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Mushrooms and Health 2014:
Clinical and Nutritional Studies in Humans

Report prepared by:

Peter Roupas, Debra Krause and Pennie Taylor
CSIRO Food and Health Flagship
Australia

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Enquiries

All enquiries should be addressed to:

Dr Peter Roupas
CSIRO Food and Health Flagship
Private Bag 16, 671 Sneydes Road
Werribee, Victoria, 3030
Australia

Tel: +61 (3) 9731 3283

E-mail: peter.roupas@csiro.au

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EXECUTIVE SUMMARY

The information in this report covers nutritional profiling of mushrooms and details of human nutritional and clinical studies undertaken on the effects of mushrooms and their components on human health. The number of studies in humans evaluating the effects of mushroom intake has been increasingly significantly in recent years, thereby building a more solid evidence-base to determine clinically-relevant human health outcomes from mushroom nutritional interventions. Below are the key updates from the 12 nutrient databases used in the nutritional profiling of mushrooms, and while the details of human studies are described in the body of this report, some new potential applications, which hold increasing promise, and warrant further research, are also highlighted below.

NUTRITIONAL PROFILING

- The current review of nutritional data identified an additional 8 mushroom varieties and a reduction of 2 mushroom varieties reported (since the 2012 report), which are shown in Table 1. This report now provides nutritional profiles for a total of 109 mushroom varieties from the previous 103.

- In total, 102 updates to existing mushroom profiles have been carried out on 59 raw mushroom varieties, 40 cooked mushroom varieties and 3 dried mushroom varieties.

- During the review of the 12 nutrient databases worldwide, a growing report of wild fungi species and mixed dishes reporting mushrooms as a large proportion of the meal have been observed and warrant future investigation.

- In comparison to common vegetables, the common white button mushroom (Agaricus bisporus) remains a remarkable source of protein, phosphorus, magnesium and vitamin D. Human trials have demonstrated the bioavailability of vitamin D2 from UV-B-irradiated button mushrooms in healthy adults deficient in serum 25-hydroxyvitamin D. Furthermore, the bioavailability of vitamin D2 from vitamin D2-enhanced button mushrooms via UV-B irradiation was effective in improving vitamin D status and not different to a vitamin D2 supplement. Mushrooms are one of the very few foods that provide a natural source of vitamin D. Biosynthesis of vitamin D levels from

ergosterols in mushrooms can be significantly enhanced by exposure to sunlight or ultraviolet light post-harvest (e.g. during drying).Vitamin D is an important factor for immune function

- Vitamin D – of the Culinary specialty mushroom varieties, Maitake Raw (Can) provides 29.5 μg/100g raw weight, and cooked (fried), Agaricus bisporus (Fin) with 15.9μg /100g. For the dried mushrooms, the new mushroom reported, Tree ears, Shiro-Kikurage, (Jap) provides a substantial 970μg/100g dried weight.

- Cultivated mushrooms (e.g. *Agaricus bisporus*/white, *Agaricus bisporus*/brown, *Lentinus edodes, Pleurotus ostreatus* and others) are a valuable source of several micronutrients and are a low kilojoule, nutrient-dense food. Mushrooms are low in sodium and high in glutamate which makes them a useful flavour addition to a low-salt diet. As they are low in kilojoules, they are ideal for incorporation in weight loss programs.

NEW APPLICATIONS IN HUMAN HEALTH

BRAIN HEALTH / COGNITION

Epidemiological studies and one direct intervention trial in humans have provided suggestive evidence for possible effects of mushroom intake on some aspects of brain health, however, to date, there is insufficient evidence from human studies to confirm clinically-relevant outcomes on brain health parameters. Although preliminary, new data showing protective effects of mushrooms on beta-amyloid peptide toxicity in the brain and mild cognitive impairment (both precursors to dementia) are noteworthy and warrant further research on the ability of mushroom consumption to potentially delay the onset of dementia / Alzheimer's disease.

