using WBM [27,87,90,92–95], with high variability in reported values. Chitin content ranged from 0.005 g/100 g to 1.2 g/100 g for whole mushroom [27,87,90], 6.4% to 42% in the stipe [92,93,95], 7.2% to 7.4% in the cap [93,95], 5.9% gills [93] and 0.005 g/100 g for the extract [94]. Cooking increased chitin content regardless of preparation technology, with comparable values in fresh and canned samples (fresh: raw  $0.6 \pm 0.04$  g/100 g vs. cooked  $0.7 \pm 0.04$  g/100 g; deep frozen: raw  $0.34 \pm 0.01$  g/100 g vs. cooked  $0.52 \pm 0.02$  g/100 g; canned: raw  $0.61 \pm 0.05$  g/100 g vs. cooked  $0.74 \pm 0.06$  g/100 g) [90]. No studies measured chitin in other mushroom types.

## 4. Discussion

This scoping literature review systematically summarised the evidence from human intervention trials and biochemical studies that reported on the health effects and bioactive compounds in *A. bisporus* mushrooms. Results confirmed that *A. bisporus* mushrooms are a rich source of beta-glucans, antioxidants and vitamin D, with a wide variability in values reported by mushroom type, cooking time and method, and exposure to UVB across studies. Several beneficial effects of *A. bisporus* consumption exist for metabolic syndrome, gastrointestinal health and cancer, with the strongest evidence of a health effect on improving vitamin D status of individuals. All studies reported that the consumption of UVB-exposed mushrooms was as effective at increasing and maintaining total serum 25(OH)D levels as

vitamin D supplements, in individuals with and without vitamin D deficiency at baseline. Despite the wide range of health benefits reported, the evidence is still quite limited and further research is warranted, specifically for inflammatory and immune function where results are promising.

The biologically distinct and nutritionally unique properties of mushrooms make them a powerful food choice to improve human health. Unlike plants, mushrooms have high concentrations of ergosterol in their cell walls [4], and when both fresh and dried varieties of mushrooms are exposed to UVB radiation, ergosterol is transformed to pre-vitamin D<sub>2</sub>, then converted to vitamin D<sub>2</sub> [30,96]. Findings confirm UVB-exposed mushrooms contain vitamin D<sub>2</sub> in a very bioavailable form that is relatively stable during storage and cooking, making them an ideal non-animal food source of vitamin D. Mushrooms also contain significant proportions of beta-glucans. We found that beta-glucans accounted for approximately 75% of total glucan concentrations in *A. bisporus* mushrooms with a volume of 8–12 g/100 g dry weight, which is substantially higher than the 3–8 g/100 g dry weight found in oats, 1.3–2.7 g/100 g dry weight in rye, and 2–20 g/100 g dry weight in barley. A number of international food governing bodies (including Food Standards Australia New Zealand, U. S. Food and Drug Administration, European Food Safety Authority, Health Canada's Food Directorate, and Singapore Food Agency) have approved a high level health claim based on the relationship between the consumption of 3 g of beta-glucans (from oats or barley) and blood cholesterol, with no such claim available for mushrooms. Given the significant proportions of beta-glucans reported in mushrooms, further research in this area is warranted to confirm the potential health effects induced by beta-glucans from mushrooms specifically.

Studies identified by this review suggest that the consumption of *A. bisporus* mushrooms may improve both components of the metabolic syndrome and gastrointestinal health. However, the only study that measured markers of metabolic syndrome provided mushrooms alongside olive oil, which exerts its own beneficial effect on human health [97]. The impact of mushrooms on satiety was inconsistent, which is likely a result of the lack of consistent comparator groups used (*i.e.* volume matched vs. energy matched portion of beef). While whole mushrooms and extracts were associated with bowel function, further research is required to explore if these effects are linked to any further health improvement as existing research did not identify any change in short chain fatty acids or bacterial fermentation.

Two included studies reported that *A. bisporus* mushrooms reduced the risk and progression of ovarian and prostate cancers, respectively. This suggests that these mushrooms may have a role as adjuvant therapy for cancer treatment. The mechanism of action for this effect may be related to the immunomodulating and anti-tumour effects of beta-glucans, ergothioneine and ergosterol [5]. Beta-glucans have been shown to have immune-stimulating effects [20,21], and ergothioneine is an immune modifier with antioxidant and cytoprotective properties [98,99]. This review found that consumption of whole WBM improved mucosal immunity in one study *via* increased serum IgA osmolarity and adiponectin [42], which may have a role in the prevention of malignancy and improved prognosis [100]. Decreased levels of ergothioneine in both blood and plasma have been observed in neurodegenerative, cardiovascular and kidney diseases [99], while increased ergothioneine concentrations may beneficially modulate the tumour microenvironment [101]. Similarly, ergosterol is an immunologically active lipid that can induce pyroptosis [102]. Although included studies regarding the effect of human *A. bisporus* mushroom consumption on immunity and cancer had high internal validity, further robust RCTs are required to confirm their cancer preventative and treatment effects in diverse samples alongside traditional therapies.

A large number of published studies reported the presence of flavonoids in *A. bisporus* mushrooms. These highlight large variability

in the measurement of total flavonoids, ranging from as little as 5.68 mg rutin equivalents per 100 g [80], up to 1636 mg per 100 g [83] in whole WBM. Estimates of daily flavonoid intake from across USA, European and Australian databases range from 209 mg to 1017 mg per day [103]. Recent evidence suggests that mushrooms may not contain flavonoids at all due to (i) the absence of genes required for their biosynthesis, and (ii) the lack of flavonoids detected when using analytic methods with higher levels of sensitivity and specificity such as high-performance liquid chromatography *versus* colorimetric assays [104]. Currently, there are no validated methods for the identification and quantification of flavonoids in foods and plants, and thus quantification of flavonoids has been inconsistent between studies [105]. Gil Raminéz et al. (2016) provide convincing evidence to suggest that another compound is being detected by assays claiming to detect flavonoids [104]. They showed that ergosterol demonstrated cross-reactivity with quercetin in a colorimetric assay, giving a positive reading in the detectable range when no quercetin was present [104]. As the majority (75%) of studies in this review measured flavonoids using colorimetric assays, caution is required when interpreting these values. Although flavonoids may or may not be present in mushrooms, a strong correlation between total flavonoids and antioxidant activity has been found [61]. Therefore, whatever the measured compound/s is, it has biological activity similar to that of flavonoids *in vitro*. If not a flavonoid, the compound could be ergosterol, as ergosterol from BBM and WBM has been highly correlated with total antioxidant activity ( $R^2=0.89$ ) [47] and could account for the antioxidant activity previously observed [61]. In turn, it may further contribute to the cancer preventative effects of *A. bisporus* mushrooms.

#### 4.1. Implications for future research

Opportunities exist for future research to confirm the causative relationship between the consumption of whole WBM *versus* extracts on human inflammatory and immune function, and its anti-cancer effects. Prior to being adopted into clinical practice and public health initiatives, replication of existing studies in other population groups is required to confirm the impact of *A. bisporus* mushrooms on human health including satiety, gastrointestinal function including its effect on the microbiota, and metabolic syndrome. Initial human studies are required to replicate findings from *in vitro* and animal studies which suggest *A. bisporus* mushrooms may improve mental health and cognitive function, as none conducted in humans have reported on these health outcomes. Further research is required to fully elucidate the bioactive compounds in mushrooms using vigorous analytical methods, such as nuclear magnetic resonance spectroscopy, and expand the immunological markers and bioactive compounds being tested.

#### 4.2. Limitations

The strengths of this review relate to the broad systematic literature search strategy used to identify the available evidence to answer the research question. This is the first review to systematically synthesise the evidence from published human trials on *A. bisporus* mushroom specifically, and its consumption on health outcomes, while further reporting on the bioactive compounds that may explain these effects. This review is further strengthened by the development of and adherence to an evidenced based protocol and comprehensive evaluation of the methodological quality of included human studies. It is limited by many studies that reported inadequate details related to sample size or power calculations. The lack of such details may confound data particularly relating to the reliability of effect sizes. There was large variability in bioactive measurements reported in mushrooms, which may be due to differing analytic methods with

varying degrees of sensitivity and specificity. Lastly, despite a growing interest in the relationship between mushrooms and health, only a small number of studies (<4 studies) have been published for each health outcome, despite over 300 narrative reviews having been published on mushrooms and health using *in vitro* and animal models. This reduces confidence in the reported effects and limits the generalisability of the conclusions to the general population.

## 5. Conclusion

*A. bisporus* mushrooms are sources of beta-glucans, ergosterol, ergothioneine, vitamin D and an antioxidant compound usually reported as flavonoids; with varying concentrations depending on the type of mushroom, cooking method and duration, and UVB exposure. UVB-exposed mushrooms increase and maintain serum 25 (OH)D levels to a similar degree as vitamin D supplements. Further, the evidence shows *A. bisporus* may lower the risk of cancer, and could potentially improve metabolic syndrome, immune function and gastrointestinal health. Due to the small number of studies examining each health outcome and the lack of replication of reported results, further research is required to confirm these effects on health to enable findings to be adopted into clinical practice.

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## Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.jnutbio.2020.108453>.

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**APPENDIX 10: MS112 GP VITAMIN D BROCHURE**

# WHEN IT COMES TO VITAMIN D, TWO SOURCES ARE BEST:

**A whole food, lifestyle approach to addressing vitamin D deficiency**

*"Did you know that Australians spend over \$100M a year on vitamin D supplements, yet 1 in 4 are vitamin D deficient? It is my pleasure to share with you the findings from a first-of-its-kind research, highlighting the importance of diet as a second source of vitamin D."*



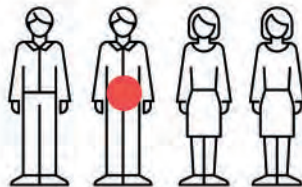
Flavia Fayet-Moore, PhD, MNutDiet, RNutr, APD, FASLM  
CEO Nutrition Research Australia



## UNDERSTANDING THE PROBLEM IN AUSTRALIA

23%

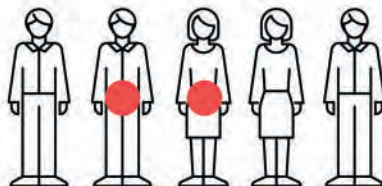
Serum 25(OH)D <50nmol/L



**Almost 1 in 4 Australians are vitamin D deficient<sup>1</sup>**  
results in impaired bone health

43%

Serum 25(OH)D 50 to <75 nmol/L



**2 in 5 Australians are vitamin D insufficient<sup>2</sup>**  
may increase the risk of other disease outcomes

Vitamin D deficiency is also a public health problem worldwide



Watch the free Vitamin D webinar: [nraus.com/blog-webinar-vitamind-2019](https://nraus.com/blog-webinar-vitamind-2019)



## FACTORS THAT INCREASE DEFICIENCY RISK<sup>2-4</sup>

### NON-MODIFIABLE



Higher latitude



Winter



Low and high phototype



Born outside Australia



Older age

### MODIFIABLE



Low dietary sources



Smokers



Lower physical activity



BMI >30 kg/m<sup>2</sup>



Limited sun exposure



Not taking supplements

### DID YOU KNOW?

Vitamin D receptors are in nearly every tissue and thousands of binding sites on our genome, controlling over 200 genes, and are thus implicated in many other diseases beyond bone health<sup>5</sup>



### SUN EXPOSURE GUIDELINES

In winter, the recommended time increases substantially



Minutes needed to reach 1000 IU (25µg) with 15% of the body exposed (hands, face and arms)<sup>6</sup>



### CURRENT VITAMIN D GUIDELINES

RACGP guidelines recommend one source to address vitamin D deficiency: sun exposure or supplements<sup>4</sup>

At risk	Mild deficiency	Moderate to severe deficiency
<50 nmol/L	30-49 nmol/L	<30 nmol/L
 Screen	 Sun exposure	 Supplements

"There are few opportunities in Australia to obtain the equivalent of 1000 IU 25(OH)D within a realistic duration while adhering to sun smart messages"<sup>7</sup>



Sun exposure guidelines for 25(OH)D adequacy are ineffective in winter in Australia<sup>8</sup>



### DIETARY INTAKES ARE ALSO BELOW TARGETS

"Given our increasingly indoor lifestyles, there is a need to develop and promote strategies to maintain adequate vitamin D status through safe sun exposure and dietary approaches"<sup>2</sup>

2-3 µg  
80-120 IU

AVERAGE DIETARY INTAKE<sup>6</sup>

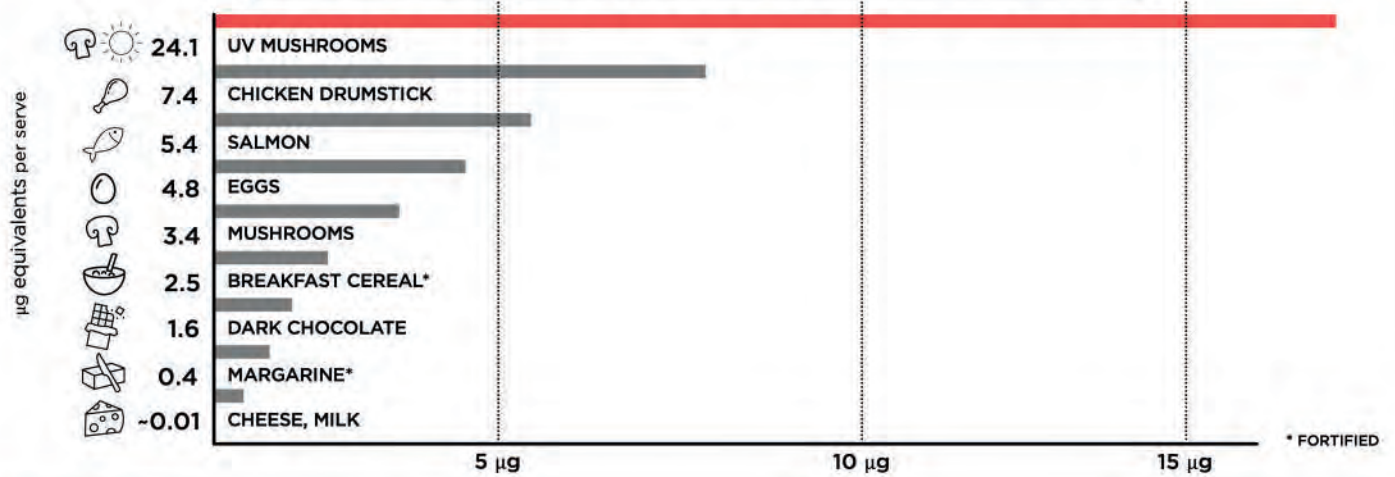


ADEQUATE INTAKE BY AGE GROUP<sup>9</sup>



Margarine, which is mandatorily fortified with vitamin D, is the leading contributor to vitamin D intake<sup>6</sup>

## THERE ARE FEW GOOD SOURCES OF VITAMIN D<sup>10,11</sup>



## MUSHROOMS IN SUNLIGHT FOR 10-60 MINUTES INCREASES VITAMIN D UP TO 10x<sup>10,12</sup>

2-3 µg



UV



24 µg

100 grams (5 button or 1 portobello) of UV-exposed mushrooms provides almost 1000 IU vitamin D

## INCREASING YOUR MUSHROOM'S VITAMIN D



## TIPS TO RETAIN VITAMIN D



### REFRIGERATE

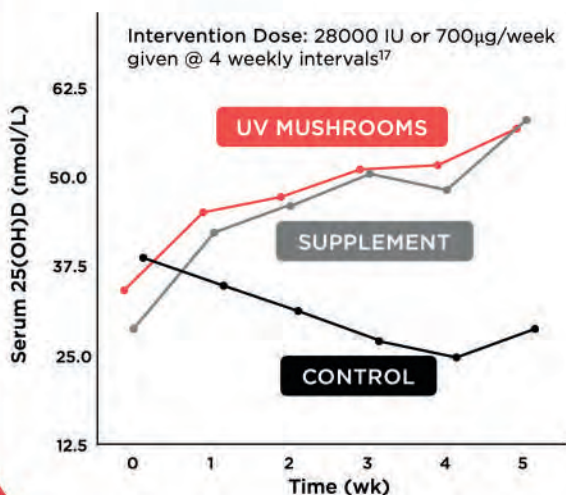
Sun exposed mushrooms retain vitamin D for up to 8 days<sup>15</sup>



### PAN FRYING

Lemon juice increases vitamin D retention. Cook with it to help increase non-heme (plant based) iron absorption as well<sup>16</sup>

## UV MUSHROOMS = SUPPLEMENTATION



Results from a meta-analysis show that in those who are deficient, UV exposed mushrooms are as effective as supplements at increasing vitamin D levels<sup>18</sup>

Mushroom soup made with UV exposed mushrooms

Mushroom soup made with regular mushrooms plus a vitamin D pill

Mushroom soup made with regular mushrooms

## THERE'S MORE TO MUSHROOMS

- A** Alpha and beta glucans
- B** Bioactive phytonutrients
- C** Carbohydrate profile (fibrous)
- D** Vitamin D
- E** Ergothioneine
- F** Flavonoids

## CONSIDERATIONS WHEN RECOMMENDING DIETARY APPROACHES

- Individual & family food preferences
- Access to the food
- Cooking skills
- Lower risk of toxicity and skin cancer
- Compliance - may be higher or lower

## LIFESTYLE AX CHECKLIST FOR VITAMIN D DEFICIENCY

	DECREASED RISK	INCREASED RISK
<b>Non-Modifiable</b>		
Season	<input type="checkbox"/> Spring/Summer	<input type="checkbox"/> Autumn/Winter
Phototype	<input type="checkbox"/> Olive (III,IV)	<input type="checkbox"/> Dark or pale (I, II, V, VI)
Office worker	<input type="checkbox"/> No	<input type="checkbox"/> Yes
<b>Modifiable</b>		
Smoking	<input type="checkbox"/> No	<input type="checkbox"/> Yes
Supplement	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Sun exposure (time outdoors)	<input type="checkbox"/> Some	<input type="checkbox"/> None
<b>Diet</b>		
Fish	<input type="checkbox"/> Some	<input type="checkbox"/> None
Mushrooms	<input type="checkbox"/> Some	<input type="checkbox"/> None
Eggs	<input type="checkbox"/> Some	<input type="checkbox"/> None

Use this checklist to help determine which of your clients are at risk. The more ticks for 'increased risk', the greater the need for intervention.

Consider the modifiable factors first, and what your patient or client is willing to change.

### Benefits of lifestyle recommendations for vitamin D



Diet

- ✓ Encourages whole foods
- ✓ Meal occasion and social connectedness
- ✓ Additional essential nutrients and bioactives



Sun exposure

- ✓ Regulates melatonin release and sleep cycle
- ✓ Outdoor physical activity
- ✓ Stress relief

## KEY TAKEOUTS



Vitamin D deficiency is an issue in sunny Australia



Only sun exposure or supplements are recommended



Australians struggle to get enough sun exposure in winter



All strategies have limits - individualisation is key



Sun-exposed mushrooms are a leading source - as effective as supplements



To get vitamin D, tan your mushrooms instead of your skin



"When it comes to vitamin D, we need to consider more than one source. Combining evidence-based dietary strategies with current recommendations can significantly improve vitamin D status, and provide other important lifestyle benefits."

Flavia Fayet-Moore, PhD, MNutDiet, RNutr, APD, FASLM  
CEO Nutrition Research Australia

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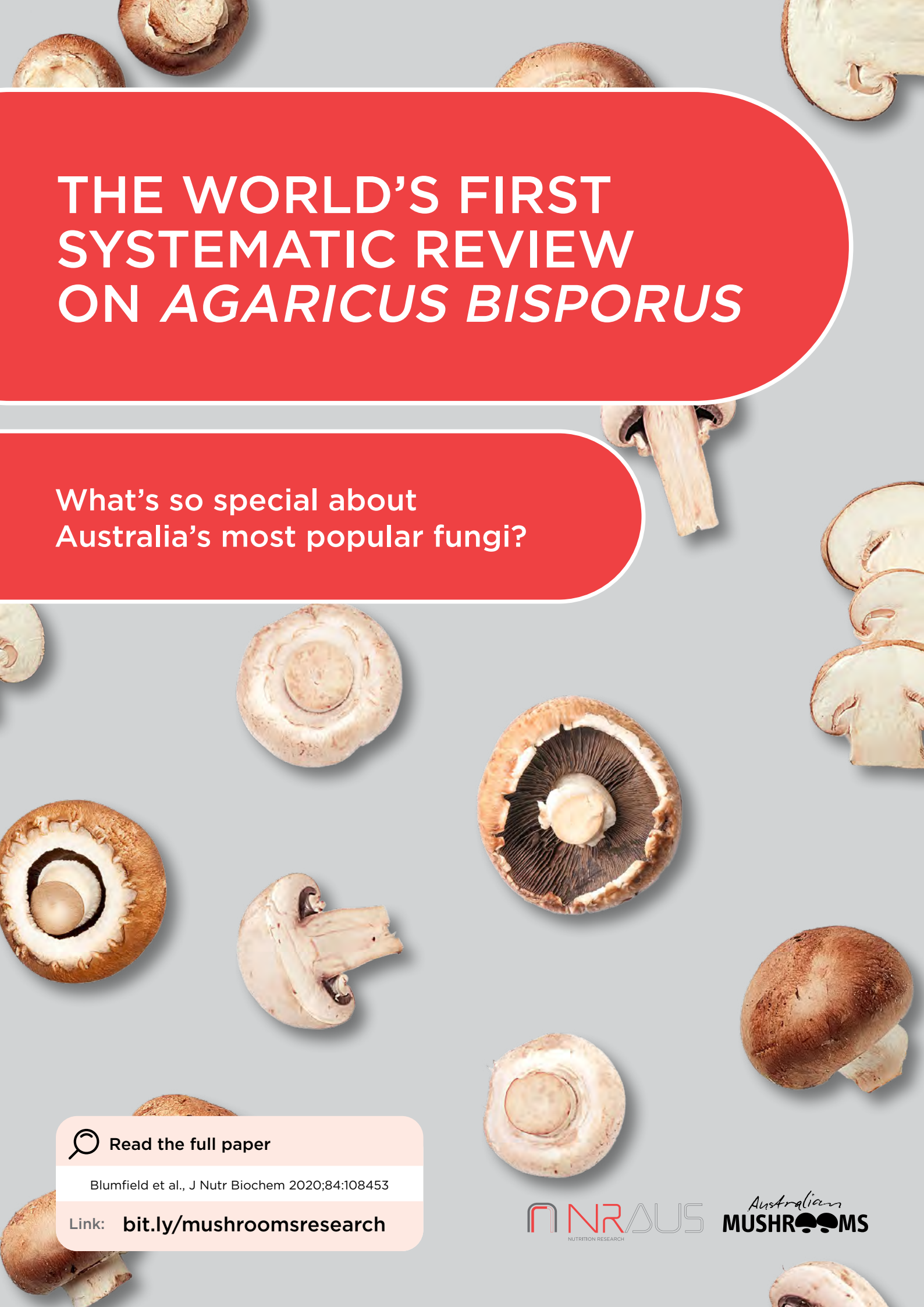
australianmushrooms.com.au

**Hort Innovation**  
Strategic levy investment

**MUSHROOM FUND**

This project has been funded by Hort Innovation, using the Mushroom Fund research and development levy and contributions from the Australian Government. Hort Innovation is the grower-owned, not-for-profit research and development corporation for Australian horticulture.

## **APPENDIX 11: MS117 SLR BROCHURE**



# THE WORLD'S FIRST SYSTEMATIC REVIEW ON *AGARICUS BISPORUS*

What's so special about  
Australia's most popular fungi?



Read the full paper

Blumfield et al., J Nutr Biochem 2020;84:108453

Link: [bit.ly/mushroomsresearch](https://bit.ly/mushroomsresearch)

 **NRAUS**  
NUTRITION RESEARCH

Australian  
**MUSHROOMS**

## What you need to know about mushrooms



**NOT A VEGETABLE**  
But contains:  
resistant starch  
phytonutrients  
potassium



**NOT AN ANIMAL**  
But contains:  
vitamin B12  
vitamin D



**NOT A WHOLE GRAIN**  
But contains:  
beta-glucans  
prebiotics  
riboflavin



**NOT A NUT**  
But contains:  
copper  
selenium



### What is *Agaricus bisporus*?



It's the world's most popular mushroom and includes<sup>[1]</sup>:



FLAT



SWISS BROWN/CREMINI



CUP



BUTTON



PORTOBELLO

### **?** FUN-gi FACT

Button, cup and flat mushrooms all come from the same mushroom, just grown for different lengths of time.

### What's the research gap?

Over  
**300**  
reviews exist  
on mushrooms

Yet  
**0**  
specifically on  
*Agaricus bisporus*

## What was done?

Nutrition Research Australia conducted the world's first systematic review on *Agaricus bisporus*, to investigate its key bioactive components and effects on health in humans.

5 databases searched  
up to June 2019

Medline  
Embase  
Scopus  
CINHAL  
Cochrane Library

**5,707**  
records found

**1,037**  
full-text articles  
screened

**68**  
articles included  
in the review

## What was found?



**53**  
articles on  
bioactive  
components

**A**NTIOXIDANTS  
**B**ETA-GLUCANS  
**C**HITIN  
**D** VITAMIN  
**E**RGOTHIONEINE



**15**  
articles on human  
health effects

⬆️ Vitamin D status  
⬇️ Inflammation  
⬆️ Satiety  
⬇️ Cancer risk & its metabolites  
⬆️ Gut health  
⬆️ Cardiometabolic health  
⬆️ Immune function



# What are the key bioactives in *Agaricus bisporus*?



What is it?

How much?

## A ANTIOXIDANTS

An array of antioxidants usually reported as flavonoids and polyphenols, including catechin, myricetin, quercetin & kaempferol<sup>[2]</sup>. Mushrooms are one of the few non-plant foods that contain antioxidants.



Kaempferol in *Agaricus bisporus* vs. Strawberries (/100g wet weight)

## B BETA-GLUCANS

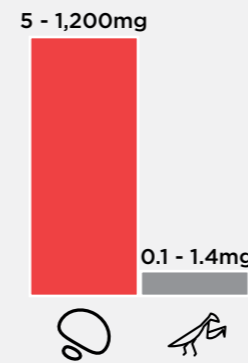
A soluble fibre, commonly found in oats, that has cholesterol lowering properties<sup>[5]</sup>.



Beta-glucans in *Agaricus bisporus* vs. Oats (/100g dry weight)

## C CHITIN

A unique prebiotic polysaccharide that makes up the cell wall of fungi - it's like cellulose in plants<sup>[7]</sup>. It's not found in any other foods, except for insects and yeasts.



Chitin in *Agaricus bisporus* vs. Edible Insects (/100g wet weight)<sup>[8]</sup>

## D VITAMIN D

The sunshine vitamin. Mushrooms naturally contain vitamin D2, with levels increased up to 10 times after the surface of the mushroom is exposed to UVB light (i.e. sunlight)<sup>[10]</sup>.



Vitamin D equivalents in UV-exposed *Agaricus bisporus* vs. Raw Eggs (/100g wet weight)<sup>[11]</sup>

## E ERGOTHIONEINE

An antioxidant that can only be made by some fungi and bacteria<sup>[13]</sup>. Mushrooms are the largest dietary source.



Ergothioneine in *Agaricus bisporus* vs. Tempeh (/100g dry weight)



How to maintain in cooking?

Cook for a shorter amount of time<sup>[3, 4]</sup>.

Not affected by cooking<sup>[6]</sup>.

Increases with cooking, regardless of whether the mushroom was fresh, frozen or canned<sup>[9]</sup>.

Using UV-exposed mushrooms, squeeze some lemon juice in the pan, cook at lower temperatures and for shorter times<sup>[12]</sup>.

Cook for a shorter amount of time<sup>[3, 4]</sup>.

WHICH TYPE IS BEST?

+ More vitamin D<sup>[14]</sup>



+ More ergothioneine<sup>[16]</sup>



WHICH PART IS BEST?










28% more antioxidants in the cap (vs the stem)<sup>[17, 18]</sup>

40% more beta-glucans in the stem (vs the cap)<sup>[19]</sup>

**FUN-gi FACT**

The stem is a valuable source of bioactives. Don't waste it!

# What is the evidence for *Agaricus bisporus* and human health?

	7 health outcomes	Reference	Study Type	Quality of Study*	Sample Size	Population	Intervention	Control	Result
	<b>1 Vitamin D status</b>	Stephensen et al. (2012) <sup>[20]</sup>	RCT	Higher	29	Healthy adults	88 g/day UV white button mushrooms for 6 wks	Non-UV white button	↑ serum 25(OH)D
		Keegan et al. (2013) <sup>[21]</sup>	RCT	Lower	25	Healthy adults	2000 IU vit D/day UV white button mushroom extract for 12 wks	Vitamin D supplement	↑ serum 25(OH)D (equivalent to a supplement)
		Urbain et al. (2011) <sup>[22]</sup>	RCT	Higher	26	Healthy adults	28 000 IU vit D/day UV white button mushrooms for 5 wks	Non-UV white button + placebo supplement	↑ serum 25(OH)D
		Shanely et al. (2014) <sup>[23]</sup>	RCT	Neutral	34	Athletes insufficient in vitamin D	600 IU vit D/day UV powdered portobello mushroom for 6 wks	Placebo	↑ serum 25(OH)D
	<b>2 Inflammation</b>	Calvo et al. (2016) <sup>[24]</sup>	RCT	Higher	37	Adults with metabolic syndrome	100 g/day UV white button mushrooms for 16 wks	Vitamin D supplement	↑ ergothioneine, ORAC, adiponectin ↓ oxidative stress factors
		Volman et al. (2010) <sup>[25]</sup>	RCT	Neutral	56	Adults with hypercholesterolemia	Juice with 5 g/day of α-glucans extracted from white button mushrooms for 5 wks	Juice without α-glucans extracted from white button	↓ TNFα ↔ IL-1b and IL-6
		Weigand-Heller et al. (2012) <sup>[26]</sup>	RCT	Neutral	20	Healthy adults	8 g and 16 g/day powdered mushroom over 3 days	Placebo	↓ oxygen radical absorbance capacity ↑ ergothioneine
	<b>3 Satiety</b>	Hess et al. (2017) <sup>[27]</sup>	RCT	Neutral	70	Healthy adults	226 g/day mushrooms for 10 days	Beef (kJ and protein matched)	↑ satiety ↔ energy intake
		Cheskin et al. (2008) <sup>[28]</sup>	RCT	Neutral	152	Healthy adults	1418 kJ/day white button mushrooms for 4 days	Beef (volume matched)	↓ energy intake ↔ satiety
	<b>4 Cancer risk &amp; its metabolites</b>	Lee et al. (2013) <sup>[29]</sup>	Case-control	Higher	1000	Cases of ovarian cancer	N/A	Healthy adults (no ovarian cancer)	↓ ovarian cancer risk at intakes >2 g/day after 2 years
		Twardoski et al. (2015) <sup>[30]</sup>	Phase 1 trial	Higher	36	Adults with elevated prostate specific antigen	4-14 g/day powdered white button for 10 months	N/A	↓ prostate specific antigen
	<b>5 Gut health</b>	Hess et al. (2018) <sup>[31]</sup>	RCT	Neutral	70	Healthy adults	226 g/day mushrooms for 10 days	Beef (kJ matched)	↑ faecal weight and microbiota composition
		Nishihira et al. (2017) <sup>[32]</sup>	RCT	Lower	80	Adults with problematic halitosis, faecal or body odour	50 to 1000 mg/day mushroom extract for 4 weeks	Placebo	↓ odour and bowel strain
	<b>6 Cardiometabolic markers</b>	Abd-alwahad et al. (2018) <sup>[33]</sup>	Non-randomised trial	Lower	50	Not specified	2 g/kg body weight mushroom (in olive oil) /day for 30 days	Usual diet	↓ glucose, LDL cholesterol, triglycerides, body weight ↑ HDL cholesterol
		Weigand-Heller et al. (2018) <sup>[26]</sup>	RCT	Neutral	20	Healthy adults	8 or 16 g/day powdered mushrooms for 3 days	Placebo	↔ cholesterol and triglycerides
	<b>7 Immune function</b>	Jeong et al. (2018) <sup>[34]</sup>	RCT	Higher	20	Healthy adults	100 g/day white button mushrooms for 7 days	Usual diet	↑ salivary igA secretion

\*Quality of study assessed using the Quality Criteria Checklist by the Academy of Nutrition and Dietetics.

## Memorable mushroom messages

### Bioactive Properties

#### 1 Nutrition allrounder



Mushrooms provide nutrients found not only in vegetables, but in meat and whole grains too.

#### 2 The special sterol



Mushrooms contain a unique sterol called ergosterol, that converts to vitamin D when exposed to light.

#### 3 Beta-ful on the inside



The cell wall of mushrooms consists of the soluble fibre beta-glucan.

#### 4 Unparalleled prebiotic



Mushrooms contain chitin, a unique prebiotic fibre that's not found in fruits, vegetables or grains.

#### 5 First for ergothioneine



Mushrooms contain more ergothioneine (a unique antioxidant) than any other food.

### Health Benefits

#### 1 Fill up with fungi



Swapping beef for mushrooms has been shown to lower calorie intake, with no difference to satiety.

#### 2 Nature's supplement



UV-exposed mushrooms can be as effective as a vitamin D supplement.

#### 3 Healthy heart



Mushrooms cooked in extra virgin olive oil may help to improve markers of heart health.

#### 4 Your gut bacteria loves them



Mushrooms contain special prebiotics which feed your gut bacteria.

#### 5 Tan your mushrooms



Putting 1 cup in the sun for 15 mins can provide you with your daily vitamin D needs.

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This project has been funded by Hort Innovation, using the Mushroom Fund research and development levy and contributions from the Australian Government. Hort Innovation is the grower-owned, not-for-profit research and development corporation for Australian horticulture.

**Hort Innovation**  
Strategic levy investment

**MUSHROOM FUND**

## **APPENDIX 12: RECIPE BOOKLET & FACT SHEET**



# FUN-GI VEGGIE FACTS



LEARN INTERESTING INFORMATION ABOUT VEGGIES AND MUSHROOMS, INCLUDING TOP TIPS ON HOW TO EAT MORE!

## 3 REASONS TO VEG OUT ON VEGGIES



### THE NATURAL GUT FOOD

Vegetables are nutrient dense and contain dietary fibre, which is an important nutrient for gut health.



### YOUR HEART LOVES THEM

Eating plenty of vegetables can be protective against cardiovascular or heart disease, as part of a balanced diet.



### BRIGHTEN UP YOUR DAY

Vegetables naturally contain plant compounds such as carotenoids (a pre-form of vitamin A), which add colour to your plate.

## 3 REASONS TO MUNCH ON MUSHROOMS



### ONE OF A KIND

Mushrooms are a fungi, and not a plant. This means they provide a unique nutritional package that includes nutrients found not only in vegetables, but in whole grains and animal foods too.<sup>1</sup>



### THE SUNSHINE FOOD

Mushrooms are a natural and vegan source of vitamin D. Putting 1 cup of uncooked mushrooms in the sun for 15 minutes can provide you with your daily vitamin D needs.<sup>2</sup>



### MEATY FLAVOUR

Mushrooms have a unique meaty texture and umami (savory) profile. They're a natural flavour enhancer and a tasty addition to vegetarian dishes.



This project has been funded by Hort Innovation using the mushroom research and development levy and funds from the Australian Government. For more information on the fund and strategic levy investment visit [horticulture.com.au](http://horticulture.com.au)

## -TOP TIPS- VEGGIES

### 1 FILL ½ YOUR PLATE WITH VEG



Serve vegetables or salad as a side dish.

### 2 ENJOY TWICE A DAY

Enjoy a variety at least twice a day.



### 3 EMBRACE ALL THE OPTIONS

#### Frozen, fresh or canned?

They're all good for you. Frozen and canned varieties are nutritious, convenient, produce less waste and are available all year round. Remember legumes count as veggies too.



## HOW MUCH?



Enjoy 5 serves of vegetables and mushrooms every day

### WHAT'S A SERVE?

Green leafy or raw salad vegetables = 1 cup

OR

Cooked, canned or frozen vegetables = ½ cup

OR

75g

OR

1 cup uncooked mushrooms = 1 Portobello  
3 Cup  
5 White button

## -TOP TIPS- MUSHROOM

### 1 EAT THE WHOLE MUSHROOM



Did you know that the mushroom 'cap' contains more antioxidants, while the mushroom 'stem' contains more of the soluble dietary fibre called beta-glucan.<sup>3</sup>

### 2 TRY THE DIFFERENT TYPES

Portobello? Cup? Button? Swiss Brown? Different mushrooms have different nutritional profiles, so make sure you enjoy a variety!



### 3 SWAP MEAT FOR MUSHROOMS



Swapping some of your meat for mushrooms can help to reduce your meat intake, while still maintaining the meaty flavour.

#### REFERENCES

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# Veggie-licious



**SIX DELICIOUS VEGETABLE &  
MUSHROOM BASED RECIPES**

# Bioactive benefits of eating more vegetables and mushrooms

## 1. A vitamin and mineral powerhouse.

Veggies provide you with many essential nutrients needed to keep our bodies in tip top health, like vitamin C, folate, potassium and magnesium. Mushrooms are unique as although they share many of the same nutrients and count towards your daily vegetable intake, they are classified as a fungi and not a plant.

## 2. A valuable source of phytochemicals.

Phytochemicals, like polyphenols and antioxidants, are special compounds produced by vegetables and fungi. Consuming plenty of vegetables and mushrooms helps to ensure that you get enough of these important substances.

## 3. A fibre favourite.

Fibre is a superstar nutrient that is naturally occurring in vegetables and fungi, and is needed for good digestion.

### GET TO KNOW YOUR VEGGIES

- ✓ Both frozen and canned veggies are highly nutritious and convenient options.
- ✓ Legumes or beans such as baked beans, lentils and chickpeas, count as veggies too!





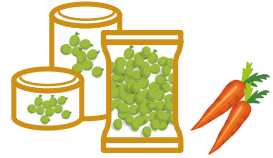
## WHAT'S A SERVE?



1 portobello mushroom or 3 cup mushrooms



1 cup of green leafy or raw salad vegetables



½ cup or 75g of cooked, frozen or canned vegetables (includes legumes)

## What's a serve of vegetables and mushrooms?

The Australian Dietary Guidelines recommends adults aim for at least 5 serves of veggies every day, including different colours and types.

1 serve is about 75 grams, or:

- ½ cup cooked vegetables (such as broccoli, carrot or pumpkin)
- 1 cup salad vegetables
- 1 cup uncooked mushrooms
- ½ cup cooked beans/legumes
- ½ medium potato or other starchy vegetable

5 ways to achieve 5 serves:

1. **Focus on frequency:** Enjoy vegetables or mushrooms at least 2-3 times a day.
2. **Fill half the plate:** Aim for your veggies or mushrooms to make up half your plate.
3. **Snack attack:** From capsicum or carrot sticks, to cherry tomatoes or celery with peanut butter, make veggies your next snack option.
4. **Up your legumes:** Include legumes 2-3 times a week.
5. **Spice up your life:** Embrace a variety of different coloured vegetables, every day.



## Savoury Cauliflower Pancakes with Mushrooms

PREPARATION 20 min • COOKING 20 min • SERVES 4

500g packet frozen Birds Eye  
Cauliflower Veggie Rice

3 eggs, lightly beaten

1 cup grated tasty cheese

2 tablespoons self raising flour

½ teaspoon paprika

½ teaspoon dried oregano

3 tablespoons extra virgin olive oil

200g swiss brown mushrooms,  
sliced

Breakfast sides, of choice e.g.  
tomatoes or wilted spinach.

1. Defrost frozen Birds Eye Cauliflower Veggie Rice in the refrigerator. Once defrosted, squeeze excess moisture from cauliflower rice using a muslin cloth, clean chux or through a fine sieve.

2. In a medium bowl, combine cauliflower rice, eggs, cheese, flour, paprika and oregano. Season to taste. Form mixture into 4 x 10cm patties.

3. Heat 1 tablespoon oil in a non stick frypan over medium-high heat. Cook pancakes one at a time. Spoon a quarter of the mixture into the pan pressing down with a spatula to flatten to 10cm and 1cm thick. Cook for 2-3 minutes on both sides until golden brown. Add more oil to frypan between cooking pancakes, if required. Remove pancakes from pan, place onto absorbent paper and keep warm.

4. Wipe frypan clean, heat remaining oil and add mushrooms. Cook for 4-5 minutes stirring regularly until golden. Serve mushrooms with cauliflower pancakes and breakfast sides of choice.

### VEGETABLE SERVES





## *Better-for-you brekkie!*

We all know how important breakfast is to get our day started off on the right foot. Adding veggies or mushrooms at breakfast helps you to reach your 5 serves a day and starts your day off packing a nutritious punch!

### **7 delicious ways to enjoy veggies or mushrooms at breakfast:**

1. **Veggie breakfast tacos** - tortillas or wraps stuffed with mushrooms, capsicum, black beans & corn with scrambled eggs.
2. **Savoury sweet potato veggie waffles** topped with smashed avocado.
3. **Green smoothie** with spinach, carrot & kale.
4. **Veggie quiche** with grilled eggplant, zucchini, green capsicum & onion.
5. **Spinach, mushroom & potato omelette** served with grilled tomato.
6. **Steamed carrot or zucchini "zoodles"** topped with edamame beans and ricotta cheese.
7. **Pea pesto** – just substitute cooked frozen peas or edamame beans for basil in pesto recipes (kids love this!).



## Mushroom 'Steak' Sandwich with Pea Pesto

PREPARATION 15 min • COOKING 10 min • SERVES 4

2 cups frozen Birds Eye Garden Peas  
1 cup baby rocket leaves  
1 small clove garlic, peeled  
¼ cup finely grated parmesan cheese  
¼ cup pine nuts, toasted  
3 tablespoons extra virgin olive oil  
4 portobello mushrooms  
4 slices sourdough bread, toasted  
Watercress and shaved radish, for serving

1. Drain cooked Birds Eye Peas and set ½ cup peas aside. Place remaining peas, rocket, garlic, parmesan, pine nuts and 2 tablespoons of oil in a food processor and process until pureed. Season to taste. Stir reserved peas through pea pesto.
2. Place mushrooms on a baking paper lined tray and drizzle with remaining oil. Place under a preheated grill on high and cook for 2 minutes on either side until lightly browned.
3. Spread pea pesto on bread, top with mushrooms, watercress and radish. Serve immediately.

### VEGETABLE SERVES



**Tip:** Use leftover pea pesto on toast with eggs as an alternative to smashed avocado.





## *Mushrooms: The nutritional all rounder*

Being classified as a fungi and not a plant, mushrooms contain nutritional properties that other vegetables don't:

1. **Nutritionally unique:** Mushrooms provide nutrients commonly found in vegetables, like fibre and potassium, but also some typically found in other food too, like vitamin B12 and selenium.
2. **The special sterol:** Mushrooms contain a unique sterol called ergosterol, that converts to vitamin D when exposed to sunlight.
3. **Beta-ful on the inside:** The cell wall of mushrooms contains a special soluble fibre called beta-glucan, that is also found in oats.

### **Looking to eat less meat?**

- ✓ Adding mushrooms to your meals can help provide a unique umami (savory) flavour and maintain a meaty texture.



## Broccoli & Cauliflower Tabbouleh

PREPARATION 15 min • COOKING 4 min • SERVES 4

500g packet frozen Birds Eye Broccoli and Cauliflower Veggie Rice

2 tomatoes, seeded and diced

½ cup finely chopped fresh mint

½ cup finely chopped fresh parsley

1 small red onion, finely chopped

Lemon infused oil, for serving.

1. Place frozen Birds Eye Broccoli and Cauliflower Veggie Rice in a microwave safe dish and cook uncovered on HIGH for 4 minutes. Drain any excess moisture from rice and spread on a tray to cool.
2. Combine all ingredients in a large bowl, season to taste and served dressed with Lemon Oil.

### VEGETABLE SERVES



**Tip:** Add Edgell Snack Time chick peas with zesty vinaigrette for added flavour and texture.





## Show a lot of legume love

### Legumes - the hidden vegetable

Did you know that legumes, such as lentils, beans, and chickpeas, are included as a vegetable in the Australian Dietary Guidelines? That makes them an incredibly versatile option to help increase your veggie intake.

### What makes legumes so special?

Legumes are unique as they are both a whole plant food and a protein source. Packed with fibre, B-vitamins and essential minerals, enjoying ½ cup of legumes at least 3 times a week is recommended to realise their unique health benefits.

#### Watching your salt intake?

- ✓ When having canned legumes, rinse in fresh water after draining to wash the brine off and reduce the salt content.
- ✓ Look out for the 'No Added Salt' canned varieties too, particularly if you've been advised to lower your salt intake.



## Veggie Rice & Mushroom Nourish Bowl

PREPARATION 10 min • COOKING 15 min • SERVES 4

2 tablespoons extra virgin olive oil  
200g swiss brown mushrooms,  
halved  
1 tablespoon salt reduced soy sauce  
500g packet frozen Birds Eye Carrot  
Cauliflower Broccoli Veggie Rice  
1 cup baby spinach leaves  
1 avocado, sliced  
2 cups, finely shredded red cabbage  
Roasted sesame dressing, for serving

1. Heat 1 tablespoon oil in a non stick frypan over medium-high heat. Add mushrooms and cook, stirring regularly for 4-5 minutes or until golden. Add soy sauce and stir to coat. Remove from pan, set aside and keep warm.
2. Add remaining oil to same frypan. Add frozen Birds Eye Veggie Rice and cook for 6 minutes, stirring regularly.
3. Stir through spinach and continue to cook for a further 2 minutes.
4. Divide cooked veggie rice, mushrooms, avocado and cabbage in serving bowls. Drizzle over dressing and serve immediately.

### VEGETABLE SERVES



**Tip:** Roasted sesame dressing can be found in the Asian aisle of most major supermarkets.







## Creamy Pumpkin & Cauliflower Baked Gnocchi

PREPARATION 10 min • COOKING 25 min • SERVES 4

1 tablespoon extra virgin olive oil  
1 onion, chopped  
3 sprigs fresh thyme, leaves only  
500g packet frozen Birds Eye Pumpkin  
& Cauli Veggie Mash  
½ cup light cream  
½ cup water  
500g packet gnocchi  
¼ cup grated parmesan

1. Heat oil in a large non stick frypan over medium heat. Add onion and cook for 5-6 minutes or until soft but not coloured. Add thyme leaves.
2. Add frozen Birds Eye Veggie Mash and cook for 5 minutes, stirring continuously. Add cream and water and stir to combine. Add spinach and cook a further 2 minutes until sauce is smooth, steaming hot and spinach is wilted.
3. Meanwhile, cook gnocchi following packet directions. Drain and add gnocchi to frypan with sauce. Stir to coat well.
4. Transfer gnocchi to a baking dish, top with parmesan and bake in a preheated oven at 200°C for 10 minutes or until cheese is melted and golden.

### VEGETABLE SERVES



**Tip:** Want even more veg? Try adding ½ cup frozen Birds Eye Garden Peas with the spinach in step 2.





## Chick Pea, Mushroom & Sweet Potato Curry

PREPARATION 20 min • COOKING 40 min • SERVES 4

1 tablespoon oil  
1 onion, diced  
1 small bunch fresh coriander  
¼ cup korma paste  
1kg sweet potato, peeled and cut into chunks  
400ml coconut milk  
½ cup water  
400g can Edgell Chick Peas, drained  
200g white button mushrooms, halved  
Steamed brown rice, for serving  
Chopped peanuts, for garnish

1. Heat oil in a large non stick frypan over medium heat. Add onion and cook for 3 minutes or until soft. Finely chop coriander roots and add to onion. Cook for 1 minute. Stir in curry paste and cook for 1 minute or until aromatic.
2. Stir in sweet potato, coconut milk and water. Bring to the boil. Reduce heat and simmer covered for 20 minutes. Add Edgell Chick Peas and mushrooms and cook uncovered for a further 10 minutes or until potato is tender.
3. Chop half the remaining coriander, reserving some sprigs for garnish, and stir through curry. Serve with steamed brown rice and garnish with remaining coriander sprigs and peanuts.

### VEGETABLE SERVES



**TIP:** Serve curry with cooked Birds Eye Cauliflower and Broccoli Rice as an alternative to brown rice.





*Tan your mushrooms,  
not your skin!*

#### **Mushrooms and the "sunshine" vitamin:**

Vitamin D is essential for good health, yet 1 in 4 Aussies are deficient. What's more, we have one of the highest rates of skin cancer in the world.

This is where mushrooms come in. Due to their unique ergosterol content, mushrooms can be turned into a vitamin D powerhouse. All you need to do is place 1 cup of uncooked mushrooms in the sun for 15 minutes - this can provide you with 100% of your daily vitamin D needs.

#### **Getting the most vitamin D from your mushrooms:**

1. Slice your mushrooms to put them in the sun with the underside of the mushroom cap facing up. This maximises the surface area for vitamin D production.
2. You can store your mushrooms in the fridge after they have been outside- the vitamin D can last for up to 8 days!
3. Squeeze lemon juice over your mushrooms during cooking. This helps preserve their vitamin D content.



## *Raising happy little veggie-mites*

Early exposure to veggies is important for creating lifelong healthy eating habits among babies and toddlers. Young children learn through imitating and have more interest in eating & learning about foods that they have helped to prepare.

The Australian Dietary Guidelines recommend Aussie kids aim for:

- 2-3 serves of veggies a day for children aged under 5 years.
- 4-5 serves of veggies a day for primary school children.

Fresh salads and self-select share platters are kid-friendly ways to add an extra serve of veggies.



## Top tips to help your child enjoy veggies

**Get them involved:** Make vegetables fun by having them help you to grow a veggie garden, choosing the veggies when grocery shopping, helping to mix a salad, or making veggie kebabs together.