CANCER THERAPY ADJUVANTS

Aromatase converts androgens to estrogens and aromatase expression occurs in cancerous breast tumours. While mushroom extracts have previously been suggested to inhibit aromatase activity, new research has recently suggested that beta-glucans in such extracts may be responsible for this action. The potential effects of beta-glucans on estrogen receptors and aromatase activity in breast cancer remain to be confirmed by well-designed clinical trials using purified beta-glucans, as to date

the studies have been done with beta-glucan containing extracts, primarily from mushrooms and yeasts, and therefore, other components in these extracts may also play a role in the observed effects. However, such studies suggest that beta-glucans may have physiologically relevant effects e.g. via direct effects on estrogen receptors which are separate from their previously described immunomodulatory effects.

Several human trials have recently described physiological benefits and significant improvements in quality of life indicators from mushroom consumption by patients affected by a variety of cancers (with the main exception of prostate cancer, where the data have not shown any clinically-relevant benefits from mushroom consumption), thereby significantly strengthening the body of evidence for physiologically-relevant impacts on human health outcomes. For example, clinical trials have reported that chemo-immunotherapy using Lentinan, the backbone of beta-(1, 3)-glucan with beta-(1, 6) branches, purified from Shiitake mushrooms as an adjuvant to chemotherapy, prolonged the survival of patients with advanced gastric cancer, compared to chemotherapy alone. Lentinan has now been approved as a biological response modifier for the treatment of gastric cancer in Japan.

There is a rapidly growing body of evidence that suggests that mushrooms may have an immune-stimulatory effect on immune-compromised patients.

RESPIRATORY TRACT INFECTIONS

A clinical trial in children with recurrent respiratory tract infections has reported preventative effects of pleuran, an insoluble beta-glucan isolated from Pleurotus ostreatus, on morbidity caused by respiratory infections. The product significantly decreased the frequency of flu and flu-like disease and the number of lower respiratory tract infections and provided a statistically significant modulation of humoral and cellular immunity. Additional human trials have also shown that pleuran significantly reduced the incidence of upper respiratory tract infection symptoms in athletes, increased the number of circulating natural killer cells and prevented reduction of natural killer cell activity. Interestingly, soluble oat beta-glucan supplementation did not alter the incidence of upper respiratory tract infection symptoms in endurance athletes. These data from multiple clinical trials in different population/age groups significantly strengthen the level of evidence for an effect of this mushroom beta-glucan on respiratory tract infections.

VACCINE ADJUVANTS

Polysaccharide K (PSK), extracted from *Coriolus versicolor* has been demonstrated to activate dendritic cells *in vitro* and *in vivo* and may have an application as a vaccine adjuvant, with another recent study also reporting that lectin purified from Pleurotus Ostreatus, used as an adjuvant, enhanced immunogenicity of hepatitis B virus DNA vaccination, also suggesting a possible use as a vaccine adjuvant in humans.

SCOPE

This report has evaluated published human trials on consumption of edible mushrooms and health outcomes in order to identify the levels of evidence, and to identify areas where future human dietary intervention trials are warranted to substantiate the effects of mushroom consumption on human health outcomes. While the report focuses on clinical and nutritional studies in humans, animal and *in vitro* studies that provide lower levels of evidence are also discussed, particularly where they provide insights into the cellular mechanisms that may mediate potential human health outcomes.

METHODOLOGY

CAPTURE AND EVALUATION OF MEDICAL AND SCIENTIFIC INFORMATION

The information on mushrooms and health was sourced via detailed and thorough strategic electronic searches of medical, scientific and technical literature based on the edible mushroom varieties and health conditions identified in the research proposal. The systematic literature searches were carried out using the following databases:

PubMed – a service of the US National Library of Medicine that includes over 16 million citations from the MEDLINE database and other life science journals.

SCOPUS - an abstract database covering 25 million abstracts from over 16,000 journals across 4,000

publishers.

Web of Science – 10,000 major journals across 164 scientific disciplines.

CSIRO Electronic Journals Collection (4,000 e-journals).