**Rethink the school lunchbox:** Try making savoury veggie muffins, falafel & sliced mushroom wraps, or add a few pieces of raw veggies like cherry tomatoes or mini cucumbers.

**Offer them variety:** Plating up a variety of healthy foods including veggies of different colours can help to make mealtimes fun.

**Make them a new snack:** Offer veggies with other healthy snack options when kids are hungry after school, such as corn & pea fritters or veggie sticks served with hummus dip.



## Acknowledgements

Australian  
**MUSHROOMS**

MUCH HEALTHIER. MUCH TASTIER.



[birdeye.com.au](http://birdeye.com.au)



[edgell.com.au](http://edgell.com.au)

**Hort Innovation**  
Strategic Levy Investments

**MUSHROOM FUND**

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## **APPENDIX 13: MS120 ROUNDTABLE WHITE PAPER REPORT**

# FUNGI Foods

Where do they fit in a plant-based diet?

An Expert Roundtable Discussion





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# Summary

## Background

The value of plant-based diets has become increasingly recognised over the past decade. They are now recommended in dietary guidelines internationally, including in Canada, Brazil, and the landmark EAT-Lancet report.<sup>1-3</sup> With the increasing focus on dietary patterns according to whether they are derived from ‘plants’ or ‘animals’, fungi foods – a separate kingdom to both plants and animals – appear to have been relatively ignored.

As dietary guidance shifts away from nutrients to dietary patterns, particularly those that are plant-based, where does that leave fungi foods, and mushrooms specifically?

This white paper, developed by Nutrition Research Australia (NRAUS) and funded by Hort Innovation, summarises an expert roundtable discussion, held virtually in November 2020. The NRAUS hosted roundtable brought together experts in different fields to present on various aspects of the role of fungi foods in a healthy diet.

## Findings

The group heard that fungi foods are unique and biologically distinct from both plant-and animal-derived foods.<sup>4</sup> Classified as either lower order fungi (moulds and yeasts) or higher order fungi (mushrooms), they have been consumed and valued for thousands of years, including within Australian Indigenous culture, for their medicinal

actions and culinary properties, with research supporting a unique nutritional and bioactive composition.<sup>5,6</sup> The most commonly consumed edible mushroom worldwide is the *Agaricus bisporus* (*A. bisporus*) species<sup>6</sup>. Over the past 10-15 years, there has been a growing scientific evidence base of the health benefits of consuming *A. bisporus*, with a very recent systematic literature review<sup>7</sup> of mostly randomised controlled trials showing seven different potential benefits to human health.

A significant discussion point of the roundtable was how mushrooms, *A. bisporus* specifically, could have a greater focus in dietary guidance given their unique nutritional and bioactive composition, the growing substantiation of potential health effects, and valuable culinary properties, particularly in supporting plant based dietary patterns.

## Recommendations

Three key areas were discussed as important in achieving this endeavour including further high-quality long term prospective observational and intervention studies, establishing clear serving size recommendations within a healthy dietary pattern, and more specific communication and recognition given to these unique and valuable foods in food group categories within dietary guidelines.



# Background

The value of 'plant-based' diets has become increasingly recognised over the past decade. They are now recommended by guidelines internationally, including the National Dietary Guidelines in Canada and Brazil, and the landmark EAT-Lancet report,<sup>1-3</sup> for health and environmental reasons. With increasing recommendations on foods and dietary patterns based on whether they are derived from 'animals' or 'plants', the third food kingdom – 'fungi' – appear to have been relatively ignored.

Fungi are neither an animal nor a plant, and belong to their own biologically separate kingdom.<sup>5</sup> The most commonly eaten edible fungi, mushrooms, contain a unique package of micronutrients, as well as other bioactive and flavour compounds. There is a growing evidence base supporting positive human health effects from their consumption.<sup>7</sup> They offer unique nutritional, health, and culinary properties, yet this may fail to be exposed with their classification as a vegetable.

With the shift away from nutrients to dietary patterns, particularly those that are 'plant-based', where does that leave fungi foods, and mushrooms specifically? How can the unique properties of mushrooms be better captured in this context?

An expert roundtable was held virtually on the 25th of November 2020. The event, hosted by Nutrition Research Australia (NRAUS), brought together five experts across different fields, including nutrition research, food science, indigenous culture, and culinary nutrition, to explore these questions and to discuss the specific role of fungi foods in a healthy diet. The expert roundtable included five presentations and was followed by a panel discussion.

This white paper summarises the main themes and key messages from the roundtable presentations and discussion, offering evidenced-based insights for the consideration of health professionals and policy makers.

# About the experts



## Dr Emma Beckett

*(PhD, MScMgt, GDipClinEpi, GCertHumNutr, BBiomedSci)*

Emma moderated the event and panel discussion. Emma is a food and nutrition scientist and lecturer at the University of Newcastle, specialising in gene nutrient-environment interactions.



## Glenn Cardwell

*(BSc, GradDipDiet, GradDipAppSc)*

**Presentation: The Facts on Fungi: What are they and what makes them unique?**

Glenn is an Advanced Accredited Practising Dietitian with nearly 40-years' experience in clinical and public health nutrition. At the time of the roundtable, he was a director at Dietitians Australia and his research was focused on mushrooms and vitamin D.



## Dr Flavia Fayet-Moore

*(PhD, MNutrDiet, APD, RNutr, FASLM)*

**Presentation: How healthy are fungi? Examining their bioactive & health benefits**

Founder and CEO of NRAUS, Flavia is a registered nutritionist, Accredited Practising Dietitian, sports nutritionist, and Honorary Associate of the University of Sydney.



## Jim Fuller

*(AssocDegChem, BAgrSci)*

**Presentation: Beyond nutrients: The role of fungi foods in culinary nutrition**

Currently Chief Science officer at Fable Food Co, Jim is a fine dining chef, and globally renowned mycologist educator and consultant.



## Arpad Kalotas

*(BScHons)*

**Presentation: Native mushrooms: The consumption of fungi in Indigenous culture**

An environmental consultant, Arpad has expertise in botany, ethnobotany and Indigenous heritage research, predominantly throughout central Australia.



## Professor Linda Tapsell

*(PhD FDA FNSA AM)*

**Presentation: Translating science into dietary advice: Where & how would fungi foods fit?**

Professor Linda Tapsell AM is currently an Honorary Professorial Fellow at the University of Wollongong where she directed major food research centres and conducted dietary trials on the effects of food consumption on health. She is a Fellow of the Dietitians Australia and the Nutrition Society of Australia.

# Fungi foods: What are they?



Fungi are classified as either lower or higher order fungi.<sup>9</sup> The lower classes of fungi, like yeasts and moulds, produce spores in simple ways or on primitive microscopic structures, while the higher classes of fungi produce spores on larger, often woody or fleshy structures (**Figure 1**).

## Classification

Fungi were biologically considered as plants until research in the 1960s recognised that they are a separate life form, with a closer relationship to animals than to plants<sup>8</sup>. They are now recognised as unique and distinct from both plants and animals, belonging to a separate ‘third’ food kingdom.<sup>4, 5</sup>

Fungi foods have a unique structural, chemical, and nutrition composition that sets them apart from plant and animal foods. They obtain nutrients from their environment either as parasites (from a plant, fungal, or animal host), saprophytes (from dead or decaying organic matter), or symbiotes (forming beneficial relationships with hosts).

“Fungi food are neither a plant nor an animal but belong to an entire kingdom of their own.”

**Glenn Cardwell**

“If anything, the mushroom is more like an animal than a plant. Plants make their own food by generating glucose from photosynthesis, whereas animals have to source their food.”

**Jim Fuller**

## Historic and Contemporary Use

Fungi have been consumed and valued in traditional medicines by diverse human populations for thousands of years.<sup>5, 6</sup> The discovery of the first antibiotic of the modern health era, penicillin, came from the fungus *Penicillium notatum*.<sup>10</sup> There is evidence that the First Nation People of Australia valued and consumed a number of higher order fungi. Unfortunately, little is known of their nutritional value, and traditional and contemporary usage, but a wide variety of Australian native fungi have been identified and documented (**Figure 2**).

Mushrooms are a significant part of the dietary pattern of China, Korea and Japan<sup>11</sup>. Today, the Asian Pacific region is a leader in the global mushroom market, with China representing over 80% of the global mushroom market.<sup>11</sup> In Australia, four out of five people report that they eat mushrooms, with around one third claiming to be regular consumers.<sup>12</sup>

As mushrooms are the most common source of fungi in the diet, they were the focus for the roundtable discussion.

<b>Figure 1</b> <b>The Lower Fungi</b>	<b>The Higher Fungi</b>
<p><b>Yeast</b></p> <ul style="list-style-type: none"><li>• Unicellular</li><li>• Spores created internally</li></ul> <p><b>Moulds</b></p> <ul style="list-style-type: none"><li>• Multicellular</li><li>• Filamentous</li><li>• spores are produced on microscopic structures</li></ul> <p>Usually found in soils, cereals or on the surfaces of everything.</p>	<p><b>Commonly called Mushrooms</b></p> <ul style="list-style-type: none"><li>• Multicellular</li><li>• Filamentous</li><li>• Large woody or fleshy spore bearing structures - mushrooms</li></ul> <p>Usually found everywhere there is sufficient moisture, often associated with plants. Grassy fields, forest soils, fallen trees.</p>



## White Button Mushroom: The most commonly eaten mushroom

The common white button mushroom, belonging to *A. bisporus* species, is a recent (1926) mutant form from an original wild ancestor. It is the most commonly consumed edible mushroom species worldwide.<sup>6</sup>

### *Agaricus bisporus* (*A. bisporus*)

There are more than 2000 varieties of edible mushrooms worldwide, with the white button mushroom from the *A. bisporus* species the most commonly consumed.<sup>6</sup> In Australia, *A. bisporus* represents around 95% of fresh edible mushroom consumption. *A. bisporus* includes button mushrooms, cup and portobello mushrooms, with all being the same mushroom at different stages of maturity.

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There is very little known of the nutritional values of wild edible fungi utilised by Indigenous peoples, and opportunities exist for Indigenous communities and other researchers to undertake more detailed studies, including Indigenous biocultural knowledge of fungi in general.'

Arpad Kalotas

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### Figure 2: Native Australian Fungi

Australia is known to have a number of native wild fungi which were valued and consumed by Indigenous Australians. These include:

- **True truffles** *Elderia arenivaga*, *Mattirolomces mulpu*, *Mycoclelandia arenacea* and *M. bulundari* predominantly found in arid Australia,
- **Myrtle Beech Orange** (*Cyttaria gunnii*), a host-specific fungus on Myrtle beech (*Nothofagus cunninghamii*) in Tasmania and southern Victoria,
- **Native Bread** (*Laccocephalum mylittae*), that grows in southwest Western Australia and the Eastern states in rainforests and Eucalypt forests,
- **White Punk** (*Laetiporus portentosus*), a parasitic 'shelf' or 'bracket' fungus on eucalypts found throughout Southern Australia,
- **Horse Dung Puffballs** (*Pisolithus spp.*), found throughout Australia,
- **Beefsteak Fungus** (*Fistulina hepatica*), a 'shelf fungus' on living and dead eucalypt wood, found predominantly across southern Australia, and
- **Mulga Bolete** (*unidentified species*) of arid regions.

Native bread (pictured) was a much sought-after fungus of the First Nation Peoples throughout its range. It was regarded for its good taste and may have played a significant role in traditional subsistence activities at certain times of the year.



Photo courtesy of Eileen Laidlaw (CC BY-SA)

# What makes mushrooms unique?



## Nutritional and bioactive composition

Mushrooms provide micronutrients and bioactive compounds found across different food groups, including vegetables, grains, nuts, and meats, as well as three unique bioactive compounds not commonly found in animals or plants (**Figure 3**).

Mushrooms (*A. bisporus*) contain:<sup>13</sup>

- Flavonoids, common to vegetables.
- Beta-glucan and B vitamins, common to some grains.<sup>14</sup>
- Vitamin D, selenium and biotin common to animal foods.
- Copper common to some nuts.
- Chitin, a unique prebiotic fibre that is only found in mushrooms, crustaceans and insects.<sup>15</sup>
- Ergothioneine,<sup>16</sup> the sulphur containing amino acid antioxidant, which is otherwise only produced by bacteria.<sup>17</sup>
- Ergosterol, a sterol compound found in high concentrations in the fungi cell wall and converts to vitamin D when exposed to ultraviolet (UV) light.<sup>18</sup>

When mushrooms are exposed to ultraviolet (UV) light (either during the drying process or after purchase), ergosterol is converted to highly bioavailable ergocalciferol (vitamin D2). A serve (3 'Cup mushrooms') of UV exposed mushrooms provides 24ug (nearly 1000IU)

**Mushrooms (*A. bisporus*) contain three unique bioactive compounds not commonly found in animals or plants.**



**Chitin** – Prebiotic fibre properties found only in crustaceans, insects and fungi.<sup>15</sup>



**Ergosterol** – a steroid found in high concentrations in fungi cell walls.<sup>17</sup> On exposure to UV light ergosterol is converted to vitamin D2 (ergocalciferol).



**Ergothioneine** – made only by bacteria and fungi, experimental studies show it to be an immune modifier with antioxidant and cytoprotective actions.<sup>19, 20</sup>

vitamin D, which is over 100% of the daily adequate intake across all age groups and the equivalent found in most vitamin D supplements.<sup>21</sup>

The vitamin D in mushrooms has been shown to be largely stable during cooking, particularly at low temperatures, and for up to 8 days refrigeration.<sup>18, 21</sup> A meta-analysis of randomised controlled trials showed that UV exposed mushrooms were effective in increasing active vitamin D levels in adults with low levels of vitamin D,<sup>22</sup> and randomised controlled trials have shown that it can be just as effective as supplements at increasing vitamin D levels in the blood.<sup>23, 24</sup>

**Figure 3** Mushrooms: A unique nutritional profile



Flavonoids



Beta-Glucan  
Niacin



Ergosterol  
Ergothioneine  
Chitin



Vitamin D  
Selenium  
Biotin



Copper

Mushrooms (*A. bisporus*) share key nutritional components with vegetables, grains, nuts and animal foods. Additionally, they contain 3 bioactives, ergosterol, ergothioneine and chitin, that are not commonly found in plants or animals.



**28%**

more antioxidants in the cap (vs the stem)<sup>25</sup>

**40%**

more beta-glucans in the stem (vs the cap)<sup>26</sup>

**Which part is best?**

Research shows that the concentration of bioactives in mushrooms depends on:<sup>7</sup>

- the type of mushroom,
- the cooking method used,
- the mushroom’s structural component (stem, gills versus cap), and
- the duration of UV exposure.

Cooking appears to increase the level of some bioactive compounds such as beta-glucans, whilst decreasing others such as flavonoids and vitamin D.<sup>27-29</sup>

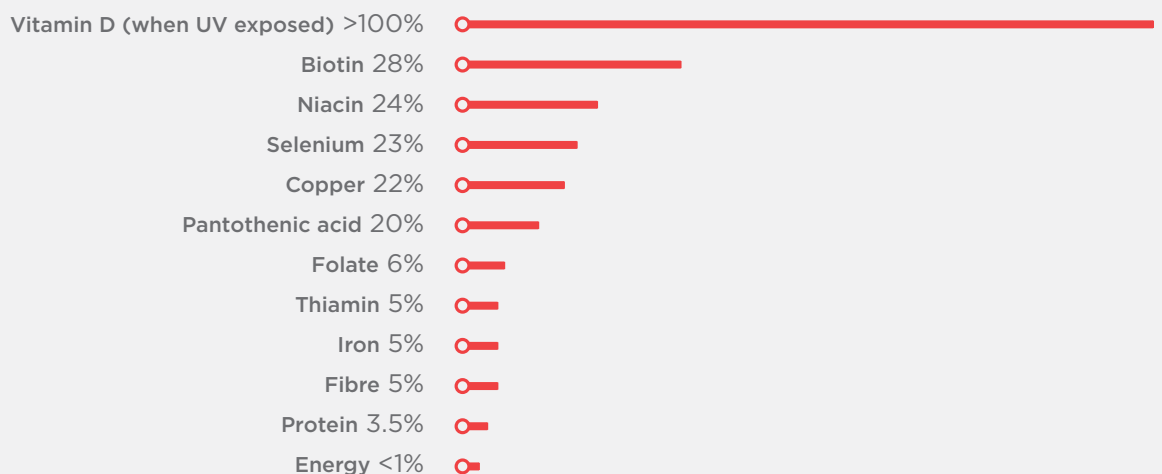


“Tan your mushrooms and save your skin. Exposing 1 portobello mushroom to 15 minutes of sunlight can provide the same amount of vitamin D as a low dose vitamin D supplement (1000IU).”

**Dr Flavia Fayet-Moore**

**Mushroom’s (*A. bisporus*) Nutritional Profile<sup>13, 30</sup>**

*% recommended daily or adequate intake^ per 100g*



*\*based on nutritional composition common, fresh, raw A. bisporus and estimated intake of average adult 8700kJ/day and Nutrient Reference Values for male 31-50 years<sup>13, 30</sup>*

# The culinary X-factor

Beyond their nutritional and bioactive profile, mushrooms contain unique flavour compounds including glutamates, ribonucleotides, and a number of synergistic volatiles, which are often referred to as odour active compounds. Together, these compounds are responsible for the characteristic 'umami' savoury taste and the pleasant odours associated with cooked mushrooms,<sup>31</sup> that can help to enhance the flavour of meals and with less salt.

As the flavour compounds occur intracellularly, in order for the flavour to be fully appreciated, they need the cell wall to be degraded.<sup>32</sup> Drying, freezing, and boiling are the best methods to degrade the cell wall and strengthen the mushroom's umami taste, enhancing its flavour.

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'Mushrooms and associated fungi (yeast) extracts offer a nutritious, lower salt but still flavoursome way to provide the savoury 'umami' taste that can help drive palatability of other foods.'

**Jim Fuller**

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Jim Fuller, Chef turned mycologist, recommends breaking down the resistant cell walls of mushrooms during cooking to allow the flavour compounds to be released. Whilst these compounds are present externally with lower fungi, mushrooms flavour compounds are located intracellularly. Access to these compounds is often key to the flavour.

In order to release the flavour notes, the cell wall must first be broken, and this does not necessarily happen with simple cooking methods such as frying, but drying, freezing or boiling will all help to break down the cell wall more easily.

**Jim's top tip is to simply boil your mushrooms by:**



1. Pouring a little water in a hot pan and bring to the boil,
2. Throwing in your mushrooms, and then
3. Reducing the water before you then sauté.



Older aged mushrooms are often considered the tastiest because they undergo autodigestion as the cell wall is naturally breaking apart. This makes the internal contents more easily accessed.



# Mushrooms and health:

## A traditional food for the modern health era

Long traditional use with growing evidence base of human health effects<sup>7</sup>



Immune system



Mental health



Wound healing



Antibiotics

Recent scientific health effects of *A. Bisporus* mushrooms<sup>7</sup>



↓ Cancer risk & its metabolites



↑ Vitamin D status



↑ Satiety



↑ Gut health



↓ Inflammation



↑ Cardiometabolic health

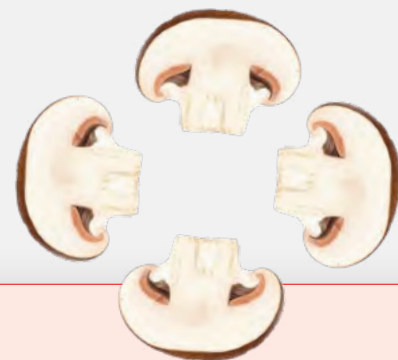


↑ Immune function

Mushrooms have a long traditional medicinal usage, and are highly valued for their immunomodulatory actions.<sup>6</sup> A number of experimental and *in vivo* animal model studies have shown that mushrooms, of different species, can have a favourable influence on immune function, glycaemic control, lipid profile, blood pressure, bone density, gut health, cancer and cognitive function.<sup>30, 33-42</sup>

Over the past decade, the scientific evidence base, including human studies supporting potential health benefits from consuming the most common edible mushroom, *A. bisporus*, has grown substantially. A recent scoping review showed seven different health benefits from 15 different human studies, of which eleven were randomised controlled trials (RCTs).<sup>7</sup>

The actions of unique bioactive compounds in mushrooms may explain these health effects. Beta-glucans, ergothioneine, and ergosterol have been shown in experimental studies to have immunomodulating and anti-tumour effects.<sup>43-45</sup> Ergothioneine has demonstrated antioxidant and cytoprotective actions,<sup>19, 20</sup> whilst beta-glucans, particularly those from mushrooms, have immune stimulating properties.<sup>46, 47</sup>



### Mushrooms and immunity support

Mushrooms are rich in bioactive compounds, including vitamin D, ergosterol, ergothioneine, beta-glucan and selenium, all favourably linked to immune function in experimental studies.<sup>41, 42</sup> The few human studies to date suggest that consumption of the common edible mushroom species (*A. bisporus*)

is linked with an increase in immune markers and associated with a decreased risk and progression of cancer.<sup>48-50</sup> Further high-quality human studies are needed to fully elucidate mushrooms role in immunity and corresponding health benefits.



A recent systematic review of evidence suggests that consuming common edible mushrooms (*A. bisporus*) may improve vitamin D status (strongest evidence), have a positive impact on immune function and inflammatory markers, and a beneficial effect on metabolic syndrome

and markers of gastrointestinal health, as well as cancer risk reduction (ovarian) and management (prostate).<sup>7</sup> Further research would consolidate these initial observations.

## Emerging Health Benefits of common edible Mushrooms (*A. bisporus*)



### Vitamin D Status

The strongest evidence of mushrooms on health appears to be on vitamin D status.<sup>51</sup> This is highly relevant to populations like Australia, with almost 1 in 4 deficient (serum 25(OH)D <50 nmol/L) and a further 2 in 5 insufficient (serum 25(OH)D 50 to <75 nmol/L).<sup>52, 53</sup>

Research supports that consumption of UVB exposed mushrooms was as effective at increasing and maintaining serum vitamin D levels as vitamin D supplementation in individuals with and without vitamin D deficiency at baseline.<sup>51</sup> The retention of vitamin D in mushrooms is reported up to 8 days in fridge.<sup>18</sup>



### Gut Health

Interest in gut health has increased exponentially over recent years. Understanding what drives a healthy gut is still in its infancy, and current knowledge suggests that a healthy gut is dependent on an abundant and diverse gut microbiota.<sup>54</sup> Lower gut microbiota diversity is associated with a range of disorders and disease states, including cardiovascular disease, type 2 diabetes and inflammatory bowel disease.<sup>54</sup>

A randomised controlled trial showed that the replacement of meat meals for mushroom meals led to greater stool weight, less strain, decreased odour and changes in specific microbiota in the gut with greater abundance of Bacteroidetes and lower abundance of Firmicutes.<sup>55</sup>



### Immunity & Cancer

With the re-emergence of infectious disease, the nutritional modulation of the immune system has become an important focus for clinicians and consumers,<sup>56</sup> and research with mushrooms is emerging. In one study, compared to usual diet, eating 100g of cooked white button mushrooms for 7 days was associated with increased serum IgA osmolarity, secretion rate, and concentration, all markers of immune function.<sup>48</sup>

A Chinese case control study showed consumption of >2g white button mushrooms per day reduced the odds of ovarian cancer by 32%.<sup>49</sup> A phase 1 clinical trial showed that a mushroom extract at increased doses (4-14g extract/day), equivalent to 40-140g fresh white button mushroom was associated with decreased total prostate specific antigen (PSA) levels in 36% of patients.<sup>50</sup>



## How can mushrooms fit into dietary guidance targeting healthy dietary patterns?

With increasing scientific evidence, the focus of dietary guidelines has shifted to start with dietary patterns, identifying foods that contribute to these patterns and then ensuring the food combinations meet nutrient requirements and avoid the risk of chronic disease. This trend is evidenced in the recently released Dietary Guidelines for Americans.<sup>57</sup> With the COVID-19 pandemic, there is further recognition of the need to consider the concurrent susceptibility to infection alongside that of chronic disease.

‘In view of our understanding of poorer outcomes from COVID 19 in those with diet related chronic disease, future dietary guidelines will need to consider not only chronic disease prevention, but also how the associated inflammation may play out in our immune response.’

**Dr Linda Tapsell**



Dietary patterns vary depending on life stage, accessible and preferred foods and cuisines, and considerations for the environment, particularly toward plant based foods. The unique characteristics of mushrooms, including their nutritional and bioactive components, warrants considered attention in the modern Australian context.

Given that cuisine has a significant influence on dietary patterns, mushrooms may help drive plant based dietary patterns while contributing to their nutritional value. As for the food supply generally, the environmental impact of modern mushroom production would still benefit from further research.



## How can we achieve greater focus on mushrooms?

Considering the scope of information discussed thus far, directions for the future can be seen as the need for further research exposing the health benefits of mushroom consumption, establishing evidence-based serving guidance for intakes in a healthy dietary pattern, and communications that acknowledge the uniqueness and value of mushrooms, particularly in plant based cuisines.

### Further research

Most research to date on the health effects of *A. bisporus* in humans has been observational and short term. Little is known about the health effects of the lower fungi foods (e.g., moulds, yeast). A greater body of research overall will strengthen the evidence base supporting mushrooms as a significantly healthy food.

In food research studies it would help if mushrooms were classified as separate food items, independent of vegetables for example in food frequency questionnaires. This would enable better identification of associations between intakes and health outcomes through analyses of nationally representative cohort studies from across the globe.

Additional nutritional and bioactive compositional research is a second research priority, with a focus on diverse lower and higher fungi foods, including those of cultural importance to our First Nation people and those produced sustainably.

### Establish clear serve sizes

Establishing and communicating clear and practical serve sizes specific to fungi foods, with mushrooms as a focus, is also considered important in providing more concrete dietary guidance. Currently mushrooms are classified as a vegetable, with a serve defined by the Australian Guide to Healthy Eating as 75g (1 cup uncooked), or about three 'Cup mushrooms', based on their culinary usage.<sup>46</sup>

For *A. bisporus* mushrooms, the strongest evidence for health benefits is in improving vitamin D status. Research shows that 100g of mushrooms exposed to UV light for 10-15 minutes is enough to meet >100% of daily requirements across all age groups, and as effective as a vitamin D supplement in treating vitamin D deficiency.<sup>51</sup>

Larger quantities may bring additional health benefits. For example, one study found around 226g mushrooms (equivalent to around nine 'Cup mushrooms') produced a positive effect on the gut microbiota.<sup>55</sup>

### 1 cup uncooked mushrooms



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'Based on current limited evidence we should be aiming to consume at least 3 Cup Mushrooms (1 cup uncooked) regularly'

**Dr Flavia Fayet-Moore**  
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## Dietary guidelines recognition

As single foods, there is no mention of the unique nutritional value of fungi foods, nor their bioactive composition or health benefits in the current Australian Dietary Guidelines. The guides do however refer to food groups and mushrooms are included in the vegetable group.

This classification may mask the unique characteristics of mushrooms as fungi foods, and miss opportunities for cultural and cuisine use. However, as consumers seem to perceive and use them as a vegetable, it is debatable whether arguing for a separation of mushrooms or fungi foods into their own food group has a place here.

On the other hand, there is a case for seeing mushrooms as unique, distinguishable from plant- and animal-derived foods in both the nutritional and culinary context. In this sense, naming them within a food group, similar to foods like legumes and nuts, may be appropriate.

## How can we achieve greater focus for mushrooms?

Three key recommendations were provided by the expert panel for attaining more focus on mushrooms in dietary guidance to the public.

### 1. Conduct further research:

The effects of fungi foods on human health to be a research priority, with mushrooms categorised independently of vegetables.

### 2. Establish clear serve sizes:

Aim for at least 1 cup uncooked mushrooms regularly. Dietary modelling research is recommended to position this serve recommendations in the context of overall healthy dietary pattern.

### 3. Dietary Guidelines recognition:

Based on their uniqueness from plant- and animal-derived food, there is opportunity for greater recognition in nutrition guidelines, similar to legumes and nuts.

## Key takeaway messages



Fungi foods comprise their own food kingdom, distinct from both animals and plants.



Traditionally valued for thousands of years, including with our First Nation People, and with a strong medicinal reputation in Asian cultures.



Mushrooms contain unique flavour compounds that contribute to their well-regarded savoury 'umami' taste profile, a known desirable culinary driver of taste.



Mushrooms have a unique nutritional composition, comprising micronutrients and bioactive compounds found in both plants and animals, along with three bioactive compounds (Ergosterol, Ergothioneine and Chitin) not commonly found in both.



Emerging research has shown mushrooms to have favourable effects on gut health, inflammation, immune function, cancer risk and satiety. It has been established that consuming UV enriched types improve vitamin D status.



## Consensus of the expert roundtable

The roundtable concluded that fungi foods are unique, distinct from both plant and animal foods. The unique nutritional, bioactive, health and culinary properties of *A. bisporus* mushrooms, make them worthy of a greater focus, especially in the modern Australian health context. As we move increasingly towards plant-based diets, this distinct food deserves the consideration of a more prominent place in research and subsequent dietary guidance.

Three key areas were discussed as important in achieving greater focus in research and dietary guidance, including:

- further high-quality long term prospective epidemiological and intervention studies,
- establishing clear serving recommendations for dietary intake, and
- specific communications given to these unique and valuable foods in dietary guidelines.

‘As dietary guidance aims to combat chronic disease and the re-emergence of infectious disease, while moving towards plant-based diets for environmental sustainability, mushrooms offer a unique combination of nutrients and bioactives shown to improve health, as well as valuable culinary properties. This makes them a valuable food for the modern health era.’

## Making the most of mushrooms: 5 practical tips



### Tan them:

Placing 1 cup of mushrooms in the sun for 15 minutes can provide greater than 100% of the daily adequate intake of vitamin D (15µg/day).<sup>18</sup> Increasing the surface area exposed to UVB light helps to increase the rate that ergosterol is converted to Vitamin D, so face the 'gills' (the underside of the mushroom) to the sun, or slice mushrooms, for maximum Vitamin D.



### Choose 'one serve' regularly:

The common edible mushroom species *A. bisporus* includes white button mushrooms, cup mushrooms and portobello. 1 serve = 1 cup (uncooked mushrooms) = 1 Portobello, 3 Cup or 5 Button mushrooms.



### Eat them whole:

While the 'cap' of mushrooms is a richer source of antioxidants, its stem contains 40% more of the soluble fibre beta-glucan.<sup>26</sup>



### Cook on low:

A versatile food, mushrooms can be enjoyed raw or cooked. To maintain antioxidant and nutrients, cook on a lower heat.<sup>28</sup>



### Add lemon juice:

Adding lemon juice to mushrooms when cooking can help to retain their vitamin D content.<sup>27</sup>

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- **Jim Fuller** is co-founder and Chief Science Officer of Fable Food Co, a company that uses mushrooms to recreate the taste and texture of meat.
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- **Professor Tapsell** was formerly director of the ARC Key Centre for Smart Foods and the National Centre of Excellence in Functional Foods based at the University of Wollongong, and as such lead numerous research and consultancy projects across various sectors of the food value chain. She has served on the Science Advisory Council of the California Walnut Commission and the McCormick Science Institute. She is currently on the steering committee of the Horticulture Australia project, 'Naturally Nutritious' and continues to advise and work with Nuts for Life. In 2019 she received the Excellence in Research award from the International Nut and Dried Fruit Council (INC). She is a member of the Consumer and Public Health Dialogue of Food Standards Australia New Zealand and served on the Advisory Committee of the 2013 Australian Dietary Guidelines.
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**APPENDIX 14: MS124 HCP CLIENT BROCHURE VITAMIN D**

# ARE YOU DEFICIENT IN VITAMIN D?

Nearly 1 in 4 Australians are.<sup>1</sup>



## Why do I need vitamin D?

You may have heard that vitamin D helps your body absorb calcium and supports healthy bones and muscles.<sup>2</sup> But did you know that vitamin D also plays an integral role in ensuring your immune system is healthy?<sup>2</sup>



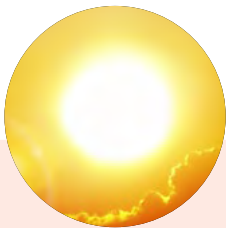
IMMUNITY



MUSCLES & BONES

## Where do I get it from?

Called the 'sunshine vitamin', vitamin D is produced in your skin when exposed to sunlight. Some foods and supplements are also sources of vitamin D.



### SUN

- ✔ Vitamin D is produced in your skin when exposed to sunlight.
- ✘ Can be challenging to get enough sun exposure during winter and adhere to sun smart guidelines in summer.



### FOOD

- ✔ Natural source of vitamin D and provide other essential nutrients.
- ✘ Few foods are a good source of vitamin D.



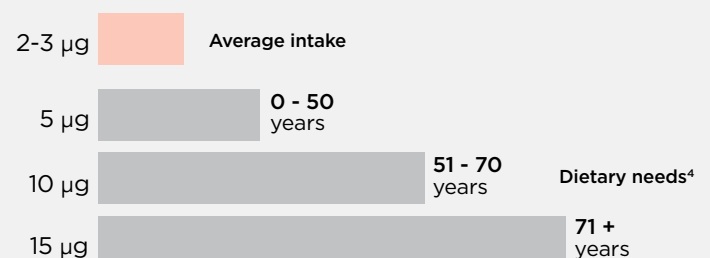
### VIT D SUPPLEMENTS

- ✔ Can provide 100% of your daily vitamin D needs.
- ✘ Can be an added cost and typically provide few other nutrients.



### DID YOU KNOW?

Australians are getting less than they need from food<sup>3</sup>



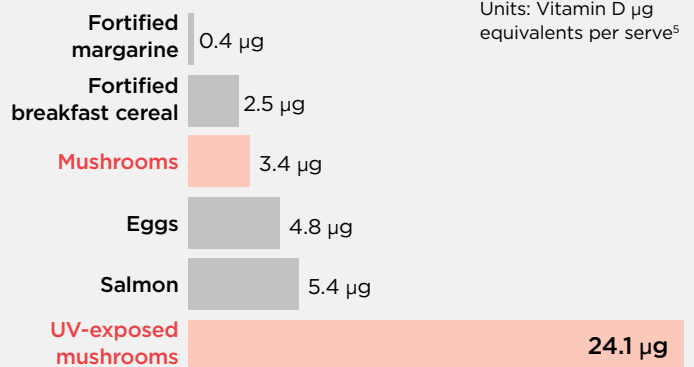
# SUN-EXPOSED MUSHROOMS

A stand out source of vitamin D to support immunity.\*

Mushrooms are one of the only non-animal sources of vitamin D, with one serve providing at least 20% of daily dietary needs.<sup>5</sup> Like humans, clever mushrooms produce vitamin D on sunlight exposure.

Placing just 3 Cup or 5 Button mushrooms in the sun for about 15 minutes can provide over 100% of daily vitamin D needs!<sup>6</sup>

## FOOD SOURCES OF VITAMIN D



## Tan your mushrooms, not your skin!



### STEP 1: PREPARE

Choose one serve which is equal to 1 portabello, 3 cup mushrooms or 5 button mushrooms. Use the whole mushroom as there are different nutrients in the stem compared to the caps.<sup>7,8</sup>



### STEP 2: TAN

Put them in the sun for just 15 minutes and you can increase vitamin D content to 100% of your daily needs.<sup>6</sup> They retain their vitamin D in the fridge for up to 8 days.<sup>9</sup>



### STEP 3: COOK

Cook on low heat and add some lemon juice to help preserve vitamin D content.<sup>10,11</sup>

## Much more than vitamin D

✓ VEGAN AND VEGETARIAN

✓ PROVIDES B VITAMINS

✓ GLUTEN FREE



LOW IN KILOJOULES ✓

ADDS FLAVOUR TO MEALS ✓

LOW IN SODIUM ✓

For recipes and more facts: [australianmushrooms.com.au](http://australianmushrooms.com.au)

Australian  
**MUSHROOMS**

**NRAUS**

**Hort  
Innovation**  
Strategic levy investment

**MUSHROOM  
FUND**

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\*As part of a healthy and varied diet.

**APPENDIX 15: MS106 KEY MESSAGING ('DR FLAV'S FUN FACTS') DOSSIER**



## Dr Flav's Fun Facts

Prepared for Hort Innovation  
**March 2020**

Prepared by Nutrition Research Australia

## Summary

During the research process for the systematic literature review, *'Examining the health effects and bioactive components in Agaricus bisporus mushrooms: A scoping literature review'*, NRAUS came across many fun facts that could be used in the communication messages to healthcare professionals and to support the consumer marketing campaign.

The NRAUS team reviewed all of the collated facts and prepared a Dr Flav's Fun Facts table for your consideration. Each fun fact is supported by a brief scientific description, any other information that should be considered with its use, and references. Fun facts that have been used to date in communication materials are marked with an asterisk (\*).

Please note that these fun facts are not an extensive summary of that topic. They are provided as a source of information from which we can gather more evidence if requested for public use. Food regulations also need to be considered before any fact is communicated. The impact of food regulations often depends on the context of the claim (e.g. if communication is regarded as advertisement).



Table 1. Dr Flav's Fun Facts

Fun Fact	Scientific Description	Other Considerations	References
<b>Nutrient composition</b>			
100g of white button mushrooms (about 5) contain more potassium than a medium banana (98g).	Potassium is a mineral essential for cardiac function and maintenance of blood pressure. For prevention or management of hypertension (high blood pressure), individuals should aim for foods with a high ratio of potassium to sodium. 100g banana = 358mg potassium 100g white button mushrooms = 396mg potassium	Generally, a 25% difference is required for a comparison claim to consumers, but this message can still be used in general education messages	Australian Food Composition Database, 2019, Food Standards Australia and New Zealand  Food Standards Code 1.2.7
Eating just 4 white button mushrooms counts as a serve of vegetables (about 75g)!	Fewer than 1 in 10 Australians eat the recommended 5 serves of vegetables each day. Adding just 4 white button mushrooms (75g) to the daily diet counts as one vegetable serve!		<a href="https://ncci.canceraustralia.gov.au/prevention/diet/vegetable-consumption">https://ncci.canceraustralia.gov.au/prevention/diet/vegetable-consumption</a> Eat for Health Australian Dietary Guidelines
<i>Agaricus bisporus</i> mushrooms have healthy omega-6 fatty acids generally found only in meat or dairy.	Conjugated linoleic acid is a type of polyunsaturated, omega-6 fatty acid that is believed to have various health benefits. It is commonly found in meat and dairy, and may positively benefit body composition and cardiometabolic risk factors.  Findings from the American Heart Association's scientific statement on omega-6 found that: <ul style="list-style-type: none"> <li>• omega-6 fats are associated with a reduced risk of heart disease</li> </ul>		Chen S, Oh SR, Phung S, et al. Anti-aromatase activity of phytochemicals in white button mushrooms ( <i>Agaricus bisporus</i> ). <i>Cancer Res</i> 2006;66(24):12026-34.  Lehnen TE, da Silva MR, Camacho A, et al. A review on effects of conjugated linoleic fatty acid (CLA) upon body composition and energetic metabolism. <i>J Int Soc Sports Nutr</i> 2015;12:36.

Fun Fact	Scientific Description	Other Considerations	References
	<ul style="list-style-type: none"> <li>• omega-6 are not pro-inflammatory when consumed within existing health eating guidelines</li> <li>• replacing energy from saturated fat or carbohydrate with energy from linoleic acid was associated with a lower risk of coronary heart disease events and death.</li> </ul> <p>Further, the Australian heart Foundation Position Statement on Dietary Fat and Heart Healthy Eating recommends including sources of Omega-6 PUFA, and that most Australian's have intakes of linoleic acid below recommended targets (4-10% total energy).</p> <p>If an imbalance between Omega-3 and Omega-6 is a concern, this can be addressed by including more food sources of Omega-3 PUFA.</p>		<p>Clifton P and Keogh J. Dietary fats and cardiovascular disease: an evidence check rapid review brokered by the Sax Institute for the National Heart Foundation of Australia. 2017.</p> <p>Harris WS, Mozaffarian D, Rimm E, Kris-Etherton P, Rudel LL, Appel LJ, et al. Omega-6 fatty acids and risk for cardiovascular disease: a science advisory from the American Heart Association Nutrition Subcommittee of the Council on Nutrition, Physical Activity, and Metabolism; Council on Cardiovascular Nursing; and Council on Epidemiology and Prevention. <i>Circulation</i>. 2009;119(6):902-7.</p> <p><a href="https://www.heartfoundation.org.au/images/uploads/main/For_professionals/Dietary_Fats_Position_Statement_2017.pdf">https://www.heartfoundation.org.au/images/uploads/main/For_professionals/Dietary_Fats_Position_Statement_2017.pdf</a></p>
<p>*Nutrition allrounder: Mushrooms not only provide nutrients found in fruit and vegetables, but</p>	<p>Mushrooms can be a source of niacin (commonly found in meat and grains), pantothenic acid (meat and dairy), selenium (meat and grains) and copper (meat). Mushrooms are also an excellent source of riboflavin (meat, grains and dairy).</p>		<p>Jo Feeney M, Miller AM, Roupas P: Mushrooms-Biologically Distinct and Nutritionally Unique: Exploring a "Third Food Kingdom". <i>Nutrition today</i> 2014, 49:301-307.</p>

Fun Fact	Scientific Description	Other Considerations	References
also those found in meat and grains too.	Mushrooms are consumed in a similar way to plants, but have the some of the nutritional properties of animal derived foods. For example, mushrooms contain chitin (carbohydrate found in crustaceans and insects), ergosterol (rather than cholesterol found in mammals), and conjugated linoleic acids (commonly found in meat and dairy products)		U.S Department of Health and Human Services. National Institutes of Health. Dietary supplement fact sheets. <a href="https://ods.od.nih.gov/factsheets/list-all/">https://ods.od.nih.gov/factsheets/list-all/</a>
*A natural innovator: Unlike plants, mushrooms lack chlorophyll and obtain sustenance from complex organic materials of plants and animals.	Mushrooms are different to other vegetables as they don't have chlorophyll to make their own food through photosynthesis. They are fungi. Fungi have no chlorophyll and exist on decaying material in nature to grow and thrive.		Encyclopaedia Britannica <a href="https://www.britannica.com/science/fungus">https://www.britannica.com/science/fungus</a>
Eat more edible mushrooms to add protein to any plant-based meal.	On average, edible mushrooms contain twice as many free amino acids (120.79 mg/g) compared to medicinal mushrooms (61.47 mg/g).	Mushrooms do not meet the required protein content for a nutrient content claim (5 grams per serve)	Kim MY, Lee SJ, Ahn, JK, et al. Comparison of free amino acid, carbohydrates concentrations in Korean edible and medicinal mushrooms. Food Chem 2009;113; 386–393.
<i>Prebiotics</i>			
Eating just 200g of cooked mushrooms for 10 days can act like a fertilizer to grow good bacteria in your gut.	Mushrooms contain non-digestible polysaccharides (a type of carbohydrate) which can act as food for our resident gastrointestinal microbiota. Measurable changes in faecal microbiota		Hess J, Wang Q, Gould T, et al. Impact of Agaricus bisporus Mushroom Consumption on Gut

Fun Fact	Scientific Description	Other Considerations	References
	composition have been reported in a study that compared the effect of ground beef (28g) vs mushroom (200g/day) consumption over 10 days. Greater abundance of Bacteroidetes (good bacteria) and lower abundance of Firmicutes (bad bacteria) were found. However, the clinical significance of the changes is not yet clear (if beneficial).		Health Markers in Healthy Adults. <i>Nutrients</i> 2018;10(10):1402.
Mushrooms contain special prebiotics that feed your 'good' gut bacteria to create a healthy gut microbiome.	Mushrooms contain several different types of carbohydrates that are not easily digested: low-digestible and non-digestible carbohydrates are those that you can't digest but that can feed your gut bacteria/microbiome. Mushrooms have quite a range of food options for our gut microbiota: chitin, B-glucans, raffinose, oligosaccharides, and resistant starch.		Hess J, Wang Q, Gould T, et al. Impact of Agaricus bisporus Mushroom Consumption on Gut Health Markers in Healthy Adults. <i>Nutrients</i> 2018;10(10):1402.  Aida FMNA, Shuaimi M, Yazid M, et al. Mushroom as a potential source of prebiotics: a review. <i>Trends in Food Sci Tech</i> 2009;20(11-12):567-575.
Mushrooms: a little-known source of resistant starch in the diet.	Researchers found that ~15% of the fibre content of mushrooms is resistant starch. Resistant starches resist digestion in the small intestine, traveling to the colon where they can be fermented by resident bacteria to form short-chain fatty acids, particularly butyrate. Butyrate supports digestive health and disease prevention. While resistant starch from mushrooms has not been evaluated for its impact on gut health, studies on resistant starch from other sources show that it has		Hess J, Wang Q, Gould T, et al. Impact of Agaricus bisporus Mushroom Consumption on Gut Health Markers in Healthy Adults. <i>Nutrients</i> 2018;10(10):1402.  Birt DF, Boylston T, Hendrich S, et al. Resistant starch: Promise for improving human health.

Fun Fact	Scientific Description	Other Considerations	References
	beneficial impacts on health, including improved insulin sensitivity, lower blood sugar levels, reduced appetite and improved gut health.		Advances in Nutrition 2013; 4(6):587-601.
<i>Glucans and Chitin</i>			
*Beta-ful on the inside: The cell wall of mushrooms consists of the soluble fibre beta-glucan.	Soluble and insoluble glucans form structural components of the cell wall.		Sari M, Prange A, Lelley JL, et al. Screening of beta-glucan contents in commercially cultivated and wild growing mushrooms. Food Chem 2017;216:41-51.
Mushroom contain up to four times more beta-glucans than oats.	Beta-glucans account for approximately 75% of total glucan concentrations in <i>Agaricus bisporus</i> mushrooms with a volume of 8-12g/100g dry weight, which is substantially higher than the 3-8g/100g dry weight found in oats, 1.3-2.7g/100g dry weight in rye, and 2-20g/100g dry weight in barley.		Sari M, Prange A, Lelley JL, et al. Screening of beta-glucan contents in commercially cultivated and wild growing mushrooms. Food Chem 2017;216:41-51.  Autio K, Myllymaki O, Malkki Y. Flow properties of solutions of oat beta-glucans. J Food Sci 1987;52(5):1364-1366.
Don't remove the stalk when chopping your white button mushrooms. There's over 40% more beta-glucans in the stalk than the caps!	Beta-glucan is a soluble fibre found naturally in cereal grains, yeast, some mushrooms like <i>Agaricus bisporus</i> , and sold as a supplement. Beta-glucans are known to have anti-tumour, anti-inflammatory, anti-obesity, anti-allergic, anti-osteoporotic and immunomodulating properties. In white button mushrooms, beta-glucan concentration in the cap		Sari M, Prange A, Lelley JL, et al. Screening of beta-glucan contents in commercially cultivated and wild growing mushrooms. Food Chem 2017;216:41-51.  Bashir KMI, Choi JS. Clinical and physiological perspectives of $\beta$ -

Fun Fact	Scientific Description	Other Considerations	References
	was 8.6g/100g dry matter compared to 12.3g/100g dry matter in the stalk.		glucans: The past, present, and future. Int J Mol Sci 2017;18(9):1906.
Mushrooms contain chitin, a special fibre and prebiotic.	Along with b-glucans, chitin is the dominant component of the fungal cell wall, responsible for the rigidity and shape of the cell wall. It has an important role in the nutritional value of mushrooms.		Manzi P, Aguzzi A, Pizzoferrato L. Nutritional value of mushrooms widely consumed in Italy. Food Chem 2001;73:321-325.
*A true whole food: While the 'cap' of mushrooms is a richer source of antioxidants, its stem contains more of the soluble fibre beta-glucan.	<p>Chitin is considered to promote diverse activities including antioxidant effects.</p> <p>Chitin level of the pileus (cap) is – in general – higher, than of stipes. These differences can be significant (for <i>A. bisporus</i>) or non-significant (for <i>P. ostreatus</i> and <i>L. edodes</i>). In white button mushrooms, beta-glucan concentration in the cap was 8.6g/100g dry matter compared to 12.3g/100g dry matter in the stalk. Similarly, in brown button mushrooms, beta-glucan concentration in the cap was 8.8g/100g dry matter compared to 10.1g/100g dry matter in the stalk.</p>		<p>Ngo DH, Kim Sk. Antioxidant effects of chitin, chitosan, and their derivatives. Adv Food Nutr Res 2014;73:15-31.</p> <p>Vetter J. Chitin content of cultivated mushrooms <i>Agaricus bisporus</i>, <i>Pleurotus ostreatus</i> and <i>Lentinula edodes</i>. Food Chem 2007;102(1):6-9.</p> <p>Sari M, Prange A, Lelley JL, et al. Screening of beta-glucan contents in commercially cultivated and wild growing mushrooms. Food Chem 2017;216:41-51.</p>
<i>Ergothioneine</i>			
Mushrooms are the richest food source of an amino	Ergothioneine (ET), an amino acid uniquely synthesised by and found in relatively high		Weigand-Heller AJ, Kris-Etherton PM, Beelman RB. The

Fun Fact	Scientific Description	Other Considerations	References
acid or building block of protein called ergothioneine.	concentrations (0.1-1mg/g) in fungi/mushrooms, possess significant & efficacious antioxidant activities.		bioavailability of ergothioneine from mushrooms ( <i>Agaricus bisporus</i> ) and the acute effects on antioxidant capacity and biomarkers of inflammation. <i>Prev Med</i> 2012;54(Supp1):S75-8
Ergothioneine, found in mushrooms, is a powerful antioxidant!	<p>Unlike many antioxidants, very little ergothioneine is excreted from our bodies, showing just how important it is to get from our diet!</p> <p>OCTN1 receptors in the intestines are highly selective and specific for ergothioneine. OCTN1 also distributes ergothioneine to most body tissues. Expression of OCTN1 is concentrated at sites of tissue injury, and ergothioneine is highly retained with very little excreted through urine or faeces. The human body has no capacity for endogenous synthesis of ergothioneine</p>		Halliwell B, Cheah IK, Tang RMY. Ergothioneine – a diet-derived antioxidant with therapeutic potential. <i>FEBS Lett</i> 2018;592(20):3357-3366.
*Putting the one in ergothioneine: Mushrooms contain more ergothioneine: a unique sulphur-containing antioxidant - than any other food!	Ergothioneine is so important that our bodies have special receptors just for it, even though we can't make it in our body. Separate analyses of specific compounds in mushrooms including the sulfur-containing amino acid ergothioneine have been published. This sulfur-containing amino acid cannot be made by humans but has a unique transport system, implying it is important for human health.		<p>Grundemann D, Harlfinger S, Golz S, et al. Discovery of the ergothioneine transporter. <i>Proc Natl Acad Sci USA</i> 2005;102: 5256Y261.</p> <p>Kalaras MD, Richie JP, Calcagnotto A, et al. Mushrooms: A rich source of the antioxidants ergothioneine and glutathione. <i>Food Chem</i> 2017; 233:429-433.</p>

Fun Fact	Scientific Description	Other Considerations	References
<i>Ergosterol</i>			
*The special sterol: mushrooms contain a unique sterol called ergosterol, that converts to vitamin D when exposed to light.	Fungi contain a unique sterol, ergosterol, rather than cholesterol found in mammalian cells.  Mushrooms exposed to ultraviolet light converts the naturally present ergosterol to ergocalciferol (vitamin D <sub>2</sub> ).		Jo Feeney M, Miller AM, Roupas P: Mushrooms-Biologically Distinct and Nutritionally Unique: Exploring a "Third Food Kingdom". Nutrition today 2014;49:301-307.
<i>Agaricus bisporus</i> mushrooms have more ergosterol than many other edible mushrooms.	Ergosterol content was measured in <i>Agaricus bisporus</i> , Oyster mushrooms, and Enoki mushrooms. Ergosterol was highest in the <i>Agaricus bisporus</i> , and lowest in the Enoki mushrooms. However, oyster mushrooms had a better conversion of ergosterol to Vitamin D than the other edible mushrooms, but they all made some vitamin D with sun exposure.		Jasinghe VJ, Perera CO. Distribution of ergosterol in different tissues of mushrooms and its effect on the conversion of ergosterol to vitamin D2 by UV irradiation. Food Chem 2005;92(3):541-546.
<i>Polyphenols</i>			
Mushrooms contain polyphenols like quercetin and kaempferol which act as antioxidants.	Mushrooms are thought to contain phenolic acids such as hydroxybenzoic acid and hydroxycinnamic acid, and antioxidants such as quercetin, resveratrol and kaempferol.		Kozarski M, Klaus A, Jakovljevic D, et al. Antioxidants of edible mushrooms. Molecules 2015;20:19489-525
<i>Vitamin D</i>			
Sunbake your store-bought mushrooms to increase their vitamin D content.	Mushrooms are one of the only natural vegetarian food sources of vitamin D, which is produced by the conversion of ergosterol to ergocalciferol after exposure to ultraviolet (UV) light.		Cardwell G, Bornman JF, James AP, et al. A review of mushrooms as a potential source of dietary vitamin D. Nutrients 2018;10:1498.