The captured records were cross-checked across the above databases. Epidemiological and clinical trials were also included in the review and evaluations. The last series of searches on the above databases were completed on May 8, 2014 and the database contains papers published up to this time. Searches for clinical trials were last updated on May 23, 2014.

CLINICAL TRIAL DATABASES

The search strategy aimed to find published English language studies. A three-step search strategy was utilised to complete the report. An initial limited search of MEDLINE was undertaken followed by analysis of the text words contained in the title and abstract, and of the index terms used to describe relevant articles. A second search, using identified keywords, MESH and index terms, was then undertaken across all included databases. Thirdly, the reference list of identified reports/trials and articles was searched for additional studies. The listing of the sources and databases used is provided below.

The following databases were searched for systematic reviews of clinical trials and for the primary studies (clinical trials):

- Medline on Pub Med
- Science Citation Index (searched on the CSIRO Network)
- Cochrane Central (Database of Systematic Reviews and Cochrane Collaboration Central Register of Controlled Trials).
- Centre for Reviews and Dissemination Databases (Database of Reviews of Effects (DARE), NHS Economic Evaluation Database (NHS EED), Health Technology Assessment (HTA) Database, Centre for Reviews and Dissemination (CRD).
- Joanna Briggs Institute (JBI) Library of Systematic Reviews and Implementation Reports.

Current ongoing trials and as-yet-unpublished trials that might yield data were identified using the following databases:

- Clinical trials.gov
- ISRCTN International *meta*Register of Current Controlled Trials which includes the following sub-files:

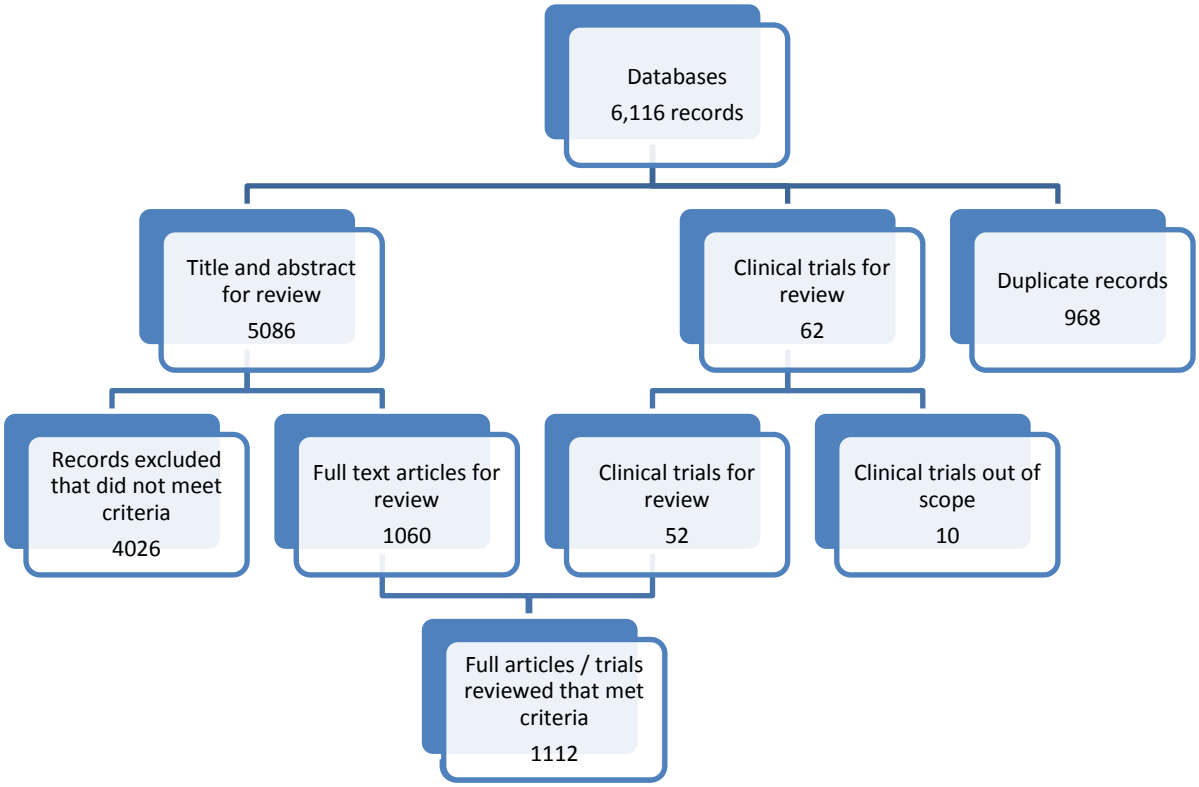
Action Medical Research (UK)
Medical Research Council (UK)
UK Trials (UK)
The Wellcome Trust (UK)
NIHR Health Technology Assessment Program (HTA) (UK)
NIH Clinical Trials.gov Register
Cochrane Collaboration Central Register of Controlled Trials
Australian and New Zealand Clinical Trials Registry (ANZCTR)

- World Health Organization (WHO) International Clinical Trials Registry Platform (ICTRP) portal which includes the following sub-files:

Australian New Zealand Clinical Trials Registry
ClinicalTrials.gov
ISRCTN
Chinese Clinical Trial Registry
Clinical Trials Registry – India
German Clinical Trials Register
Iranian Registry of Clinical Trials
Japan Primary Registries Network
Sri Lanka Clinical Trials Register
The Netherlands National Trial Register

The searches did not include unpublished and non peer-reviewed studies, nor did they include abstracts from conference proceedings where the primary data was not available for evaluation.

Figure 1. Flow diagram of literature reviewed.



NUTRIENT PROFILING OF MUSHROOMS

DATABASE UPDATE AND OBSERVATIONS

The 2014 review of the available nutritional data for mushrooms identified an additional 8 newly profiled mushrooms varieties (since the 2012 report), shown in Table 1. This report now provides nutritional profiles for a total of 109 mushroom varieties, which is steadily increasing from 72 mushroom species profiled 2010 and 103 in 2012. For completeness, the deletions are also noted.

Table 1: Mushroom varieties added and deletions - 2014 Report

RAW MUSHROOMS	COOKED MUSHROOMS
Common Mushroom (Agaricus bisphorus) Mushroom, raw (UK) Mushroom, honey (Ger) **Culinary Specialty Mushrooms** Boletus edible (Ger)	**Common Mushroom (Agaricus bisphorus)** Mushroom, Stewed (UK) Mushrooms, cooked in sunflower oil (UK)
DRIED MUSHROOMS	
Culinary Specialty Mushrooms Tree ears, Kiurage, Dried (Jap) Tree ears, Shiro-kikurage, Dried (Jap) Tree ears, Arage-kikurate, Dried (Jap)	
DELETED MUSHROOMS	
Raw Mushrooms, Common Raw (UK) **Cooked** Mushrooms, Common fried in butter (UK) Mushrooms, Fried in corn oil (UK)	

The UK currently holds over 10,000 mushrooms in their nutrient database, however data was not clearly distinguishable between edible versus inedible mushrooms and consequently such data is not captured. During the review of the 12 nutrient databases worldwide, growing reports of wild fungi species and mixed dishes reporting mushrooms as a large proportion of the meal have been observed. The safety of intake is a concern amongst the wild fungi species, so these species are outside the scope of this report until safety of intake is confirmed. Due to comprehensive food coding requirements to classify the contribution of mushrooms of a mixed dish, accurately, for nutrient profiling, the nutrient composition tables for mixed dishes by proportion of mushrooms is also outside the scope of this report.

It is clear that the growing interest in the nutritional and health benefits of mushrooms are on the rise as we progress towards personalised nutrition. As a result, future reports will need to consider the growing varieties of mushrooms/fungi and mixed dishes for comprehensive reporting.

MACRONUTRIENTS AND MICRONUTRIENT CONTENT

The review process identified a steady report of nutrients between 2012-2014 for which the common mushroom varieties provide >10% recommended dietary intake (RDI) or Adequate Intake (AI) for Adults 19 years and over by 100g (20g for dried mushroom varieties).