Fun Fact	Scientific Description	Other Considerations	References
Tan your mushrooms, not your skin.	The sun's ultraviolet (UV) radiation is both a major cause of skin cancer and our best source of vitamin D. In Australia, almost all our vitamin D comes from the sun's UV radiation. However, at least 2 in 3 Australians will be diagnosed with some form of skin cancer before the age of 70 years. Placing mushrooms in sunlight will allow them to absorb vitamin D to meet your daily requirements without any risk to you skin.		Cardwell G, Bornman JF, James AP, et al. A review of mushrooms as a potential source of dietary vitamin D. <i>Nutrients</i> 2018;10:1498.  Cancer Council. Skin cancer in Australia factsheet. <a href="https://actcancer.org/prevention/sunsmart/skin-cancer-in-australia/">https://actcancer.org/prevention/sunsmart/skin-cancer-in-australia/</a>
Putting your mushrooms in the sun for 15mins can provide you with your daily vitamin D needs!	Placing mushrooms in the sun for 15 minutes will provide greater than 100% of the daily adequate intake of vitamin D (15µg/day).		Phillips KM, Rasor AS. A nutritionally meaningful increase in vitamin D in retail mushrooms is attainable by exposure to sunlight prior to consumption. <i>J Nutr Food Sci</i> 2013;3:236.
Sunlight-exposed mushrooms can be as effective as a vitamin D supplement.	Eating UV-exposed mushrooms enriched with vitamin D are as good as taking a vitamin pill at increasing serum 25(OH) concentrations in those with low serum Vitamin D	This is a health claim and so needs to be communicated as nutrition education only	Urbain P, Singler F, Ihorst G, et al. Bioavail-ability of vitamin D <sub>2</sub> from UV-B-irradiated button mushrooms in healthy adults deficient in serum 25-hydroxyvitamin D: a randomized controlled trial. <i>Eur J Clin Nutr</i> 2011;65(8):965Y971.
Windows block UV-B, so place mushrooms outside to make vitamin D.	All types of glass block the majority of UV-B radiation. Therefore, mushrooms must be placed outside to create vitamin D. UV-B cannot be transmitted through window glass.		Almutawa F, Vandal R, Wang SQ et al. Current status of photoprotection by window glass, automobile glass, window films and sunglasses. <i>Photodermatol</i>

Fun Fact	Scientific Description	Other Considerations	References
			Photoimmunol Photomed 2013;29(2):65-72.
Place your mushrooms sunny side up! Face gills or the underside, to the sun or slice your mushrooms for maximum Vitamin D creation.	Increasing the surface area exposed to UVB light helps to increase the rate that ergosterol is converted to Vitamin D		Simon RR, Phillips KM, Horst RL, et al. Vitamin D mushrooms: comparison of the composition of button mushrooms ( <i>Agaricus bisporus</i> ) treated postharvest with UVB light or sunlight. J Agric Food Chem 2011;59:8724Y8732.
Sunlight-exposed mushrooms retain their vitamin D levels in the fridge for up to 8 days.	After cooking, vitamin D enriched mushrooms retain ~60 - 80% of their vitamin D content.		Roberts JS, Teichert A, McHugh TH. Vitamin D Formation from post-harvest UV-B treatment of mushrooms ( <i>Agaricus bisporus</i> ) and retention during storage. J Agric Food Chem 2008;56(12):4541-4544.
*Devoted to vitamin D: The vitamin D content of dried mushrooms is still 50% of its original value after 18 months.	Three types of mushroom (button, shiitake, and oyster) exposed to a UV-B lamp and then hot air-dried, had relatively good retention of vitamin D <sub>2</sub> up to eight months when stored in dry, dark conditions at 20 °C in closed plastic containers. However, there was a steady loss of vitamin D <sub>2</sub> during storage between 8 and 18 months. In the case of hot air-dried button mushrooms, vitamin D <sub>2</sub> concentration decreased from 14.3 µg/g DM to 9.3 µg/g DM over eight months, then to 6.9 µg/g DM over the following 10 months.		Cardwell G, Bornman JF, James AP, et al. A review of mushrooms as a potential source of dietary vitamin D. Nutrients 2018;10:1498.

Fun Fact	Scientific Description	Other Considerations	References
<i>Metabolic markers</i>			
Mushrooms have been shown to improve adiponectin in people with metabolic syndrome – a key hormone for metabolic health.	<p>In a sample of adults with at least two features of the metabolic syndrome, adiponectin increased after daily consumption of 100g of cooked mushrooms over the 16-week intervention (<math>7.9 \pm 3.2 \mu\text{g/mL}</math> baseline; <math>8.8 \pm 3.5 \mu\text{g/mL}</math> 16 weeks, <math>p=0.03</math>).</p> <p>Adiponectin, the most abundant anti-atherogenic and anti-inflammatory adipocytokine found in circulation, has direct effects on glucose and lipid metabolism and improves insulin sensitivity and central fat distribution (12, 13). A low level of adiponectin is associated with insulin resistance, obesity, metabolic syndrome and cardiovascular disease.</p>		<p>Calvo MS, Mehrotra A, Beelman RB, et al. A retrospective study in adults with metabolic syndrome: Diabetic risk factor response to daily consumption of Agaricus bisporus (white button mushrooms). <i>Plant Foods Hum Nutr</i> 2016;71:245-51.</p> <p>Yosae S, Khodadost M, Esteghamati A, et al. Adiponectin: An indicator for metabolic syndrome. <i>Iran J Public Health</i> 2019;48(6):1106-1115.</p>
<i>Immune system</i>			
Eating 100g of mushrooms for 7 days may help to support markers of immune function.	Compared to usual diet, eating 100g of cooked white button mushrooms for 7 days was associated with increased serum IgA osmolarity ( $p<.0001$ ), secretion rate ( $p<.0005$ ) and concentration ( $p<.0005$ ), which are markers of immune function.		Jeong SC, Koyyalamudi SR, Pang G. Dietary intake of Agaricus bisporus white button mushroom accelerates salivary immunoglobulin A secretion in healthy volunteers. <i>Nutrition</i> 2012;28:527-31.
<i>Satiety</i>			

Fun Fact	Scientific Description	Other Considerations	References
Mushrooms have been shown to help reduce hunger and increase fullness, compared to a protein-matched beef meal.	In 35 young adults (age 23±4 years), eating mushrooms was associated with lower hunger (p=0.045), greater fullness (p=0.05) and a lower food intake during the rest of the day (p=0.03) compared with a protein-matched beef meal without mushrooms.		Hess JM, Wang Q, Kraft C, Slavin JL. Impact of Agaricus bisporus mushroom consumption on satiety and food intake. <i>Appetite</i> 2017;117:179-185.
<i>Cancer</i>			
Fungotherapy – mushrooms may be the new source of natural compounds for future cancer therapy.	<p>Medicinal mushrooms have been used throughout the history of mankind for treatment of various diseases including cancer.</p> <p>There has been a strong progress in the field of medicinal mushroom research in terms of anticancer drug development, but this work continues, and much more progress still awaits us, especially in the fields of molecular targets of the medicinal mushrooms and the complex synergistic interplay of their different components. Watch this space!</p>		Blagodatski A, Yatsunskaya M, Mikhailova V, et al. Medicinal mushrooms as an attractive new source of natural compounds for future cancer therapy. <i>Oncotarget</i> 2018;9(49):29259-29274.
Mushroom extract has been tested as a promising way to help manage prostate cancer in preliminary experimental trials.	In prostate cancer patients, mushroom extract at increased doses (4g to 14g extract daily; equivalent to 40g to 140g fresh WBM) was associated with decreased prostate specific antigen (PSA) levels in 36% of patients, with stable PSA levels or no effect in the remaining patients. Minimal side effects were reported and mostly limited to Grade 1 abdominal bloating. PSA levels are used by doctors		Twardowski P, Kanaya N, Frankel P, et al. A phase I trial of mushroom powder in patients with biochemically recurrent prostate cancer: Roles of cytokines and myeloid-derived suppressor cells for Agaricus bisporus-induced prostate-specific antigen

Fun Fact	Scientific Description	Other Considerations	References
	to help detect prostate cancer or other prostate abnormalities.		responses. Cancer 2015;121:2942-50.
<i>Patterns of consumption</i>			
When is mushroom season? All year-round! Interestingly though, winter is when online searches for mushroom recipes peak! That's great, because sun-exposed mushrooms in winter is a great way to help maintain your summer vitamin D levels though!	According to patterns seen in Google Trends, online searches for 'mushroom recipes' peaks annually in the winter months in both the southern and northern hemispheres.	Winter is the also the season where vitamin D levels drop - there could be an opportunity for a targeted message for dietary vitamin D	www.google.com
Love or hate mushrooms? It could be written in your genes.	Italian researchers have identified 17 genes which were associated with certain foods, including mushrooms. Interestingly, none of the genes were directly associated with taste or smell receptors.		European Society of Human Genetics (ESHG). "Revolutionizing diets, improving health with discovery of new genes involved in food preferences." ScienceDaily. ScienceDaily, 1 June 2014. <www.sciencedaily.com/releases/2014/06/140601201954.htm
Just 5 mushroom species accounts for 85% of global mushroom sales, even though over 2000 plus edible species have been	<i>Agaricus bisporus</i> , <i>Lentinus edodes</i> (shiitake mushroom), <i>Pleurotus Ostreatus</i> (oyster mushroom), <i>Auricularia polytricha</i> (black fungus mushroom), and <i>Flammulina velutipes</i> ( enoki mushroom). Just five species account for 85% of		Royse DJ, editor A global perspective on the high five: Agaricus, Pleurotus, Lentinula, Auricularia & Flammulina2014.

Fun Fact	Scientific Description	Other Considerations	References
identified by scientists!	the global sales of edible mushrooms, with nearly half (40% from the humble <i>Agaricus bisporus</i> (white button mushroom).		
<i>Cooking</i>			
Cooking at high temperatures and for too long destroys antioxidants found in mushrooms. The greater the cooking time, the greater the loss. So cook your mushrooms at low temps until they are just cooked for your liking.	Cooking mushrooms reduces antioxidant concentrations. Antioxidant concentration for raw mushrooms was the highest across all studies.		<p>Ganguli A, Ghosh M, Singh N. Antioxidant activities and total phenolics of pickles produced from the Edible Mushroom, <i>Agaricus bisporus</i>. <i>J Culinary Sci Tech</i> 2006;5:131-142.</p> <p>Ng ZX, Tan WC. Impact of optimised cooking on the antioxidant activity in edible mushrooms. <i>J Food Sci Technol</i> 2017;54:4100-4111.</p>
Add lemon juice to mushrooms before cooking to help preserve more of their vitamin D content.	Adding lemon juice to the mushrooms before heating them helps retain their vitamin D during cooking. It could be explained by the antioxidant properties of ascorbic acid that is present in the lemon juice, but the reason is still unknown.		<p>Ložnjak P, Jakobsen J. Stability of vitamin D3 and vitamin D2 in oil, fish and mushrooms after household cooking. <i>Food Chem.</i> 2018;254:144-149.</p> <p>Hajimahmoodi M, Aliabadipoor M, Moghaddam G, et al. Evaluation of in vitro antioxidant activities of lemon juice for safety assessment. <i>Am J Food Technol</i> 2012;7(11):708-714.</p>

Fun Fact	Scientific Description	Other Considerations	References
<p>Cook your mushrooms at lower temperatures and for a shorter amount of time to preserve their vitamin D content!</p>	<p>Cooking method can impact the amount of vitamin D initially contained within a mushroom. Mushrooms will lose some vitamin D in the cooking process and higher heat will lead to a larger loss of vitamin D. To retain the maximum amount of vitamin D, use shorter cooking times at a lower heat.</p>		<p>Ložnjak P, Jakobsen J. Stability of vitamin D3 and vitamin D2 in oil, fish and mushrooms after household cooking. <i>Food Chem.</i> 2018;254:144-149.</p>
<i>Culinary applications</i>			
<p>Mushrooms: The way forward for creating plant-rich diets and sustainable food practices.</p>	<p>Mushrooms contain several important nutrients and at the same time, are low in kilojoules/calories and in sodium. Mushroom production can also be an energy efficient process and can help to improve soil quality.</p> <p>Cooking with mushrooms can also lower food costs. Based on a 2014 Northern California retail market price report, a 50:50 ground beef with button mushrooms taco blend saves 20% on the food cost, and if 80% of the beef is substituted with mushrooms, the food cost savings increase to 33%.</p>		<p>Jo Feeney M, Miller AM, Roupas P: Mushrooms-Biologically Distinct and Nutritionally Unique: Exploring a "Third Food Kingdom". <i>Nutrition today</i> 2014;49:301-307.</p> <p>Grimm D, Wosten HAB. Mushroom cultivation in the circular economy. <i>Appl Microbiol Biotechnol</i> 2018;102(18):7795-7803.</p>
<p>Blend your burger: beef-mushroom burgers are good for business.</p>	<p>Blended burgers represent an exciting sustainability opportunity for restaurants and food service operators, as beef accounts for a sizable portion of these companies' greenhouse gas emissions.</p> <p>Acceptance and satiety of a blended and all-beef burger are comparable.</p>		<p>Clune S, Crossin E, Verghese K. Systematic review of greenhouse gas emissions for different fresh food categories. <i>J Clean Prod</i> 2017;140(2):766-783.</p> <p>Summers AC, Ezike A, Smith P, et al. Acceptance of a mushroom-soy-</p>

Fun Fact	Scientific Description	Other Considerations	References
			beef blended burger among school aged children. Health Behav Policy Rev 2017;4(3):274-281.
Growing mushrooms can be a sustainable practice for the food supply.	Mushroom production relies on heat produced through composting. Therefore, it is an energy efficient process. The substrate it is grown in is also recycled to improve soil quality (i.e. soil amendment: the practice of improving mine soil quality in terms of its structure and biochemical function).		<p>Jo Feeney M, Miller AM, Roupas P: Mushrooms-Biologically Distinct and Nutritionally Unique: Exploring a "Third Food Kingdom". Nutrition today 2014;49:301-307.</p> <p>Lonie J, Phelps L. Sustainable production practices in mushroom farming. Mushroom News. 2011;59:4Y8.</p> <p>Grimm D, Wosten HAB. Mushroom cultivation in the circular economy. Appl Microbiol Biotechnol 2018;102(18):7795-7803.</p>
Mushrooms: the mighty meat alternative with all the flavour.	Based on findings of a sensory study, the flavour of dishes was reported to improve when mushrooms were partially substituted for minced meat e.g. in a beef taco. This is because of the characteristic <i>umami</i> -rich flavour profile of mushrooms.		<p>Myrdal Miller A, Mills K, Wong T, et al. Flavor-enhancing properties of mushrooms in meat-based dishes in which sodium has been reduced and meat has been partially substituted with mushrooms. J Food Sci 2014;79(9): S1795-804.</p> <p>Kurihara K: Umami the Fifth Basic Taste: History of Studies on</p>



Fun Fact	Scientific Description	Other Considerations	References
			Receptor Mechanisms and Role as a Food Flavor. Biomed Res Int 2015;2015:189402.
Replacing some of your meat with mushrooms can boost the flavour of your meal and help to increase your daily recommended serves of vegetables.	<p>Due to the spectrum of vitamins (e.g. Vit B and D) and minerals found in mushrooms, adding mushrooms to dishes increases its nutrient profile.</p> <p>Based on findings of a sensory study, flavour/texture of dishes was reported to improve when mushrooms are partially substituted for minced meat e.g. in a beef taco. This is likely due to the characteristic <i>umami</i>-rich flavour profile of mushrooms.</p>		<p>Jo Feeney M, Miller AM, Roupas P: Mushrooms-Biologically Distinct and Nutritionally Unique: Exploring a "Third Food Kingdom". Nutrition today 2014;49:301-307.</p> <p>Myrdal Miller A, Mills K, Wong T, et al. Flavor-enhancing properties of mushrooms in meat-based dishes in which sodium has been reduced and meat has been partially substituted with mushrooms. J Food Sci 2014;79(9):S1795-804.</p> <p>Kurihara K: Umami the Fifth Basic Taste: History of Studies on Receptor Mechanisms and Role as a Food Flavor. Biomed Res Int 2015;2015:189402.</p>
<i>Other</i>			
*World's top pick: <i>Agaricus bisporus</i> is the world's most commonly consumed mushroom.	Although more than 2000 varieties of mushrooms are edible, the white button mushroom in the <i>Agaricus bisporus</i> species is the most commonly consumed mushroom in the world.		Jo Feeney M, Miller AM, Roupas P: Mushrooms-Biologically Distinct and Nutritionally Unique: Exploring

Fun Fact	Scientific Description	Other Considerations	References
			a "Third Food Kingdom". Nutrition today 2014;49:301-307.
*Three of the same: Button, cup and flat mushrooms all come from the same mushroom, just left longer to grow!	Mushroom maturity is usually scored on a 7-point arbitrary developmental scale devised by Hammond & Nichols (1975), sometimes described as rate of veil opening. Stage 1 is the 'pinhead', stage 2 the 'button', stage 3 'closed cup', stage 4 'cup' veil break stage, stage 5 open 'cup', stage 6 the 'flat', stage 7 'flat' with an inverted cap. Although the scale is arbitrary, measurement of maturity during a postharvest period is linear using the scale.		Hammond JBW, Nichols R. Changes in respiration and soluble carbohydrates during the post-harvest storage of mushrooms ( <i>Agaricus bisporus</i> ). J Sci Fd Agric 1975;26(6):835-842.
Do the mushroom munch – a friendly fungi for a healthy gut.	Replacing meat with mushrooms can create a more beneficial gut microbiota profile (significantly more Bacteroidetes and less Firmicutes) and better laxation (increased stool weight) in adults. This is due to the unique carbohydrate profile present in mushrooms. Chewing mushrooms thoroughly will help enhance the digestion process by increasing availability of "low-digestible" carbohydrates which will in turn increase the production of beneficial metabolites such as short-chain fatty acids.		Hess JM, Wang Q, Kraft C, et al. Impact of <i>Agaricus bisporus</i> mushroom consumption on satiety and food intake. Appetite 2017;117:179–185.  Manzi P, Pizzoferrato L. Beta-glucans in edible mushrooms. Food Chem 2000;68:315–318.
What's on your pizza? Mushrooms were ranked as Britain's #1 pizza topping in 2018, beating pepperoni for the top prize.	N/A		<a href="https://www.vouchercodes.co.uk/press/infographics/VoucherCodes-lifetime-of-pizza-full-results">https://www.vouchercodes.co.uk/press/infographics/VoucherCodes-lifetime-of-pizza-full-results</a>

**APPENDIX 16: EDM- 2019**



Nutrition Research  
Australia

Australian  
**MUSHROOMS**

# HEALTHCARE PROFESSIONALS RESEARCH

*When it comes to mushrooms, we know our stuff!*

*But what about you?*

It goes without saying that we're passionate about mushrooms.. however there is a limited awareness in the community around the many health benefits and nutritional properties which make this food so unique.

That's why we're conducting the very first systematic literature review on the world's most commonly consumed edible mushroom: **Agaricus bisporus**.

As a member of the Australian Mushrooms' healthcare professional network, you'll be the very first to receive updates and key findings as the research unfolds.

*But first, we want to hear from you!*

We understand that you're busy, and we'd greatly appreciate if you could take 5-10 minutes to answer this anonymous **short survey** on mushrooms.

Our aim is to understand your thoughts on mushrooms, their health benefits and nutritional properties, if you like mushrooms and if you recommend them.

WIN ONE OF TWO

**\$100**

VOUCHERS

FROM A MAJOR SUPERMARKET

As a thank you for participating, you'll be in with the chance of winning one of two \$100 gift vouchers to spend on something delicious.

**START SURVEY**

**Thanks in advance for your time!**

Nutrition Research Australia  
& Australian Mushrooms

# MUSHROOM FACTS



## WORLD'S TOP PICK

*Agaricus bisporus* is the world's most commonly consumed mushroom.



## THREE OF THE SAME

Button, cup and flat mushrooms all come from the same mushroom, just left longer to grow!



## A NATURAL INNOVATOR

Unlike plants, mushrooms lack chlorophyll and obtain sustenance from complex organic materials of plants and animals.

You are receiving this email because you have previously subscribed to an email database associated with Australian Mushrooms and/or Nutrition Research Australia.

If you no longer want to hear from us, you can **opt-out here**. If you are leaving, we're sorry to see you go and if you would like to rejoin please visit [australianmushrooms.com.au/health](http://australianmushrooms.com.au/health)

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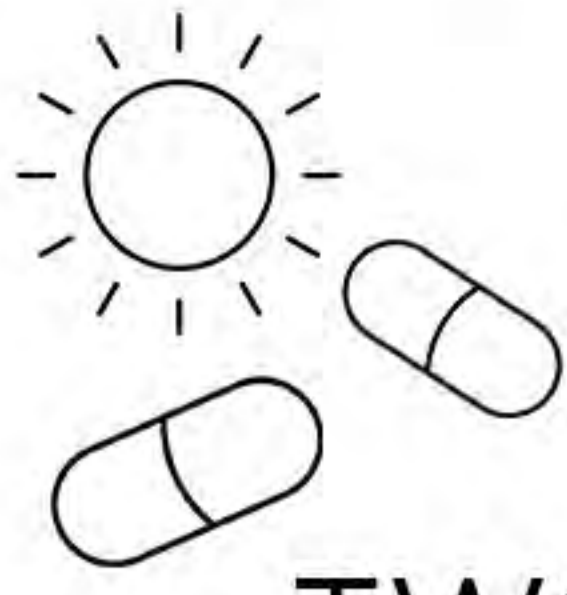
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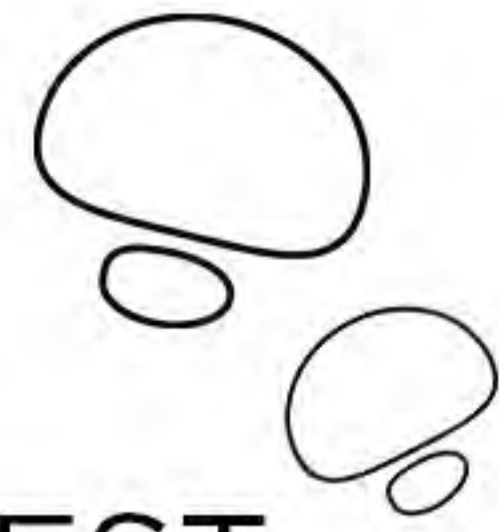
**Hort  
Innovation**  
Strategic levy investment

**MUSHROOM  
FUND**

This project has been funded by Hort Innovation using the mushroom research and development levy and funds from the Australian Government. For more information on the fund and strategic levy investment visit [horticulture.com.au](http://horticulture.com.au)



# WEBINAR: WHEN IT COMES TO VITAMIN D, TWO SOURCES ARE BEST



Did you know that Australians spend over \$100 million a year on vitamin D supplements and we have the highest rate of skin cancer globally? Yet, 1 in 4 Aussies are vitamin D deficient.

Dear John,

In this first-of-its-kind free webinar, you're invited to join nutrition scientist **Dr Flavia Fayet-Moore** and **GP Dr Jill Gambert** as they explore a new way to improve vitamin D status and address this nutrient of concern for all Australians.

**Date**  
Tuesday 29<sup>th</sup> October 2019

**Time**  
12:30pm - 1:30pm AEDT

**Webinar topic**  
When it comes to vitamin D,  
two sources are best

**REGISTER NOW**

**In this webinar, you'll learn about:**

- Pros and cons of different strategies to improve vitamin D status
- How to determine which clients are at risk
- Lifestyle strategies to meet vitamin D needs
- New research on mushrooms and the connection to vitamin D

At the end of the webinar, you'll understand why when it comes to vitamin D, two sources are best.

## Have a question for the panel?

Submit your questions now on what you would like to know about the latest vitamin D or mushroom research ahead of the webinar.

**SUBMIT HERE**

## We can't wait to see you there!

**REGISTER NOW**

### SHARE THIS WITH YOUR COLLEAGUES



Brought to you by  
**Nutrition Research Australia and Australian Mushrooms**



**Dr Flavia Fayet-Moore**  
PhD, MNutrDiet, RNutr, APD, FASLM

The CEO of Nutrition Research Australia, where she leads a team of highly skilled researchers to conduct end to end nutrition and communications projects.

Flavia is a Registered Nutritionist, Accredited Practising Dietitian, Honorary Associate of the University of Sydney, and the first dietitian in Australia to be board certified in Lifestyle Medicine.



**Dr Jill Gambert**  
MBBS (Hons), FRACGP

Completed her medical degree at the University of New South Wales in 2007 and became a fellow of The Royal Australian College of General Practitioners in 2015.

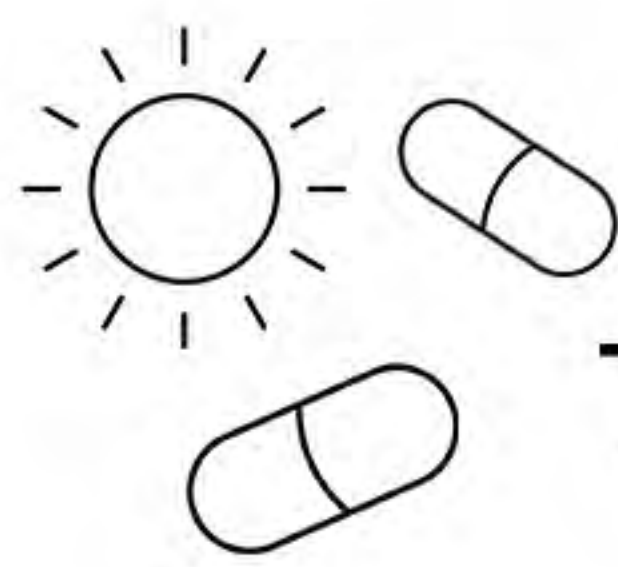
Jill is a board certified lifestyle medicine physician who is passionate about communicating the importance of lifestyle interventions in the prevention and treatment of her patients.

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# VITAMIN D, TWO SOURCES ARE BEST



Thank you for registering to our webinar on exploring a new way to address Vitamin D deficiency in Australia. We really hope you found the information valuable not only as a healthcare professional, but also for your own lifestyle.

Your feedback is important to us, and we would be most grateful if you could please take 2 mins to let us know how you found it.

## WEBINAR FEEDBACK

**Duration: 2 minutes**

### Webinar Recording

You can now access the webinar online.  
Please feel free to share this with your colleagues.



## GPCE CONFERENCE MELBOURNE NOV 15 - 17



Dr Flavia Fayet-Moore will be speaking about Vitamin D and how can we best address Vitamin D deficiency in our patients. These sessions will explore emerging lifestyle medicine strategies that can help to ensure your patients get enough of this essential vitamin.

**Saturday 16 & Sunday 17 November**  
**10.15am - 11.15am**

### Dr Flav's Fun Facts



#### A true whole food

While the 'cap' of mushrooms is a richer source of antioxidants, its stem contains more of the soluble fibre beta-glucan.



#### Putting the one in ergothiONEine

Mushrooms contain more ergothioneine - a unique sulphur-containing antioxidant - than any other food.



#### Devoted to vitamin D

The vitamin D content of dried mushrooms is still 50% of its original value after 18 months.

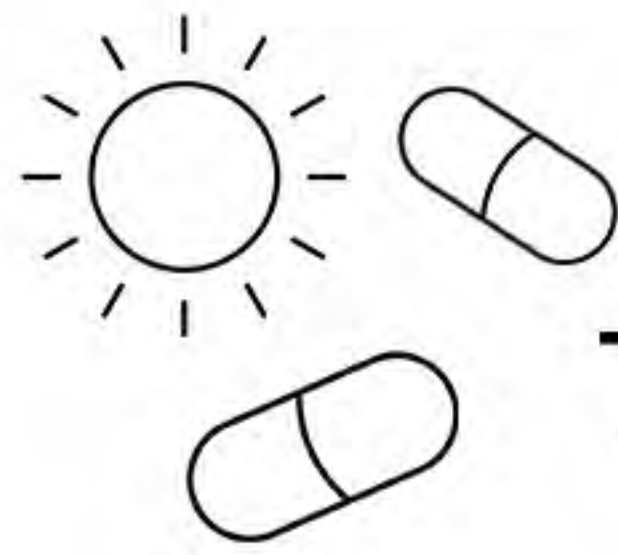
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# VITAMIN D, TWO SOURCES ARE BEST



Missed out on our recent webinar on a new way to address Vitamin D deficiency in Australia?

- **GP Dr Jill Gamberg** unpacked how lifestyle medicine plays a role in addressing this nutrient of concern for all Australians.
- Nutrition scientist **Dr Flávia Fayet-Moore** revealed a whole food approach to meeting vitamin D needs, plus shared how just 5 button mushrooms, or 1 portobello mushroom, can supply 1000 IU of vitamin D when exposed to the sun, as well as some exciting new research about the factors that influence vitamin D production in mushrooms.

You can now access a full recording of the webinar online. Please feel free to share this with your colleagues!



Your feedback is important to us, and we would be most grateful if you could please take 2 mins to let us know how you found it.

**WEBINAR FEEDBACK**

**Duration: 2 minutes**

## GPCE CONFERENCE MELBOURNE NOV 15 - 17



Dr Flavia Fayet-Moore will be speaking about Vitamin D and how can we best address Vitamin D deficiency in our patients. These sessions will explore emerging lifestyle medicine strategies that can help to ensure your patients get enough of this essential vitamin.

**Saturday 16 & Sunday 17 November**  
**10.15am - 11.15am**

### Dr Flav's Fun Facts



**A true whole food**

While the 'cap' of mushrooms is a richer source of antioxidants, its stem contains more of the soluble fibre beta-glucan.



**Putting the one in ergothiONEine**

Mushrooms contain more ergothioneine - a unique sulphur-containing antioxidant - than any other food.



**Devoted to vitamin D**

The vitamin D content of dried mushrooms is still 50% of its original value after 18 months.

Brought to you by  
**Nutrition Research Australia and Australian Mushrooms**

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**WEBSITE**

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**APPENDIX 17: EDM – 2020**



**JUST PUBLISHED:  
THE WORLD'S FIRST SYSTEMATIC  
REVIEW ON AGARICUS BISPORUS**

**WHAT'S SO SPECIAL ABOUT  
AUSTRALIA'S MOST POPULAR FUNGI?**

Dear ,

You probably know that mushrooms are not your typical vegetable. Being a fungi, mushrooms are not classified as a vegetable at all, and have nutritional properties similar to whole grains, animal foods and nuts, too.

But what you may not know is the science behind a mushroom's unique nutritional and health properties. Indeed, there has never been a systematic review published on the world's most popular mushroom, *Agaricus bisporus* - which includes the flat, swiss brown, cup, white button and portobello mushroom varieties.

It's our pleasure to share with you this newly published world-first systematic review, hot off the press!

**WHAT WAS DONE?**

Combining the data from 68 studies on *Agaricus bisporus*, this systematic review is a comprehensive look at decades of work.

In it, you'll learn all about the world's most popular mushroom, including:

- What are its key bioactive components?
- What are its seven different health effects?
- How strong is the evidence from human studies?

Time poor? We've created a downloadable brochure that takes you through the key findings at a glance.

[DOWNLOAD THE FREE BROCHURE](#)



Want the full details? Read the complete systematic review published in *The Journal of Nutritional Biochemistry*.

[CLICK HERE TO READ THE FREE PAPER](#)

Available to download for free

**A TASTE OF WHAT'S INSIDE**



**Unparalleled prebiotic**

Mushrooms contain *oligosaccharides*, a unique prebiotic that's not found in fruits, vegetables or grains.



**Healthy heart**

Mushrooms cooked in extra virgin olive oil may help to improve markers of heart health.



**Nature's supplement**

Unpasteurised mushrooms can be as effective as a vitamin D supplement.

**Hungry for more?**

Visit our mushroom hub

[www.nraus.com/mushroomhub](http://www.nraus.com/mushroomhub)

It's got all the latest mushroom resources in one place, developed especially for professionals like you.

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[WEBSITE](#)

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Hort Innovation

MUSHROOM FUND

This project has been funded by Hort Innovation using the mushroom research and development levy fund. Thank you to the Australian Government for more information on the fund visit [www HortInnovation.com.au](http://www HortInnovation.com.au)



THE WORLD'S FIRST SYSTEMATIC REVIEW ON AGARICUS BISPORUS

**MEET THE RESEARCHERS  
BEHIND THE SCIENCE**

DISCOVER IMPORTANT FINDINGS AND PRACTICAL RECOMMENDATIONS  
IN UNDER 2 MINUTES

Dear <insert name>,

You might have seen the recent systematic review on Australia's most popular mushroom, which explores its bioactive properties and health effects in humans. But what do the researchers have to say about it?

**WATCH NOW**



Hear from the authors, including **Dr Flavia Fayet-Moore**, as they discuss the key findings from the publication. In under 2 minutes, you'll discover:

- The surprising **bioactive properties** of mushrooms
- How mushrooms may have a unique effect on our **gut health**
- That mushrooms can be as effective as a **particular supplement** (can you guess which one?)
- **What's next** for the humble mushroom?

**FREE BROCHURE:**  
**THE WORLD'S FIRST SYSTEMATIC REVIEW  
ON AGARICUS BISPORUS**

Missed our last newsletter? Be sure to get your free downloadable brochure for an evidenced-based summary on the bioactive properties and health effects of the world's most popular mushroom.

**DOWNLOAD THE FREE BROCHURE**

**Hungry for more?**

Visit our mushroom hub

[www.nraus.com/mushroomhub](http://www.nraus.com/mushroomhub)

For all the latest mushroom resources in one place, including the full systematic literature review.



**ARE YOU A  
HEALTHCARE PROFESSIONAL?  
YOU'RE INVITED TO COMPLETE THE MUSHROOM SURVEY!**

As a valued member of the Australian Mushrooms' healthcare professional network, you're invited to participate in our mushroom survey for healthcare professionals.

This survey is anonymous and takes 5-10 minutes to complete, and your responses will help us to understand what you think about our favourite fungi.

**START SURVEY**



**WIN  
\$150 VISA GIFT CARD  
& HOME MUSHROOM KIT**  
As a thank you for participating, you'll go into the draw to win a Visa gift card as well as a mushroom kit to grow your own at home!

Thank you so 'mush' for all of your help!

Nutrition Research Australia & Australian Mushrooms

**DR FLAV'S FUN FACTS**



**Double agent**  
Mushrooms are one of the few non-plant foods that also contain polyphenols.



**Keep your cool**  
Cooking mushrooms at a lower heat helps to protect their antioxidant content.



**A fun-gi therapy**  
Mushroom extract has shown promise in helping to manage prostate cancer in preliminary experimental trials<sup>1</sup>.

1. Tycański et al. Cancer. 2015;120(17):2942-50.

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		This project has been funded by Hort Innovation using the mushroom research and development levy and funds from the Australian Government. For more information on the Fund and Strategic Levy Investment visit <a href="http://horticulture.com.au">horticulture.com.au</a>



ARE YOU A HEALTHCARE PROFESSIONAL?

DON'T MISS YOUR LAST CHANCE TO COMPLETE THE MUSHROOM SURVEY!

START SURVEY

Have you completed the mushroom survey for healthcare professionals yet? If not, only 3 days remain to do so - that is not mush-room left!

This survey is anonymous and takes 5-10 minutes to complete, and your responses will help us to understand what you think about our favourite fungi.



Thank you so 'mush' for all of your help!

Nutrition Research Australia & Australian Mushrooms

### DR FLAV'S FUN FACTS



#### Go for 1, 3 or 5

One serve (1 cup) of mushrooms is equivalent to just 1 portobello, 3 cup or about 5 button mushrooms.



#### Know your ABCs

Windows block UV-B light, so be sure to open your window if you are tanning your mushrooms on the window sill.



#### A 5-star food

Mushrooms contain 5 different carbohydrates that may support a healthy microbiome: chitin, beta-glucan, raffinose, oligosaccharides and resistant starch<sup>1</sup>.

<sup>1</sup> Aida et al. Trends in Food Sci Tech. 2009;20(11-12):567-575.

CONTACT US

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Hort  
Innovation  
through every treatment

MUSHROOM  
FUND

This project has been funded by Hort Innovation using the mushroom research and development levy and funds from the Australian Government. For more information on the fund and its eligible levy treatments visit [horticulture.com.au](http://horticulture.com.au)

**APPENDIX 18: EDM - 2021**



## WANT TO KNOW EVEN MORE ABOUT MUSHROOMS?

JOIN THE FUN-GI COMMUNITY OF HEALTH PROFESSIONALS TODAY

Hi x,

**Do you want to know more about mushrooms?** You're receiving this email as you attended the Dietitians Unite Conference in May 2021, where we presented on the health and culinary benefits of mushrooms as part of the breakfast session 'Taste: the forgotten message to enjoying mushrooms and vegetables'.

We'd like to invite you to join our community of Health Care Professionals and be the first to receive the latest information on Australian Mushrooms.

By signing up, you'll receive all the latest news and research, details on upcoming educational webinars or events, and practical client-focused educational resources.

Here are some of the most recent...

 <p><b>Research Summary</b></p> <p>World's first systematic review on the health effects of <i>Agaricus bisporus</i> mushrooms.</p>	 <p><b>White Paper</b></p> <p>Expert report on the role of fungi foods in a plant-based diet.</p>	 <p><b>Client Brochure</b></p> <p>Practical information for clients at risk of vitamin D deficiency.</p>
--	--	--



**SIGN UP FOR YOUR FUTURE FREE RESOURCES**

Just click above if you'd like to receive all the latest information and resources on mushrooms when they are released. It's free!

We hope you'll join us!

**Nutrition Research Australia and Australian Mushrooms.**



## Hungry for more?

Visit our mushroom hub

[www.nraus.com/mushroomhub](http://www.nraus.com/mushroomhub)

For all the latest mushroom resources in one place.

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## FUNGI FOODS: WHERE DO THEY FIT IN A PLANT-BASED DIET?

HEAR WHAT THE EXPERTS THINK

Hi x,

Dietary guidance is moving away from nutrients to dietary patterns, particularly those that are plant-based. So where does that leave fungi foods - a separate kingdom to both plants and animals - and mushrooms, specifically?

In this update, we bring you a white paper of a recent expert roundtable hosted by NRAUS. The roundtable brought together experts across different fields to discuss the role of fungi foods in a healthy diet.

**A taste of what's inside:**



We've also included a brochure on mushrooms and vitamin D for your clients, that many of you have asked for. It educates on the importance of vitamin D, where we obtain it from, and highlights that only 3 sun-exposed cup mushrooms can provide over 100% of daily vitamin D needs.



DOWNLOAD THE WHITE PAPER

In this expert roundtable white paper, discover what experts had to say about the role of fungi foods in a plant-based diet.



DOWNLOAD THE NEW VITAMIN D BROCHURE

This printable handout for clients contains easy-to-understand information for those at risk of low vitamin D, including how sun-exposed mushrooms can help.



## Hungry for more?

Visit our mushroom hub

[www.nraus.com/mushroomhub](http://www.nraus.com/mushroomhub)

For all the latest mushroom resources in one place.

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**'FOOD AS MEDICINE'  
FOR THE MODERN HEALTH ERA:  
MUSHROOMS & EXTRA VIRGIN OLIVE OIL**

**SIGN UP FOR THIS FREE WEBINAR**

Dear X,

Today's health landscape is changing rapidly. The rise of infectious disease on the backdrop of increasing chronic diseases presents a dual health challenge, but also, a new opportunity.

In this free webinar, you'll join Herbalist and Naturopathic clinician **Ian Breakspear** and Nutrition Scientist and mushroom researcher **Dr Flavia Fayet-Moore** as they explore a 'food as medicine' approach to health and immunity, and its potential to help combat the health challenges that we face today and into the future.



Date: **Friday 17 September 2021**

Time: **12:00 - 1:00pm AEST**

Topic: **The emerging dual health challenge of infectious and chronic disease: Mushrooms and extra virgin olive oil as key therapeutic foods**

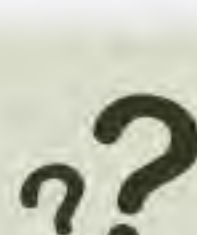
**REGISTER NOW**

Hosted by Professor Catherine Itsiopolous, Executive Dean, School of Health and Biomedical Sciences, at RMIT University, and a standing international leader in the Mediterranean diet.

This webinar is a collaboration between Australian Mushrooms and The Olive Wellness Institute.

**In this webinar, you'll learn about:**

- The dual health challenge of today: chronic and infectious disease.
- Key nutrients for immunity, including why vitamin D is getting a lot of attention right now.
- New research on common edible mushrooms and their connection to vitamin D.
- Latest research on extra virgin olive oil including its immune supporting actions.



**Questions?**

Submit your questions now on what you would like to be covered ahead of the webinar.

**SUBMIT QUESTIONS HERE**

We can't wait to see you there!

**REGISTER NOW**

Brought to you by  
**Australian Mushrooms, Olive Wellness Institute  
and Nutrition Research Australia.**



**Flavia Fayet-Moore**

PhD, MNutrDiet, RNutr, APD, FASLM

The CEO of Nutrition Research Australia, where she leads a team of highly skilled researchers to conduct end to end nutrition and communications projects.

Flavia is a Registered Nutritionist, Accredited Practising Dietitian, Honorary Associate of the University of Sydney, and the first dietitian in Australia to be board certified in Lifestyle Medicine.



**Ian Breakspear**

MHerbMed (USyd) DipNat DipBotMed CertPhyto FNHAA

Ian is a naturopath, herbalist, educator and researcher with almost 30 years of experience. He is a Senior Learning Facilitator at Torrens University Australia, and also maintains a private practice specialising in helping patients with cardiovascular and chronic inflammatory conditions.

Ian is Chair of the Naturopathic Editorial Board for the Natural Health Science Foundation, Chair of the Board Member Advisory Committee of the Naturopaths & Herbalists Association of Australia, and an Expert Contributor for the Olive Wellness Institute.



**Olive Wellness  
INSTITUTE™**

**Olive Wellness Institute Partnership**

The Olive Wellness Institute is an evidence-based science repository on the nutrition, health and wellness benefits of olives and olive products such as Extra Virgin Olive Oil, which is all subject to extensive peer review.



**Hungry for more?**

Visit our mushroom hub

**[www.nraus.com/mushroomhub](http://www.nraus.com/mushroomhub)**

For all the latest mushroom resources in one place.

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**CALLING ALL HEALTHCARE PROFESSIONALS: WE NEED YOU!**

**YOU'RE INVITED TO COMPLETE THE MUSHROOM SURVEY**

Hi X,

As a valued member of the Australian Mushrooms' healthcare professional network, you're invited to participate in our final mushroom survey as part of our three-year research.

The survey is anonymous and will take only 5-10 minutes to complete. You also have the chance of winning one of five \$100 Visa cards to spend on anything you like!

**START SURVEY**



**WIN**

**ONE OF 5 \$100 VISA GIFT CARDS**

As a thank you for participating, you'll go into the draw to win one of five VISA gift cards to spend on anything you like.

Thank you so 'mush' for your time!

**Nutrition Research Australia & Australian Mushrooms.**

**Fungi fun facts**



**Choose 1, 3 or 5**

One serve of mushrooms is equivalent to just 1 portobello, 3 cup or about 5 button mushrooms.



**Tan for 15 min**

Putting a serve of mushrooms in the sun for 15 minutes can provide over 100% of daily vitamin D needs.



**Cook on low**

Cooking mushrooms at a lower heat helps to protect their vitamin D content.



**Hungry for more?**

Visit our mushroom hub

[www.nraus.com/mushroomhub](http://www.nraus.com/mushroomhub)

For all the latest mushroom resources in one place.

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## DON'T MISS YOUR LAST CHANCE TO COMPLETE THE MUSHROOMS SURVEY!

FOR A CHANCE TO WIN

Hi X,

Have you completed the mushroom survey for Healthcare Professionals yet? If not, there's not much room left with only X days remaining.

By completing the survey you have the chance to win one of five \$100 Visa gift cards to spend on anything you like!

The survey is anonymous and only takes 5-10 minutes to complete.

START SURVEY



Your help is greatly appreciated.

**Nutrition Research Australia & Australian Mushrooms.**



## Hungry for more?

Visit our mushroom hub

[www.nraus.com/mushroomhub](http://www.nraus.com/mushroomhub)

For all the latest mushroom resources in one place.

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# YOUR MASTER VITAMIN D & MUSHROOM LIBRARY

FREE EVIDENCE-BASED RESOURCES  
FOR YOU TO DOWNLOAD

Hi X,

**Vitamin D is a hot topic in nutrition** with almost 2 in 3 Australian adults insufficient or deficient<sup>1,2</sup>. Important for immunity, emerging evidence has also shown that lower vitamin D levels are linked with increased risk and severity of COVID-19 infection<sup>3</sup>.

The impact of diet for vitamin D is often forgotten, with few foods being rich sources. Most adults are unlikely to meet 100% of their dietary vitamin D needs through food alone<sup>4</sup> and risk increases as we reduce our animal food intake.

### The Vitamin D standout: mushrooms exposed to UV-light

Remarkably, just 3 cup or 5 button mushrooms exposed to UV-light can provide more than 100% of daily vitamin D needs<sup>5</sup>. And research has shown that mushrooms are as effective as vitamin D supplements at increasing vitamin D levels, especially among those who are deficient<sup>5,6</sup>.

### Your comprehensive resources in the one place

We have put together for you a range of resources, including a research paper, brochures, webinars, and a video, all with a focus on vitamin D and the mighty common mushroom – *Agaricus bisporus*, including some to share with your clients.