The comprehensive compositional tables for the macronutrient contents, vitamin and mineral contents of raw/fresh, canned, dried and culinary specialty varieties of the common mushroom varieties remain to be a key component of the mushroom and health report and are found in Appendix 1. The compositional data has been tabulated against RDI's, EAR (Estimated Average Requirement) and AI's for females and males of different ages for comparison. Summary tables also remain an integral component of this report. New nutrients reaching >10% of RDI/AI for the 2014 report include Iodine for the mushroom Agaricus bisporus (Ger).

Table 2. Common raw mushroom (*Agaricus bisporus*) macronutrient content – raw weight 100g, Australian nutrient composition data.

Nutrient	Content
Protein (g)	3.3
Carbohydrate (g)	0.3
Fat (g)	0.3
Fibre (g)	1.5
Energy (kcal/kj) Inc. Dietary fibre	25 / 103

As shown in Tables 2 and 3, the common white button mushroom (Agaricus bisporus) is a valuable source of several micronutrients in a low energy, nutrient dense food.

As a food, mushrooms are low in protein providing 2-3g/100g raw weight. Protein quality of mushrooms to date, has not been extensively investigated. The amino acid profile of common mushroom protein suggests the Protein Digestibility Corrected Amino Acid Score (PDCAAS) - a method of evaluating the protein quality based on the amino acid requirements of humans – is approximately 0.66, assuming a digestibility of 70%. The highest score is 1, which applies to animal protein sources. As such, this suggests a moderate protein quality. Studies of protein quality in other species suggest a lower score. Of note is that the PDCAAS score does not consider where the protein was digested within the gastrointestinal tract (i.e. past the ilium) therefore warranting future research on the protein quality in mushrooms.

Ten popular species of both edible and medicinal Korean mushrooms have been analysed for their free amino acids and disaccharides. The average total free amino acid concentration was 121 mg/g in edible mushrooms and 61 mg/g in medicinal mushrooms, respectively. The average total of free amino acids for all mushrooms, edible mushrooms and medicinal mushrooms was 91.13 mg/g. *Agaricus blazei* (227.00 mg/g) showed the highest concentration of total free amino acids; on the other hand, *Inonotus obliquus* (2.00 mg/g) showed the lowest concentration among the 10 species of mushrooms. The average total carbohydrate concentration was 46.67 mg/g in the 10 species of mushrooms, where the edible mushrooms contained 66.68 mg/g and the medicinal mushrooms contained 26.65 mg/g. The carbohydrate constituents of the 10 mushroom species were mainly mannose (36.23%), glucose (34.70%), and xylose (16.83%) (Kim et al., 2009).

Vitamin B12 has a molecular weight of 1355.4 and belongs to the “corrinoids” group. Vitamin B12 commonly refers to cyanacobalmin, the chemically stable and unnatural form of cobalamin. The usual sources of vitamin B12 are commonly reported as animal-derived sources, including meat, milk and eggs. Plant based sources remain a topical area of interest as they are reported as being devoid of B12, consequently highlighting the risks of vitamin B12 deficiencies in the vegetarian population. However, mushrooms cultivated on (organic) manure-enriched compost, may contain considerable amounts of inactive corrinoid compounds and may be responsible for previous reports of high vitamin B12 levels in mushrooms. Wantanabe and colleagues report that edible wild mushroom species are popular amongst vegetarians in European countries although they identified only trace levels of approximately 0.09μg vitamin B12 /100g dry weight wild mushrooms. Conversely it was identified that the wild mushrooms, black trumpet *(Craterellus conucopioides)* and golden Chantrelle (*Cantharellus cibarius)* contained greater detectable levels of vitamin B12 (1.09–2.65 μg/100 g raw weight) as does the dried Shiitake mushroom (*Lentinula edodes)* providing an average of 5.1μg/100g

of dried weight (1.3-12.7μg/100g). Although it is predicted that 50g of dried shiitake mushrooms would meet the RDI of 2μg/day this level of dried weight mushroom is large and likely not sustainable for daily intake (Watanabe et al., 2014).