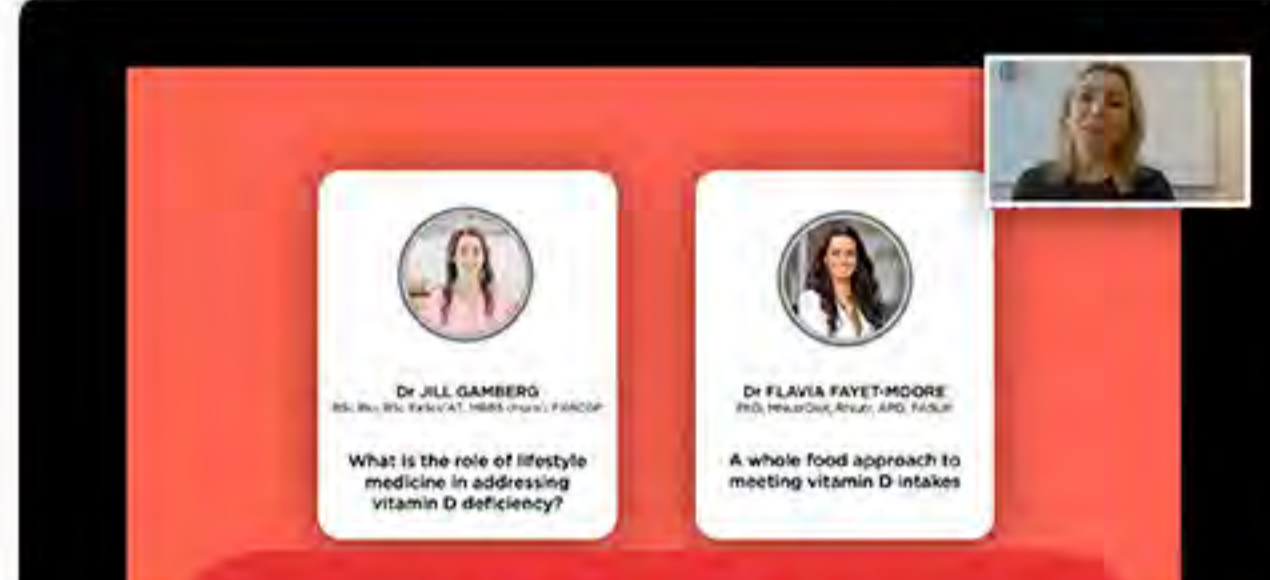
### SCIENTIFIC PAPER

This world first systematic review examines the health effects and bioactive components of *Agaricus bisporus*.



### WHITE PAPER

In this expert roundtable white paper, discover what experts had to say about the role of fungi foods and where they fit in a plant-based diet.



### WEBINAR 1

### When it comes to Vitamin D, two sources are best

GP Dr Jill Gamberg and APD Dr Flavia Fayet-Moore explore the role of diet in meeting vitamin D needs, with practical evidence-based tips for boosting your clients vitamin D intake.



### WEBINAR 2

### 'Food as Medicine' for the modern health era: Mushrooms & Extra Virgin Olive Oil

Naturopath Ian Breakspear and APD Dr Flavia Fayet-Moore explore a 'Food as Medicine' approach to health and immunity and its potential to help combat health challenges of today and the future. Current evidence on vitamin D and immunity presented.



### CLINICIAN BROCHURE

Educational resource summarising key research highlights of vitamin D and mushrooms. Includes a vitamin D checklist for assessing the risk of vitamin D deficiency in your clients.



### VIDEO

Your ultimate 2 minute guide to tanning your mushrooms. A practical step by step guide on how mushrooms can be transformed into a rich source of vitamin D.



### BROCHURE - FOR CLIENTS

Printable handout for clients containing easy-to-understand information for those at risk of low Vitamin D, and how sun-exposed mushrooms can help.

We hope you enjoy these free resources on our favourite fungi, to help educate and spread the word about this valuable unique food in helping people get more vitamin D and support health.

**Nutrition Research Australia & Australian Mushrooms.**

#### References

1. Malacova et al. Br J Nutr, 2019. 121(8): p. 894-904.
2. ABS, Australian Health Survey: Biomedical Results for Nutrients. 2011-12.
3. Brighthope et al. Adv Integr Med, 2021. 8(2): p. 77-78.
4. Nowson et al. Med J Aust, 2012. 196(11): p. 686-7.
5. Urbain et al. J Agric Food Chem, 2015. 63(37): p. 8156-61.
6. Cashman et al. J Nutr, 2016. 146(3): p. 565-75.



## Hungry for more?

Visit our mushroom hub

[www.nraus.com/mushroomhub](http://www.nraus.com/mushroomhub)

For all the latest mushroom resources in one place.

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## **APPENDIX 19: AUSTRALIAN MUSHROOMS WEBSITE CONTENT**



# **A review of current nutrient and health claims on the ‘Australian Mushrooms’ Website**

Prepared for Hort Innovation

**April 2020**

Prepared by Nutrition Research Australia Pty Ltd.

## Brief

Hort Innovation requested Nutrition Research Australia (NRAUS) to review the nutrient and health claims on the Australian Mushrooms website ([www.australianmushrooms.com.au](http://www.australianmushrooms.com.au)) to assess the current claims for scientific accuracy. A word document with all of the claims on the website were provided to NRAUS by Hort Innovation.

## Overview

Three documents have been prepared in response:

### 1) A detailed assessment of the claims

- An excel spreadsheet that assesses all current nutrient and health claims made on the website.
- Where claims do not have scientific substantiation or could be improved, the rationale and recommended wording to use as an alternative are provided.

### 2) A revised and updated word document with tracked changes

- A word document with the updated website copy and references, based on the assessment above.
- Changes that can be scientifically substantiated have been made as tracked changes.
- Changes were also made to the wording to help improve clarity and readability, where appropriate.

### 3) Final claims word document

- A 'clean' version of 2) with all tracked changes accepted.

## Methods

- 1) All nutrient claims on the 'Australian Mushrooms' website were identified and coded as either a 'nutrient' or a 'health' claim.
- 2) Claims were reviewed for scientific accuracy according to the reference provided against the claim. To identify whether the recent literature contradicts or supersedes the claim, a brief literature search was also conducted on PubMed and Google Scholar. Where no reference was provided, the literature was searched to identify whether the claim could be scientifically supported. An assessment was made and reported using the following criteria:
  - a. **No amendments required.**  
**Green ("Yes")**: Claim has scientific substantiation and can be supported by current references.
  - b. **Amendments required.**  
**Red ("No")**: Claim does not have scientific substantiation.
  - c. **Amendments recommended.**  
**Orange ("Maybe")**: Claim has scientific substantiation but may require rewording for other reasons.

*If the claim was assessed as 'No' or 'Maybe':*

- 3) Rationale for the assessment was provided.
- 4) Recommended wording or action/s was provided.

## Outcomes

Eighty-two health or nutrient claims were identified on the Australian Mushrooms' website:

- 25 claims were assessed as "Yes", i.e. could be substantiated with the current wording and referencing, and no further action necessary.
- 26 claims were assessed as "No", i.e. could not be scientifically substantiated with the current wording, and require further action, and
- 31 claims were assessed as "Maybe", i.e. were scientifically accurate, but may require additional references or rewording for reasons other than scientific accuracy.

## Regulatory considerations

The Food Standards Code has a number of regulatory considerations concerning nutrient and health claims made on labels or in advertisements about foods. Claims on the Australian Mushrooms' website were assessed for scientific accuracy only, under the assumption that they are used for educational purposes and not for advertisement. If the website is used for advertisement purposes, then significant changes would be required to meet the regulatory conditions outlined in the Code. For claims where no clear scientific benchmark was available, e.g. "source of folate", we used the Food Standards Code to guide us in our assessment of the claim.

## New claims

A number of possible new claims, which are currently not on the website, were identified while researching the systematic literature review. These claims are summarised in the 'Dr Flav's Fun Facts' document and may be considered as additional claims for the website.



## **APPENDIX 20: AUSTRALIAN MUSHROOMS MEDIA RELEASE**

## **NEW RESEARCH SHOWS EVERYDAY MUSHROOMS CAN BE AS EFFECTIVE AS VITAMIN D SUPPLEMENTS**

New research to be published in the October issue of the *Journal of Nutritional Biochemistry* has revealed that common mushrooms contain a host of unique properties that can improve human health, including increasing vitamin D status when exposed to UV light.<sup>1</sup>

The Australian [study](#) is the first ever systematic review on the human health benefits of the popular *Agaricus Bisporus* mushroom variety, which includes Button, Cup, Swiss Brown, Portobello and Flat mushrooms.

The review included 68 research studies spanning more than 20 years and found the consumption of mushrooms exposed to UV light (which you can get from the sun) was as effective at increasing vitamin D levels as a vitamin D supplement.<sup>2</sup> Moreover, the vitamin D found in these mushrooms is a bioavailable form that is largely retained during storage and cooking.

The findings revealed additional potential health benefits linked to eating the world's most popular mushrooms, including:

- Lowering the risk of ovarian cancer<sup>3</sup> and progression of prostate cancer<sup>4</sup>
- Improving markers of gastrointestinal<sup>5,6</sup> and metabolic health<sup>7</sup>
- Supporting immune function<sup>8</sup>
- Reducing cholesterol levels<sup>7</sup>

The study also found the most commonly consumed mushrooms contain a range of bioactive compounds, found not only in vegetables but also some meats, whole grains and nuts.<sup>10</sup>

Dr Flavia Fayet-Moore, CEO of Nutrition Research Australia, led the analysis and said the results make a strong case for positioning mushrooms as a genuine superfood.

“Mushrooms are their own food kingdom and research from around the world, spanning more than 20 years, has given us reason to regard them as such. They are biologically distinct to both plants and animals, yet contain unique bioactive compounds found in both categories, making them a valuable food choice for anyone looking to support their health,” Dr Fayet-Moore said.

“The body of scientific evidence shows that mushrooms have a remarkable profile of bioactive compounds that may support immunity on a cellular level and positively affect gut microbiota too,” she said.

This Australian research is the first time the worldwide evidence on *Agaricus Bisporus* mushrooms has been collated, screened and analysed to identify the many bioactive components of *Agaricus Bisporus* mushrooms and their effects on human health.

As well as having the potential to be a highly prized source of vitamin D, this comprehensive review highlights that everyday mushrooms also contain:

- Beta-glucans - a soluble fibre commonly found in oats, known to reduce cholesterol<sup>11</sup>
- Chitin - a unique prebiotic found in the cell walls of mushrooms<sup>12</sup>
- Antioxidants - usually reported as flavonoids, with anti-inflammatory properties<sup>1</sup>
- Ergothioneine - an amino acid with antioxidant properties and can only be made by some fungi and bacteria<sup>13,14</sup>

Accredited Practising Dietitian and Research & Development Manager at Hort Innovation Jemma O’Hanlon said it is important to recognise mushrooms are part of their own unique food kingdom, and hopes more Australians will consider using mushrooms in their daily meals.

“We now know a host of health benefits that eating more of the common mushrooms like Button, Cup, Swiss Brown, Flat and Portobello mushrooms may provide. They are also a wonderful food to consider if you’re looking to reduce your intake of animal foods,” she said.

“This study has shown us that adding more mushrooms to your diet will provide a range of nutritional properties that may support your health. To make sure you’re reaping the vitamin D rewards, leave your mushrooms to tan in the sun for 15 minutes - then cook or store in the fridge for up to 8 days.”

Please find a copy of the published report available here:

<https://bit.ly/mushroomsresearch>

-ENDS-

**For media enquiries: Please contact – Sara Golec at Bite  
Communications on 02 9977 8195  
or email [sara@bitecom.com.au](mailto:sara@bitecom.com.au)**

### ***Issued on behalf of Australian Mushrooms***

*The brand Australian Mushrooms is managed by Hort Innovation on behalf of the nation’s mushroom growers. Hort Innovation is the grower-owned, not-for-profit research and development corporation for Australian horticulture, which delivers more than \$100 million in R&D, marketing and trade activities on behalf of industry each year. Facebook: @AustralianMushrooms Instagram: @AustralianMushrooms Website: [www.australianmushrooms.com.au](http://www.australianmushrooms.com.au)*

References:

1. Blumfield M, et al. Examining the health effects and bioactive components in *Agaricus bisporus* mushrooms: a scoping review. *Journal of Nutritional Biochemistry*. 84 (2020) 108453

<https://www.sciencedirect.com/science/article/pii/S095528632030485X?via%3Dihub>

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## **APPENDIX 21: STRATEGIC INVESTMENT ADVISORY PANEL (SIAP) PRESENTATION**

**Hort  
Innovation**  
Strategic levy investment

**MUSHROOM  
FUND**

**MU17002: Educating healthcare professionals about Australian Mushrooms**



# Project Overview



**2019**

**The Mushroom Multi**  
Mushrooms are nutritionally  
unique



**2020**

**Not a plant,  
nor an animal**  
Mushrooms are associated  
with range of health benefits



**2021**

**More to mushrooms**  
Mushrooms taste great and are  
environmentally friendly

# Presentation Outline

1. Audience Sentiment Research findings
2. Systematic Literature Review update
3. GP Webinar
4. General Practice Conference & Exhibition (GPCE)
5. What's in store for 2020?





# Audience Sentiment Survey

August 2019



# Objectives

1. Gather insights to better tailor our communications approach
2. Track changes and success over time



Knowledge of the nutritional properties and health benefits of mushrooms



Value placed on mushrooms for their properties



Perception of mushrooms for health

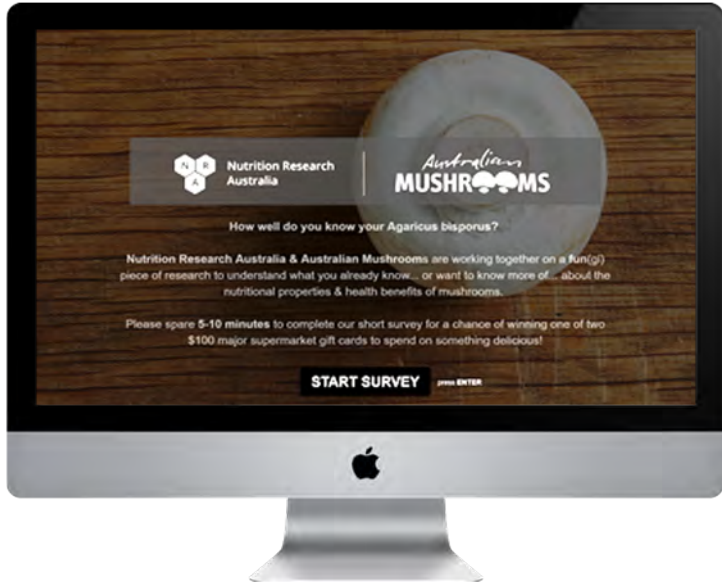


Behaviour around recommending mushrooms

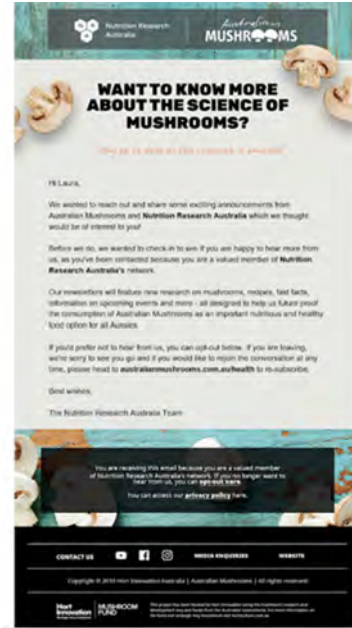
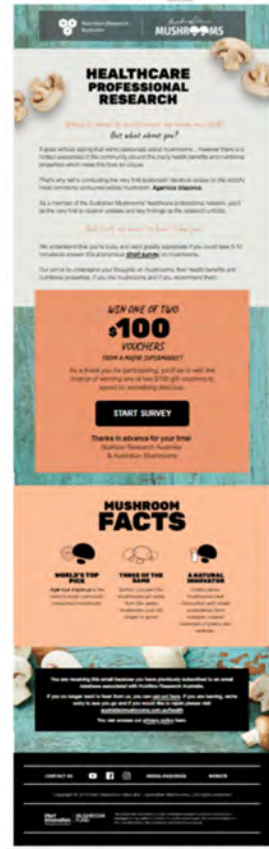


Frequency of recommendation or behaviour

# Assets



Survey platform



Series of EDMs



Social ads and third party organisations

# Most consider mushrooms as just another vegetable



**23%** familiar or very familiar with key nutritional properties and can specify them



**15%** describe mushrooms as more valuable than other vegetables



**34%** perceive mushrooms as very important for overall health



**41%** personally consume mushrooms more than once per week



**31%** who see clients regularly recommend mushrooms



# Takeaways



**FOCUS ON BITESIZE,  
DIGESTIBLE  
CONTENT**



**DRIVE TRAFFIC TO  
THE AUSTRALIAN  
MUSHROOMS  
WEBSITE**



**IDENTIFY  
OPPORTUNITIES TO  
WORK WITH THIRD  
PARTY PLATFORMS  
TO SHOWCASE OUR  
FINDINGS**



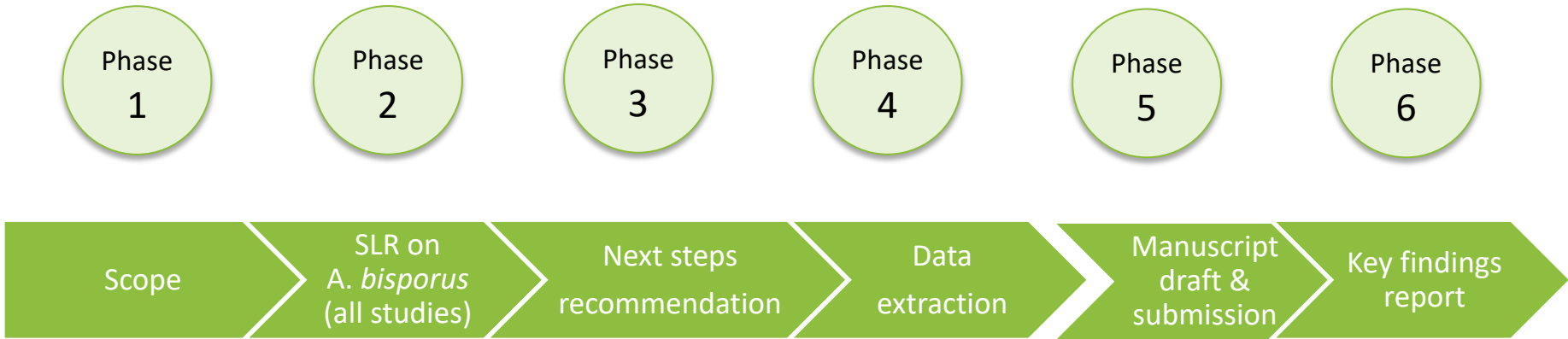
**DIETARY FIBRE IS  
KNOWN - LET'S  
FOCUS ON OTHER  
PROPERTIES AND  
BIOACTIVES LESS  
KNOWN**

# Systematic Literature Review Update

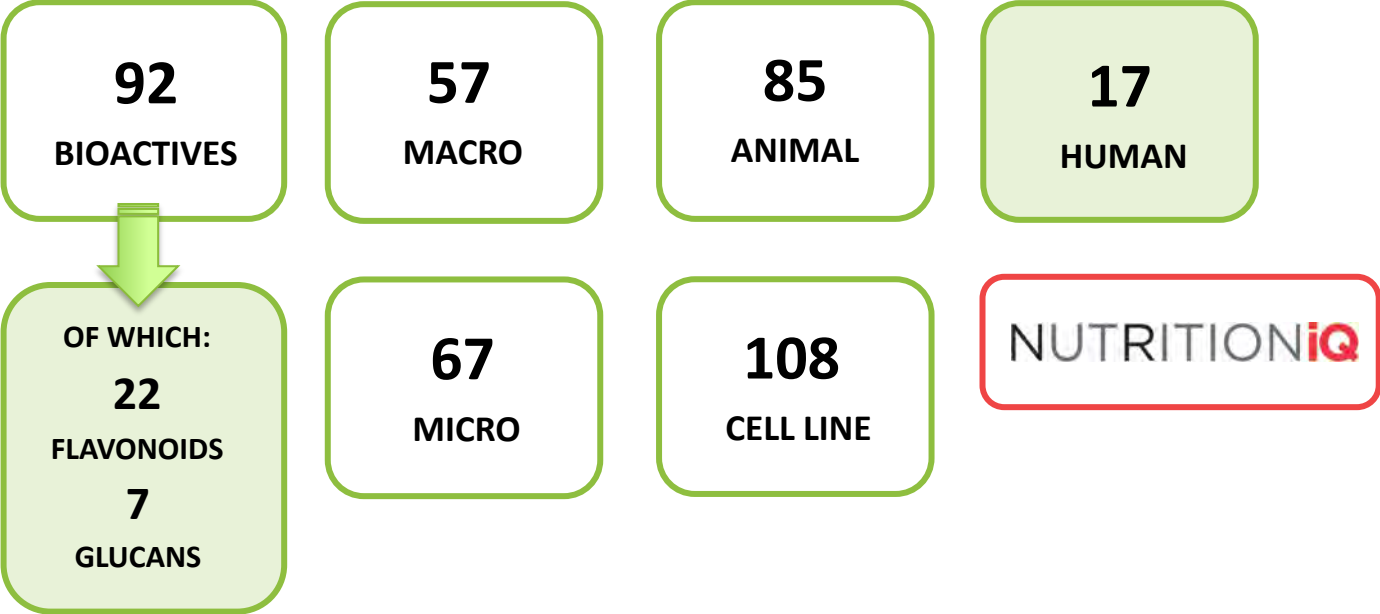
September 2019



# SLR update: the science on *A. bisporus*



# New research database of 501 studies (46 in SLR)





# THE EMERGING EVIDENCE FOR *A. BISPORUS*

Type 2 Diabetes

Weight management

Cancer

Gut Health

Inflammation

Cholesterol

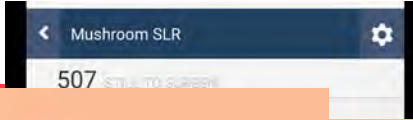
Immunity

17 human studies  
including 12 RCTS

Satiety



# Dr Flav's Fun Facts



## MUSHROOM FACTS



### WORLD'S TOP PICK

*Agaricus bisporus* is the world's most commonly consumed mushroom.



### THREE OF THE SAME

Button, cup and flat mushrooms all come from the same mushroom, just left longer to grow!



### A NATURAL INNOVATOR

Unlike plants, mushrooms lack chlorophyll and obtain sustenance from complex organic materials of plants and animals.



### ON THE DE

Wall of consists of fibre beta-an.



### THE SPECIAL STEROL

While animal foods contain cholesterol, mushrooms contain a unique sterol called ergosterol, that converts to Vitamin D when exposed to light.

Vitamin D  
content of  
is still  
value  
ns.



# Additional bite sized info



# GP Webinar

October 29, 2019



# When it comes to vitamin D, two sources are best



**What is the role of lifestyle medicine in addressing vitamin D deficiency?**

**Dr JILL GAMBERG**  
BSc Bio, BSc ExSci/AT,  
MBBS (Hons), FRACGP



**November 2nd**



**A whole food approach to meeting vitamin D intakes**

**Dr FLAVIA FAYET-MOORE**  
PhD, MNutrDiet, RNutr, APD,  
FASLM

# Approach

## 7 channels:

**eDM**  
87 regos

**Eventbrite**  
6 regos

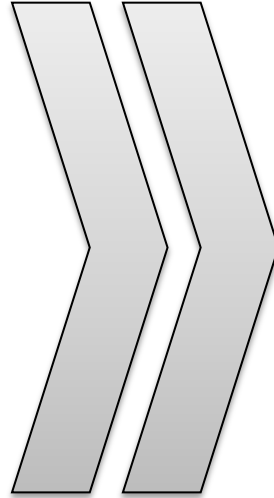
**LinkedIn**  
16 visits  
1 rego

**Facebook**  
1032 visits  
10 regos

**ASLM**  
33 visits  
5 regos

**RACGP**  
37000 impressions  
76 visits  
10 regos

**Medical Republic**  
50 visits  
6 regos



## Ahead of targets:


**125 registrations**  
(vs. 80 target)

**54 unique viewers**  
(vs. 40 target)

# “Tan your mushrooms when you can’t tan your skin”


TA

At the





**Dr JILL GAMBERG**  
BSc Bio, BSc ExSci/AT, MBBS (Hons), FRACGP

# Q&A



**Dr FLAVIA FAYET-MOORE**  
PhD, MNutrDiet, RNutr, APD, FASLM



This project has been funded by Hort Innovation, using the Mushroom Fund research and development levy and contributions from the Australian Government. Hort Innovation is the grower-owned, not-for-profit research and development corporation for Australian horticulture.

38

# Post webinar: 541 views



## Activities:

- NRAUS website, YouTube, AU Mushrooms
- eDM
- Q&A
- Social campaign
- Medical Republic

## Outcomes:

- 380 click throughs
- 541 views
- Average VT is at 8mins



# Feedback Survey

**9 / 10**  
for overall enjoyment

**100%**  
Would recommend  
to a colleague

## Some key learnings:

“The potential mushrooms have to boost our vitamin D intake”

“UV mushrooms have the same bioavailability as a supplement”

# Impact

**Thinking Nutrition**  
29 October at 13:26 · 🌐

MEDICALXPRESS.COM  
**Cocoa: A tasty source of vitamin D?**  
Many people do not get enough vitamin D. Brittle bones and an increase...

👍❤️👎 102      17 comments 31 shares

👍 Like    💬 Comment    ➦ Share

Most relevant ▾

Write a comment... 🗨️ 📷 📺 📄

**Fernanda Rodrigues** I've just watched a webinar with Dr. Fayet-Moore about exactly that! But, still the best sources are sun light and mushrooms. 😊

Like · Reply · 3w      👍❤️👎 2

"Most relevant" is selected, so some replies may have been filtered out.

**Thinking Nutrition** That's where I picked that nugget up from! 😊 I detest mushrooms so it's chocolate for the win for me 🍫🍫🍫

Like · Reply · 3w · Edited      👍❤️👎 3

Optus 📶      5:18 pm      🔋 25%

**Nicole Senior**  
3 hrs · 🌐

Sunbaking my #mushrooms to increase their #vitaminD content. Yes, it's true! Place them gills up for 10-15 minutes.



👍❤️👎 Skye Andrew and others      1 Comment

👍 Like    💬 Comment    ➦ Share

🏠 📺 👤 🗣️🔴 2 🔔🔴 2 ☰

**Nicole Senior**  
@NicoleMSenior

Its World #VitaminD day. This rock star vitamin does so much but many of us don't get enough. Get safe sun exposure PLUS vit D in foods such as oily #fish, #eggs, fortified dairy, #chicken and #mushrooms. Sunbake your mushrooms, gills up, 10-15mins for extra vit D



1:52 PM · Nov 2, 2019 · TweetDeck

4 Retweets    9 Likes

# HCP Database & Claim Substantiation

## Our HCP database is growing

### Status Update

- Growth in database of 29%
  - 1292 (Nov) vs. 1002 (Jan)
- Direct contact to many thought leaders in the field
- Majority of people who completed the ASR (61%) and registered for the webinar (70%) were from our HCP database

## We're reviewing the Australian Mushrooms website claims

### Status Update

- 80 different nutrient or health claims on website that may not reflect latest science
- Opportunity to make additional claims based on findings from research database

### Next Steps

Feedback in Dec 2019

# General Practice Conference & Exhibition

November 16 & 17, 2019



# Promotion & Content

**GPCE**  
GENERAL PRACTICE CONFERENCE & EXHIBITION

22-24 May 2020 Sydney  
25-26 July 2020 Perth  
11-13 Sept. 2020 Brisbane  
13-15 Nov 2020 Melbourne

25 YEARS

REGISTER NOW

HOME ABOUT SYDNEY PERTH BRISBANE MELBOURNE EXHIBIT OR SPONSOR

**DR FLAVIA FAYET-MOORE**  
Bio  
PhD, MNutrDiet, APD, RNutr

Dr Fayet-Moore is the CEO of Nutrition Research Australia, where she leads a team of highly skilled researchers to conduct end-to-end nutrition and communications projects. She is a Registered Nutritionist, Accredited Practising Dietitian, Honorary Associate of the University of Sydney, and the first dietitian in Australia to be board certified in Lifestyle Medicine.

**SUBSCRIBE FOR UPDATES**

First Name:   
Last Name:   
Email:   
Phone:  (000)   
 See you at!

**Vitamin D decoded - how can we best address vitamin D deficiency in our patients?**  
16 Nov 2019, 10:15 AM - 11:15 AM, GPCE Melbourne  
Australia has one of the highest rates of skin cancer, and almost 1 in 4 Australians have vitamin D deficiency. This session will explore emerging lifestyle med...

**Vitamin D decoded - how can we best address vitamin D deficiency in our patients?**  
17 Nov 2019, 10:15 AM - 11:15 AM, GPCE Melbourne  
Australia has one of the highest rates of skin cancer, and almost 1 in 4 Australians have vitamin D deficiency. This session will explore emerging lifestyle med...



End to End Nutrition Research & Communication

**Vitamin D decoded:  
how can we best address  
Vitamin D deficiency in  
our patients?**

**Dr Flavia Fayet-Moore, CEO**  
Saturday & Sunday  
10:15am - 11:15am

**SUBSCRIBE  
TO NRAUS FOR THE LATEST  
RESEARCH UPDATES**



Australia has one of the highest rates of skin cancer, and almost 1 in 4 Australians have vitamin D deficiency. Scan the QR code above and subscribe to stay up to date with current research projects.

[www.nraus.com](http://www.nraus.com) | © Copyright 2019 Nutrition Research Australia Pty Ltd.

# Brochure

## WHEN IT COMES TO VITAMIN D, TWO SOURCES ARE BEST:

A whole food, lifestyle approach to addressing vitamin D deficiency

*"Did you know that Australians spend over \$200m a year on vitamin D supplements, yet 1 in 4 are vitamin D deficient? It is my pleasure to share with you the findings from a first-of-its-kind research, highlighting the importance of shift as a second source of vitamin D."*

*Dr. Peter Peaker*

Peter Peaker, PhD, MSc(Ed), BSc, APD, FASHD, CEO Nutrition Research Australia

### UNDERSTANDING THE PROBLEM IN AUSTRALIA

23%

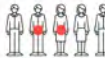
Seven 25(OH)D <10nmol/L



Almost 1 in 4 Australians are vitamin D deficient<sup>1</sup> results in impaired bone health

43%

Seven 25(OH)D 50 to <10 nmol/L



2 in 5 Australians are vitamin D insufficient<sup>2</sup> may increase the risk of other disease outcomes

Vitamin D deficiency is also a public health problem worldwide

Watch the free Vitamin D webinar: [mnaus.com/blog/webinar-vitamin-d-2018](https://mnaus.com/blog/webinar-vitamin-d-2018)



### FACTORS THAT INCREASE DEFICIENCY RISK<sup>1</sup>

#### NON-MODIFIABLE



#### MODIFIABLE



### DID YOU KNOW?

Vitamin D receptors are in nearly every tissue and thousands of genes are in our genome, controlling over 200 genes, and are thus implicated in many other diseases beyond bone health<sup>2</sup>



### SUN EXPOSURE GUIDELINES

In winter, the recommended time increases substantially



Always treated to wear (and to check) with 10% of the body exposed (hands, face and arms)

### CURRENT VITAMIN D GUIDELINES

RACGP guidelines recommend one source to address vitamin D deficiency: sun exposure or supplements<sup>3</sup>

At risk	Mild deficiency	Severe to severe deficiency <sup>4</sup>
<50 nmol/L	10-49 nmol/L	<30 nmol/L
Sedentary	Sun avoidance	Supplements <sup>5</sup>

"There are few opportunities in Australia to obtain the equivalent of 1000 IU 25(OH)D within a realistic duration while adhering to sun smart messages<sup>6</sup>"

Sun exposure guidelines for 25(OH)D adequacy are insufficient in winter in Australia<sup>6</sup>

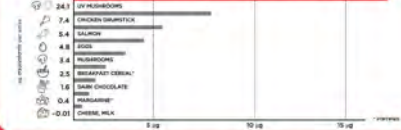
### DIETARY INTAKES ARE ALSO BELOW TARGETS

"Given our increasingly older phenotype, there is a need to address and explore strategies to maintain adequate vitamin D status through safe sun avoidance and dietary approaches<sup>7</sup>"



Margarine, which is recommended to contain vitamin D, is the leading source of vitamin D present<sup>8</sup>

### THERE ARE FEW GOOD SOURCES OF VITAMIN D<sup>8</sup>



### MUSHROOMS IN SUNLIGHT FOR 10-60 MINUTES INCREASES VITAMIN D UP TO 10x<sup>9</sup>



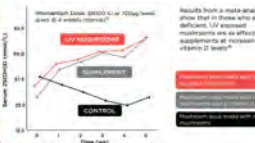
### INCREASING YOUR MUSHROOM'S VITAMIN D



### TIPS TO RETAIN VITAMIN D

**REFRIGERATE**  
Sun exposure degrades vitamin D, so keep mushrooms in the fridge.  
**RAW FERMENT**  
Lactic acid increases vitamin D, so eat fermented mushrooms like kimchi or sauerkraut.

### UV MUSHROOMS = SUPPLEMENTATION



### THERE'S MORE TO MUSHROOMS

**A** Healthy gut health (probiotics)  
**B** Immune system (beta-glucans)  
**C** Carbohydrate (chitin)  
**D** Vitamin D  
**E** Ergosterol

### CONSIDERATIONS WHEN RECOMMENDING DIETARY APPROACHES

- Individual & family food preferences
- Access to the food
- Cooking skills
- Lower risk of toxicity and skin cancer
- Compliance - may be higher or lower

### LIFESTYLE AX CHECKLIST FOR VITAMIN D DEFICIENCY

	DECREASED RISK	INCREASED RISK
Age (months)	<input type="checkbox"/> Spring/Summer	<input type="checkbox"/> Autumn/Winter
Season	<input type="checkbox"/> Olive (SLV)	<input type="checkbox"/> Dark or pale (L, S, V, VD)
Phototype	<input type="checkbox"/> No	<input type="checkbox"/> Yes
Office worker	<input type="checkbox"/> No	<input type="checkbox"/> Yes
Supplement	<input type="checkbox"/> No	<input type="checkbox"/> Yes
Sun exposure (see additional)	<input type="checkbox"/> Some	<input type="checkbox"/> None
Age	<input type="checkbox"/> No	<input type="checkbox"/> None
Smoking	<input type="checkbox"/> No	<input type="checkbox"/> Yes
Supplement	<input type="checkbox"/> No	<input type="checkbox"/> Yes
Sun exposure (see additional)	<input type="checkbox"/> Some	<input type="checkbox"/> None
Age	<input type="checkbox"/> No	<input type="checkbox"/> None
Smoking	<input type="checkbox"/> No	<input type="checkbox"/> Yes
Supplement	<input type="checkbox"/> No	<input type="checkbox"/> Yes
Sun exposure (see additional)	<input type="checkbox"/> Some	<input type="checkbox"/> None

Use this checklist to help determine which of your clients are at risk. The more boxes for increased risk, the greater the need for intervention.

Consider the modifiable factors first, and what your patient or client is willing to change.

### Benefits of lifestyle recommendations for vitamin D

- Encourages whole foods
- Most occasions and social connectedness
- Additional essential nutrients and bioactives
- Regulates melatonin release and sleep cycle
- Outdoor physical activity
- Stress relief

### KEY TAKEOUTS

- Vitamin D deficiency is as high as 23%.
- Only sun exposure or supplements are recommended.
- Australia is unique in the world where UV exposure is not recommended.
- All evidence from clinical trials is weak.
- UV mushrooms are a safe and effective way to increase Vitamin D.
- UV mushrooms are a safe and effective way to increase Vitamin D.

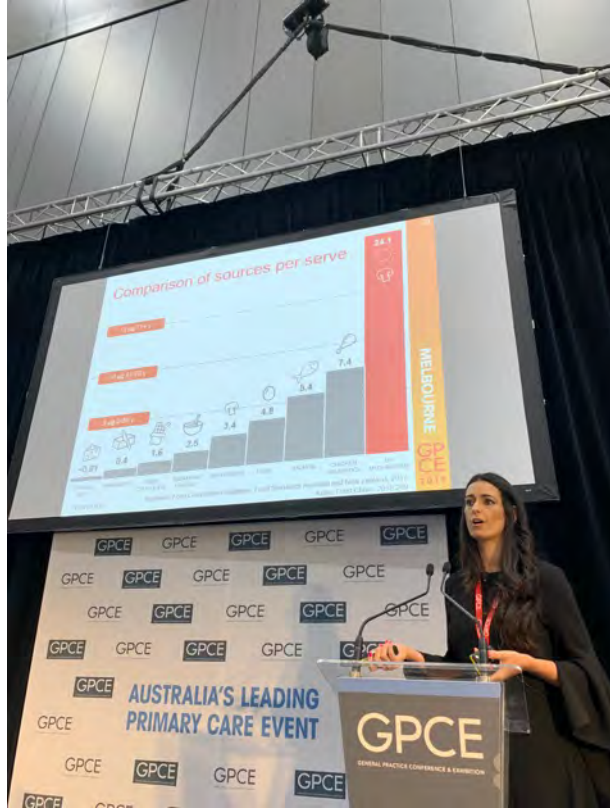
- REFERENCES**
  1. Global prevalence of vitamin D deficiency: a systematic review and meta-analysis. *PLoS One* 2018;13(12):e0205813.
  2. Vitamin D deficiency and its association with bone health: a systematic review and meta-analysis. *PLoS One* 2018;13(12):e0205813.
  3. RACGP Guidelines for the Management of Vitamin D Deficiency. [www.racgp.org.au/clinical-guidance/guidelines/vitamin-d-deficiency](https://www.racgp.org.au/clinical-guidance/guidelines/vitamin-d-deficiency)
  4. Vitamin D deficiency and its association with bone health: a systematic review and meta-analysis. *PLoS One* 2018;13(12):e0205813.
  5. Vitamin D deficiency and its association with bone health: a systematic review and meta-analysis. *PLoS One* 2018;13(12):e0205813.
  6. Vitamin D deficiency and its association with bone health: a systematic review and meta-analysis. *PLoS One* 2018;13(12):e0205813.
  7. Vitamin D deficiency and its association with bone health: a systematic review and meta-analysis. *PLoS One* 2018;13(12):e0205813.
  8. Vitamin D deficiency and its association with bone health: a systematic review and meta-analysis. *PLoS One* 2018;13(12):e0205813.
  9. Vitamin D deficiency and its association with bone health: a systematic review and meta-analysis. *PLoS One* 2018;13(12):e0205813.

# Outcomes

“This is the best brochure I have ever seen. It summarises everything that we need to know in only 4 pages.”

“Thank you for your presentation. It was so practical and relevant- it’s the best that I’ve seen in this conference.”

**91 delegates & 200 brochures handed out**



# Presentation Days





# What's in store for 2020?



# Dietitians Breakfast at Dietitians Unite

## Background

- Breakfast event to dietitians on the importance of vegetables and mushrooms
- Focus on culinary nutrition and practical tips and recommendations to boost mushroom intake
- Communicate findings from the SLR
- Panel discussion to drive engagement
- Chef and recipe booklet



## Status Update

Monthly planning meetings in place  
Brochure development  
Recipe booklet



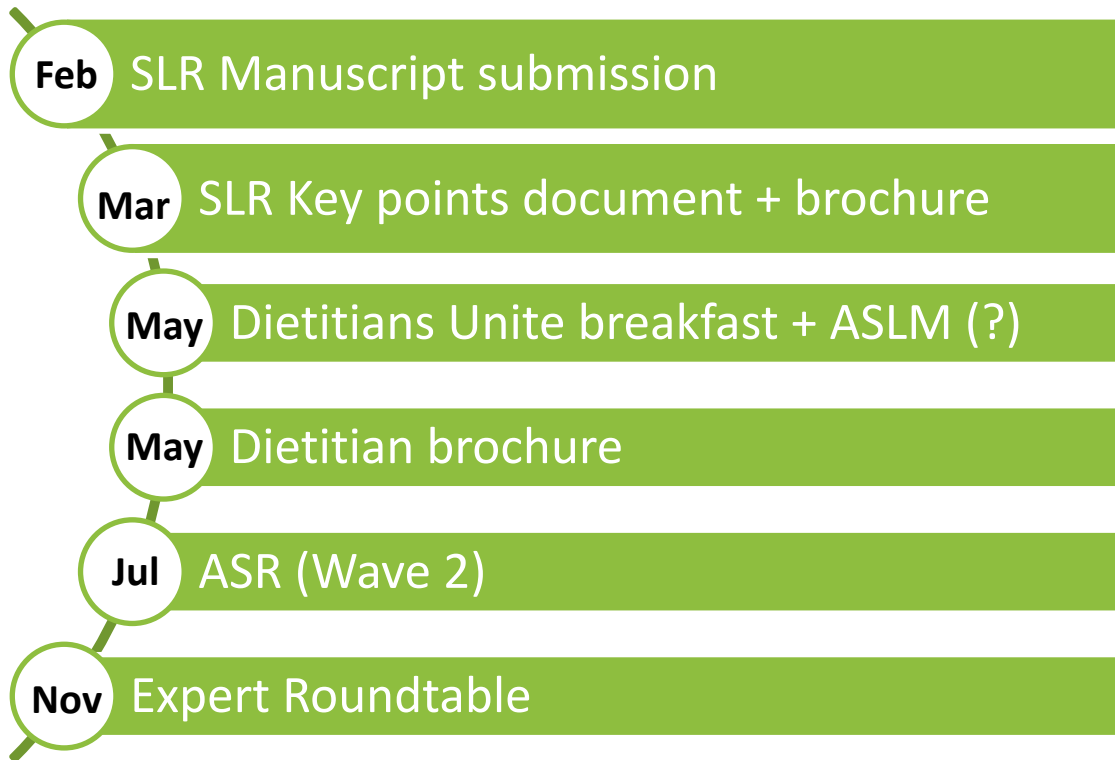
# 2020 Activities



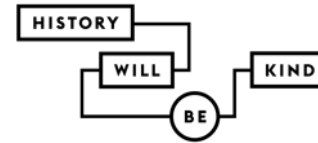
**2020**

**Not a plant,  
nor an animal**

Mushrooms are associated  
with range of health benefits



# Acknowledgements



# Thank you!



## **APPENDIX 22: APPLIED HORT PRESENTATION**

# Mushrooms for healthy diets- what's new?

Flavia Fayet-Moore

CEO NRAUS

PhD, MNutrDiet, RNutr, APD, FASLM

May 20, 2021

# Contents

1. The science behind mushrooms
2. Vitamin D: What you may not know
3. Practical mushroom tips
4. What's next for mushrooms?





# LONG HISTORY BUT LIMITED EVIDENCE IN HUMANS



# THE SCIENCE BEHIND MUSHROOMS

# WORLD FIRST REVIEW ON *A. BISPORUS*



Available online at [www.sciencedirect.com](http://www.sciencedirect.com)

**ScienceDirect**

Journal of Nutritional Biochemistry 84 (2020) 108453

**Journal of Nutritional Biochemistry**

REVIEWS: CURRENT TOPICS

### Examining the health effects and bioactive components in *Agaricus bisporus* mushrooms: a scoping review☆

Michelle Blumfield<sup>a</sup>, Kylie Abbott<sup>a,b</sup>, Emily Duve<sup>c</sup>, Tim Cassettari<sup>d</sup>, Skye Marshall<sup>a,e</sup>, Flavia Fayet-Moore<sup>f,\*</sup>

<sup>a</sup>BNutDiet (Hons), PhD, Nutrition Research Australia, Sydney, New South Wales, Australia  
<sup>b</sup>Nutraceuticals Research Group, School of Biomedical Sciences and Pharmacy, University of Newcastle, Callaghan, Australia  
<sup>c</sup>BPESS, MPH, Nutrition Research Australia, Sydney, New South Wales, Australia  
<sup>d</sup>BSc(Hons), BAppSc, Nutrition Research Australia, Sydney, New South Wales, Australia  
<sup>e</sup>Bond University, Nutrition and Dietetics Research Group, Faculty of Health Sciences and Medicine, Bond University, Gold Coast, Queensland, Australia  
<sup>f</sup>BSc(Hons), MNutDiet, PhD, Nutrition Research Australia, Sydney, New South Wales, Australia

Received 8 March 2020; received in revised form 19 May 2020; accepted 8 June 2020

#### Abstract

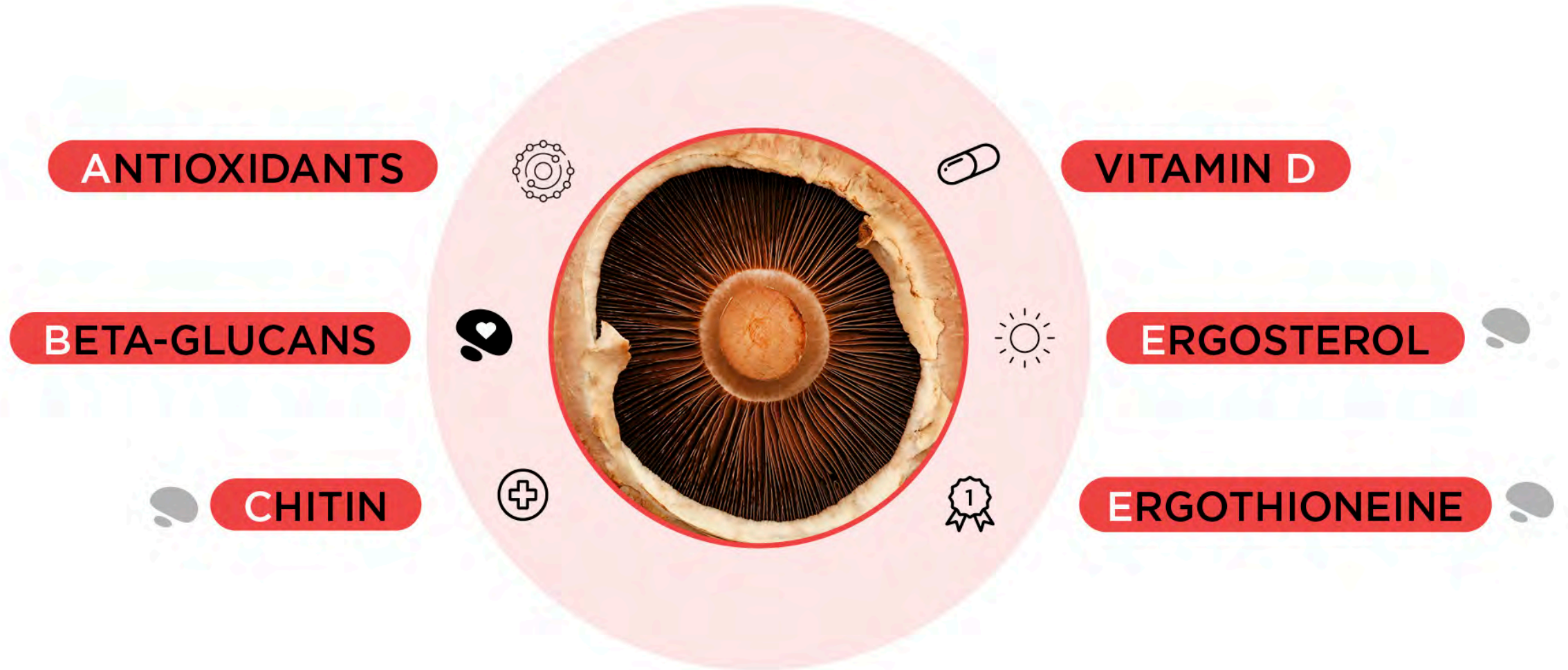
There is evidence from both *in vitro* and animal models that the consumption of edible mushrooms has beneficial effects on health. It is unclear whether similar effects exist in humans and which bioactive compounds are present. This review synthesises the evidence on the world's most commonly consumed mushroom, *Agaricus bisporus* to (i) examine its effect on human health outcomes; and (ii) determine the nutrient density of its bioactive compounds, which may explain their health effects. A systematic literature search was conducted on the consumption of *A. bisporus*, without date and study design limits. Bioactive compounds included ergosterol, ergothioneine, flavonoids, glucans and chitin. Two authors independently identified studies for inclusion and assessed methodological quality. Beneficial effects of *A. bisporus* on metabolic syndrome, immune function, gastrointestinal health and cancer, with the strongest evidence for the improvement in Vitamin D status in humans, were found. Ultraviolet B (UVB) exposed mushrooms may increase and maintain serum 25(OH)D levels to a similar degree as vitamin D supplements. *A. bisporus* contain beta-glucans, ergosterol, ergothioneine, vitamin D and an antioxidant compound usually reported as flavonoids; with varying concentrations depending on the type of mushroom, cooking method and duration, and UVB exposure. Further research is required to fully elucidate the bioactive compounds in mushrooms using vigorous analytical methods and expand the immunological markers being tested. To enable findings to be adopted into clinical practice and public health initiatives, replication of existing studies in different population groups is required to confirm the impact of *A. bisporus* on human health.

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**Keywords:** Systematic review; *Agaricus bisporus*; Mushroom; Health; Human; Bioactive



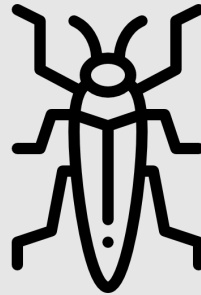
# 6 KEY BIOACTIVES THAT CAN CONTRIBUTE TO DIETS



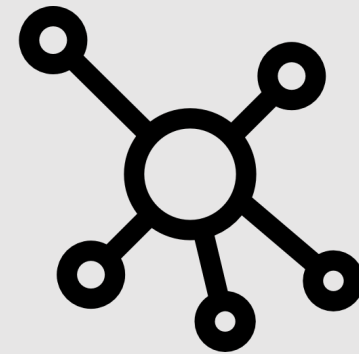
# 3 RELEVANT BIOACTIVES



ERGOSTEROL



CHITIN

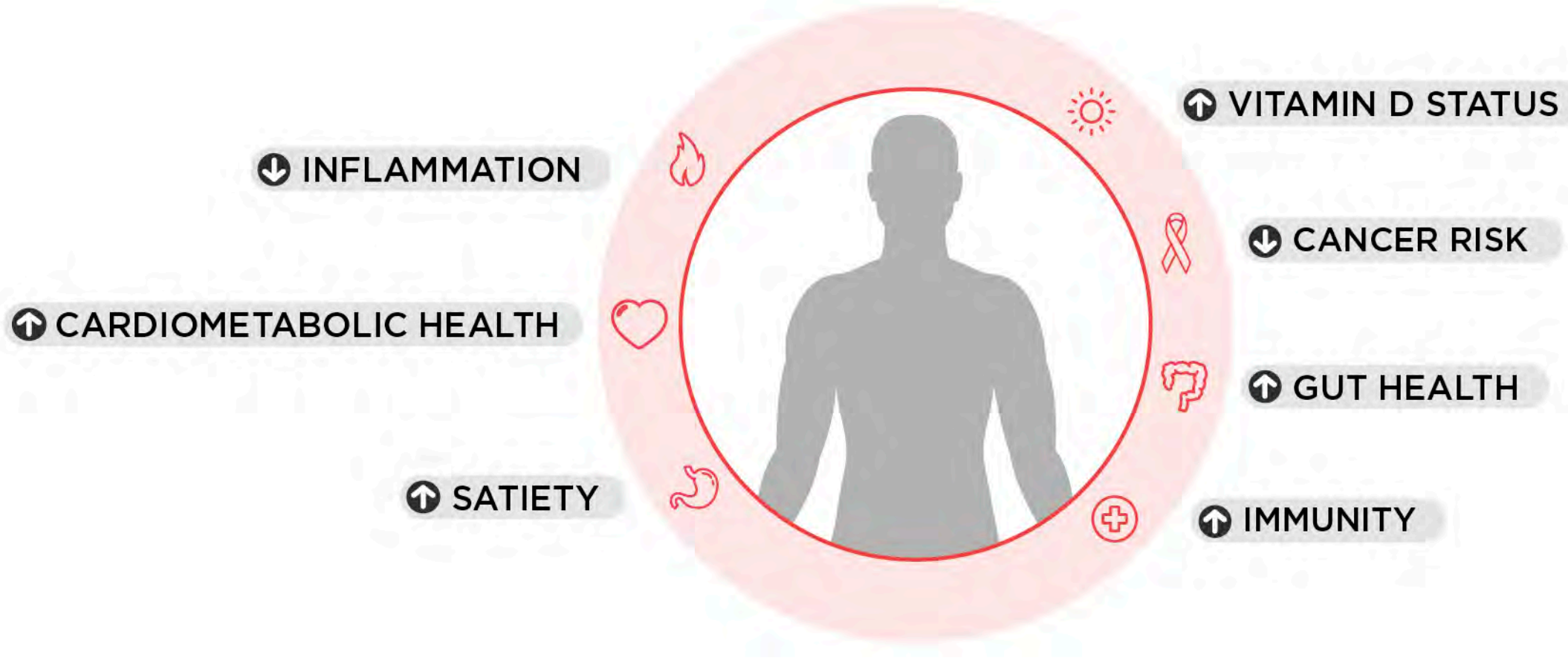


ERGOTHIONEINE

*Smith E et al. Ergothioneine is associated with reduced mortality and decreased risk of cardiovascular disease. Heart 2020;106:691-697.*



# 7 HEALTH BENEFITS IDENTIFIED



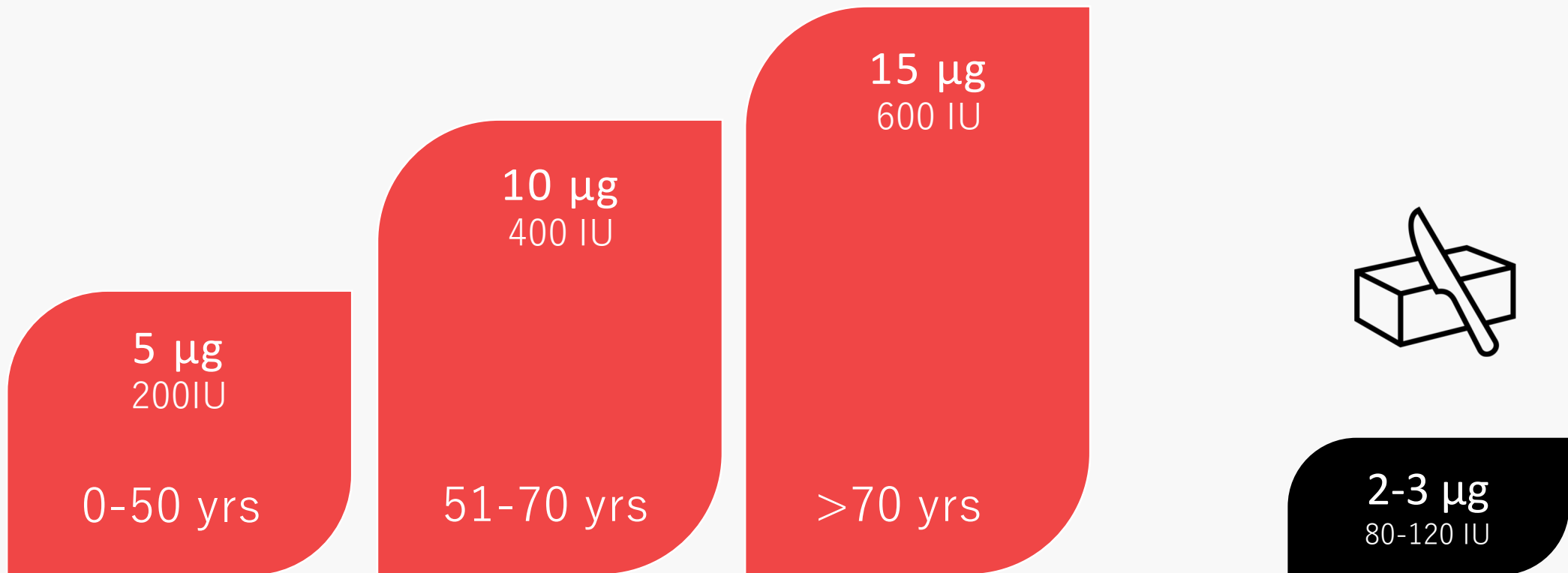
# HOW MANY DO YOU NEED TO EAT?



# VITAMIN D: *WHAT YOU MAY NOT KNOW*



# DIETARY VITAMIN D INTAKES ARE BELOW TARGETS



Adequate intake

Average intake

Nutrient Reference Values, National Health and Medical Research Council, 2006

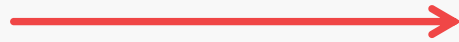
Nowson, Med J Aus. 2012;197(10)



# 3 UV exposed cup mushrooms provide almost 1000 IU



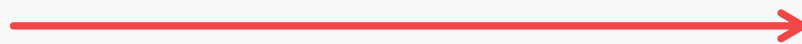
2-3  $\mu\text{g}$



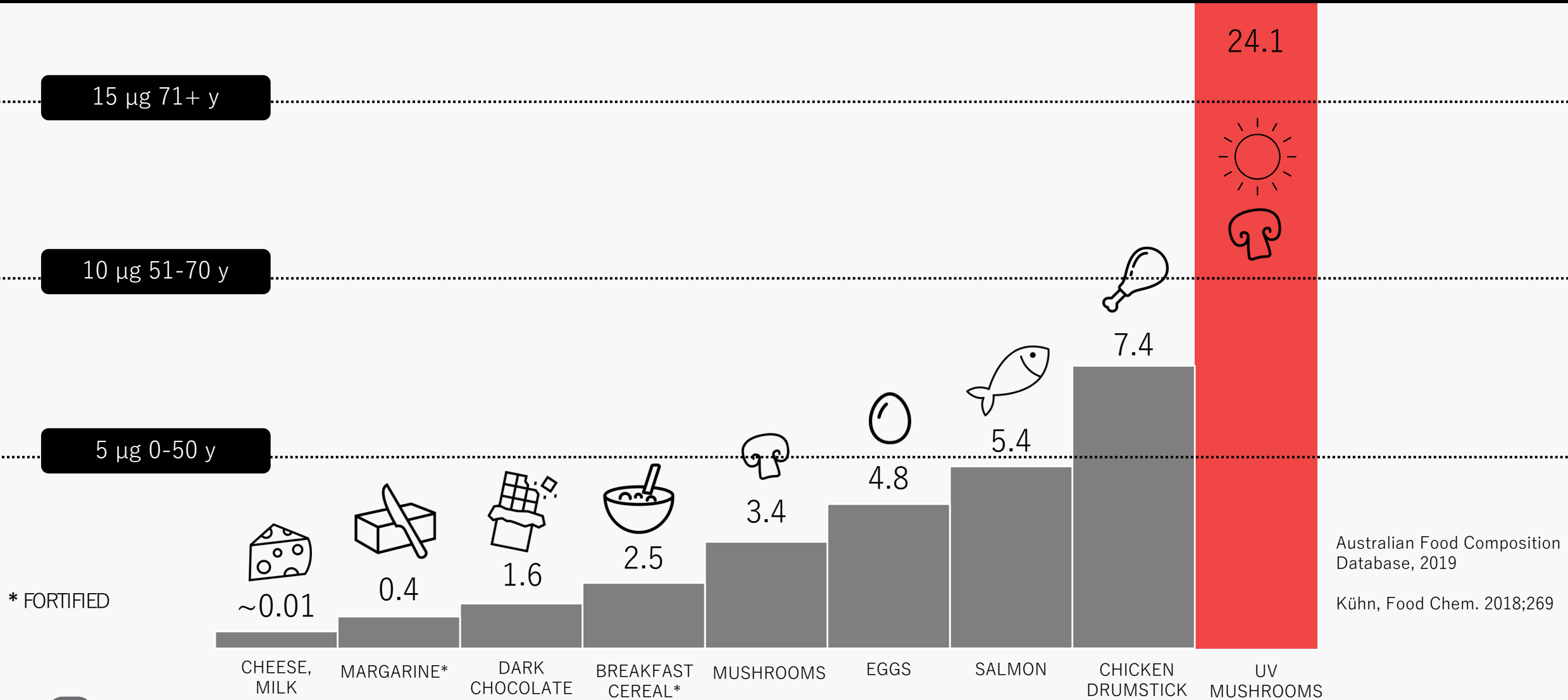
UV



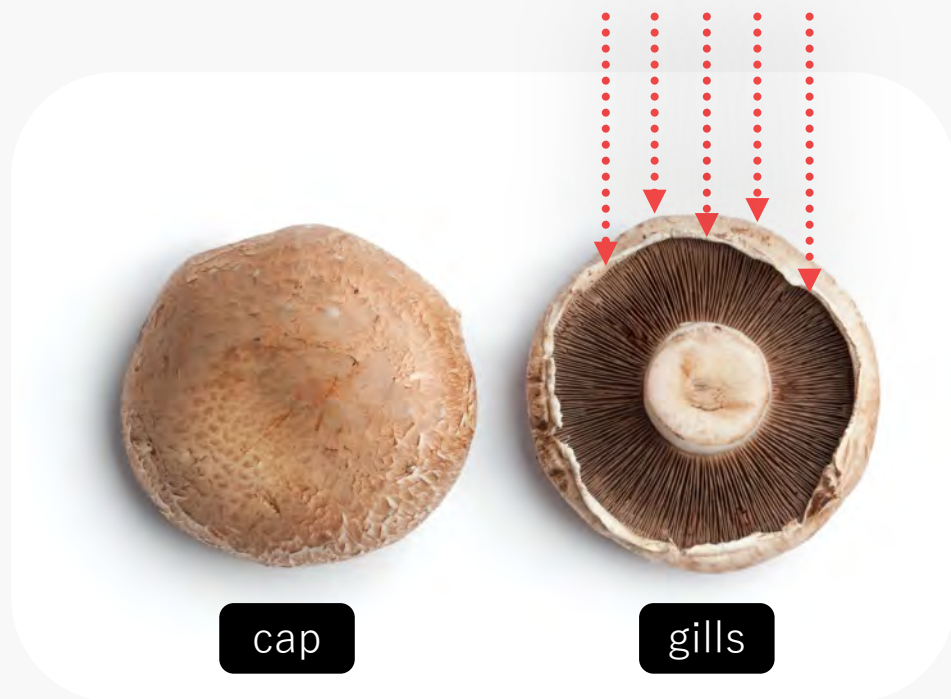
24  $\mu\text{g}$



# COMPARISON OF FOOD SOURCES OF VITAMIN D per serve

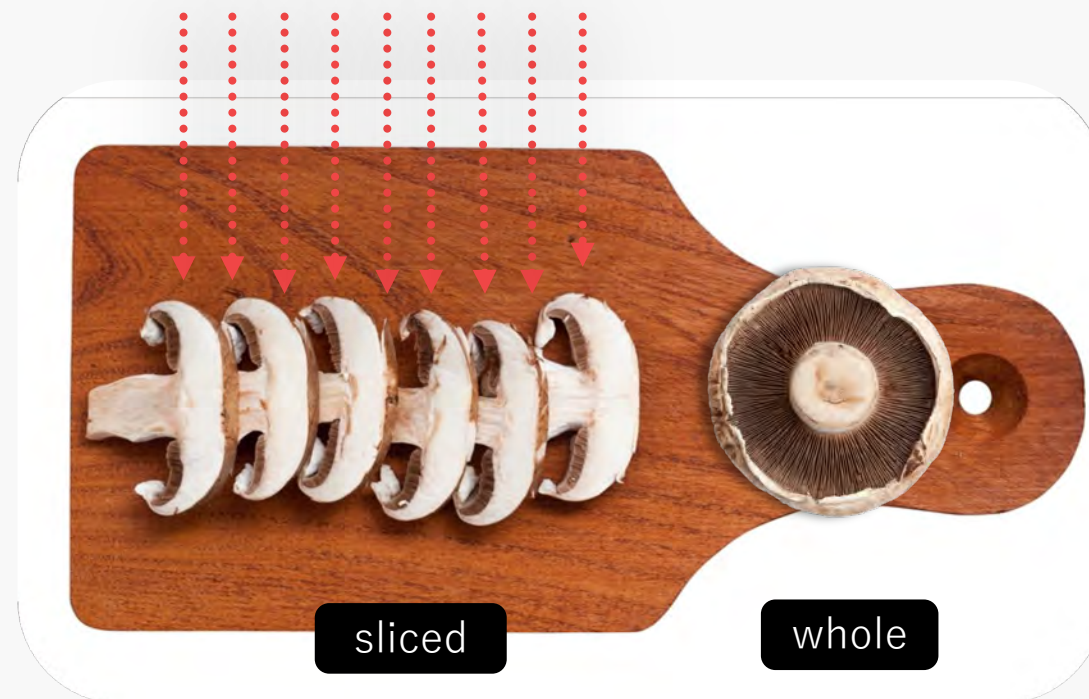


# MAXIMISING YOUR MUSHROOM'S TAN



↑ 30%

Jasinghe, Food Chem. 2005;92(3)



↑ 60%

Ko, J Agri Food Chem. 2008;56(10)



# THE EFFECT OF STORAGE, PROCESSING AND COOKING



## REFRIGERATION

up to 8 days

Slawinska, Int J Med Mushrooms.  
2017;19(3)



## DRYING

50% retention at 18  
months

Slawinska, Food Chem.  
2016;199



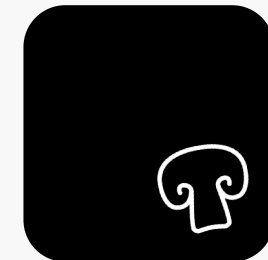
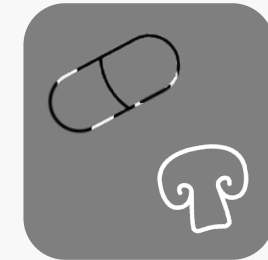
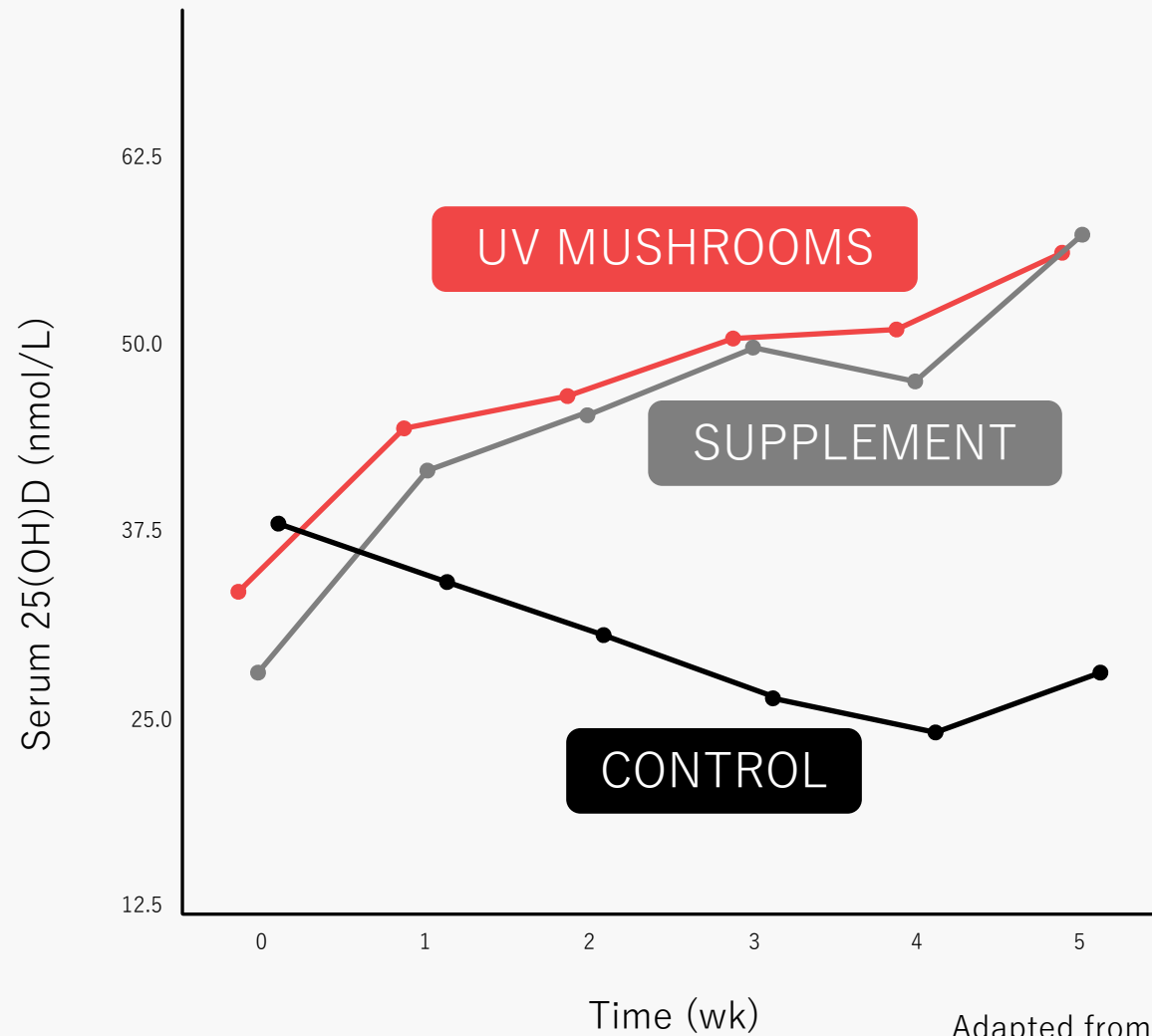
## COOKING

Lemon juice increases  
retention

Loznjak, Food Chem.  
2018;254



# EQUIVALENT TO A SUPPLEMENT



# SAME SAME BUT DIFFERENT

**1000 IU of vitamin D**



**1 UV exposed  
portobello mushroom**





**1 vitamin D pill**



# WHY IS THIS RELEVANT NOW?

Review

## Could Ergothioneine Aid in the Treatment of Coronavirus Patients?

Irwin K. Cheah <sup>1,2</sup>  and Barry Halliwell <sup>1,2,\*</sup> 

<sup>1</sup> Department of Biochemistry, Yong Loo Lin School of Medicine, National University of Singapore, Singapore 117596, Singapore; bchickm@nus.edu.sg

<sup>2</sup> Life Science Institute, Neurobiology Programme, Centre for Life Sciences, National University of Singapore, Singapore 117456, Singapore

\* Correspondence: bchbh@nus.edu.sg; Tel.: +65-6516-6663

Received: 4 June 2020; Accepted: 2 July 2020; Published: 7 July 2020



**Abstract:** Infection with SARS-CoV-2 causes the coronavirus infectious disease 2019 (COVID-19), a pandemic that has, at present, infected more than 11 million people globally. Some COVID-19 patients develop a severe and critical illness, spurred on by excessive inflammation that can lead to respiratory or multiorgan failure. Numerous studies have established the unique array of cytoprotective properties of the dietary amino acid ergothioneine. Based on studies in a range of in vitro and in vivo models, ergothioneine has exhibited the ability to modulate inflammation, scavenge free radicals, protect against acute respiratory distress syndrome, prevent endothelial dysfunction, protect against ischemia and reperfusion injury, protect against neuronal damage, counteract iron dysregulation, hinder lung and liver fibrosis, and mitigate damage to the lungs,

SU  
IM



HOME  
ut mushrooms in  
ome to cook them







# PRACTICAL MUSHROOM TIPS

# UNIQUE UMAMI TASTE



**REDUCE SALT**



**FLAVOUR ENHANCER**



**MEAT REPLACER**



# MAKING “D” MOST OF YOUR MUSHROOMS

## PLANNING



Tan to boost vitamin D  
& store in fridge

## PREPARATION



CAP : : STEM

Choose 3 &  
use it all



## COOKING



Cook on low &  
add lemon juice, extra virgin olive oil



# WHAT'S NEXT FOR MUSHROOMS?

# PLANT OR ANIMAL?



**NOT A VEGETABLE**

But contains:  
resistant starch  
phytonutrients  
potassium



**NOT AN ANIMAL**

But contains:  
vitamin B12  
vitamin D



**NOT A WHOLE GRAIN**

But contains:  
beta-glucans  
prebiotics  
riboflavin



**NOT A NUT**

But contains:  
copper  
selenium

# WHERE DO MUSHROOMS FIT?



CAROTENOIDS  
VITAMIN C  
FIBRE  
FOLATE



VITAMIN C  
FIBRE



CARBOHYDRATE  
PROTEIN  
IRON, FIBRE  
THIAMIN, IODINE  
FOLATE



PROTEIN  
IRON  
ZINC  
VITAMIN B<sub>12</sub>  
OMEGA-3



CALCIUM  
PROTEIN  
RIBOFLAVIN  
VITAMIN B<sub>12</sub>



FOLATE

ERGOSTEROL

VITAMIN D

ERGOTHIONEINE

SELENIUM

CHITIN

BIOTIN

GLUCANS

NIACIN

COPPER

PHOSPHORUS



# MEMORABLE MUSHROOM MESSAGES

## NUTRITIONAL ALL ROUNDER



Mushrooms provide nutrients found not only in vegetables, but in meat and whole grains too.

## UNPARALLELED PREBIOTIC



Mushrooms contain chitin, a unique prebiotic fibre that's not found in fruits, vegetables or grains.

## FIRST FOR ERGOTHIONEINE



Mushrooms contain more ergothioneine (a unique antioxidant) than any other food.

## BETA-FUL ON THE INSIDE



The cell wall of mushrooms consists of the soluble fibre beta-glucan.

## NATURE'S SUPPLEMENT



UV-exposed mushrooms can be as effective as a vitamin D supplement.

## TAN YOUR MUSHROOMS



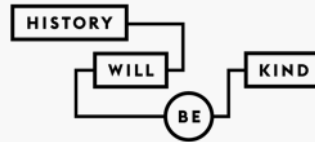
Putting 1 cup in the sun for 15 mins can provide you with your daily vitamin D needs.







# ACKNOWLEDGEMENTS



This project has been funded by Hort Innovation, using the Mushroom Fund research and development levy and contributions from the Australian Government. Hort Innovation is the grower-owned, not-for-profit research and development corporation for Australian horticulture.



# Thank you



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nr\_au



nutrition-research-australia



info@nraus.com



www.nraus.com

[www.nraus.com/mushroomhub](http://www.nraus.com/mushroomhub)



**APPENDIX 23: MS116 GP TARGETED WEBINAR PRESENTATION**

# When it comes to vitamin D, two sources are best:

A new way to address vitamin D deficiency

October 29, 2019



**Dr JILL GAMBERG**

BSc Bio, BSc ExSci/AT, MBBS (Hons), FRACGP

**What is the role of lifestyle medicine in addressing vitamin D deficiency?**



**Dr FLAVIA FAYET-MOORE**

PhD, MNutrDiet, RNutr, APD, FASLM

**A whole food approach to meeting vitamin D intakes**



**Hort  
Innovation**  
Strategic levy investment

**MUSHROOM  
FUND**

This project has been funded by Hort Innovation, using the Mushroom Fund research and development levy and contributions from the Australian Government. Hort Innovation is the grower- owned, not-for-profit research and development corporation for Australian horticulture.

What is the role  
of lifestyle medicine  
in addressing  
vitamin D deficiency?

**Dr Jill Gamberg**

BSc Bio, BSc ExSci/AT, MBBS (Hons), FRACGP

## Why lifestyle medicine?

Lifestyle (nutrition, smoking  
cessation, exercise) can  
prevent up to 80% of  
chronic disease.

Egger, *Lifestyle Medicine*, Academic Press (2017)



# WHAT IS LIFESTYLE MEDICINE?

Physical  
activity

Nutrition

Coaching / Behaviour change

Sleep Health

## Lifestyle Medicine

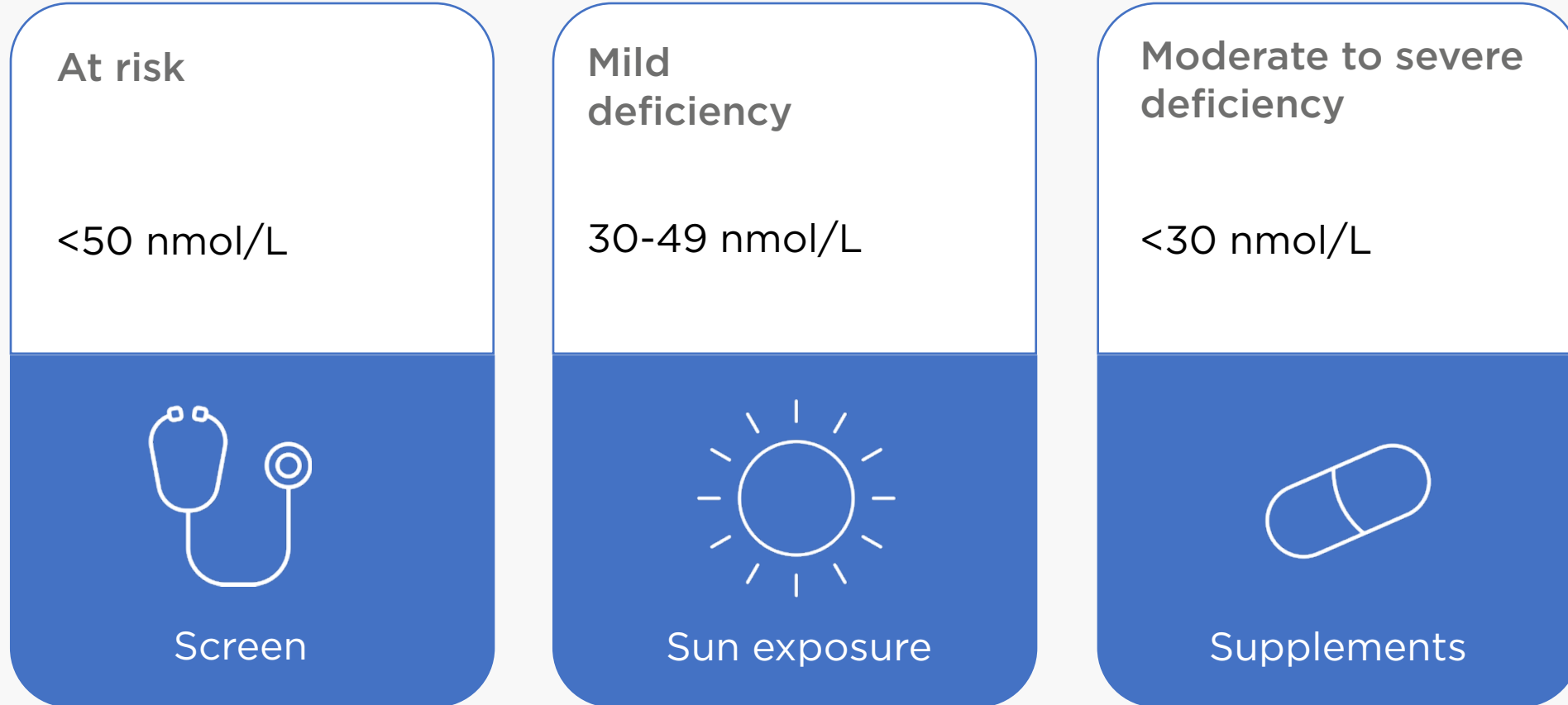
Tobacco and alcohol  
cessation

Emotional wellness /  
Stress management





# RACGP GUIDELINES RECOMMEND ONE SOURCE



# HEALTH EFFECTS OF VITAMIN D DEFICIENCY

## Established guidelines

### Musculoskeletal health

Winzenberg, Aus Fam Phys. 2012;41(3)

## Recent evidence

**Autoimmune disease** Dankers, Front Immunol. 2017;7

**Cancer** Young, Trends in Cancer Res. 2018;13

**Cardiovascular disease** Kheiri, Clin Hypertens. 2018;24

**Cognition** Anastasiou, J Alzheimers Dis. 2014;42(Suppl3)

**Fertility** Pilz, Int J Environ Res Public Health. 2018;15(10)

**Gastrointestinal health** Tabatabaeizadeh, J Res Med Sci. 2018;23

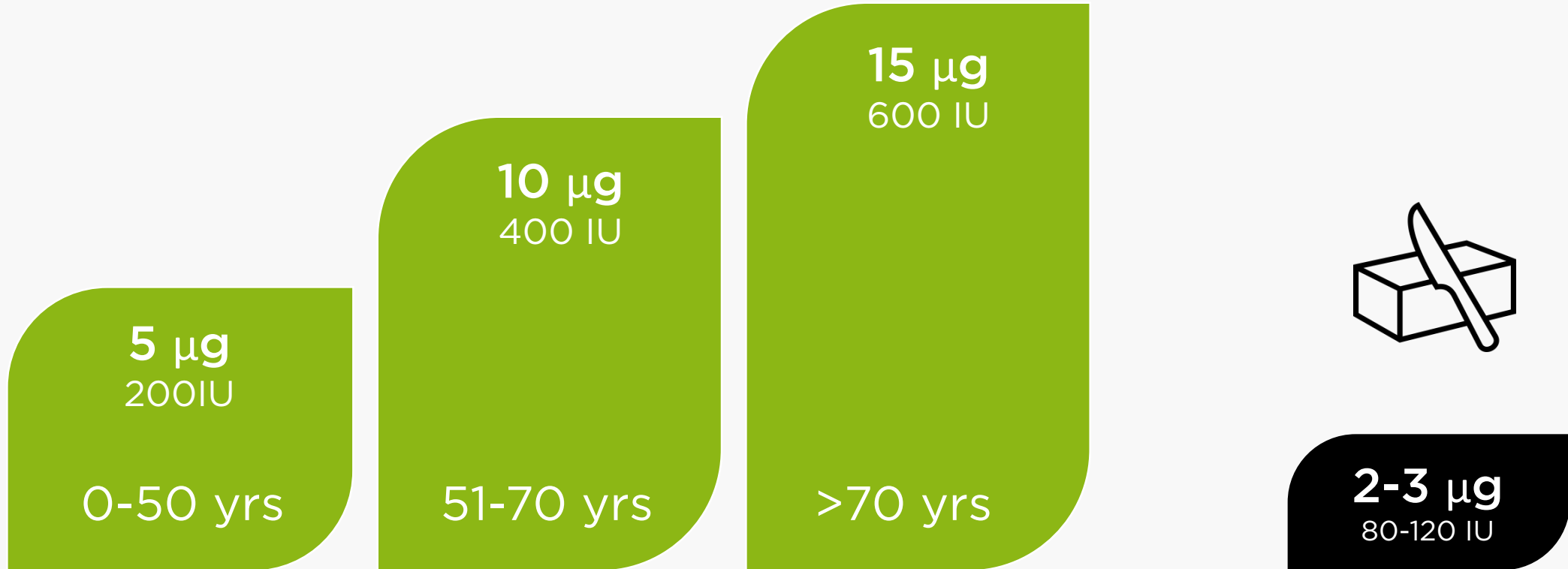
**Immune Function** Hewison, Proc Nutr Soc. 2012;71(1)

**Mental health** Lerner, Clin Nutr ESPEN. 2018;23

**Metabolic health** Palaniswamy, Nutr Metab Insights. 2016;8(Suppl1)

**Muscle strength** Gunton, Bone Rep. 2018;8

# DIETARY INTAKES ARE BELOW TARGETS



Adequate intake

Nutrient Reference Values, National Health and Medical Research Council, 2006

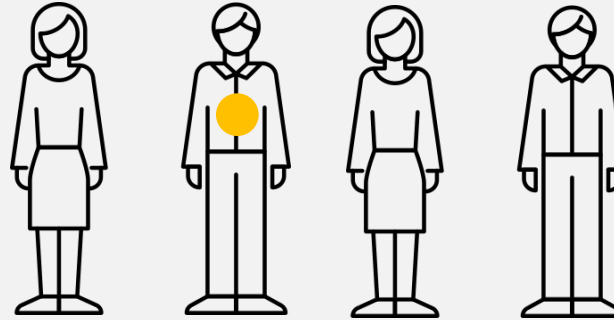
Average intake

Nowson, Med J Aus. 2012;197(10)

# VITAMIN D DEFICIENCY IN AUSTRALIA

Almost 1 in 4 (23%)

2011/12  
Australian Health Survey



Higher in

2011/12  
Australian Health Survey

Malacova, Br J Nutr 2019;121(8)



Winter



Lower latitude

18-34

Younger age



Sedentary



Smoking

29-42%

Office workers

Fayet-Moore, J Steroid  
Biochem Mol Biol. 2019;189

36%

African immigrants

Horton-French, Int J Environ  
Res Public Health. 2019;16(16)

51%

Chemotherapy patients

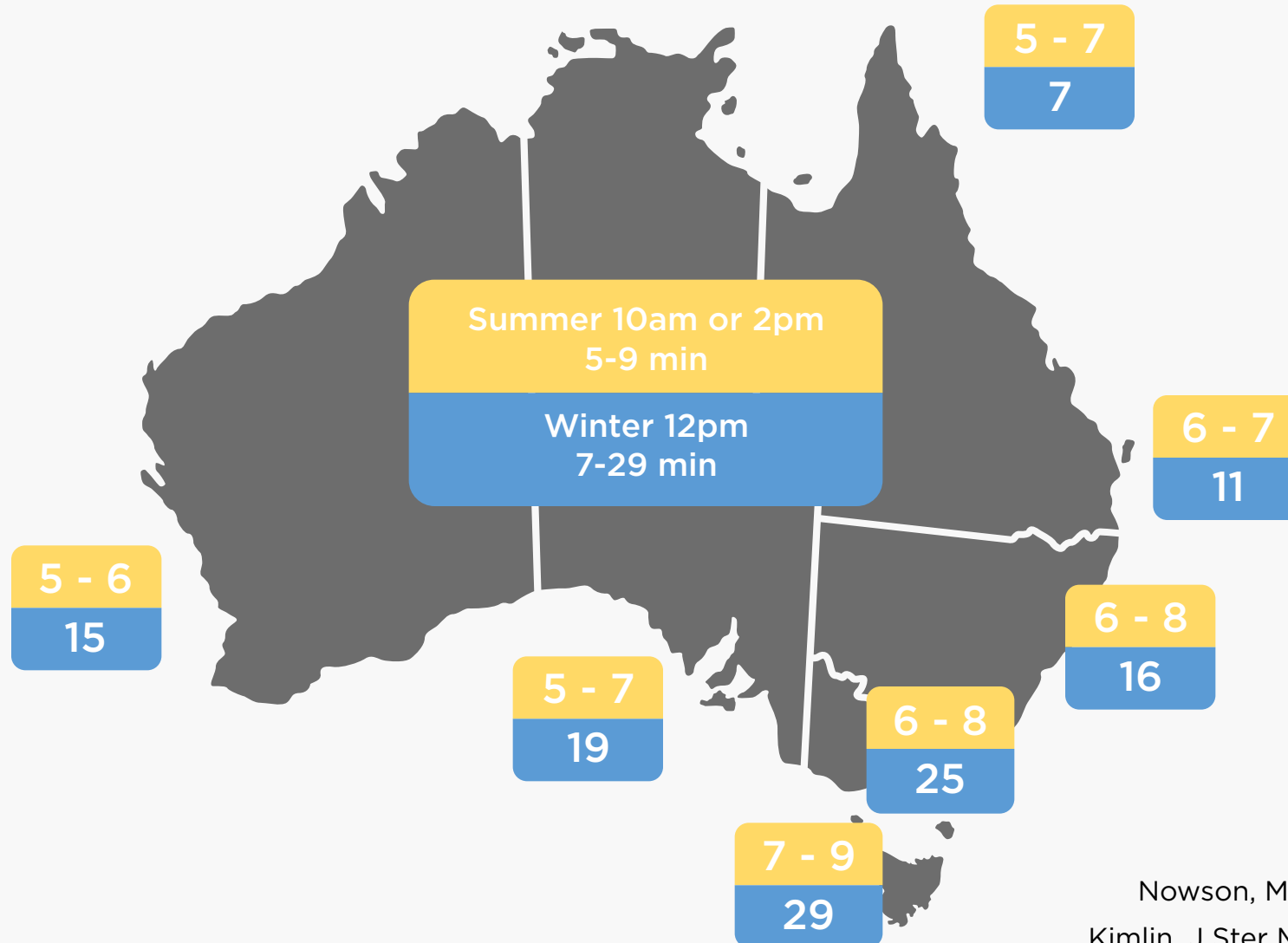
Isenring, Asia Pac J Clin  
Nutr. 2018;27(5)

Recent evidence

# SUN EXPOSURE: BALANCE IS KEY



Minutes to reach  
1000 IU (25 µg)



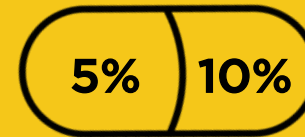
Nowson, Med J Aus. 2012;197(10)  
Kimlin, J Ster Mol Bio. 2016;155(264)

# SOME INDIVIDUALS MAY BE TAKING SUPPLEMENTS UNNECESSARILY



**3-fold rise**

Bilinski, J Nutr Metab. 2014



**Double the rate**  
in those with serum  
25(OH)D >100 nmol/L

2011/12 Australian Health Survey

# DIET: FEW ARE GOOD SOURCES

## Pros

- Whole food approach
- More than just vitamin D
- Lower risk of toxicity
- Compliance



## Cons

- Few good sources
- Effects of cooking and storage
- Access
- Food preferences
- Cooking skills
- Compliance

# TAKE HOME MESSAGES



Vitamin D deficiency is an issue in sunny Australia



Need to consider lifestyle



Only sun exposure and supplements are recommended to address it



Diet is non-existent in current guidelines

Add citation



# A whole food approach to meeting vitamin D intakes

Flavia Fayet-Moore

PhD, MNutrDiet, RNutr, APD, FASLM



# DETERMINANTS OF VITAMIN D STATUS

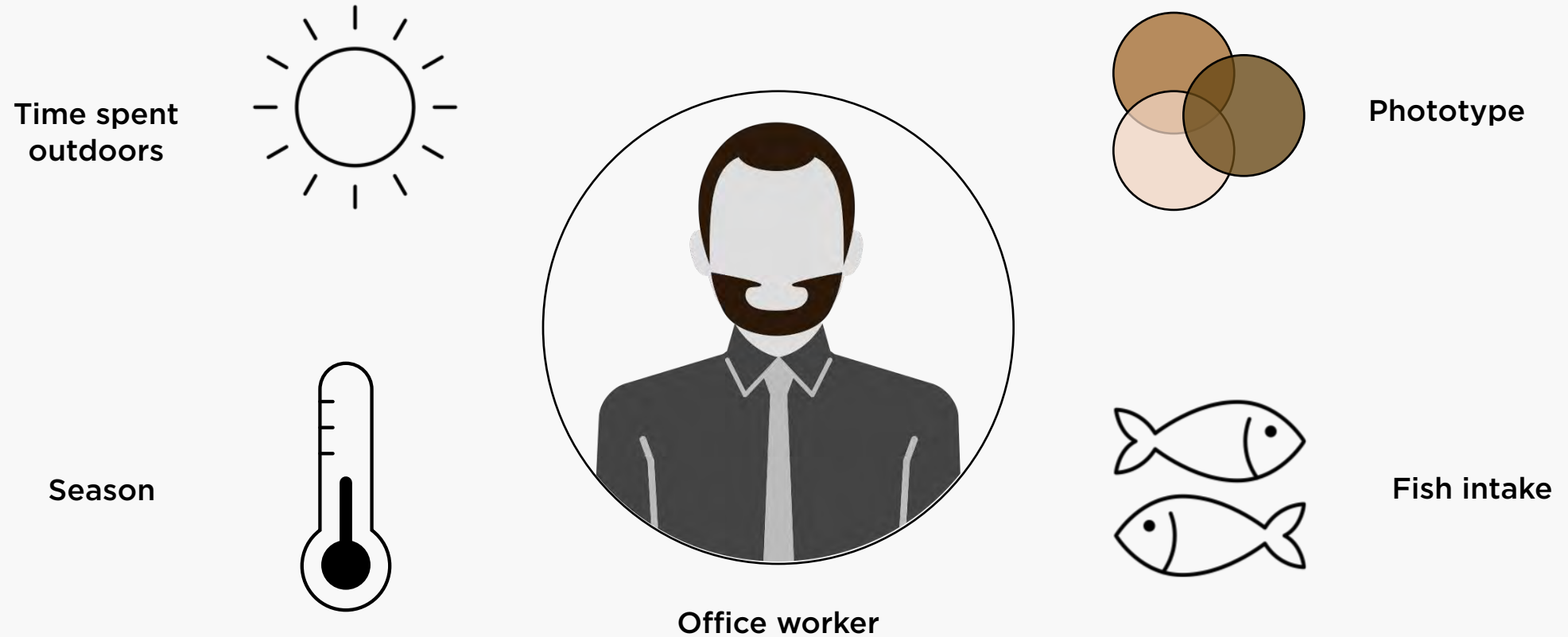


Determinants of vitamin D status of healthy office workers in Sydney, Australia

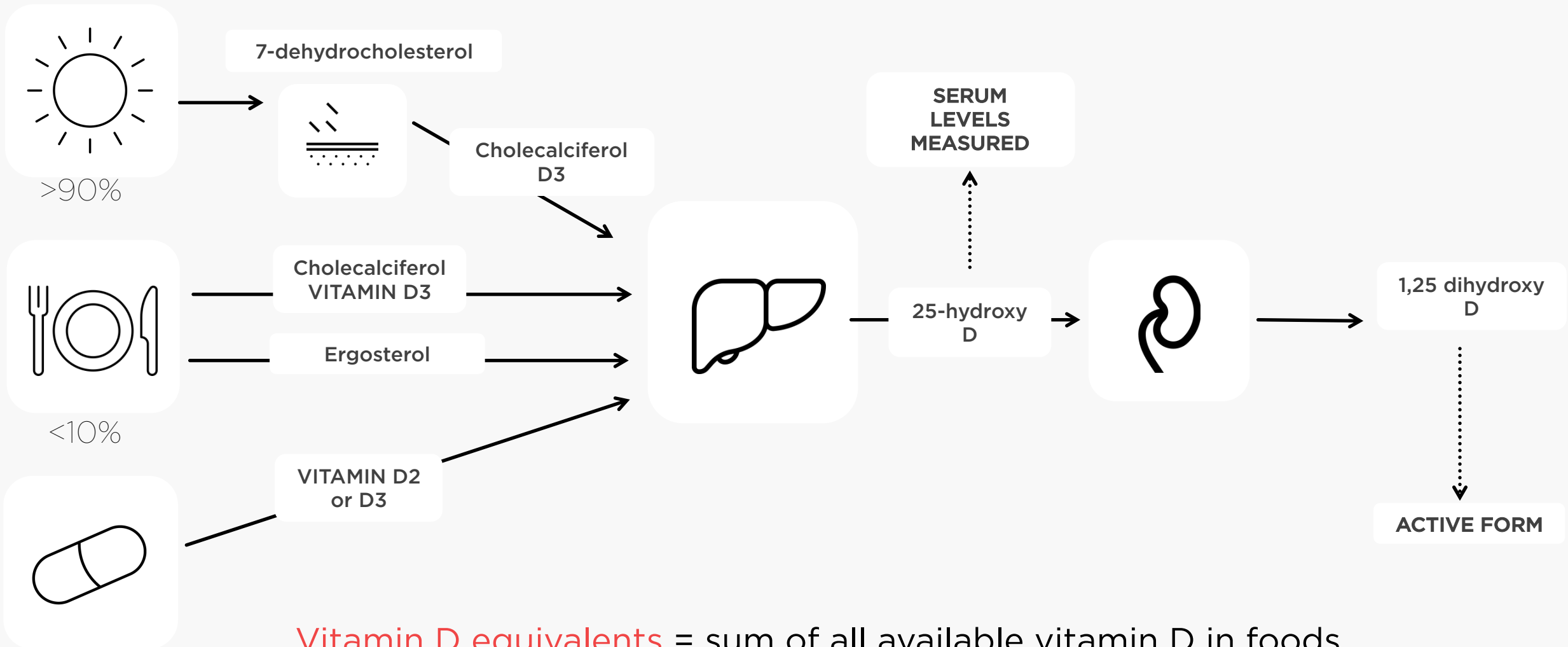
**Volume 189, May 2019, Pages 127-134**

Fayet-Moore F, Brock K, Wright J, Ridges L, Small P, Seibel MJ, Conigrave AD, Mason RS

# FOUR FACTORS INFLUENCED VITAMIN D STATUS IN OFFICE WORKERS



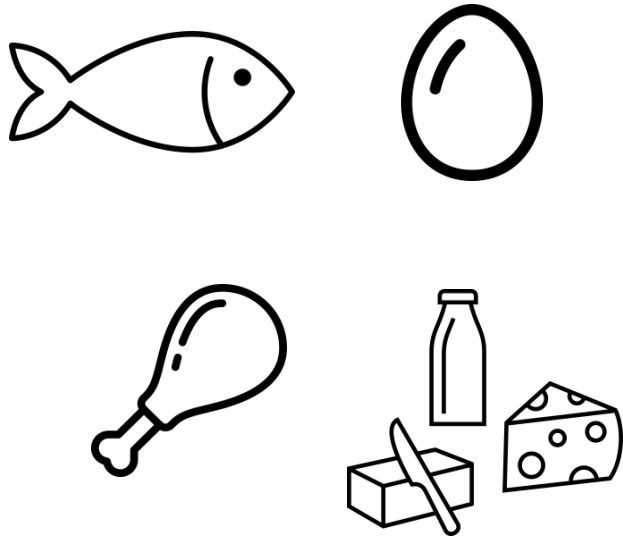
# A SNAPSHOT OF VITAMIN D METABOLISM



# THERE ARE FEW GOOD DIETARY SOURCES OF VITAMIN D

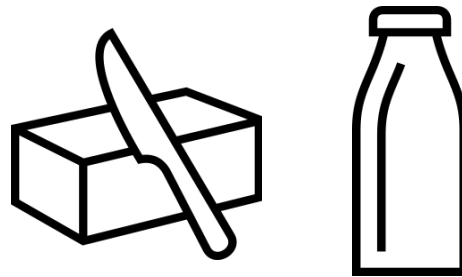
## ANIMAL

D3



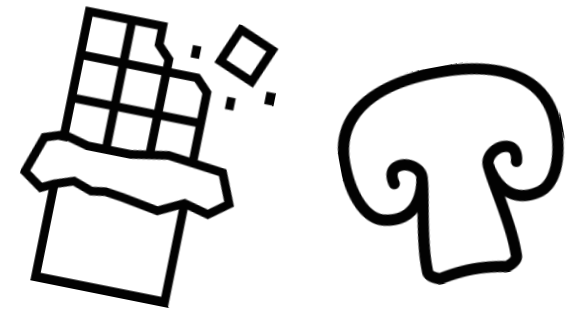
## ENRICHED

D2/D3



## FUNGHI

D2



1  $\mu$ g = 40 IU



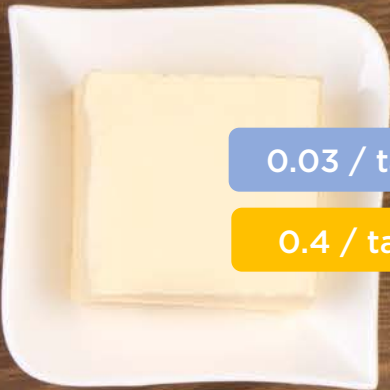
**Vitamin D  
equivalents\*  
( $\mu\text{g}/\text{serve}$ )  
25  $\mu\text{g}$  = 1000 IU**



0.04 / 42g

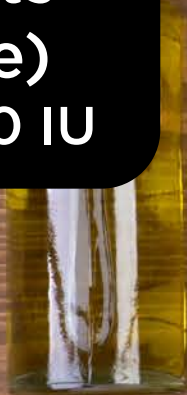


3.4 / 100g



0.03 / tablespoon

0.4 / tablespoon



1.6 / 40g



4.8 / 2 eggs



0.12 / 1 cup

1.25 / 1 cup

ANIMAL

ENRICHED

FUNGHI



5.4 / 100g



7.4 / chicken drumstick, skin on

Australian Food Composition Database, 2019

Kühn, Food Chem. 2018;269

\*Cooked

# What is the latest science on mushrooms and vitamin D?



# NOT AN ANIMAL, BUT ALSO NOT A PLANT (or a vegetable...)

White button



Flat



Portabella



**Agaricus  
*bisporus***

Cremini

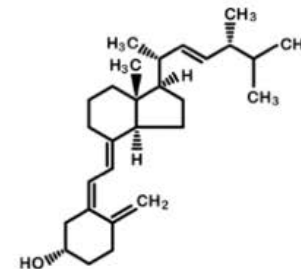
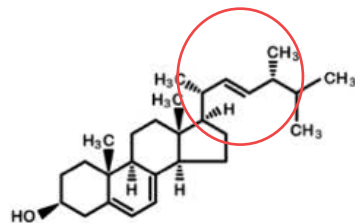
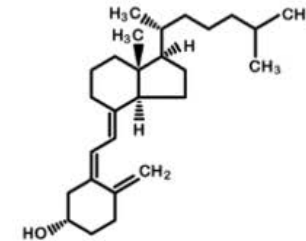
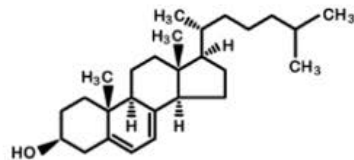