Nevertheless, the presence of any vitamin B12 is intriguing, as conventionally, only animal sources are thought to provide vitamin B12. A study of vitamin B 12 concentrations in *Agaricus bisporus* reported higher concentrations of vitamin B12 in the outer peel than in the cap, stalk, or flesh, suggesting that the vitamin B12 is probably bacteria-derived (Koyyalamudi et al., 2009). High concentrations of vitamin B12 were also detected in the flush mushrooms including cups and flats. HPLC and mass spectrometry showed the vitamin B12 retention time and mass spectra to be identical to those of the standard vitamin B12 and those of food products including beef, beef liver, salmon, egg, and milk but not of the pseudovitamin B12, an inactive corrinoid in humans. Further investigation of this is warranted (Mattila et al., 2001).

The micronutrient content of the common button mushroom (*Agaricus bisporus*) is shown in **Table 3,** which also shows the estimated average requirement (EAR) and recommended daily intake (RDI) for Australian adults that is provided by a 100g serve of mushrooms. The nutrients for which mushrooms provide >10% of the recommended daily intake (RDI) for Australian adults are riboflavin, niacin, vitamin D, phosphorus and selenium.

Mushrooms remain one of the very few foods that provide a natural source of vitamin D. The vitamin D levels can be significantly enhanced by sunlight or irradiation. The interest in vitamin D in mushrooms continues, as new mushrooms varieties, particularly dried, are provided each year. For the raw, common mushroom varieties, Agaricus bisporus is of particular interest showing that 100g of mushroom exposed to UV light can provide up to 11.2μg of Vitamin D, a significant increase in vitamin D when compared to non-exposed Agaricus bisporus providing 0.2μg (USDA).

For the culinary specialty mushroom varieties, Maitake Raw (Can) provides 29.5 μg vitamin D/100g raw weight, and of the cooked mushrooms, Agaricus bisporus (Fin) (fried) provides 15.9μg /100g. For dried mushrooms, the new mushroom reported, Tree ears, Shiro-Kikurage, dried (Jap) provides a substantial 970μg/100g dried weight. In addition, mushrooms provide 22-26% of the RDI for selenium and 20-29% of the adequate intake (AI) for copper for males and female over 19 years respectively. Mushrooms are also low in sodium and low in kilojoules.

Table 3. Micronutrient content: Fresh weight/100g of *Agaricus bisporus* - Australian nutrient composition data (unless otherwise specified) RDI[1] and EAR[2] for Australian adults >19years of age.

Nutrient	Content	%[3] EAR Male	% RDI Male	% EAR Female	% RDI Female
Thiamin (B1) (mg)	0.025	3	2	3	2
Riboflavin (B2) (mg)[4]	0.37	34	29	41	34
Niacin equivalents (B3) (mg)	3.72	31	23	34	27
Folate (mcg, =µg)	18	6	5	6	5
Vitamin B6 (mg)[5]	0.02	2	2	2	2
Pantothenic acid (mg)[6]	1.15	19 AI		29 AI	
Biotin (µg) [7]	8.9	30 AI		36 AI	
Vitamin C (mg)	1.0	3	2	3	2
Beta-carotene equivalent (µg)[8]	13 = 2 µg RE	<1	<1	<1	<1
Vitamin D (µg) [9]	0.2	4 AI		4 AI	
Copper (mg)[10]	0.342	20 AI		29 AI	
Phosphorus (mg)	110	19	11	19	11
Magnesium (mg)[11]	10	3	3	4	3
Manganese (mg)[12]	0.058	1 AI		1 AI	
Molybdenum (µg)	1.6	5	4	5	4
Sodium (mg)[13]	8.0				
Potassium (mg)[14]	310	8 AI		11 AI	
Selenium µg)	15.4	26	22	31	26
Zinc (mg)[15]	0.56	5	4	9	7
Iron (mg)[16]	0.27	5	3	3	2
Calcium (mg)[17]	3	<1	<1	<1	<1
Iodine (µg) [18]	0	Nil	Nil	Nil	Nil