Swiss Brown

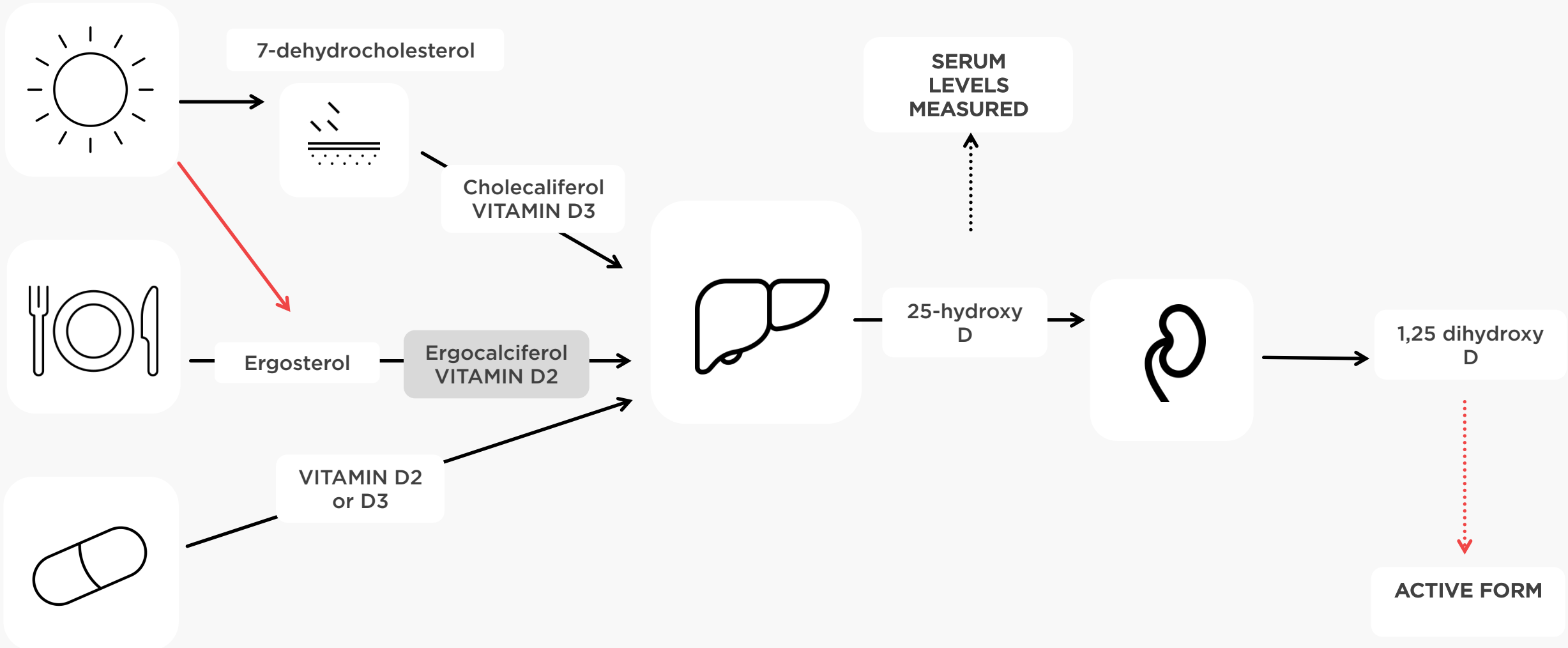




# A UNIQUE VITAMIN D FOOD



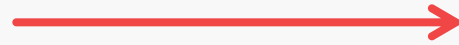
# RECAP OF VITAMIN D METABOLISM



# 100 grams of UV exposed mushrooms provide almost 1000 IU



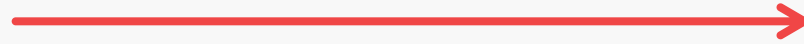
2-3  $\mu\text{g}$



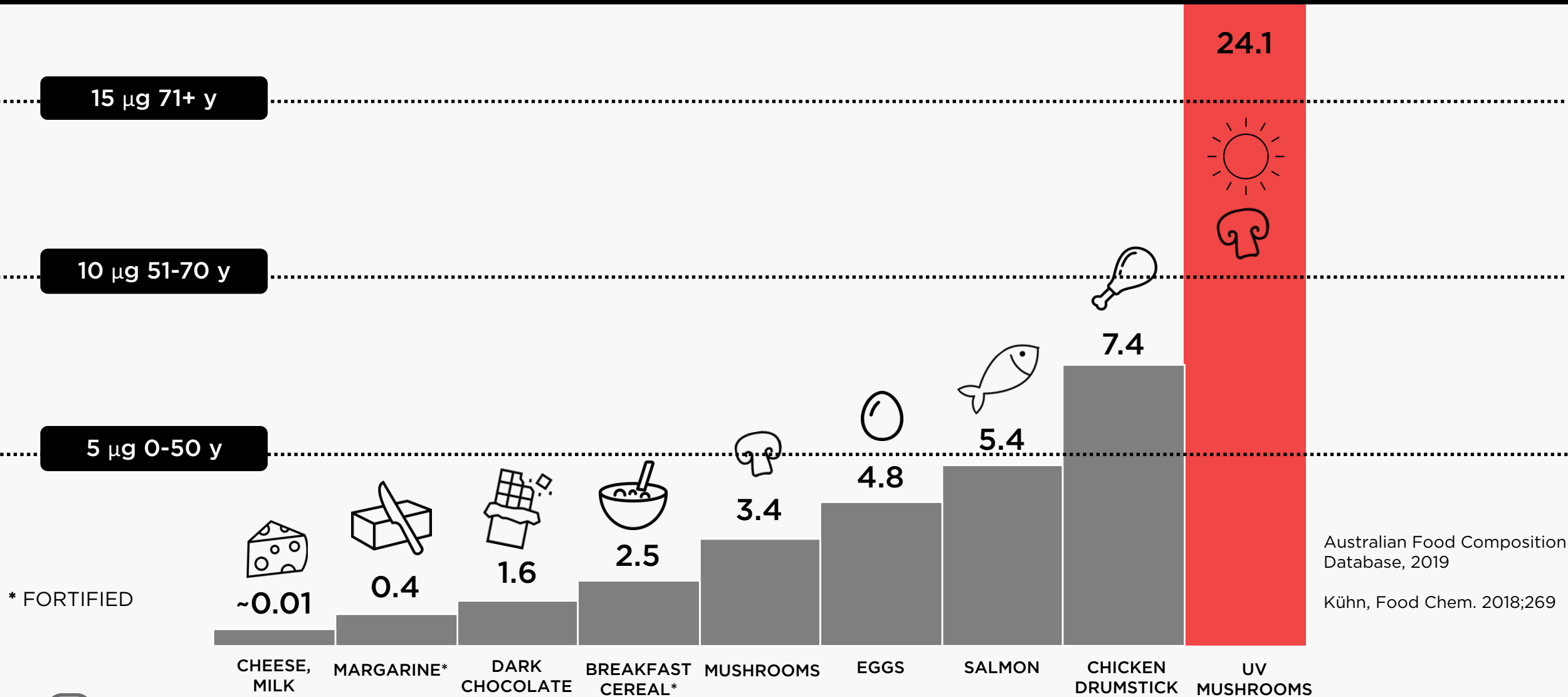
UV



24  $\mu\text{g}$



# COMPARISON OF FOOD SOURCES OF VITAMIN D per serve



# WHAT IS 100 GRAMS OF MUSHROOMS?

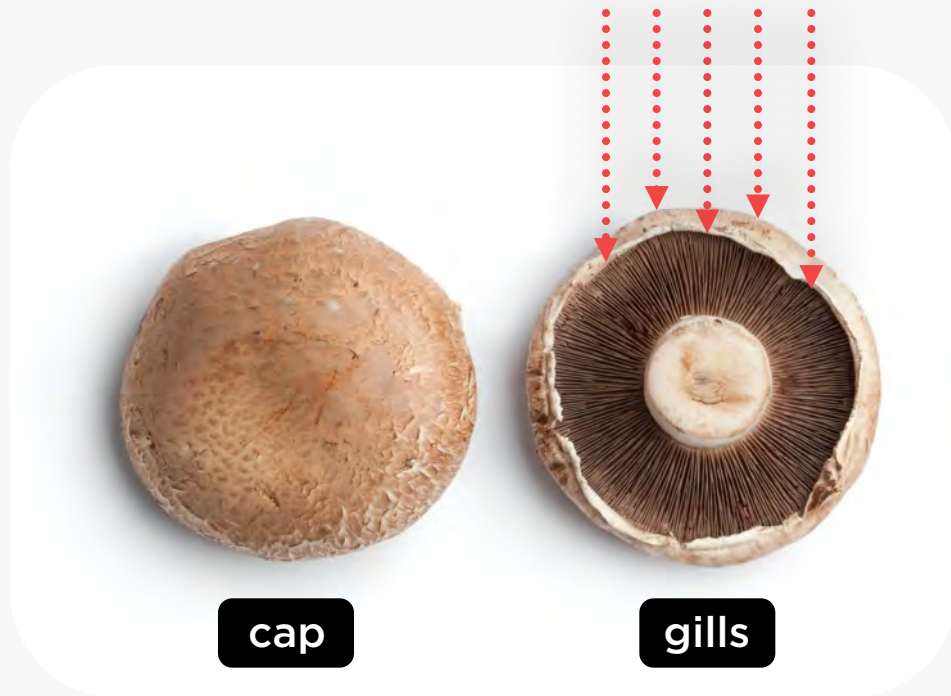
RAW



COOKED

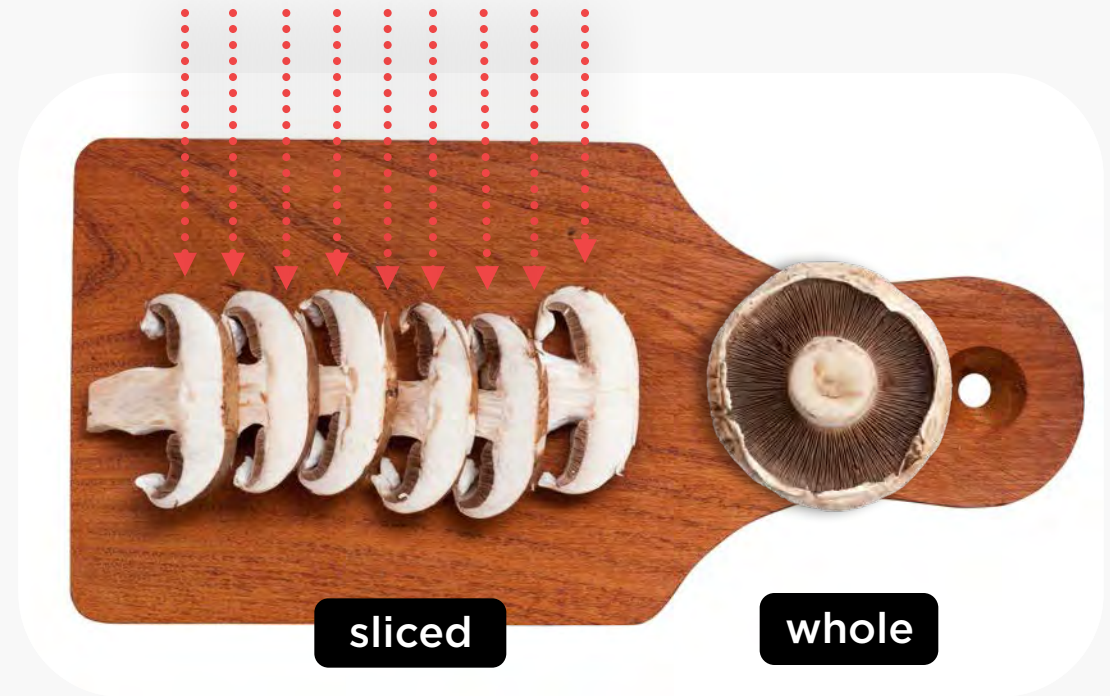


# MAXIMISING YOUR MUSHROOM'S TAN



↑ 28%-69%

Jasinghe, Food Chem. 2005;92(3)



↑ 25%

Ko, J Agri Food Chem. 2008;56(10)



# FACTORS THAT INFLUENCE VITAMIN D CONTENT



## TIME

dose-response  
up to 60 mins



## TEMPERATURE

optimal is 20-30 degrees



## LATITUDE

more UV closer  
to equator

15 mins @ 10am → 18°C → Germany → 18 µg = > 100% AI

100g of sliced mushrooms



# THE EFFECT OF STORAGE, PROCESSING AND COOKING



## REFRIGERATION

up to 8 days

Slawinska, Int J Med Mushrooms.  
2017;19(3)



## DRYING

50% retention at 18  
months

Slawinska, Food Chem.  
2016;199



## COOKING

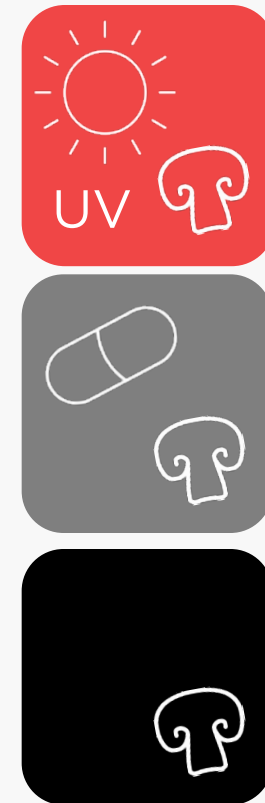
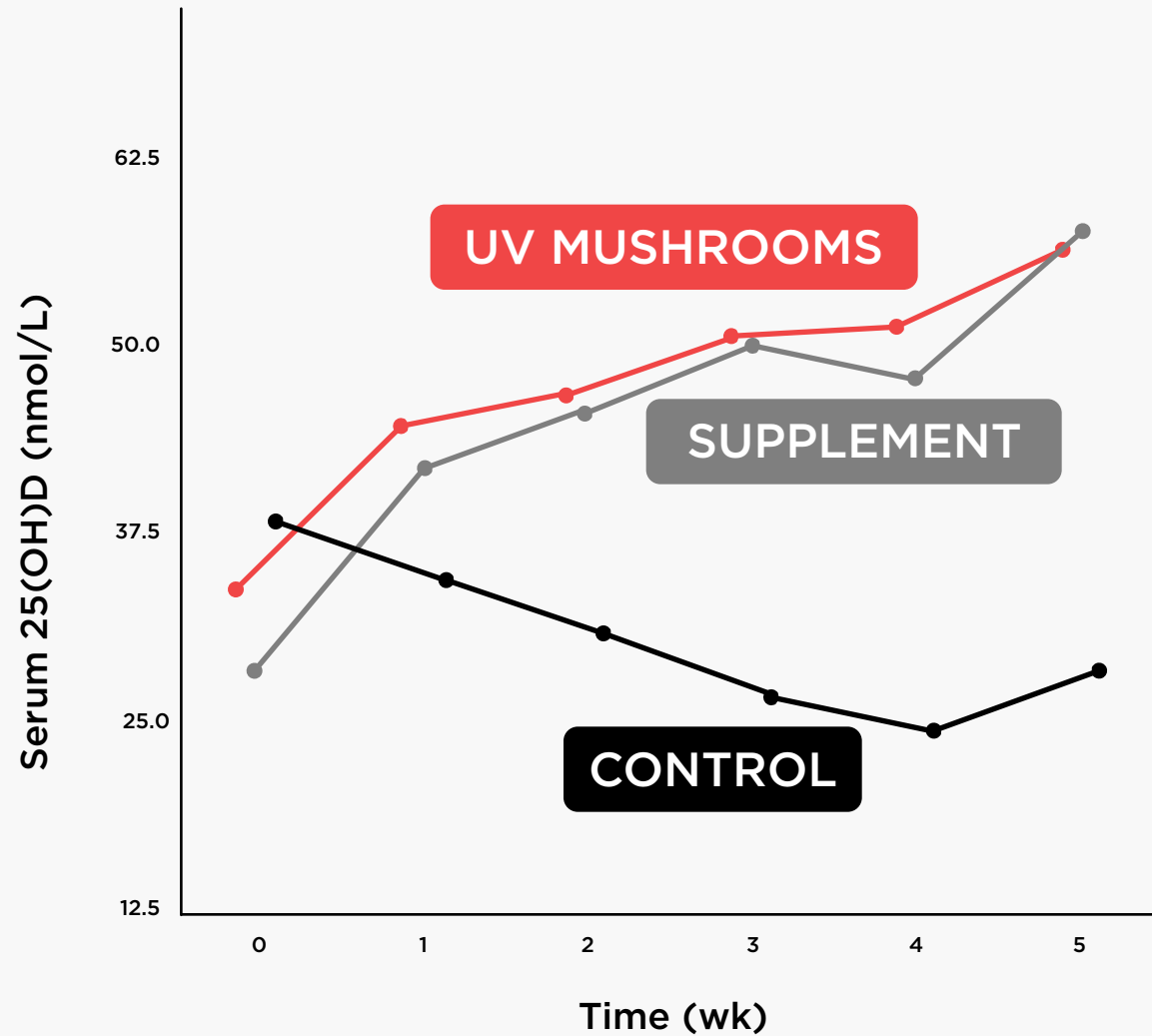
Lemon juice increases  
retention

Loznjak, Food Chem.  
2018;254





# BIOAVAILABILITY IS EQUIVALENT TO SUPPLEMENTATION



## More than just vitamin D



**Alpha and  
beta glucans**



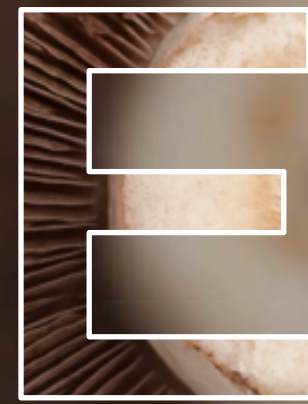
**Bioactive  
phytonutrients**



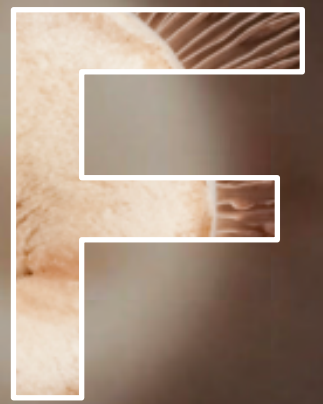
**Carbohydrate  
profile (fibrous)**



**Vitamin D**



**Ergothioneine**



**Flavonoids**

# THE EMERGING EVIDENCE FOR *A. BISPORUS*



17 human studies including 12 RCTS

Type 2 Diabetes

Weight management

Cancer

Satiety

Inflammation

Gut Health

Immunity

Cholesterol

# CONSIDERATIONS WHEN RECOMMENDING DIETARY APPROACHES



- Individual & family preferences
- Cooking skills
- Availability & access
- Adherence to recommendations

# LIFESTYLE AX FOR VITAMIN D DEFICIENCY


	DECREASED RISK	INCREASED RISK
Non-Modifiable		
Season	<input checked="" type="checkbox"/> Spring/Summer	<input type="checkbox"/> Autumn/Winter
Phototype	<input checked="" type="checkbox"/> Olive (III IV)	<input type="checkbox"/> Dark or pale (I, II, V, VI)
Office worker	<input type="checkbox"/> No	<input checked="" type="checkbox"/> Yes
Modifiable		
Smoking	<input checked="" type="checkbox"/> No	<input type="checkbox"/> Yes
Supplement	<input type="checkbox"/> Yes	<input checked="" type="checkbox"/> No
Sun exposure (time outdoors)	<input checked="" type="checkbox"/> Some	<input type="checkbox"/> None
Diet		
Fish	<input checked="" type="checkbox"/> Some	<input type="checkbox"/> None
Mushrooms	<input checked="" type="checkbox"/> Some	<input type="checkbox"/> None
Eggs	<input checked="" type="checkbox"/> Some	<input type="checkbox"/> None



# WHEN IT COMES TO VITAMIN D, TWO SOURCES ARE BEST

**At risk**


**≥ 50 nmol/L**



Screen for Vit D

**Mild deficiency**



**30 - 49 nmol/L**



Sun exposure    Diet

**Moderate to severe deficiency**

**< 30 nmol/L**



Supplements  
(6-12 weeks)    Diet



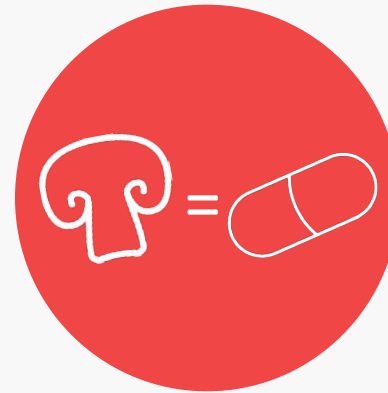
# TAKE HOME MESSAGES



Australians have one of the lowest dietary intakes of vitamin D



Few dietary sources of vitamin D can meet current guidelines & most are animal sources

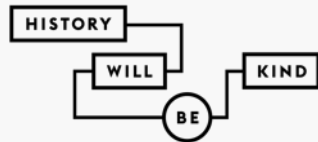


Sun-exposed mushrooms are the top source and are as effective as supplements



To get vitamin D, you can tan your mushrooms when you can't tan your skin

# ACKNOWLEDGEMENTS



**Hort  
Innovation**  
Strategic levy investment

**MUSHROOM  
FUND**

This project has been funded by Hort Innovation, using the Mushroom Fund research and development levy and contributions from the Australian Government. Hort Innovation is the grower- owned, not-for-profit research and development corporation for Australian horticulture.







**Dr JILL GAMBERG**

BSc Bio, BSc ExSci/AT, MBBS (Hons), FRACGP

# Q&A



**Dr FLAVIA FAYET-MOORE**

PhD, MNutrDiet, RNutr, APD, FASLM



**Hort  
Innovation**  
Strategic levy investment

**MUSHROOM  
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# Thank you



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-  www.nraus.com

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-  www.drjillgamberg.com

*Australian*  
**MUSHROOMS**

-  [australianmushrooms.com.au](http://australianmushrooms.com.au)

## **APPENDIX 24: MS114 GPCE PRESENTATION**

# VITAMIN D DECODED

**How can we best address vitamin D deficiency in Australia?**

Flavia Fayet-Moore

PhD, MNutrDiet, RNutr, APD, FASLM



@nutritionresearchaus



nr\_au



nutrition-research-australia



info@nraus.com

# Disclosure Statement

- Olive Wellness Institute Advisory Panel
- Consultant to Nutrigenomix Inc.
- Founding board member of the Australasian Society of Lifestyle Medicine
- Funding from Hort Innovation (Australian Mushrooms)

15 years ago...

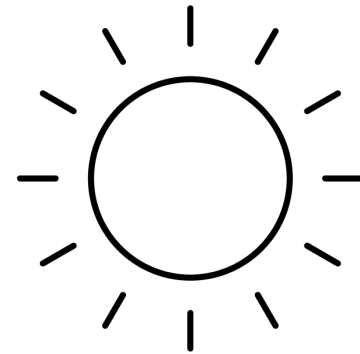


# Outline

1. Vitamin D: importance, deficiency and risk factors

2. Current guidelines and strategies

3. The role of lifestyle medicine



# Vitamin D importance, deficiency and risk factors

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# Importance of vitamin D



## THREE GIRLS WITH RICKETS

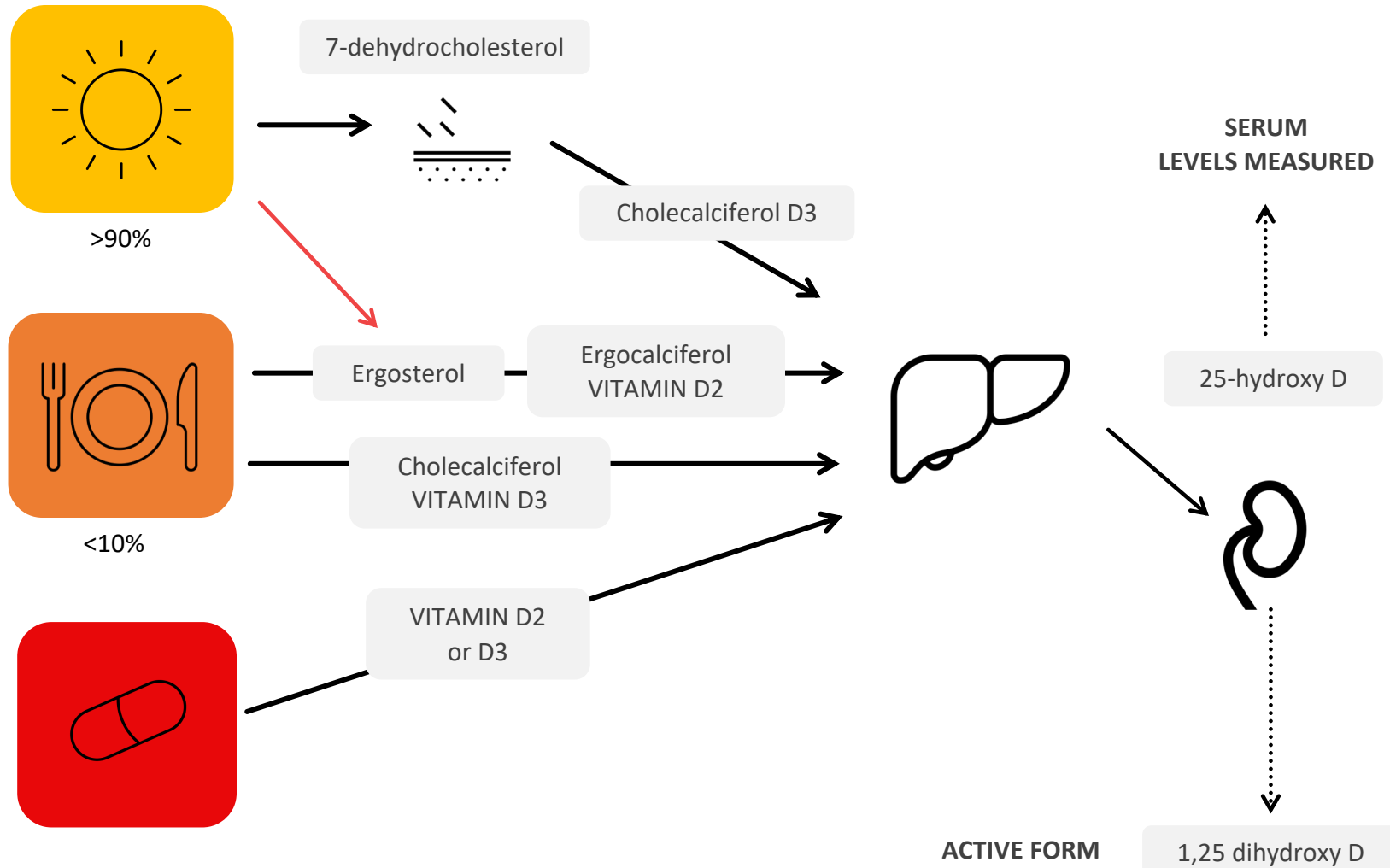
Foley J. Fossil Homids: the evidence for human evolution. Talk of Origins, 1996



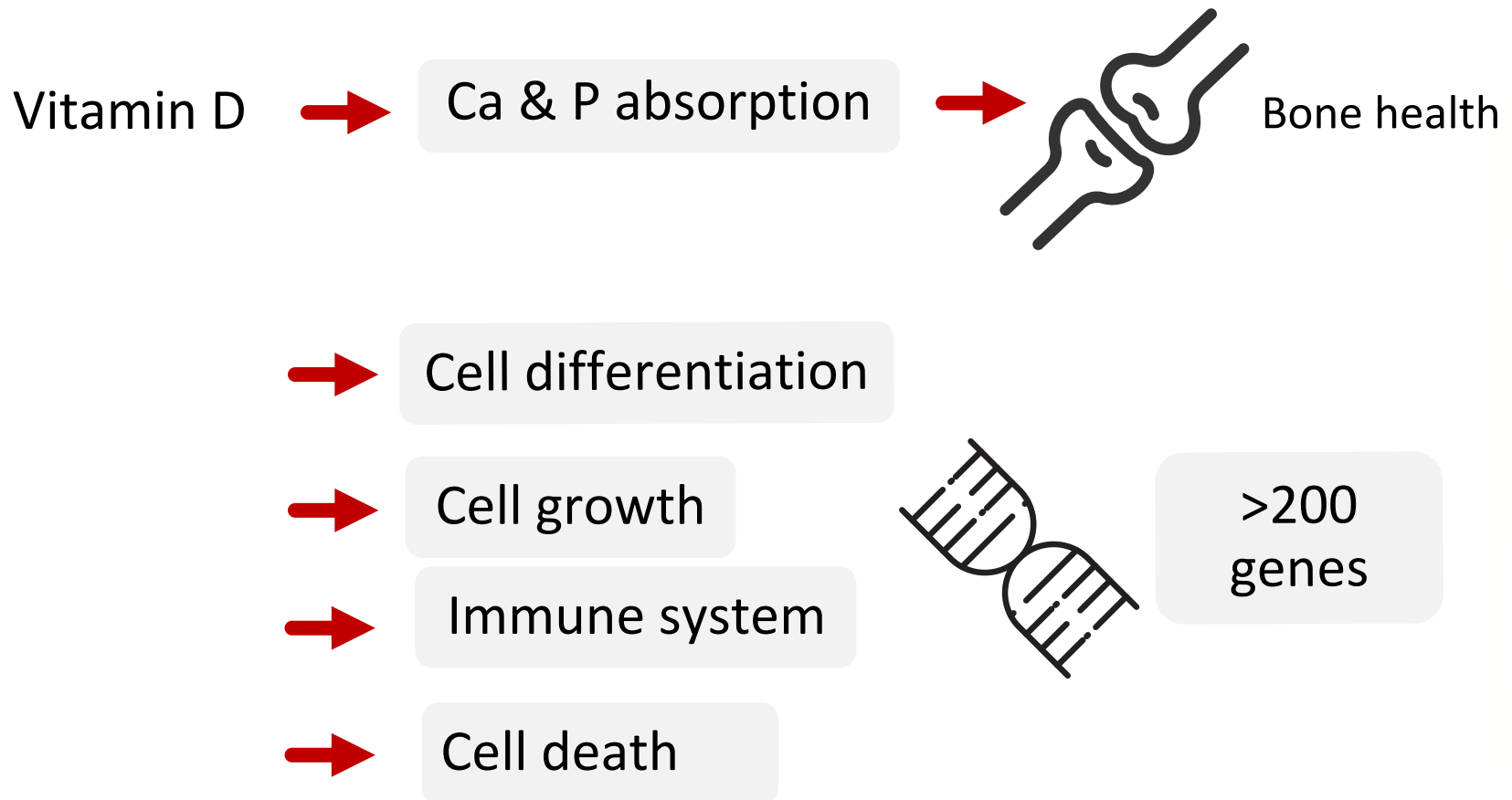
## DOG WITH RICKETS

Funk C. The Vitamines. Second ed. Baltimore: Williams & Wilkins Company; 1922

# Vitamin D metabolism



# Virtually every human cell has a vitamin D receptor



# Evidence for Vitamin D

## Established guidelines

### Musculoskeletal health

Winzenberg, Aus Fam Phys. 2012;41(3)

## Recent evidence

### Autoimmune disease

Dankers, Front Immunol. 2017;7

### Gastrointestinal health

Tabatabaeizadeh, J Res Med Sci. 2018;23

### Cancer

Young, Trends in Cancer Res. 2018;13

### Immune function

Hewison, Proc Nutr Soc. 2012;71(1)

### Cardiovascular disease

Kheiri, Clin Hypertens. 2018;24

### Mental health

Lerner, Clin Nutr ESPEN. 2018;23

### Cognition

Anastasiou, J Alzheimers Dis. 2014;42(Suppl3)

### Metabolic health

Palaniswamy, Nutr Metab Insights. 2016;8(Suppl1)

### Fertility

Pilz, Int J Environ Res Public Health. 2018;15(10)

### Muscle strength

Gunton, Bone Rep. 2018;8

# Dietary targets



## Adequate intake

1 µg cholecalciferol = 0.2 µg 25(OH)D

1 IU = 0.025 µg cholecalciferol or 0.005 µg 25(OH)D

# There are few good dietary sources of vitamin D

## ANIMAL

D3



## ENRICHED

D2/D3



## FUNGHI

D2



1  $\mu\text{g}$  = 40 IU



# How is deficiency defined?

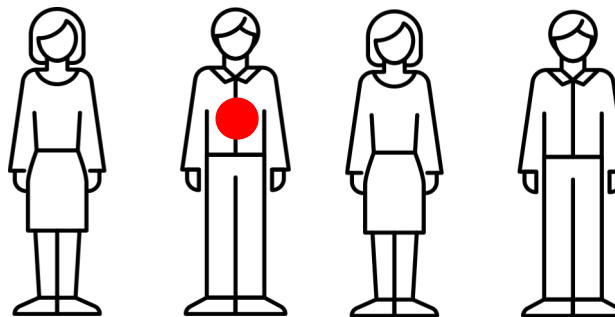
(nmol/L)	Serum 25(OH) D
≥ 50	Adequate
30 - 49	Mild deficiency
12.5 - 29	Moderate deficiency
< 12.5	Severe deficiency

**End of summer: + 10-20 nmol/L**

# Vitamin D deficiency in Australia

## 23%

2011-12  
Australian Health Survey



## 29-42%

### Office workers

Fayet-Moore, J Steroid  
Biochem Mol Biol. 2019;189

## 36%

### African immigrants

Horton-French, Int J Environ  
Res Public Health. 2019;16(16)

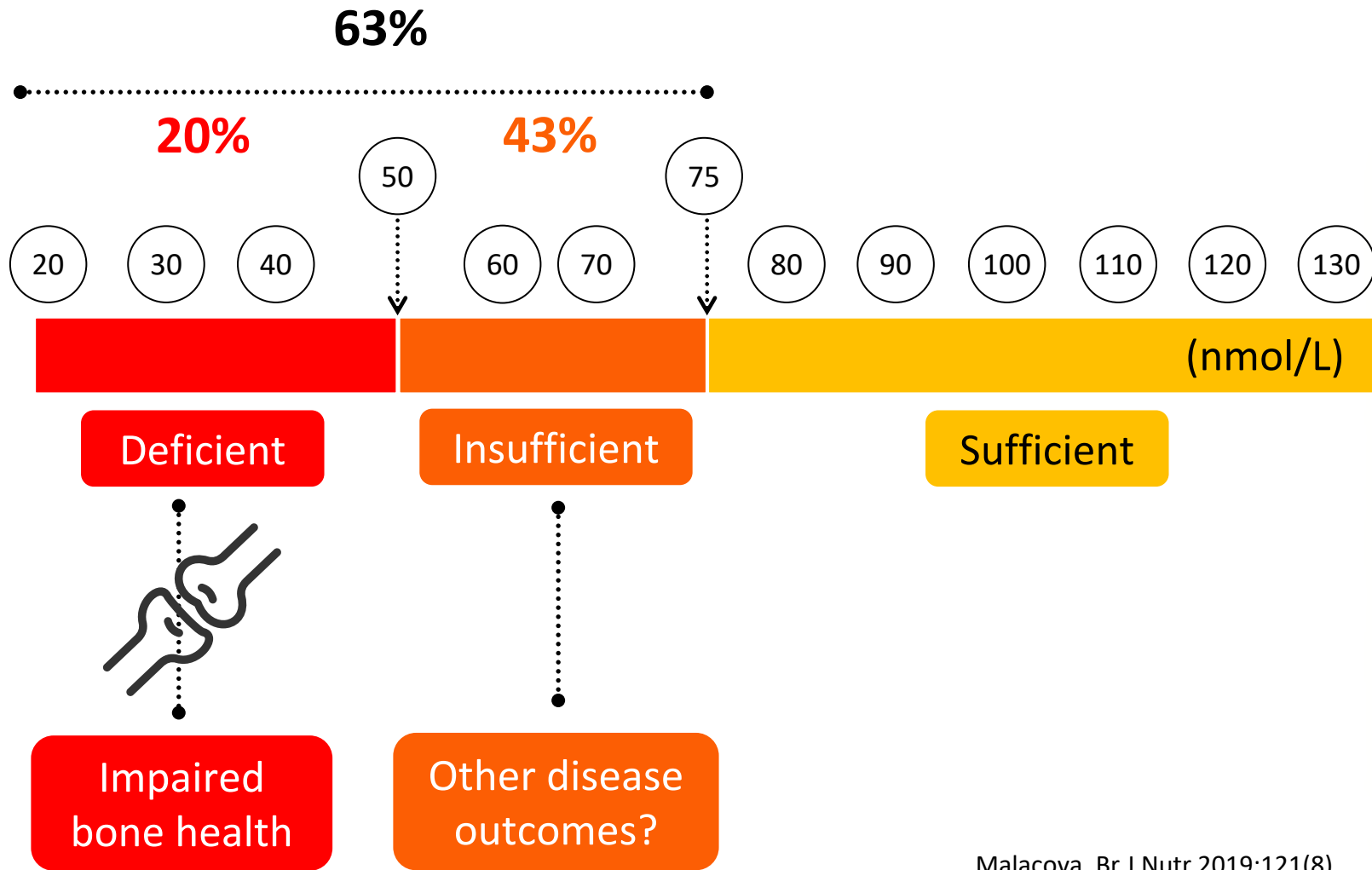
## 51%

### Chemotherapy patients

Isenring, Asia Pac J Clin Nutr.  
2018;27(5)



# Those without deficiency can still be at risk



Malacova, Br J Nutr 2019;121(8)  
Roth, Ann N Y Acad Sci, 2018;1430

# Determinants of vitamin D status in office workers

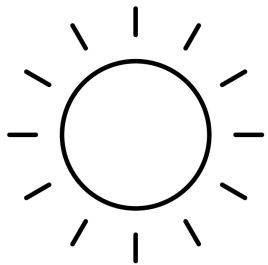


## Determinants of vitamin D status of healthy office workers in Sydney, Australia

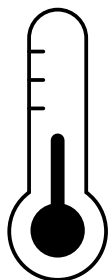
Volume 189, May 2019, Pages 127-134

Fayet-Moore F, Brock K, Wright J, Ridges L, Small P, Seibel MJ, Conigrave AD, Mason RS

# Four factors influenced vitamin D status



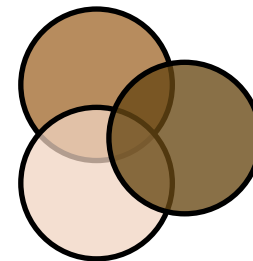
Time spent outdoors



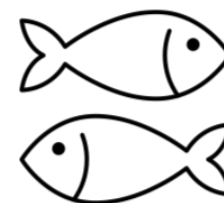
Season



**Office worker**



Skin phototype

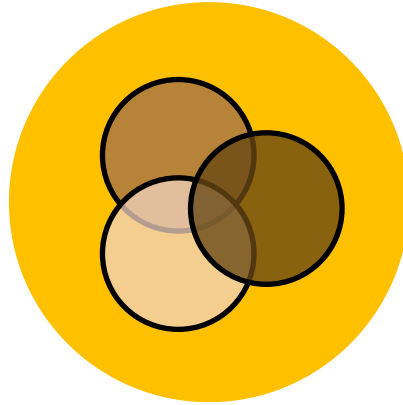


Fish intake

# Deficiency: non-modifiable factors



Season



Phototype



Born outside  
Australia



Latitude



Age

# Deficiency: modifiable factors



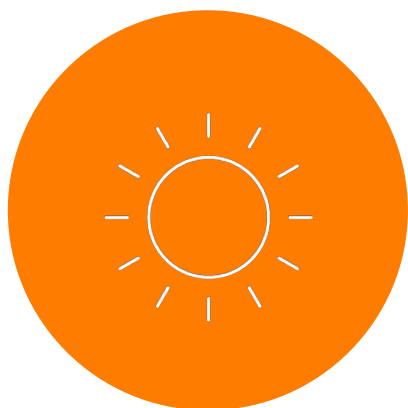
Smoking



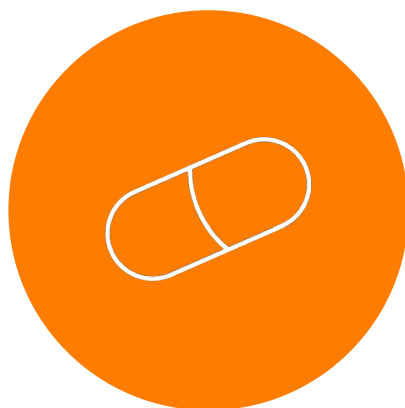
Sedentary



BMI >30 kg/m<sup>2</sup>



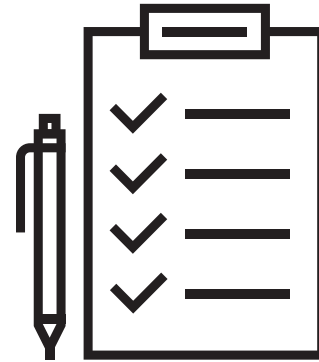
Sun exposure



Supplements



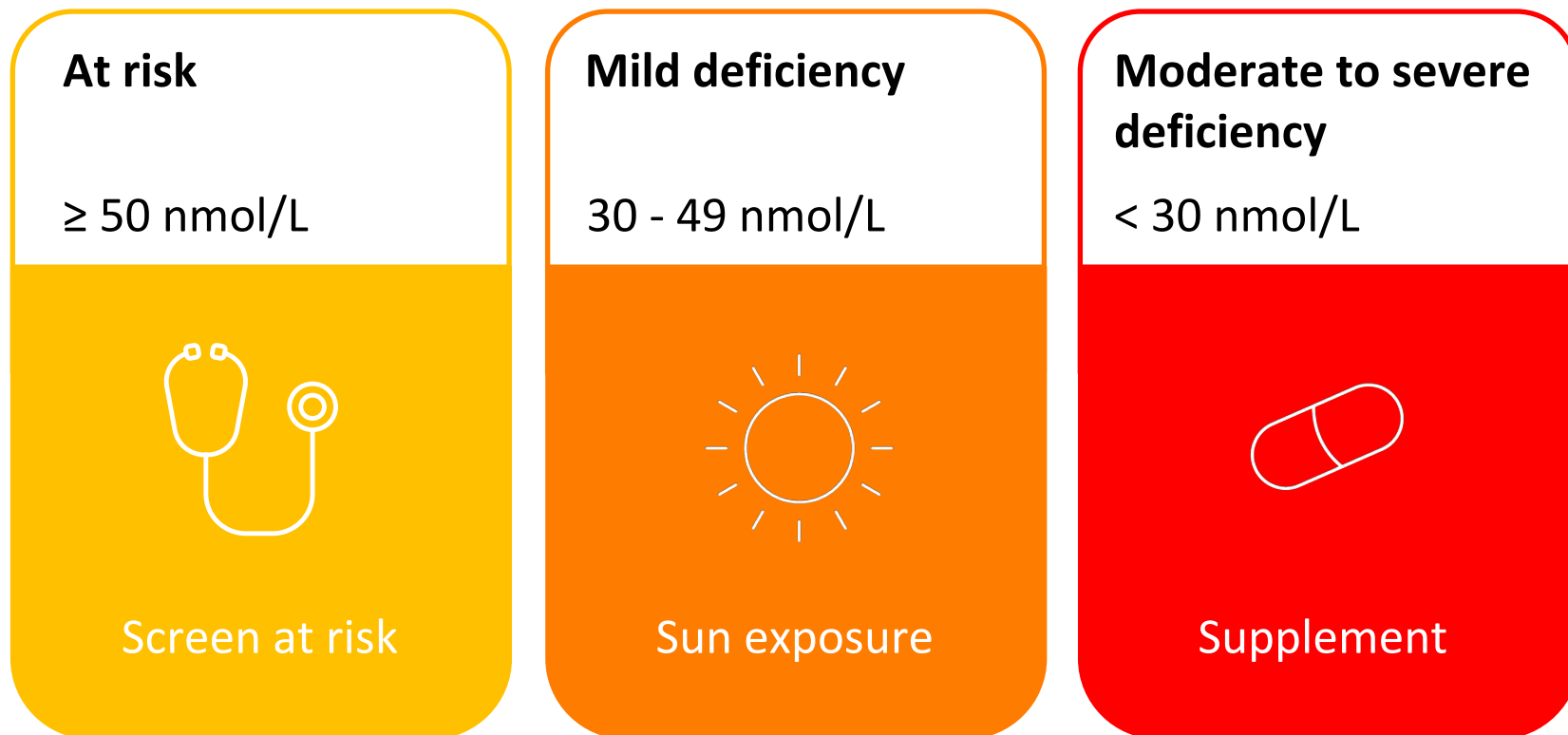
Diet



# Current guidelines and strategies

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# RACPG guidelines



# Vitamin D position paper

CLINICAL FOCUS

VOLUME 196 ISSUE 11

## Vitamin D and health in adults in Australia and New Zealand: a position statement

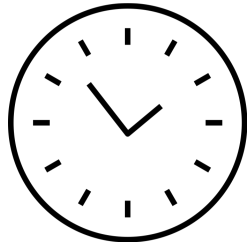
Caryl A Nowson, John J McGrath, Peter R Ebeling, Anjali Haikerwal, Robin M Daly, Kerrie M Sanders, Markus J Seibel and Rebecca S Mason

Med J Aust 2012; 196 (11): 686-687. || doi: 10.5694/mja11.10301

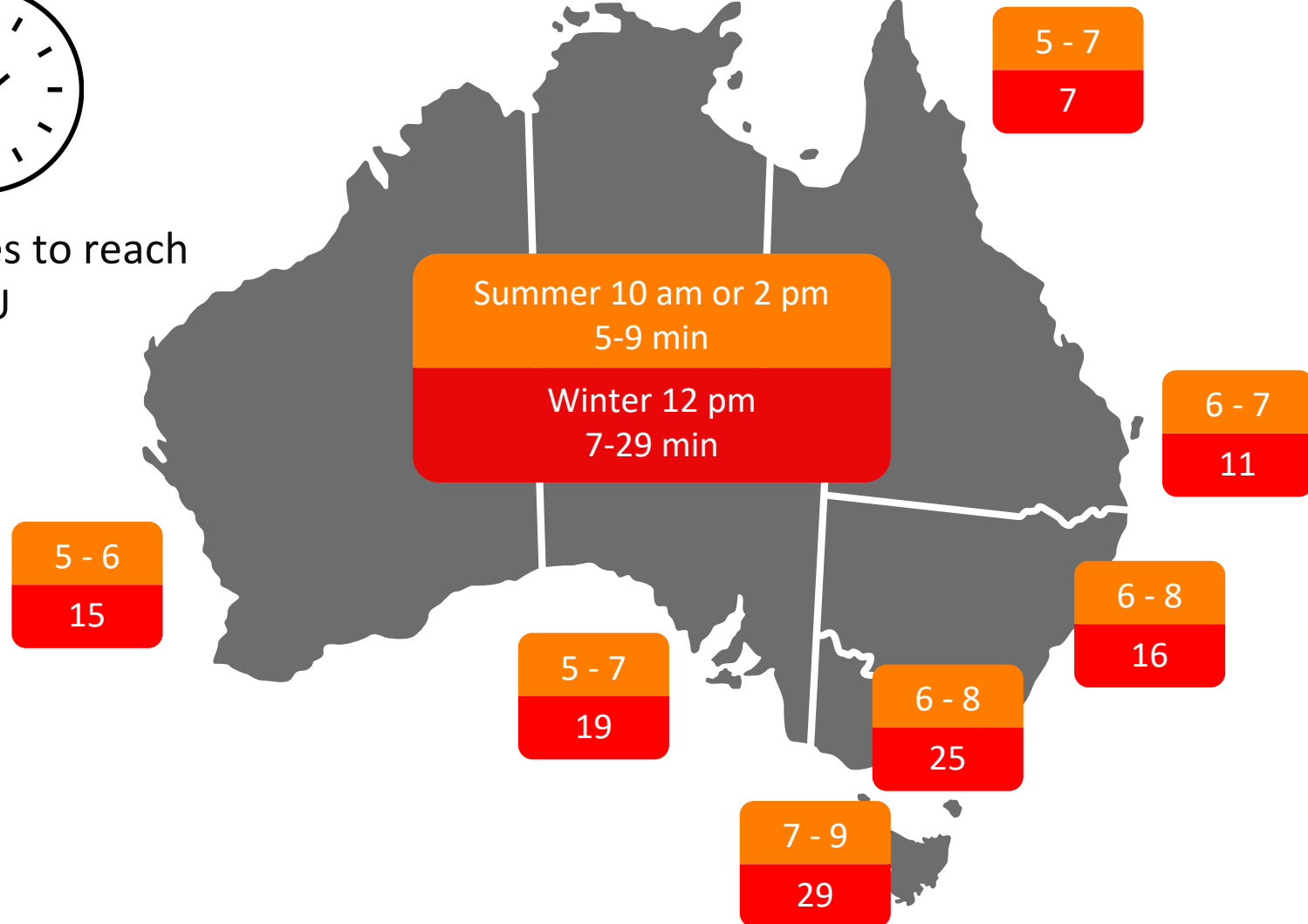
Published online: 18 June 2012



# Sun exposure: guidelines



Minutes to reach  
1000 IU  
(25  $\mu\text{g}$ )

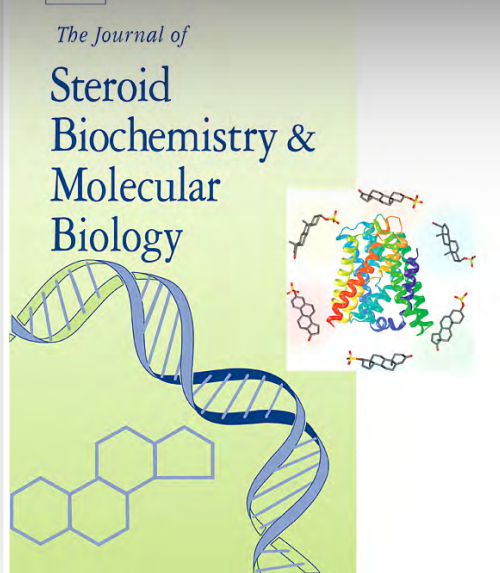


Nowson, Med J Aus. 2012;197(10)

# Difficult to achieve in winter through sun exposure alone

41.9 nmol/L in winter. At the end of the study, 69.3% of participants who complied with the summer sun exposure guidelines were 25(OH)D adequate, while only 27.6% of participants who complied with the winter sun exposure guidelines were 25(OH)D adequate at the end of the study. **The results suggest that the current Australian guidelines for sun exposure for 25(OH)D adequacy are effective for most in summer and ineffective for most in winter.**

This article is part of a Special Issue entitled '17th Vitamin D Workshop'




## Are the current Australian sun exposure guidelines effective in maintaining adequate levels of 25-hydroxyvitamin D?

Volume 155, 2016, Pages 264-270

Michael Kimlin, Jiandong Sun, Craig Sinclair, Sue Heward, Jane Hill, Kimberley Dunstone, Alison Brodie

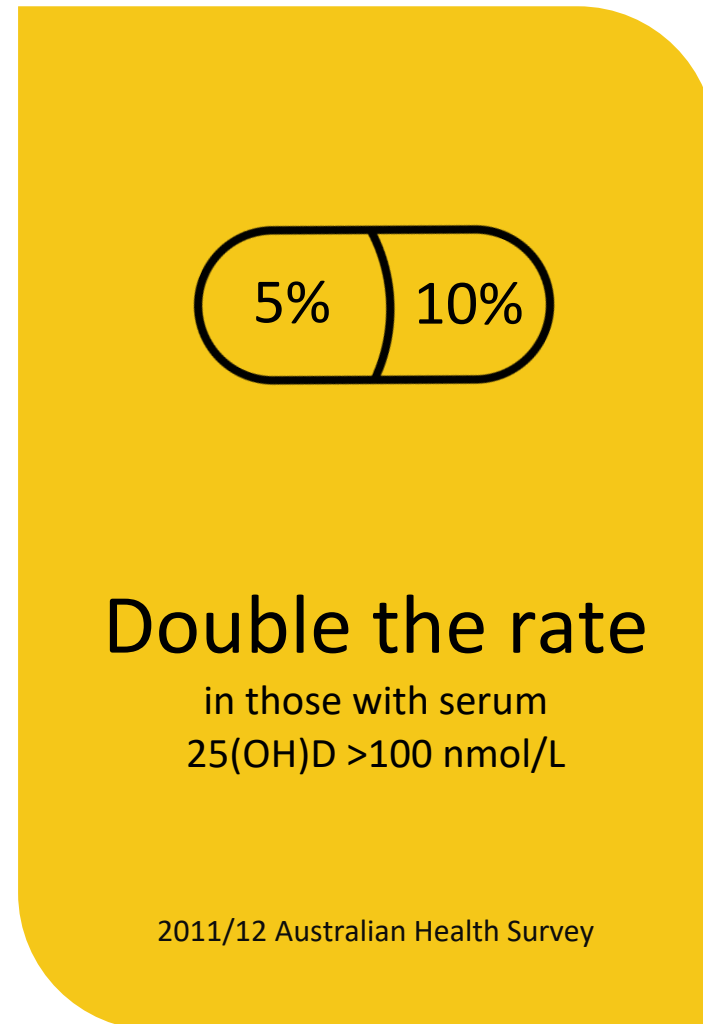
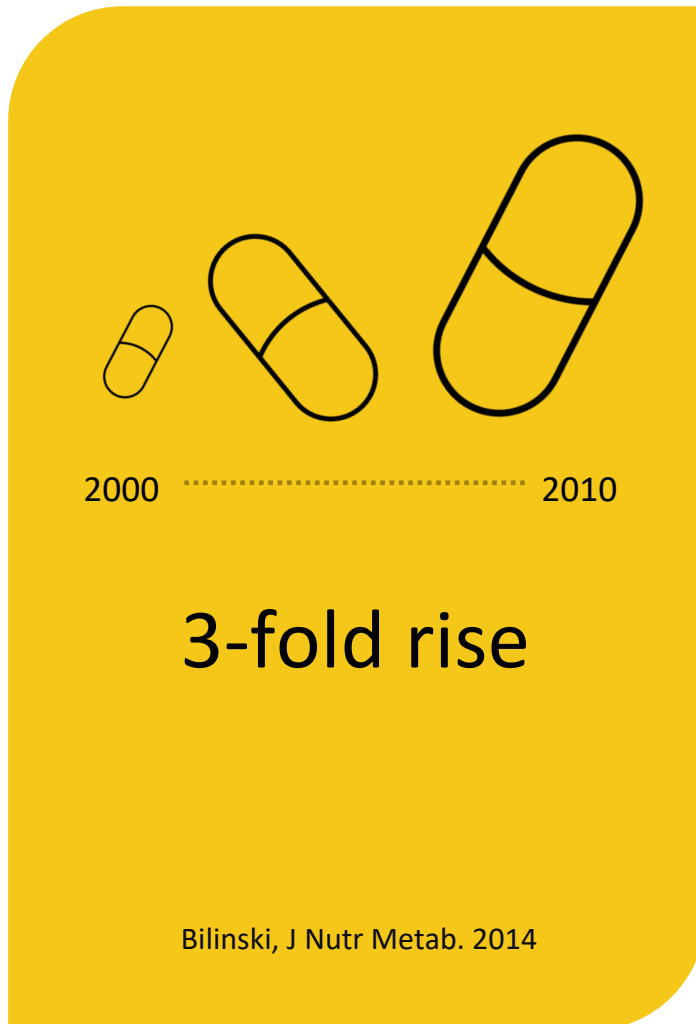
# Balancing vitamin D needs vs. skin cancer risk



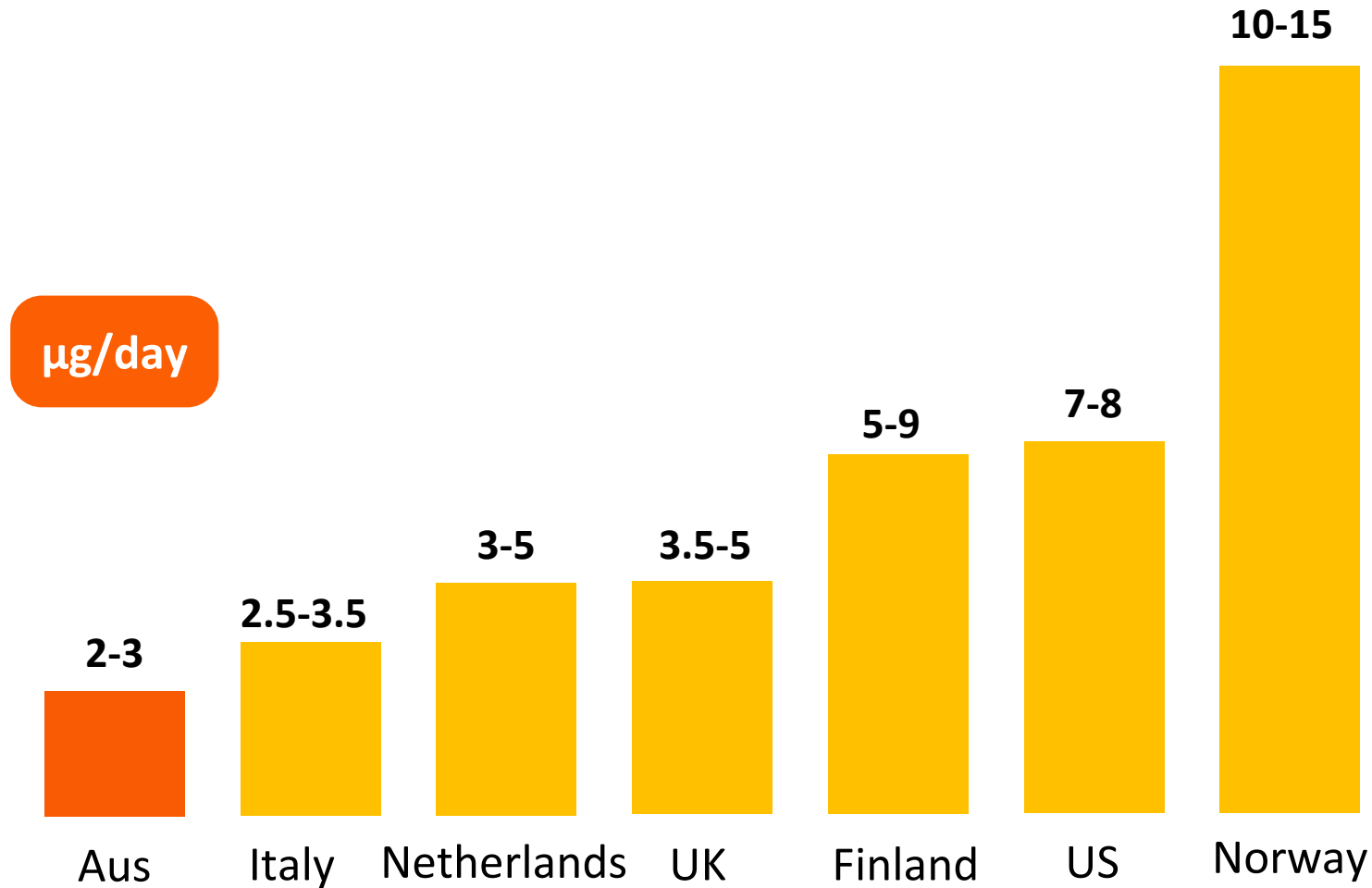
Difficult in Australia to obtain the equivalent of 1000 IU 25(OH)D while adhering to sun smart messages

Stalgis-Bilinsk, Med J Aust. 2011;194(7)

# Some individuals may be taking supplements unnecessarily



# The Australian diet is low in vitamin D



Nowson, Med J Aus. 2012;197(10).  
Calvo, J Nutr, 2005;135(2).  
Spiro, Nutr Bull, 2014;39(4)

# Dietary intakes are well below targets



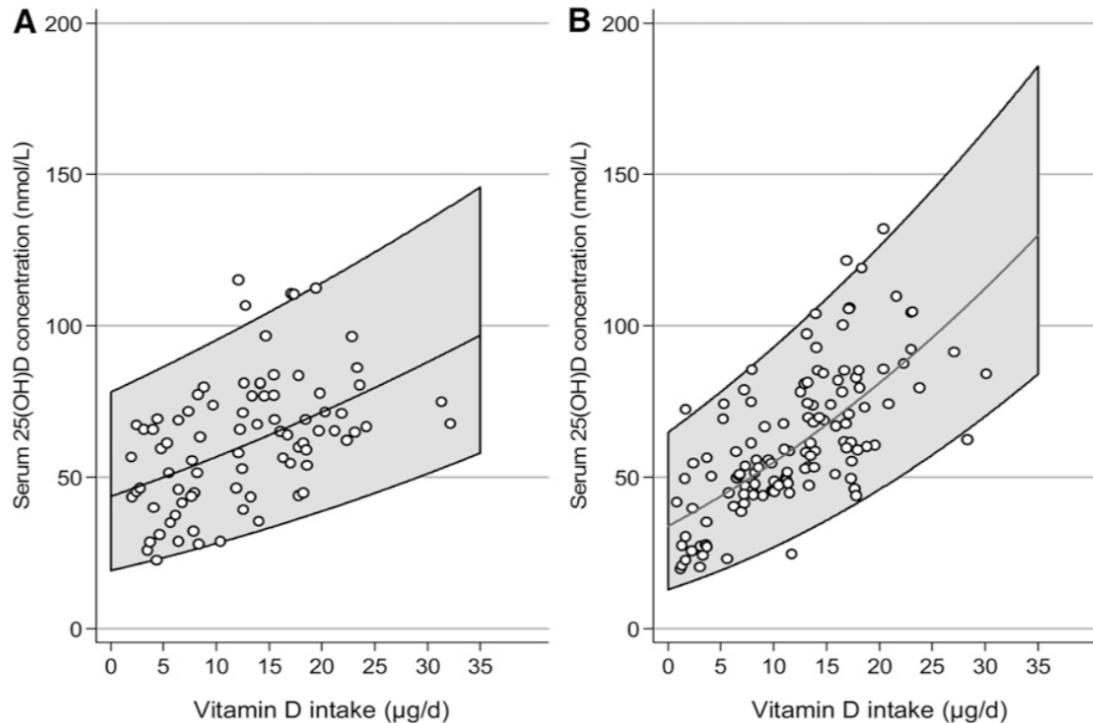
Adequate intake

Average intake

Nowson, Med J Aus. 2012;197(10)

# Some individuals need more than the Adequate Intake

65 yrs +



Men

Women

97.5%  
25  $\mu\text{g}$

AI  
10-15  $\mu\text{g}$

# Dietary sources of vitamin D



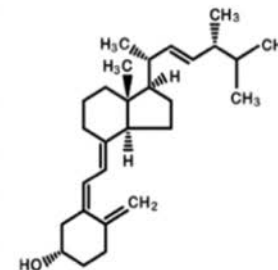
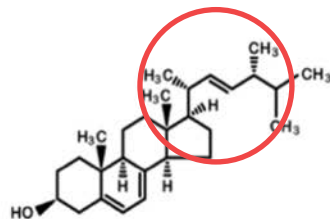
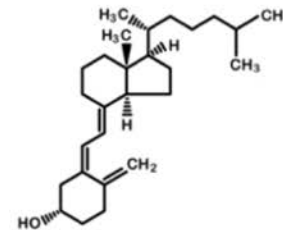
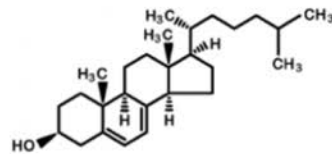
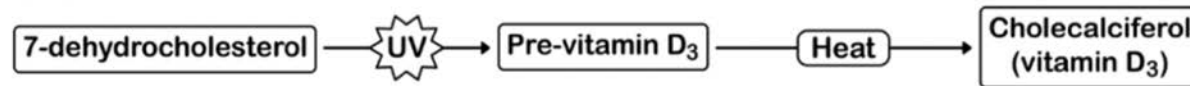
\*Cooked values  
where applicable

Australian Food Composition  
Database, 2019

Kühn, Food Chem. 2018;269



# 7-dehydrocholesterol vs. Ergosterol



# 5 button mushrooms exposed to UV provides 1000 IU



Regular

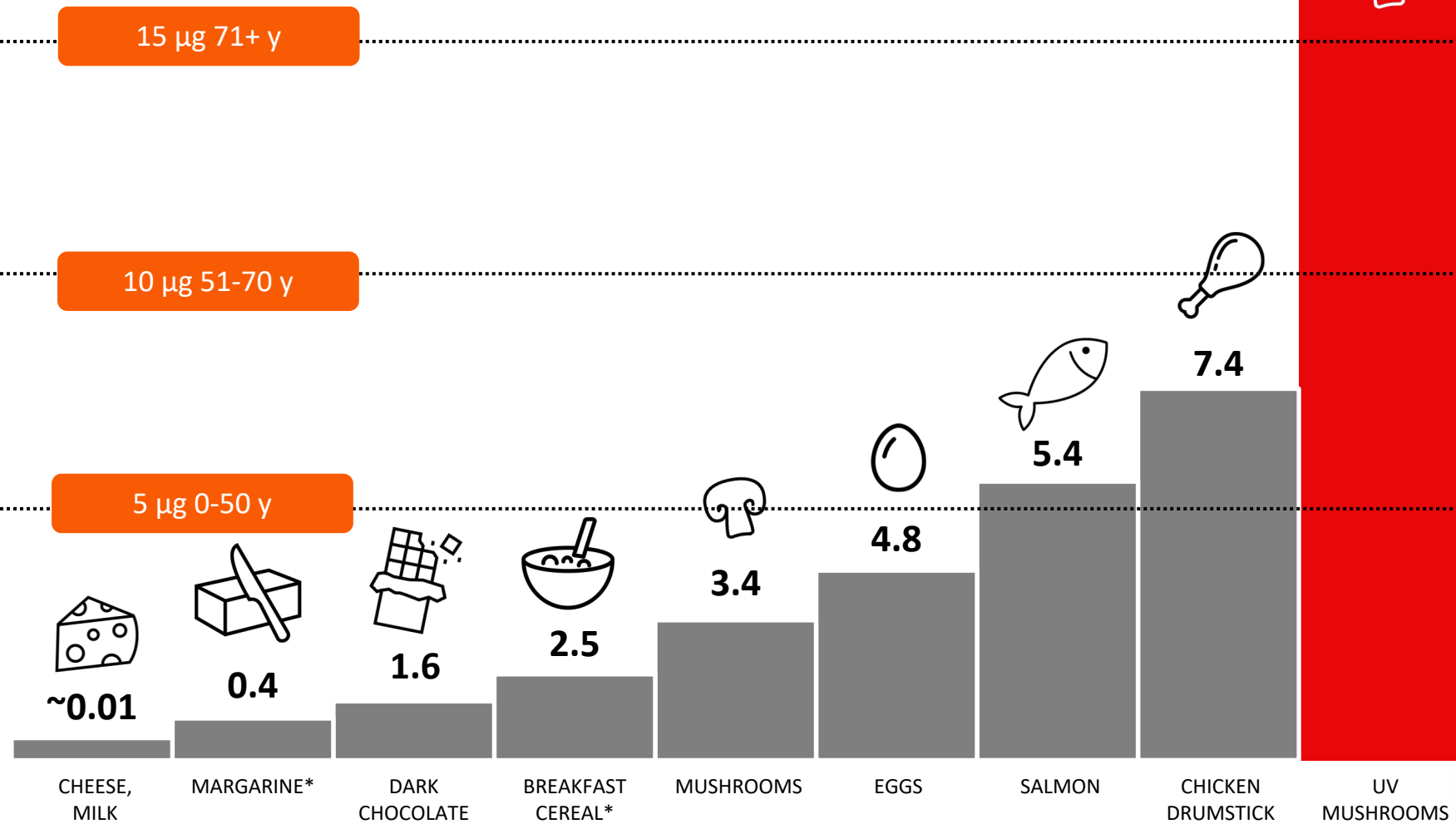
2-3  $\mu\text{g}$

UV-Exposed

24  $\mu\text{g}$

*Agaricus bisporus* mushrooms have the highest ergosterol content of all culinary mushrooms

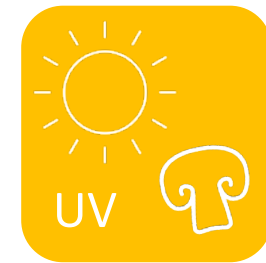
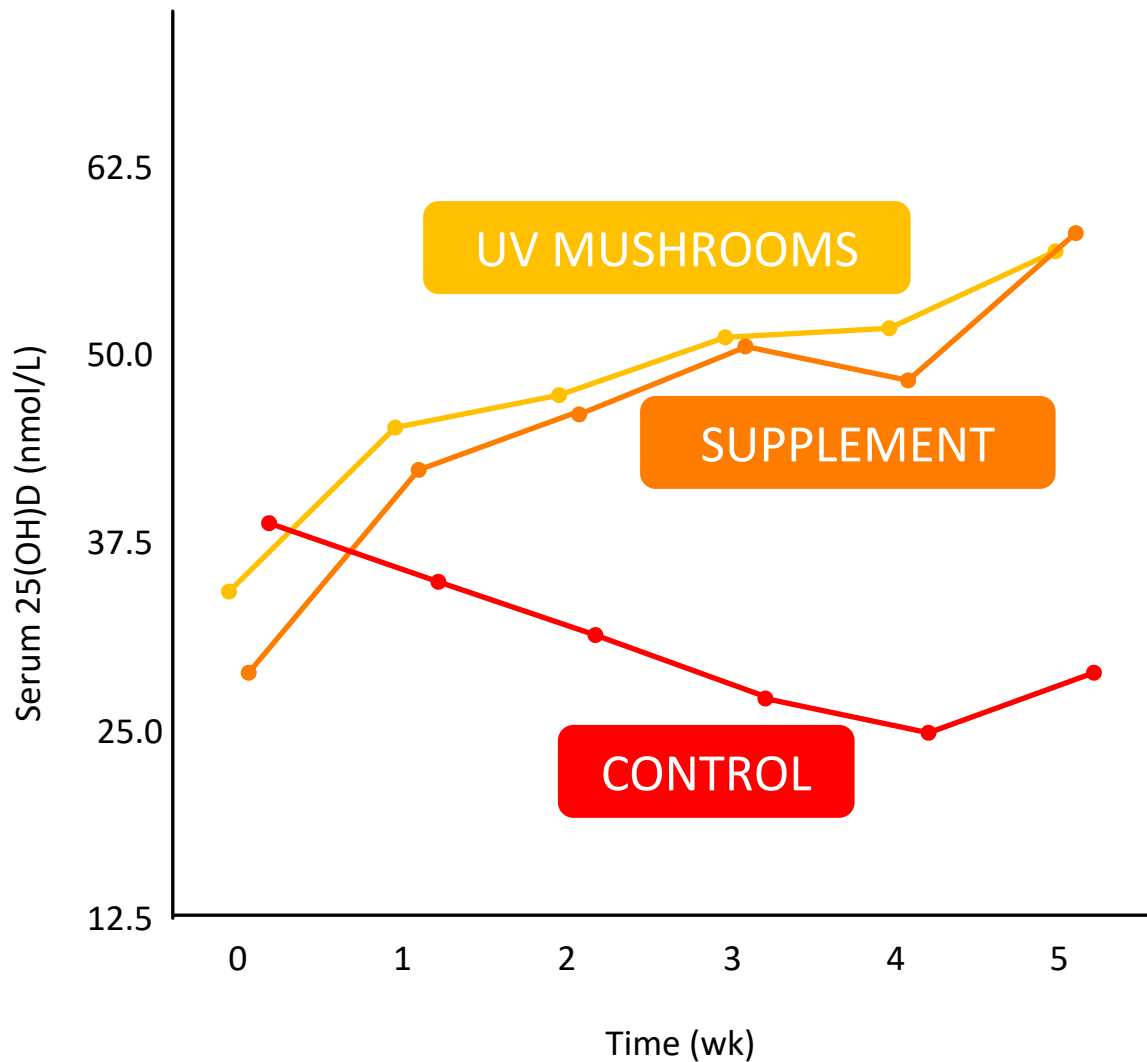
# Comparison of sources per serve



\* FORTIFIED

Australian Food Composition Database, Food Standards Australia and New Zealand, 2019  
Kühn, Food Chem. 2018;269

# Bioavailability is equivalent to supplementation



Adapted from Urbain, Eur J Clin Nutr, 2011;65

# Similar effects

**1000 IU of vitamin D**



1 UV exposed  
portobello mushroom



1 vitamin D pill



# The role of lifestyle medicine for meeting vitamin D requirements

---

# Why lifestyle medicine?

Lifestyle (nutrition, smoking cessation and exercise) can prevent up to 80% of chronic disease.

Egger, Lifestyle Medicine, Academic Press (2017)



# Lifestyle medicine approach

Coaching / Behaviour change

Physical activity

Sleep health

Nutrition

## Lifestyle Medicine

Tobacco and alcohol cessation

Emotional wellness / Stress management





# More than just vitamin D



Antioxidants

Bioactives

Cooking

Vitamin D

Eating  
occasion

Flavour

# Diet: Pros & Cons

## Pros

- Whole food approach
- More than just vitamin D
- Lower risk of toxicity
- Compliance



## Cons

- Few good sources
- Effects of cooking and storage
- Access
- Food preferences
- Cooking skills
- Compliance

# Considerations for dietary recommendations



Individual & family preferences

Cooking skills

Availability & access

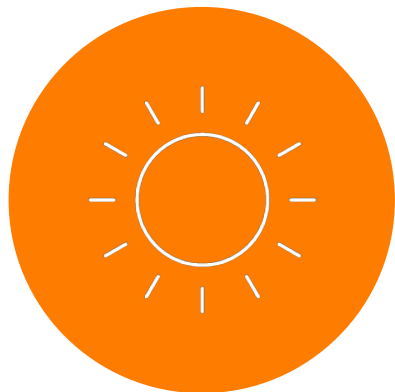
Adherence to recommendations

# Lifestyle Ax for vitamin D deficiency

	Decreased risk	Increased risk
<b>Non-Modifiable</b>		
Season	<input type="checkbox"/> Summer/Autumn	<input type="checkbox"/> Winter/Spring
Phototype	<input type="checkbox"/> Olive (III, IV)	<input type="checkbox"/> Dark or pale (I, II, V, VI)
Office worker	<input type="checkbox"/> No	<input type="checkbox"/> Yes
<b>Modifiable</b>		
Smoking	<input type="checkbox"/> No	<input type="checkbox"/> Yes
Supplement	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Sun exposure (time outdoors)	<input type="checkbox"/> Some	<input type="checkbox"/> None
<b>Diet</b>		
Fish	<input type="checkbox"/> Some	<input type="checkbox"/> None
Mushrooms	<input type="checkbox"/> Some	<input type="checkbox"/> None
Eggs	<input type="checkbox"/> Some	<input type="checkbox"/> None

Target the modifiable factors that the patient is willing to change first

# Pros and cons to each strategy



**Sun exposure**

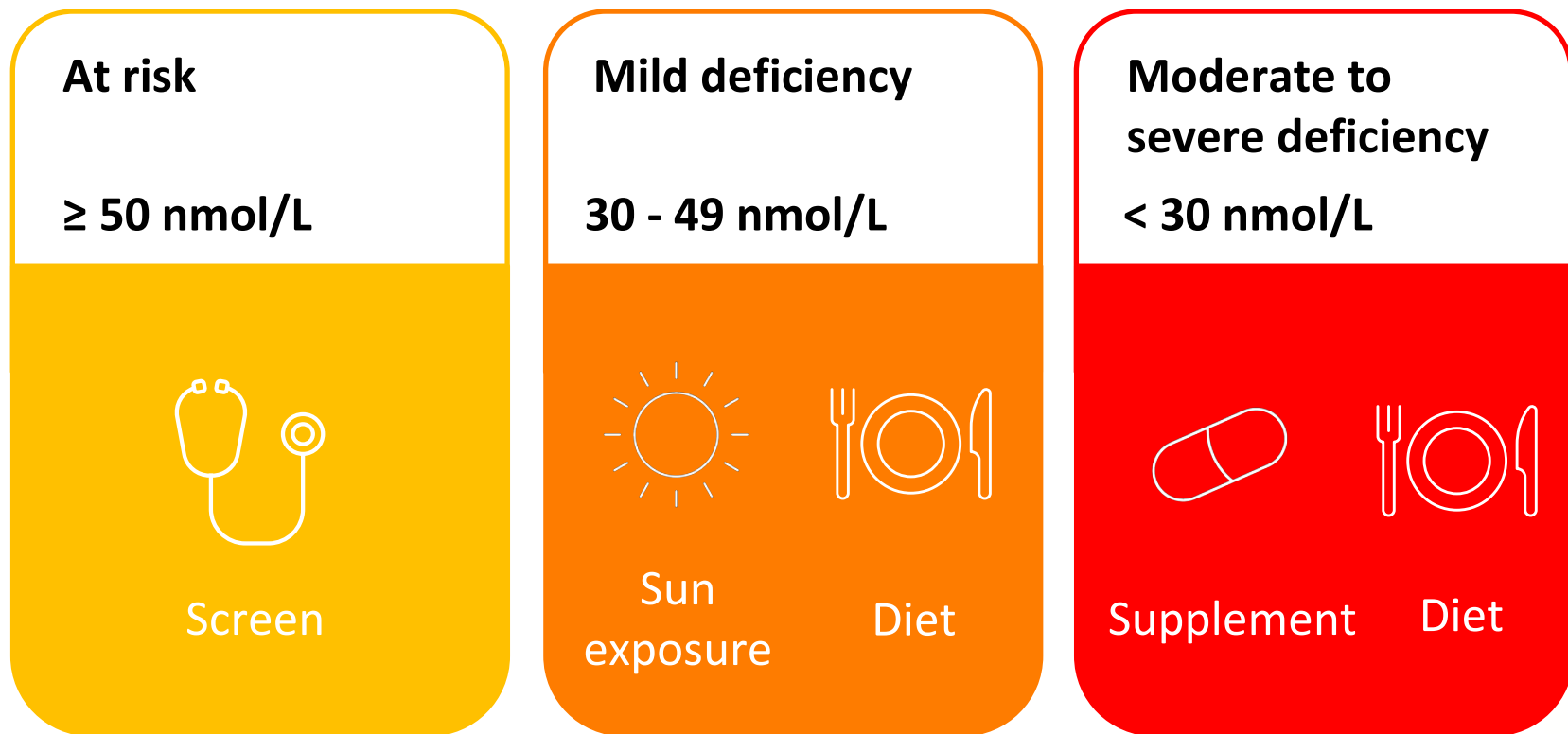


**Supplement**



**Diet**

# When it comes to vitamin D, two sources are best



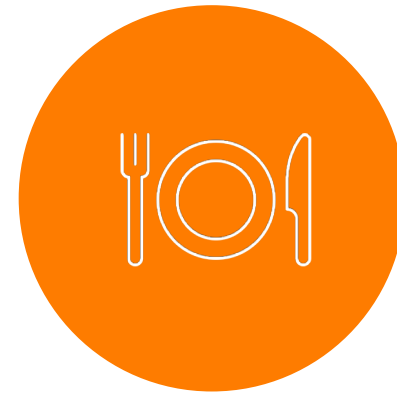
# Summary



Need to consider  
lifestyle, the individual  
& their risk factors



Only sun exposure and  
supplements are  
recommended to  
address it



Vitamin D is available  
from diet but we have  
the lowest intakes

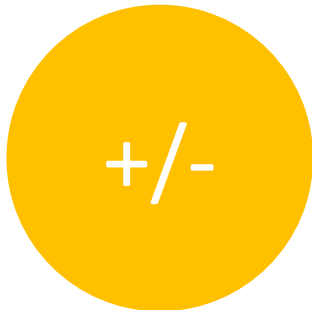
# Take Home Messages



Vitamin D deficiency  
an issue in sunny Australia



Diet can make an  
important contribution



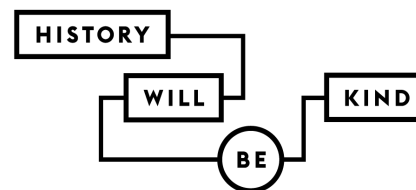
Limits to each strategy



Need to consider more  
than one source



# Acknowledgements



**Hort  
Innovation**  
Strategic levy investment

**MUSHROOM  
FUND**

This project has been funded by Hort Innovation, using the Mushroom Fund research and development levy and contributions from the Australian Government. Hort Innovation is the grower-owned, not-for-profit research and development corporation for Australian horticulture.

THANK YOU

# Accreditation Reminder

Don't forget to complete your Accreditation Documentation on the GPCE Delegate Hub in order to receive your points and certificates of completion.

Feedback for the session will be passed back to the speaker at the conclusion of the conference.

Where available, Speaker Notes will be downloadable from the GPCE Delegate Hub approximately 1 week post-conference.

Thank you.

## **APPENDIX 25: MS122 EXPERT ROUNDTABLE**

# How healthy are fungi? Examining their bioactive and health benefits

Flavia Fayet-Moore  
PhD, MNutrDiet, RNutr, APD, FASLM

25<sup>th</sup> November 2020



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2

## LONG HISTORY BUT LIMITED EVIDENCE IN HUMANS



3

## WORLD FIRST REVIEW ON A. BISPORUS



Examining the health effects and bioactive components in *Agaricus bisporus* mushrooms: a scoping review

The Journal of Nutritional Biochemistry, Volume 84, October 2020

Blumfield M, Abbott K, Duve E, Cassettari T, Marshall S, Fayet-Moore F

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4

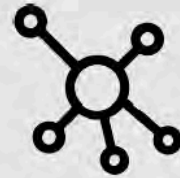
## UNIQUE BIOACTIVES FOUND



ERGOSTEROL



CHITIN



ERGOTHIONEINE

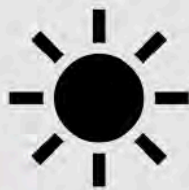


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## HEALTH EFFECTS OF A. BISPORUS MUSHROOMS



VITAMIN D

100g



GUT HEALTH

226g



CANCER

2g/d  
4-14g powder

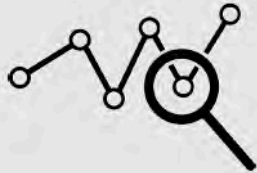


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## WHAT NEEDS TO CHANGE?



PROSPECTIVE  
COHORT  
STUDIES



MORE HIGH  
QUALITY RCTs



MEASURE  
SEPARATELY



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7

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## WHERE DO MUSHROOMS FIT?



CAROTENOIDS  
VITAMIN C  
FIBRE  
FOLATE



VITAMIN C  
FIBRE



CARBOHYDRATE  
PROTEIN  
IRON, FIBRE  
THIAMIN, IODINE  
FOLATE



PROTEIN  
IRON  
ZINC  
VITAMIN B<sub>12</sub>  
OMEGA-3



CALCIUM  
PROTEIN  
RIBOFLAVIN  
VITAMIN B<sub>12</sub>



FOLATE VITAMIN D SELENIUM BIOTIN GLUCANS NIACIN  
ERGOSTEROL ERGOTHIONEINE CHITIN COPPER  
PHOSPHORUS




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Thank you

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@drflavs

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 www.nraus.com

**Hort  
Innovation**  
Strategic levy investment

**MUSHROOM  
FUND**

This project has been funded by Hort Innovation using the mushroom research and development levy and funds from the Australian Government. For more information on the fund and strategic levy investment visit [horticulture.com.au](http://horticulture.com.au)

 **NRAUS**

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# EXPERT ROUNDTABLE: HOW SHOULD FUNGI FOODS BE INCLUDED IN DIETARY RECOMMENDATIONS?

Wednesday 25th November 2020  
12pm - 2pm AEDT

## Agenda

12:00	<b>WELCOME ADDRESS</b>	<b>NUTRITION RESEARCH AUSTRALIA</b>
	Introduction: How should fungi foods be included in dietary recommendations?	<b>EMMA BECKETT</b>
12:15	<b>NETWORKING</b>	
12:25	The facts on fungi: What are they and what makes them unique?	<b>GLENN CARDWELL</b>
	How healthy are fungi? Examining their bioactive and health benefits	<b>FLAVIA FAYET-MOORE</b>
	Beyond nutrients: The role of fungi foods in culinary nutrition	<b>JIM FULLER</b>
12:45	<b>NETWORKING</b>	
12:55	Native mushrooms: The consumption of fungi in Indigenous culture	<b>ARPAD KALOTAS</b>
	Translating science into dietary advice: Where and how would fungi foods fit?	<b>LINDA TAPSELL</b>
1:15	<b>BREAK</b>	
1:20	Panel discussion on fungi foods: How should they be included in dietary recommendations?	<b>PANEL DISCUSSION</b>
2:00	<b>EVENT CLOSE</b>	

Hosted by Nutrition Research Australia





## Jim Fuller

Jim Fuller was born and raised in Texas. Fine BBQ drew him in and Jim worked as a fine-dining chef in Texas for 10 years. Natural curiosity and wanting to understand the science behind the food he was cooking, he went to University to study Chemical Engineering and, later, Agricultural Science. Jim started working on a mushroom farm, began collecting wild mushrooms and somewhere along the way became fascinated by mushrooms and has worked as a Mycologist

(a mushroom scientist) for the last 12 years. Jim knows how to grow mushrooms, the science behind mushrooms, and how to cook them to be delicious, meaty, and healthy.

**Conflict of interest statement:**

Jim Fuller is co-founder and Chief Science Officer of Fable Food Co, a company that uses mushrooms to recreate the taste and texture of meat.



## Arpad Kalotas

Arpad Kalotas graduated as a botanist (B.Sc. Hons) at University of Western Australia and after travelling through Central Australia developed an interest in Aboriginal cultural knowledge and use of flora. He has been involved in a range of natural and cultural resource projects throughout central and Western Australia, as well as projects with Aboriginal communities and organisations in documenting and applying Indigenous ecological knowledge for a variety of purposes including bush food feasibility studies. He has

also maintained an interest in fungi first sparked by a fungal foray in his student days to the hills of Mundaring Weir with the late Roger Hilton, formerly Lecturer in Mycology at UWA. Among his publications is a chapter in the Fungi of Australia on 'Aboriginal knowledge and use of fungi'.

**Conflict of interest statement:**

Arpad Kalotas has no conflict of interest.



## Linda Tapsell

Professor Linda Tapsell is a distinguished academic in Medical and Health Sciences with discipline expertise in Nutrition and Dietetics. She is a Fellow of both the Dietitians Association of Australia (DAA) and the Nutrition Society of Australia, and in 2015 was recognised as a member of the Order of Australia for 'significant service to health science as an academic and clinician specialising in diet and nutrition'. Her contributions have extended from directing major food research centres, to participating on expert committees and panels relating to food, and nutrition, both nationally and internationally. Her numerous scientific publications, including the textbook Food, Nutrition and Health (Oxford University Press), address the impact of nutrients, foods and dietary patterns on health, and how this body of knowledge underpins food and nutrition policy and practice. Professor Tapsell continues to support future generations of nutrition scientists and dietetic practitioners through the School of Medicine at the University of Wollongong.

**Conflict of interest statement:**

Professor Tapsell was formerly director of the ARC Key Centre for Smart Foods and the National Centre of Excellence in Functional Foods based at the University of Wollongong, and as such led numerous research and consultancy projects across various sectors of the food value chain. She has served on the Science Advisory Council of the California Walnut Commission and the McCormick Science Institute. She is currently on the steering committee of the Horticulture Australia project, 'Naturally Nutritious' and continues to advise and work with Nuts for Life. In 2019 she received the Excellence in Research award from the International Nut and Dried Fruit Council (INC). She is a member of the Consumer and Public Health Dialogue of Food Standards Australia New Zealand and served on the Advisory Committee of the 2013 Australian Dietary Guidelines.



## Emma Beckett

Dr Emma Beckett is a food and nutrition scientist and lecturer at the University of Newcastle, specialising in gene-nutrient-environment interactions. Emma is also a passionate science communicator. She aims to empower people to make more informed choices about food, without fear or judgement.

**Conflict of interest statement:**

Dr Emma Beckett has contracts or grants with the following entities: Kellogg, MARS Foods Australia, The National Health and Medical Research Council, AMP Foundation, and Central Coast Health.



## Glenn Cardwell

Glenn Cardwell is an Advanced Accredited Practising Dietitian with 40 years of experience in clinical and public health nutrition. He has advised the public, the fresh produce industry, and lectures health professionals and university students. He has collaborated with farmers to promote the nutrition and health benefits of mushrooms, bananas, cherries and asparagus. He has written four books, including one that has been translated into Russian and Mandarin. Currently he is conducting a research project with Curtin

University, farmers and the National Measurement Institute on the influence of pulsed UV radiation on dried mushrooms. He is a second term director of Dietitians Australia.

**Conflict of interest statement:**

Glenn consults to the Australian Mushroom Growers' Association.



## Flavia Fayet-Moore

Dr Flavia Fayet-Moore is a registered nutritionist, Accredited Practising Dietitian, board certified Lifestyle Medicine Professional, and Honorary Associate of the University of Sydney. As CEO of Nutrition Research Australia, Flavia leads a team of highly skilled researchers to conduct end to end nutrition and communications projects. Flavia graduated from the University of Toronto with an Honours Bachelor of Science in Nutritional Sciences, and obtained both her Master of Nutrition and Dietetics and PhD in nutrition at from the University of Sydney. Flavia is passionate about improving the health of Australians, especially among children and adolescents, through research and its communication. She is a member of the Nutrition Society of Australia, the Dietitian's Association of Australia, and is a founding board member and fellow of the Australasian Society of Lifestyle Medicine.

**Conflict of interest statement:**

Dr Flavia Fayet-Moore has associations or grants with the following entities: Olive Wellness Institute Advisory Panel, Consultant to Nutrigenomix Inc, Founding board member of the Australasian Society of Lifestyle Medicine, and Funding from Hort Innovation (Australian Mushrooms).

Nutrition Research Australia invites you to join our expert panel and a small number of selected guests, for an exclusive virtual roundtable event:

## HOW SHOULD FUNGI FOODS BE INCLUDED IN DIETARY RECOMMENDATIONS?

While categorising foods and diets based on their 'plant' or 'animal' profile has become increasingly popular due to health and environmental reasons, where does that leave our third food kingdom - fungi?

### PANELISTS

Arpad Kalotas  
Dr Emma Beckett  
Dr Flavia Fayet-Moore  
Glenn Cardwell  
Jim Fuller  
Professor Linda Tapsell

### EVENT DETAILS

**DATE:**  
WEDNESDAY  
25TH NOVEMBER 2020

**TIME:**  
12.00PM - 2.00PM AEDT

This invitation only event will take place via Zoom.



RSVP

Please confirm your attendance by replying to this email:  
[events@nraus.com](mailto:events@nraus.com)  
by Wednesday 11 November 2020

Please include your full postal address in your RSVP to receive your free mushrooms kit, as a thank you for joining us at the event.

**APPENDIX 26: MS119 DIETITIAN UNITE SEMINAR PRESENTATION**

# THE HEALTH & CULINARY BENEFITS OF MUSHROOMS

Flavia Fayet-Moore

CEO NRAUS

PhD, MNutrDiet, RNutr, APD, FASLM

May 21, 2021

# PLANT OR ANIMAL?



**NOT A VEGETABLE**

But contains:  
resistant starch  
phytonutrients  
potassium



**NOT AN ANIMAL**

But contains:  
vitamin B12  
vitamin D



**NOT A WHOLE GRAIN**

But contains:  
beta-glucans  
prebiotics  
riboflavin



**NOT A NUT**

But contains:  
copper  
selenium





# THE SCIENCE BEHIND MUSHROOMS

# WORLD FIRST REVIEW ON *A. BISPORUS*

Available online at [www.sciencedirect.com](http://www.sciencedirect.com)

  **ScienceDirect**

Journal of Nutritional Biochemistry 84 (2020) 108453

**Journal of Nutritional Biochemistry**

REVIEWS: CURRENT TOPICS

Examining the health effects and bioactive components in *Agaricus bisporus* mushrooms: a scoping review☆

Michelle Blumfield<sup>a</sup>, Kylie Abbott<sup>a,b</sup>, Emily Duve<sup>c</sup>, Tim Cassettari<sup>d</sup>, Skye Marshall<sup>a,e</sup>, Flavia Fayet-Moore<sup>f,\*</sup>

<sup>a</sup>BNutDiet (Hons), PhD, Nutrition Research Australia, Sydney, New South Wales, Australia  
<sup>b</sup>Nutraceuticals Research Group, School of Biomedical Sciences and Pharmacy, University of Newcastle, Callaghan, Australia  
<sup>c</sup>BPES, MPH, Nutrition Research Australia, Sydney, New South Wales, Australia  
<sup>d</sup>BSc(Hons), BAppSc, Nutrition Research Australia, Sydney, New South Wales, Australia  
<sup>e</sup>Bond University, Nutrition and Dietetics Research Group, Faculty of Health Sciences and Medicine, Bond University, Gold Coast, Queensland, Australia  
<sup>f</sup>BSc(Hons), MNutDiet, PhD, Nutrition Research Australia, Sydney, New South Wales, Australia


Received 8 March 2020; received in revised form 19 May 2020; accepted 8 June 2020

**Abstract**

There is evidence from both *in vitro* and animal models that the consumption of edible mushrooms has beneficial effects on health. It is unclear whether similar effects exist in humans and which bioactive compounds are present. This review synthesises the evidence on the world's most commonly consumed mushroom, *Agaricus bisporus* to (i) examine its effect on human health outcomes; and (ii) determine the nutrient density of its bioactive compounds, which may explain their health effects. A systematic literature search was conducted on the consumption of *A. bisporus*, without date and study design limits. Bioactive compounds included ergosterol, ergothioneine, flavonoids, glucans and chitin. Two authors independently identified studies for inclusion and assessed methodological quality. Beneficial effects of *A. bisporus* on metabolic syndrome, immune function, gastrointestinal health and cancer, with the strongest evidence for the improvement in Vitamin D status in humans, were found. Ultraviolet B (UVB) exposed mushrooms may increase and maintain serum 25(OH)D levels to a similar degree as vitamin D supplements. *A. bisporus* contain beta-glucans, ergosterol, ergothioneine, vitamin D and an antioxidant compound usually reported as flavonoids; with varying concentrations depending on the type of mushroom, cooking method and duration, and UVB exposure. Further research is required to fully elucidate the bioactive compounds in mushrooms using vigorous analytical methods and expand the immunological markers being tested. To enable findings to be adopted into clinical practice and public health initiatives, replication of existing studies in different population groups is required to confirm the impact of *A. bisporus* on human health.