[1] RDI – Recommended Daily Intake
[2] EAR – Estimated Average Requirement
[3] Percentages have been rounded to whole numbers
[4] The RDI and EAR for riboflavin for adults >70 years is higher than adults <70 years
[5] The RDI and EAR for Vitamin B6 acid rises after 50 years
[6] Adequate Intake (AI) used as no RDI or EAR determined
[7] AI used as no RDI or EAR determined
[8] 6 µg all-trans β-carotene = 1 µg Retinol Equivalent
[9] Australian Vit D composition data are not available. USDA data was used. Data from Germany & Canada report higher levels of Vit D of 1.94µg & 1.90 µg respectively. AI was used as no RDI or EAR determined. AI rises after 50 years.
[10] AI used as no RDI or EAR determined
[11] The RDI and EAR is higher for adults>31 years therefore % RDI/EAR reduce accordingly
[12] AI used as no RDI or EAR determined
[13] It was not thought meaningful to include a % RDI or EAR for sodium
[14] AI used as no RDI or EAR determined
[15] Australian zinc composition data not available, US data was used
[16] Iron requirements for women reduce after the age of 50
[17] Calcium requirements increase after the age of 50 in women and 70 in men
[18] Iodine µg is 0 in the Australian & USDA data, 3µg in the UK data, 1 µg in the Finnish & Danish data

Mushrooms contain valuable amounts of the nutrients biotin and pantothenic acid. Biotin is necessary for a number of enzyme reactions in the body, deficiency is very unusual and has been seen rarely in people on total intravenous nutrition. Pantothenic acid is involved in fatty acid metabolism and is necessary for the production of coenzyme A (CoA). CoA plays an important role in the synthesis of fatty acids, amino acids (the building blocks of protein), some hormones and neurotransmitters. Like biotin, deficiency of pantothenic acid is very rare.

Mushrooms are also a good source of potassium. Potassium is an important electrolyte in the body and is the major cation within cells. It lessens the effect of salt on blood pressure. However, people with kidney disease should be aware that mushrooms are high in potassium, as they may need to limit their potassium intake.

The compositional tables (Appendix 1) identify the American nutrient composition data for 100g of raw weight of common white mushroom (*Agaricus Bisporus*). The nutrients providing $\geq$ 10% of the Recommended Dietary Allowance (RDA) and Allowable Intake (AI) for American males and females respectively over 19 years using USDA Dietary Reference Intakes are:

Vitamin B6 provide 11.4% RDA * Males/Females 19-50yrs
Riboflavin (B2) provide 28 -32% RDA
Niacin (B3) providing 28 -32% RDA
Pantothenic acid providing 19-28% AI
Phosphorus providing 9%-9% RDA
Copper providing 19-27% RDA
Selenium providing 13-16% RDA

In comparison with Australian grown mushrooms, the composition for riboflavin, niacin and pantothenic acid are similar. However, as mushrooms obtain a range of essential nutrients from soil growing medium such as phosphorus, copper and selenium, there are greater variances within the composition for these nutrients. Table 4 identifies the absolute mineral content for these minerals for ease of comparison.

Table 4: Key mineral content for 100g raw weight of *Agaricus bisporus* - USDA and Australian data.

***Agaricus bisporus* data source**	**Minerals**		
	[19]Phosphorus (mg)	[20]Copper (mg)	[21]Selenium (µg)
Australian composition data[22]	110	0.342	15.4
USDA Composition data[23]	86	0.318	9.3

Key Nutrient Comparisons of the common mushroom white (Agaricus bisporus) vs commonly consumed vegetables (Australian Data)

The 1995 National Nutrition Survey (NNS) identified that potatoes were the main contributor to the mean intake of vegetable products and dishes. Other notable vegetables in order of those most commonly consumed were tomatoes and tomatoe products, carrots and root vegetables, cabbage, cauliflower and brassica vegetables, peas, corn and beans, with leaf and stalk vegetables consumed less frequently.