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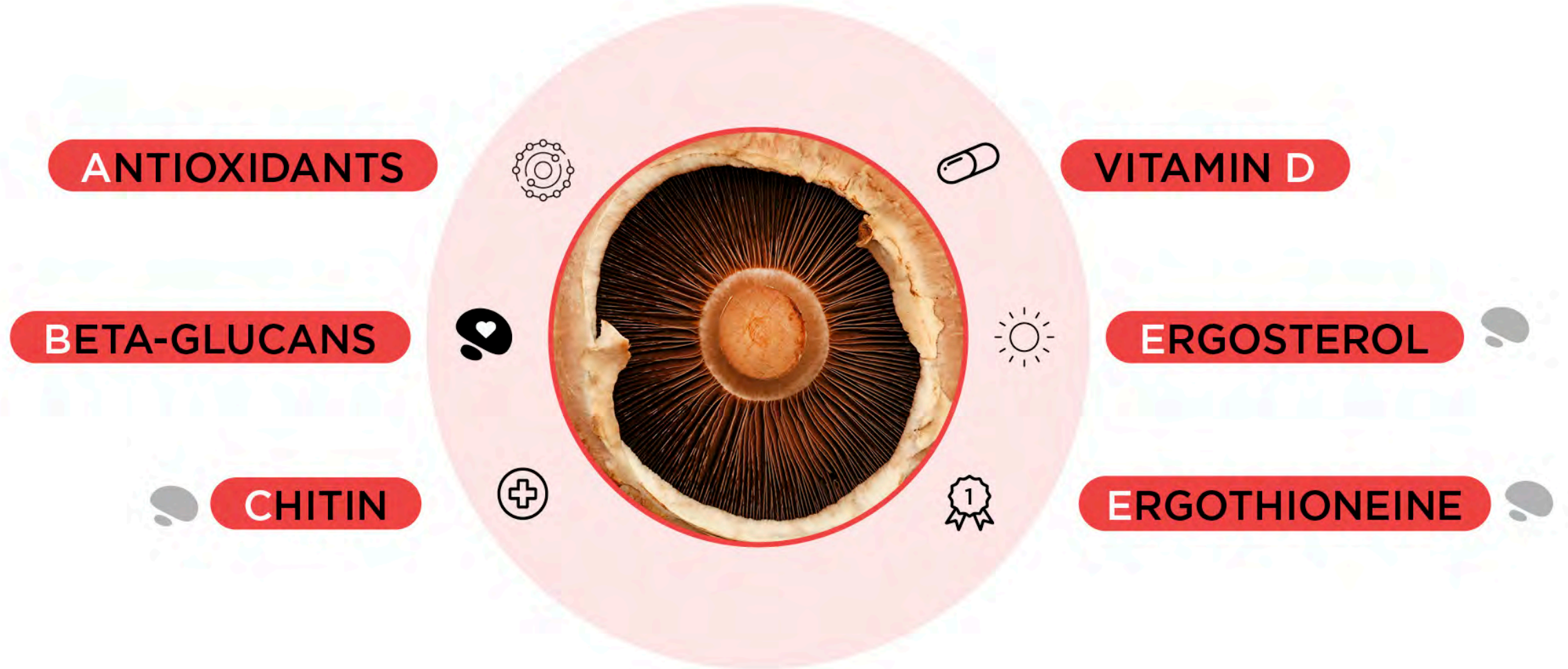
**Keywords:** Systematic review; *Agaricus bisporus*; Mushroom; Health; Human; Bioactive

 15 human studies

 53 bioactive studies



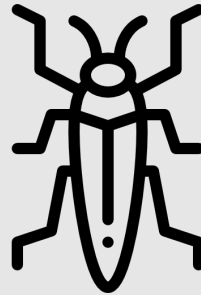
# 6 BIOACTIVES COMPONENTS



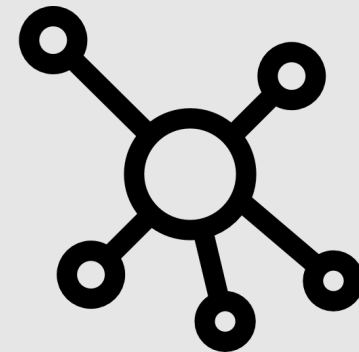
# 3 RELEVANT BIOACTIVES



ERGOSTEROL



CHITIN

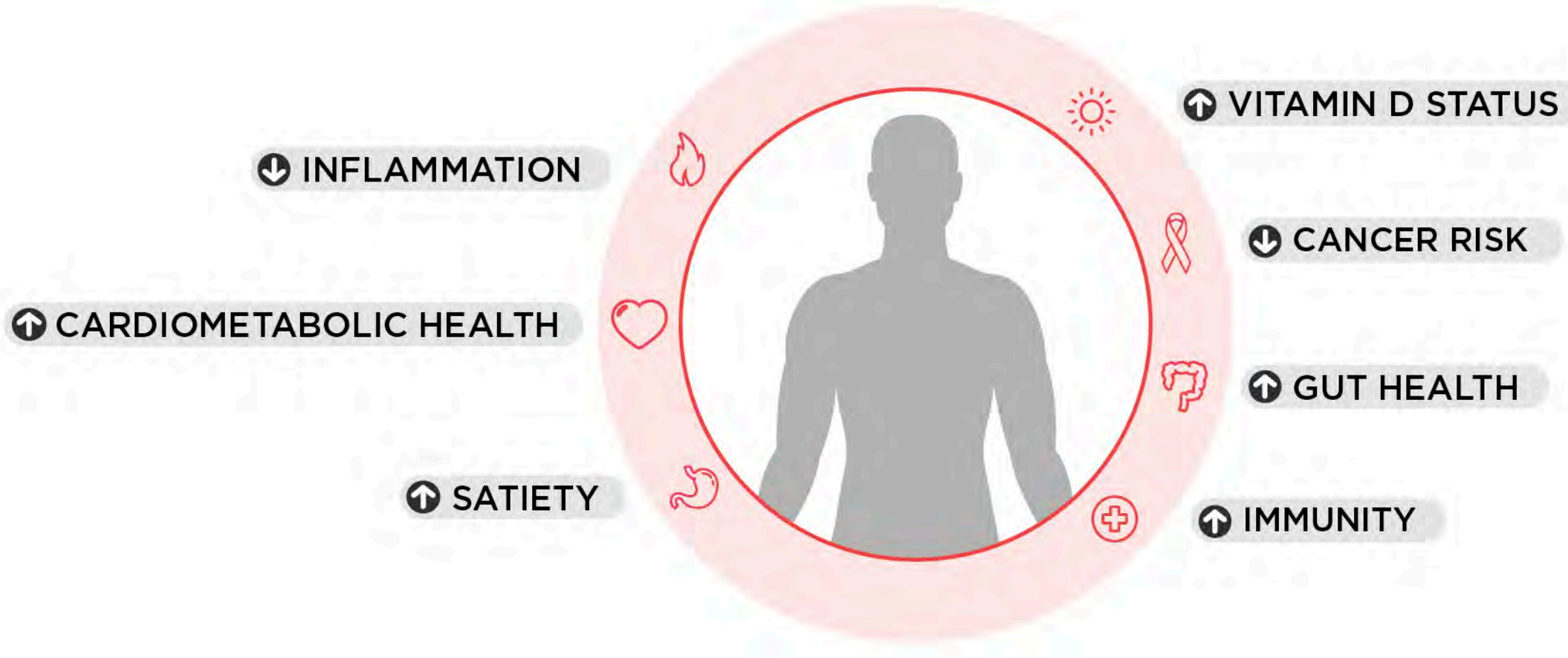


ERGOTHIONEINE

*Smith E et al. Ergothioneine is associated with reduced mortality and decreased risk of cardiovascular disease. Heart 2020;106:691-697.*



# 7 HEALTH BENEFITS





# PRACTICAL MUSHROOM TIPS

# UNIQUE UMAMI FLAVOUR



**REDUCE SALT**



**FLAVOUR ENHANCER**



**MEAT REPLACER**



# TIPS TO ENHANCE FLAVOUR



**Store  
for longer**

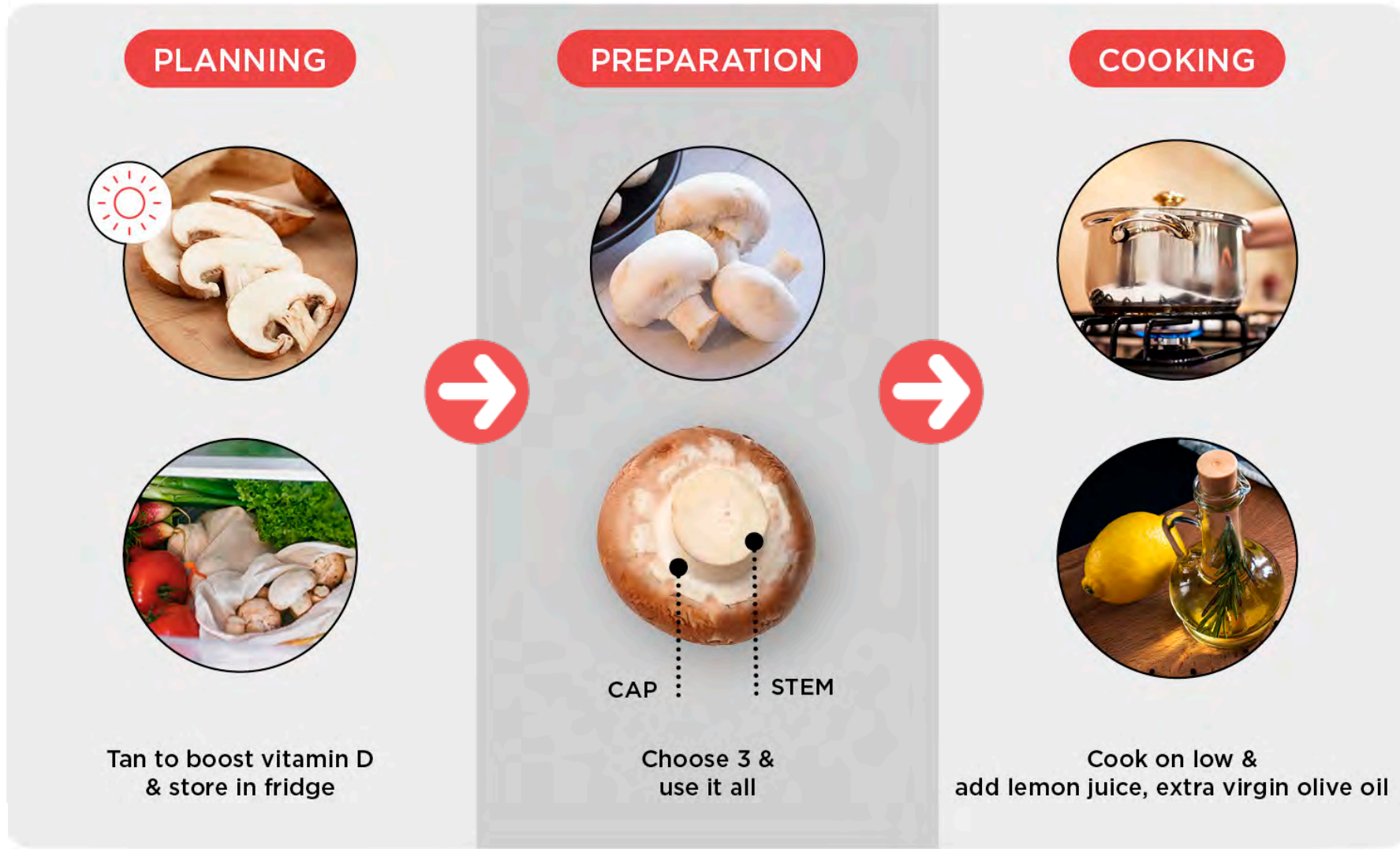
**Freeze**

**Boil**





# SUMMARY: MAKING “D” MOST OF YOUR MUSHROOMS



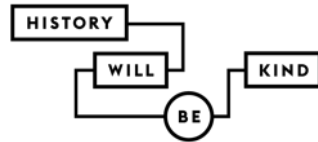
# OPPORTUNITY FOR DIETITIANS

Nutrition science  
+ Practical tips  
= Healthier habits and diets





# ACKNOWLEDGEMENTS



**Hort  
Innovation**  
Strategic levy investment

**MUSHROOM  
FUND**

This project has been funded by Hort Innovation, using the Mushroom Fund research and development levy and contributions from the Australian Government. Hort Innovation is the grower-owned, not-for-profit research and development corporation for Australian horticulture.



# Thank you



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## **APPENDIX 27: MS125 AUSTRALIAN DOCTOR**



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## Updates and Articles

## INFORMATION CATEGORY

Updates and Articles

# Addressing the vitamin D problem: now is the time for a new approach

0



The COVID-19 pandemic has shone a new spotlight on the need to address vitamin D insufficiency.

Pre-pandemic, almost 2 in 3 Australian adults were vitamin D insufficient or deficient (serum 25(OH)D <75 nmol/L)<sup>1</sup>, with close to 1 in 4 deficient (serum 25(OH)D <50 nmol/L).<sup>2</sup> With many of us staying indoors because of restrictions, numbers are now likely to be even higher, and particularly among older Australians.

The urgency to address vitamin D insufficiency has also increased due to its established role in regulating the body's immune response to viruses and respiratory illnesses.<sup>3,4</sup> Though research is in its infancy, preliminary explorations point to an inverse relationship between vitamin D status and the risk and severity of COVID-19 infection.<sup>5,6</sup> In vitro research has also inferred a protective role for vitamin D in preventing COVID-19 infection<sup>3</sup>, and even the UK government has announced plans to supplement those most at risk of deficiency with vitamin D in an effort to enhance COVID-19 defences<sup>7</sup>.

### Sun and supplements are not always enough

Clinical guidelines addressing vitamin D deficiency do not currently consider dietary sources.<sup>8</sup> Obtaining sufficient vitamin D through sun exposure is difficult to achieve year-round while also adhering to sun smart messages, especially during the winter months.<sup>9</sup> Recommending dietary sources of vitamin D may support intake needs when sun exposure is not viable (e.g., during winter months) or feasible (e.g., for darker skinned individuals). Recent Australian data revealed that serum levels of 25(OH)D remained inadequate during winter irrespective of vitamin D supplementation, highlighting the need for other interventions, to help improve vitamin D status.<sup>10</sup>

### A whole food approach to vitamin D

Diet is often forgotten in the vitamin D conversation because most adults are unlikely to obtain 100% of their daily needs from diet alone<sup>11</sup>. The one exception: mushrooms exposed to UV-light. Like humans, mushrooms produce vitamin D when exposed to UV light.<sup>12</sup> Even without UV exposure, mushrooms contain more than half of the adequate daily intake of vitamin D (for adults under 50-years of age). Remarkably, exposing just 3 mushrooms the sun (or UV-light) for just 15-minutes can increase vitamin D content by up to 10-times, providing 100% of daily vitamin D needs of the entire Australian population.<sup>13</sup> They have also been shown to be as effective as vitamin D supplements at increasing vitamin D levels.<sup>13,14</sup>

### Mushrooms: much more than vitamin D

Mushrooms are neither plant nor animal, and have a structural, chemical, and nutritional composition different to all other foods. They contain chitin, a unique prebiotic fibre found only in mushrooms, crustaceans, and insects<sup>15</sup>; and ergothioneine, an amino acid with potent antioxidant actions. Cheah et al. recently proposed ergothioneine as a potentially effective therapeutic aid to reduce the severity of COVID-19, based on in vitro and in vivo studies.<sup>16</sup>

Our systematic review of human studies showed beneficial effects of the common edible mushroom (*Agaricus bisporus*) on inflammation and immune function, vitamin D status, gut health, satiety, glycaemic control, and lipid profile.<sup>17</sup>

### Food for thought

With the re-emergence of infectious disease amid the continuing rise in

chronic disease, we now face a dual problem of under- and over-nutrition. Prescribing specific whole foods to address vitamin D insufficiency or deficiency is beneficial as it encourages the consumption of other essential nutrients, potentially replaces less nutritious foods in the diet, and unlike a pill, it can invite social connection through a meal occasion - something so many are craving in the wake of the pandemic.

It's as simple as prescribing sun-exposed mushrooms for your patients at risk of inadequate vitamin D.

For more mushroom science and facts, visit:

<https://nraus.com/mushroomhub/>

**Dr Flavia Fayet-Moore is a nutrition scientist, Accredited Practising Dietitian, Registered Nutritionist, board-certified Lifestyle Medicine Professional, Honorary Associate of the University of Sydney and Adjunct Lecturer at The University of Newcastle. She is the CEO of Nutrition Research Australia, where she leads a team of highly skilled researchers and science translators to improve human health through the creation and dissemination of research.**

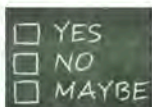
**Funding statement:** The research used to inform this article was funded by Hort Innovation, using the mushroom research and development levy and funds from the Australian Government.

**REFERENCES:** 1. Malacova, E., et al., Prevalence and predictors of vitamin D deficiency in a nationally representative sample of adults participating in the 2011-2013 Australian Health Survey. *Br J Nutr*, 2019. 121(8): p. 894-904. 2. Statistics, A.B.O., Australian Health Survey: Biomedical Results for Nutrients. 2011-12. 3. Xu, Y., et al., The importance of vitamin d metabolism as a potential prophylactic, immunoregulatory and neuroprotective treatment for COVID-19. *J Transl Med*, 2020. 18(1): p. 322. 4. Martineau, A.R., et al., Vitamin D supplementation to prevent acute respiratory infections: individual participant data meta-analysis. *Health Technol Assess*, 2019. 23(2): p. 1-44. 5. Brighthope, I., A. Sali Am, and K. Ried, Vitamin-D and COVID-19: Time for the profession to take a stand. *Adv Integr Med*, 2021. 8(2): p. 77-78. 6. Liu, N., et al., Low vitamin D status is associated with coronavirus disease 2019 outcomes: a systematic review and meta-analysis. *Int J Infect Dis*, 2021. 104: p. 58-64. 7. Owen, G. Millions of elderly and vulnerable will get free Vitamin D from government as evidence grows that it helps in battle against Covid-19. 2020; Available from: <https://www.dailymail.co.uk/news/article-8925321/Millions-elderly-vulnerable-free-Vitamin-D-government.html>. 8. Winzenberg, T., et al., Vitamin D and the musculoskeletal health of older adults. *Aust Fam Physician*, 2012. 41(3): p. 92-9. 9. Kimlin, M., et al., Are the current Australian sun exposure guidelines effective in maintaining adequate levels of 25-hydroxyvitamin D? *J Steroid Biochem Mol Biol*, 2016. 155(Pt B): p. 264-70. 10. Voo, V.T.F., et al., Vitamin D status in an Australian patient population: a large retrospective case series focusing on factors associated with variations in serum 25(OH)D. *BMJ Open*, 2020. 10(3): p. e032567. 11. Nowson, C.A., et al., Vitamin D and health in adults in Australia and New Zealand: a position statement. *Med J Aust*, 2012. 196(11): p. 686-7. 12. Jo Feeney, M., A.M. Miller, and P. Roupas, Mushrooms-Biologically Distinct and Nutritionally Unique: Exploring a "Third Food Kingdom". *Nutr Today*, 2014. 49(6): p. 301-307. 13. Urbain, P. and J. Jakobsen, Dose-Response Effect of Sunlight on Vitamin D2 Production in Agaricus bisporus Mushrooms. *J Agric Food Chem*, 2015. 63(37): p. 8156-61. 14. Cashman, K.D., et al., Effect of Ultraviolet Light-Exposed Mushrooms on Vitamin D Status: Liquid Chromatography-Tandem Mass Spectrometry Reanalysis of Biobanked Sera from a Randomized Controlled Trial and a Systematic Review plus Meta-Analysis. *J Nutr*, 2016. 146(3): p. 565-75. 15. Pusztahelyi, T., Chitin and chitin-related compounds in plant-fungal interactions. *Mycology*, 2018. 9(3): p. 189-201. 16. Cheah, I.K. and B. Halliwell, Could Ergothioneine Aid in the Treatment of Coronavirus Patients? *Antioxidants (Basel)*, 2020. 9(7). 17. Blumfield, M., et al., Examining the health effects and bioactive components in Agaricus bisporus mushrooms: a scoping review. *The Journal of Nutritional Biochemistry*, 2020. 84(108453).

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**APPENDIX 28: MS128 FOOD AS MEDICINE WEBINAR**



## The emerging dual health challenge of infectious and chronic disease: Mushrooms and extra virgin olive oil as key therapeutic foods.



**Flávia Fayet-Moore**

Nutrition Scientist and  
Accredited Practising Dietitian

PhD, MNutrDiet, RNutr, APD, FASLM



**Ian Breakspear**

Herbal and Naturopathic Clinician,  
Educator and Researcher

MHerbMed (USyd) DipNat DipBotMed  
CertPhyto FNHAA



## Rules of engagement: Simply get involved – ask questions!

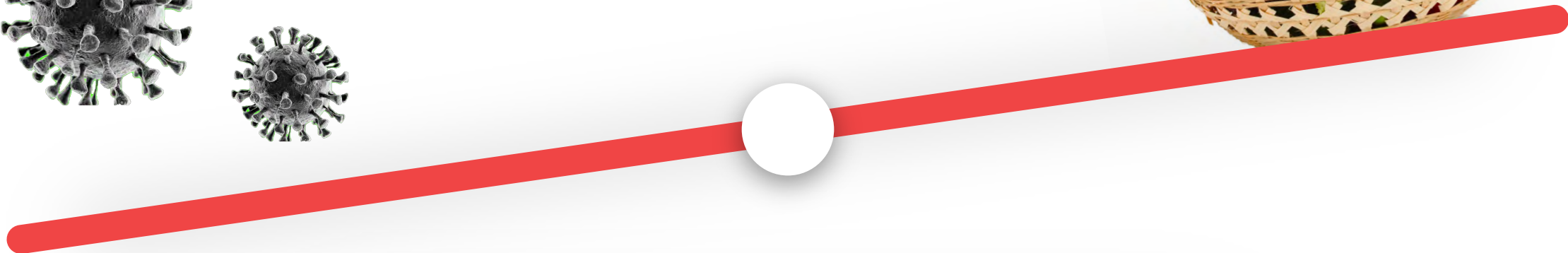
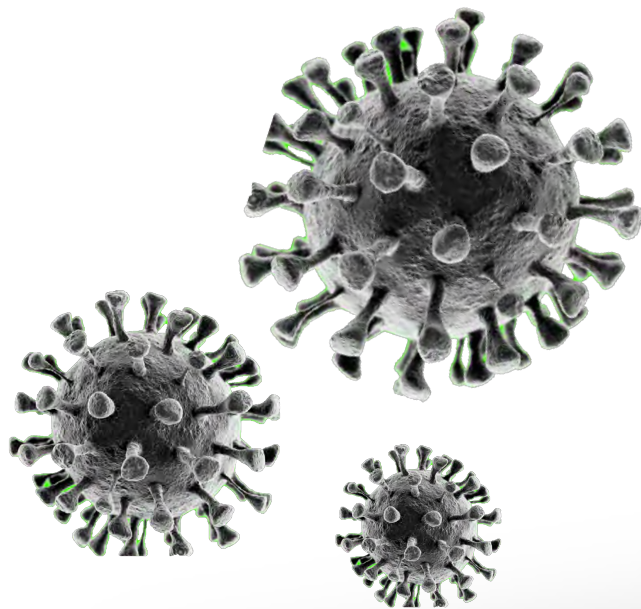
Explore 4 key themes: 40 minutes

- Infectious and chronic disease: a dual pandemic?
- Nutrition and immunity: what are the potential targets?
- Food as medicine: what foods can support the modern health era?
- Supplements Vs Food: Is there a winner?

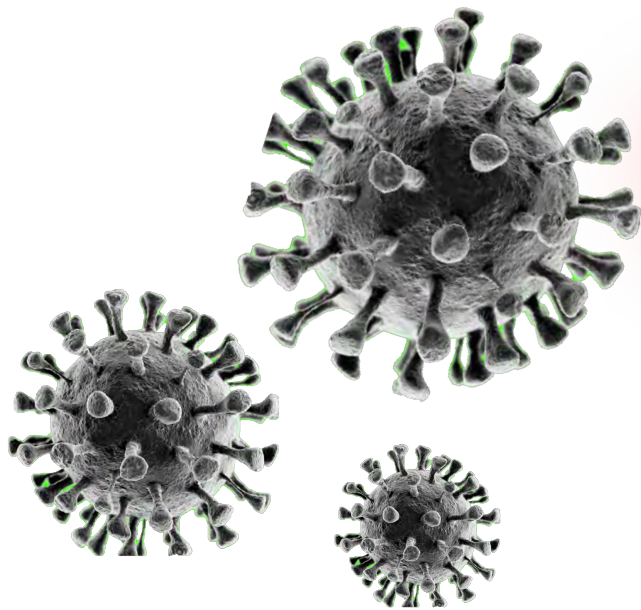
- Q&A Discussion: 15 min



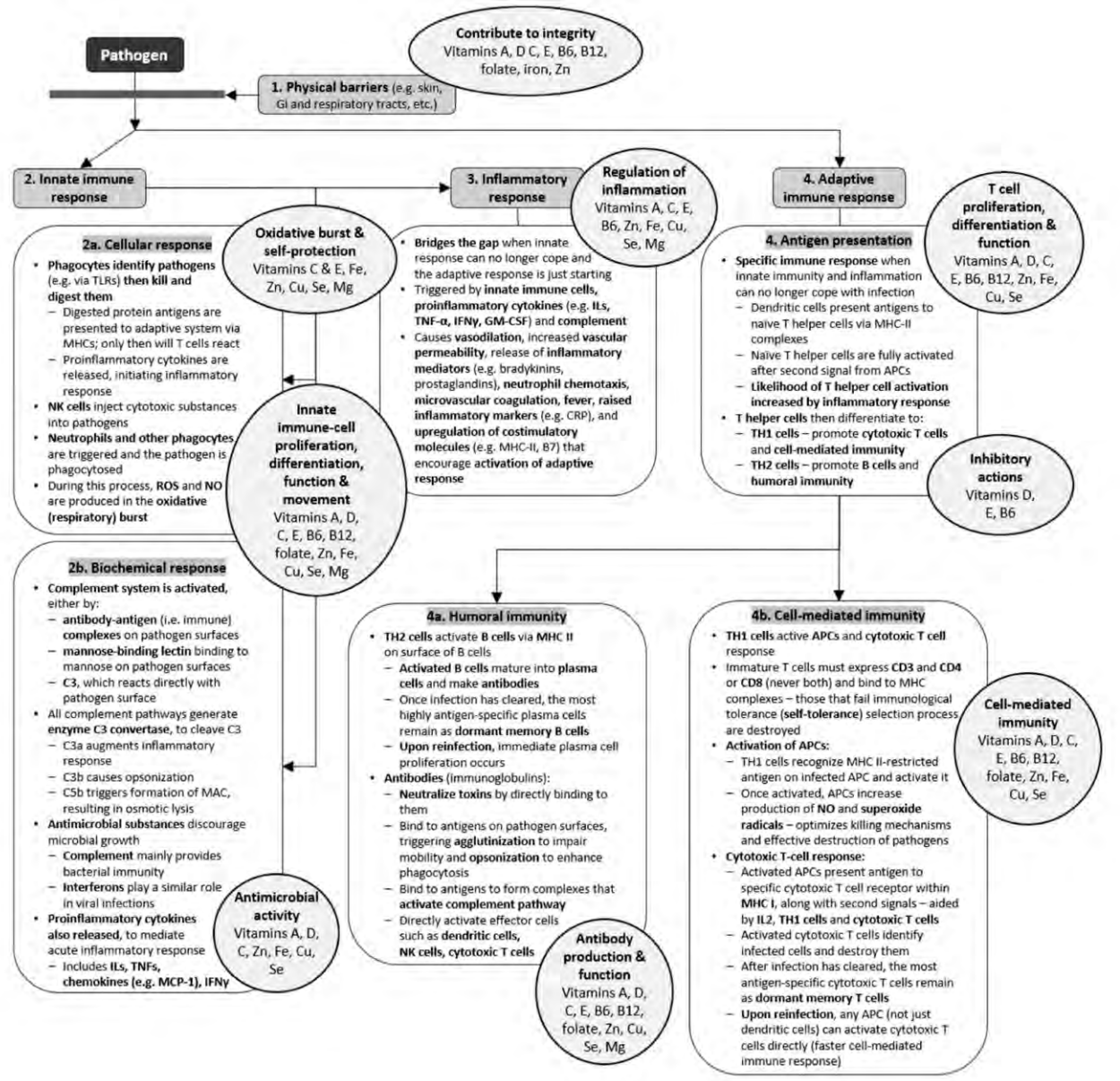
Infectious and chronic disease:  
A dual pandemic?



Nutrition and immunity:  
What are the potential targets?

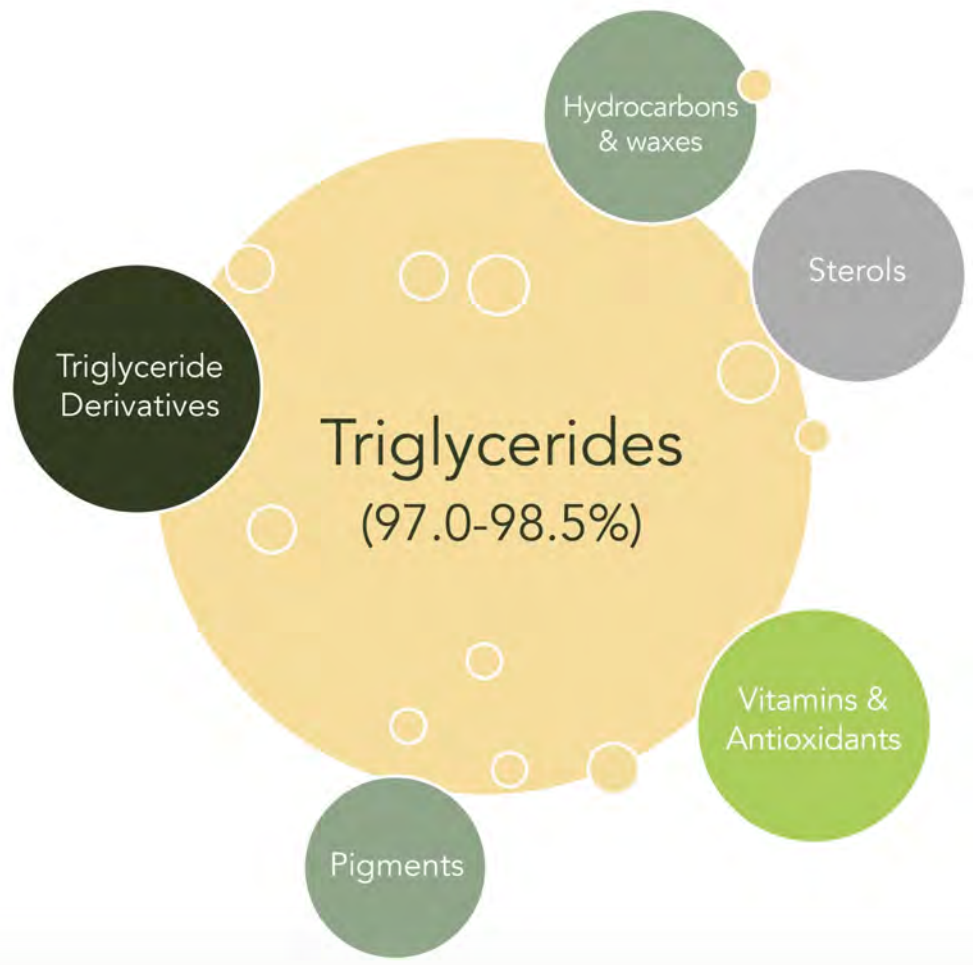
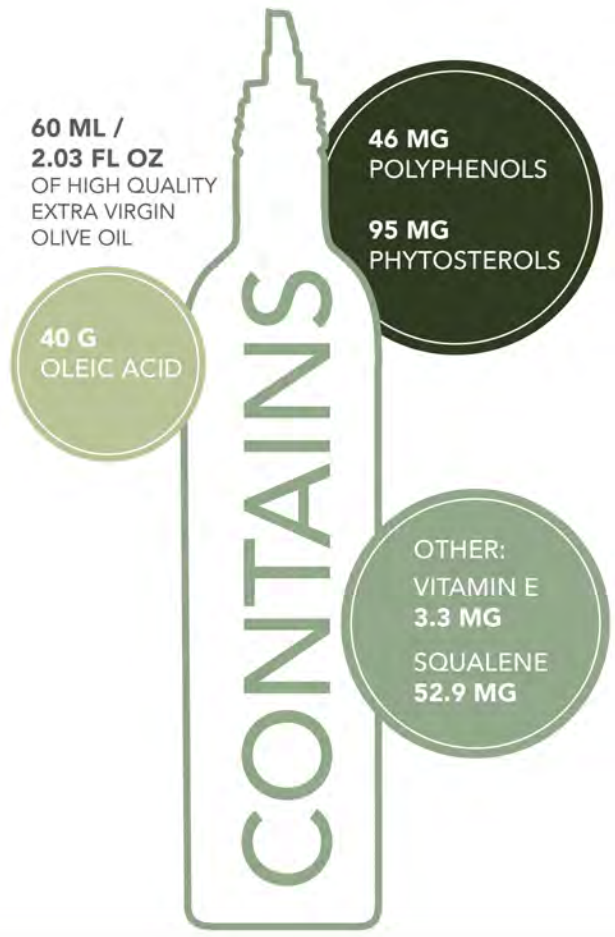


**Iron**  
**copper Folate Zinc**  
**Selenium Vitamin B12**  
**Vitamin A Vitamin C**  
**Vitamin D**



Gombart, Pierre & Maggini, Nutrients, 2020







Review

## Could Ergothioneine Aid in the Treatment of Coronavirus Patients?

Irwin K. Cheah <sup>1,2</sup> and Barry Halliwell <sup>1,2,\*</sup>

<sup>1</sup> Department of Biochemistry, Yong Loo Lin School of Medicine, National University of Singapore, Singapore 117596, Singapore; bchickm@nus.edu.sg

<sup>2</sup> Life Science Institute, Neurobiology Programme, Centre for Life Sciences, National University of Singapore, Singapore 117456, Singapore

\* Correspondence: bchbh@nus.edu.sg; Tel.: +65-6516-6663

Received: 4 June 2020; Accepted: 2 July 2020; Published: 7 July 2020



**Abstract:** Infection with SARS-CoV-2 causes the coronavirus infectious disease 2019 (COVID-19), a pandemic that has, at present, infected more than 11 million people globally. Some COVID-19 patients develop a severe and critical illness, spurred on by excessive inflammation that can lead to respiratory or multiorgan failure. Numerous studies have established the unique array of cytoprotective properties of the dietary amino acid ergothioneine. Based on studies in a range



Food as medicine:  
What foods can support the  
modern health era?



### NOT A VEGETABLE

But contains:  
resistant starch  
phytonutrients  
potassium



### NOT AN ANIMAL

But contains:  
vitamin B12  
vitamin D



### NOT A WHOLE GRAIN

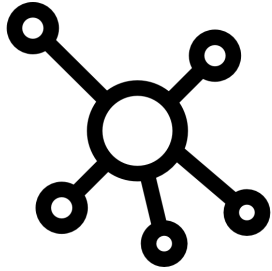
But contains:  
beta-glucans  
prebiotics  
riboflavin



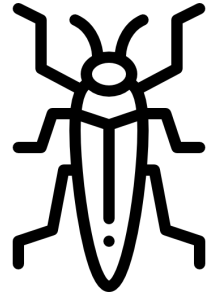
### NOT A NUT

But contains:  
copper  
selenium

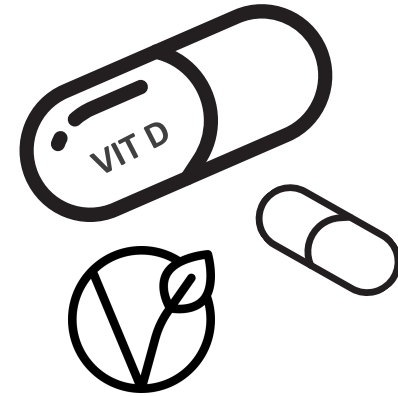
Plant or Animal?



ERGOTHIONEINE



CHITIN



ERGOSTEROL

Smith E et al. Ergothioneine is associated with reduced mortality and decreased risk of cardiovascular disease. Heart 2020;106:691-697.

3 unique compounds



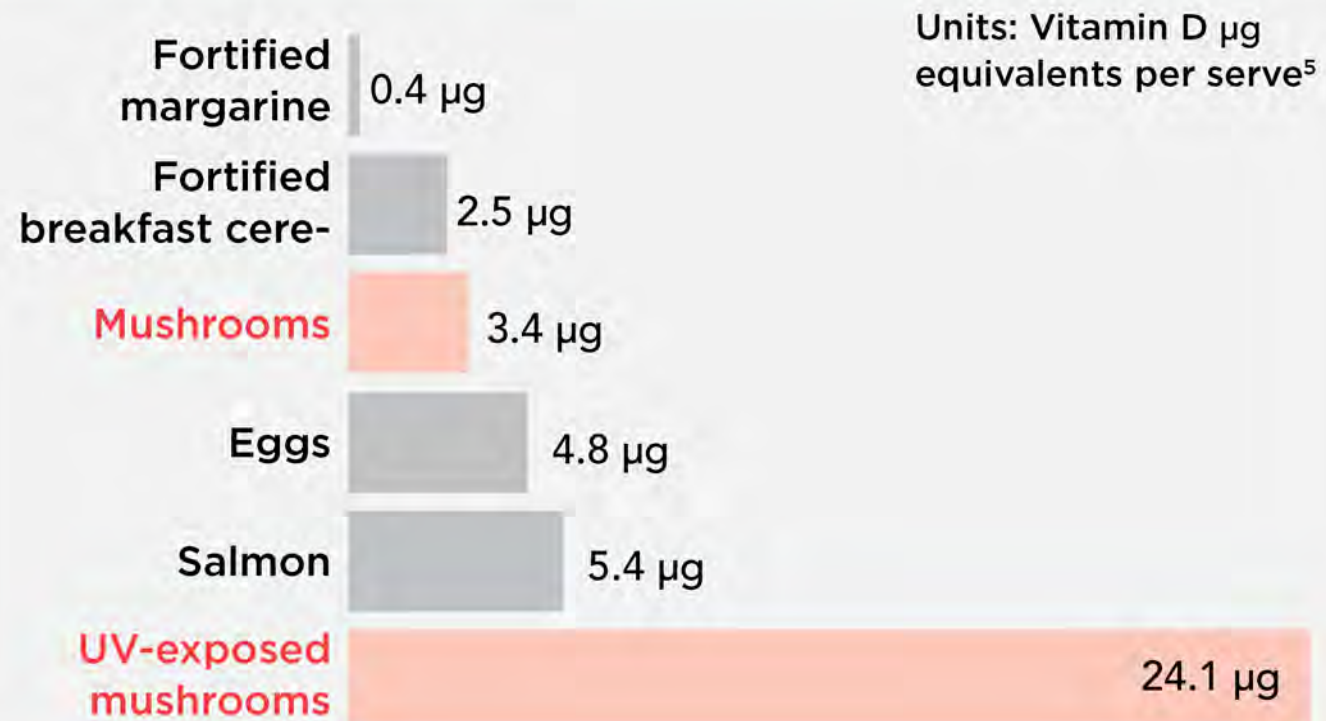
2-3 ug

UV



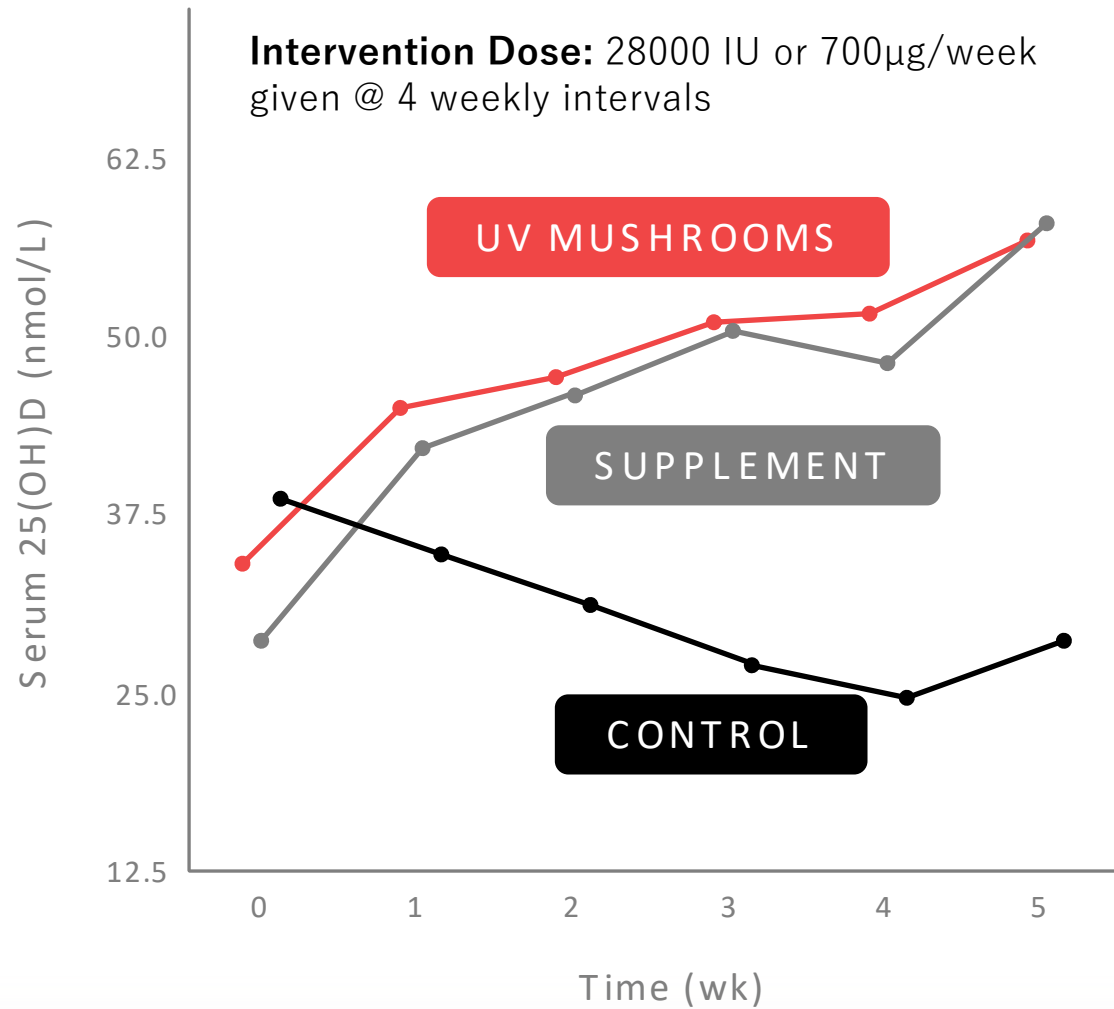
24 ug

## There are few good foods sources of vitamin D



FSANZ. Australian Food Composition Database 2019

**Intervention Dose:** 28000 IU or 700µg/week given @ 4 weekly intervals



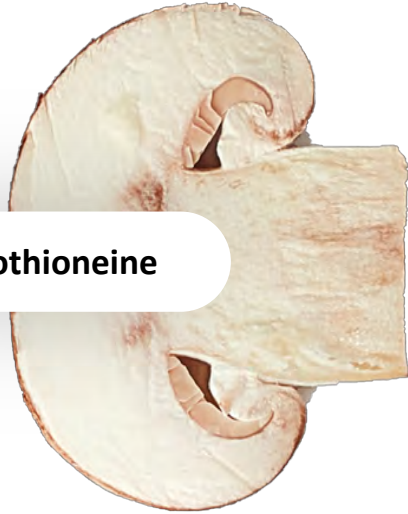
Urbain, Singler, Ihorst, Biesalski & Berts. Eur J Clin Nutr 2011



Selenium  
Copper



Ergothioneine

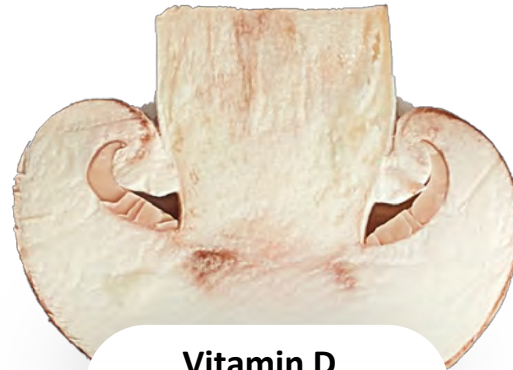


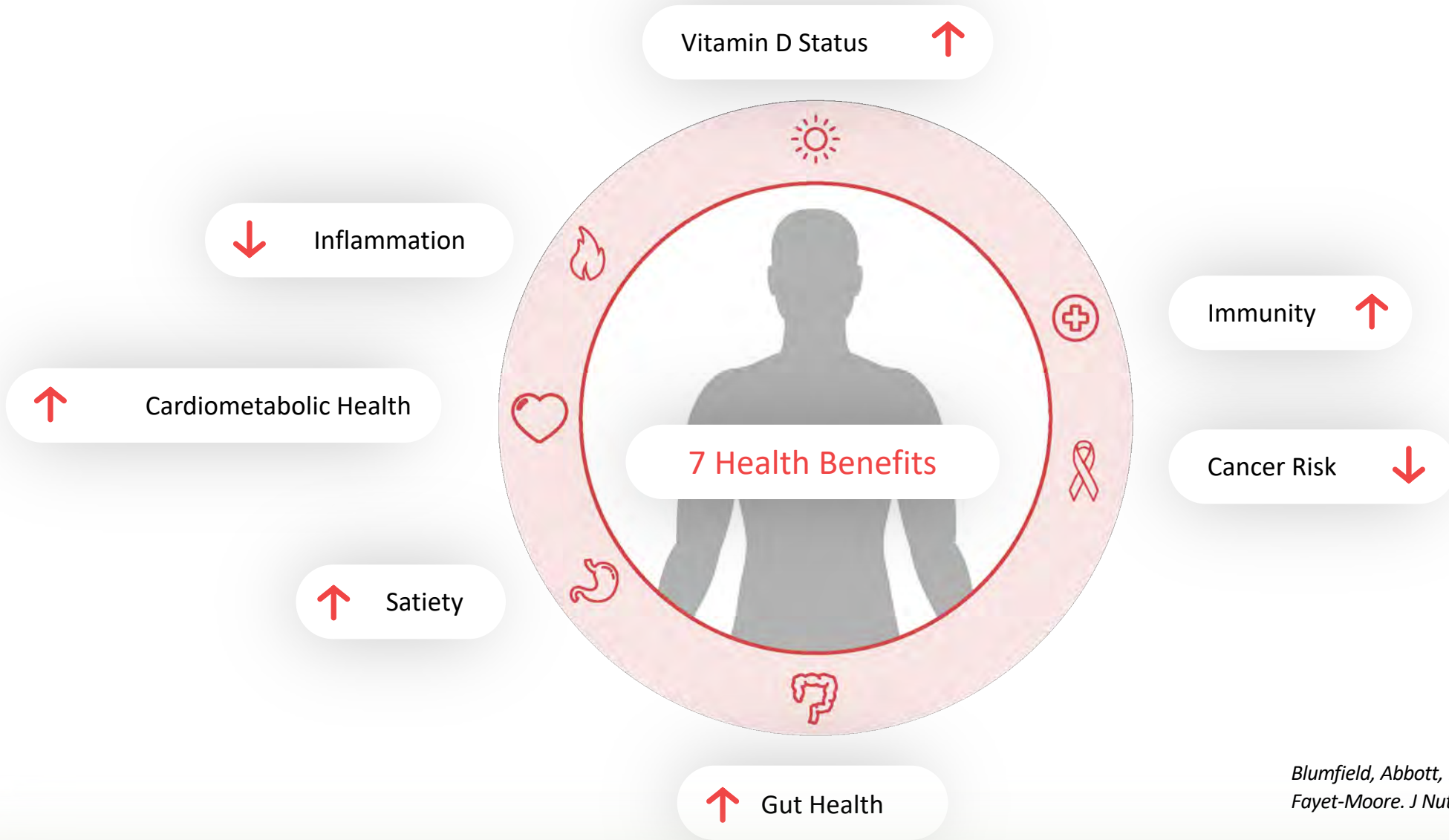
POSITIVELY LINKED WITH  
**IMMUNE  
FUNCTION**

Beta-Glucans



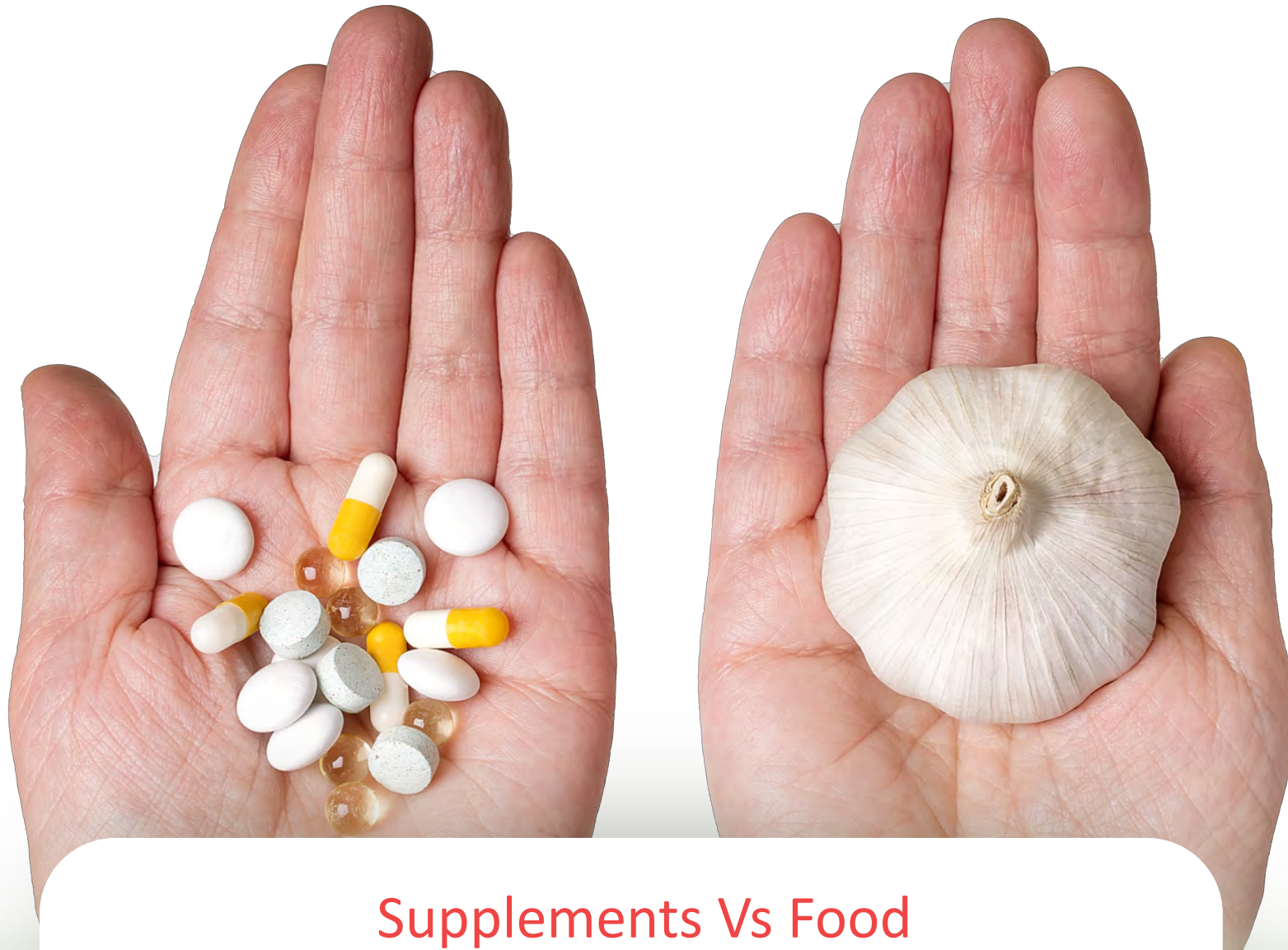
Vitamin D  
Ergosterol



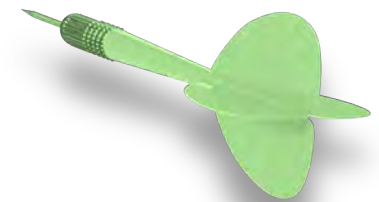
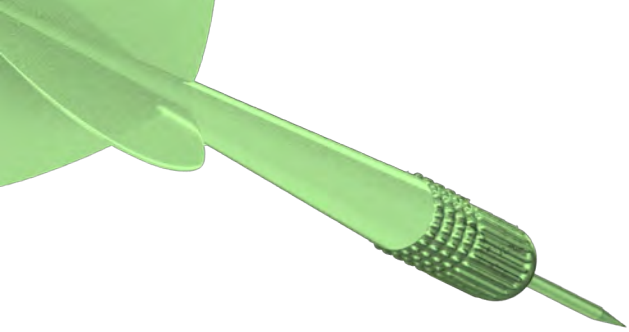


Blumfield, Abbott, Duve, Cassettari, Marshall, & Fayet-Moore. *J Nutr Biochem* 2020





Supplements Vs Food  
Is there a winner?





+



= 3





Cook on low



Add lemon juice





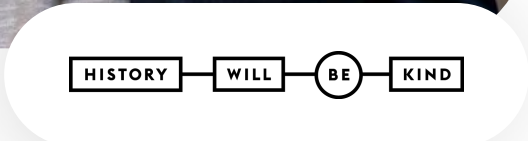


# Q&A



# Wrap Up

# Acknowledgements





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