The macronutrient content of the common mushroom (Agaricus bisporus) compared to the other commonly consumed Australian vegetables is displayed in Table 5 and Table 6. In comparison to common vegetables, the common mushroom (Agaricus bisporus) is a remarkable source of protein, phosphorus, magnesium and vitamin D.

[19] Aust RDI Male and female >19years = 1,000mg/d: USDA RDA Male and female >19years = 700mg/d
[20] Aust RDI Male > 19 years = 1.7mg/d; Female > 19 years = 1.2mg/d: USDA AI male and female >19 years = 0.9mg/d
[21] Aust RDI Male > 19 years = 70 µg/d Female > 19 years =60 µg /d: USDA RDA Male and female >19years = 55µg/d
[22] Obtained Online NUTTAB 2010 Nutrient Database – Mushroom, Common, Raw
[23] Obtained USDA Nutrient database - Mushroom, White, Raw

Table 5. Common mushroom (Agaricus bisporus) versus common vegetables - macronutrient content per 100g.

	Protein (g)	**Carbohydrate (g)**	**Fat (g)**	**Fibre (g)**	**Energy (Kcal/KJ)**
Common Mushroom (Agaricus Bisporus)	**3.3**	**0.3**	**0.3**	**1.5**	**25/103**
Corn, sweet, yellow, raw	3.3	18.7	1.35	2	86/360
Sweet potato, raw, unprepared	1.57	20.12	0.05	3	86/359
Pumpkin, raw	1.0	6.5	0.1	0.5	26/109
Carrots, raw	0.93	9.58	0.24	2.8	41/173
Broccoli, raw	2.82	6.64	0.37	2.6	34/141
Beans, snap, green, raw	1.83	6.97	0.22	2.7	31/131
Kale, Raw	4.28	8.75	0.95	3.6	49/205
Potatoes, white, flesh and skin, raw	1.68	15.71	0.1	2.4	69/288

USDA National Nutrient Database for Standard Reference, Release 26 (2013)

Table 6. Common mushroom (Agaricus bisporus) micronutrient (vitamin) content per 100g Australian Nutrient Composition Data Vs Commonly consumed vegetable (Aust and USDA).

	Thiamin (B1) (mg)	**Folate (mcg)**	**Vitamin B6 (mg)**	**Vitamin C (mg)**	**Phosphorus (mg)**	**Magnesium (mg)**	**Iron (mg)**	**Vitamin D (µg)**
Common Mushroom (Agaricus Bisporus)	0.025	18	0.02	1	110	10	0.27	0.2
Corn, sweet, yellow, raw	0.155	42	0.093	6.8	89	37	0.52	NA
Sweet potato, raw, unprepared	0.078	11	0.209	2.4	47	25	0.61	0.0
Pumpkin, raw	0.05	16	0.061	9	44	12	0.8	0.0
Carrots, raw	0.066	19	0.138	5.9	35	12	0.3	0.0
Broccoli, raw	0.071	63	0.175	89.2	66	21	.073	0.0
Beans, snap, green, raw	0.082	33	0.141	12.2	38	25	1.03	0.0
Kale, raw	0.110	141	0.27	120	92	47	1.47	0.0
Potatoes, white, flesh and skin, raw	0.071	18	0.203	19.7	62	21	0.052	0.0

BIOAVAILABILITY OF VITAMIN D IN HUMANS

Mushrooms exposed to sunlight or UV radiation are an excellent source of dietary vitamin D2 (Phillips and Rasor, 2013, Szabo et al., 2012) because they contain high concentrations of the vitamin D precursor, provitamin D2. When mushrooms are exposed to UV radiation, provitamin D2 is converted to previtamin D2. Once formed, previtamin D2 rapidly isomerizes to vitamin D2 in a similar manner that previtamin D3 isomerizes to vitamin D3 in human skin. Continued exposure of mushrooms to UV radiation also results in the production of lumisterol2 and tachysterol2 (Keegan et al., 2013, Krings and Berger, 2014). The formation of these major photoproducts has been observed to increase as a function of pulsed UV irradiation dose. Vitamin D2 was the most abundant product, followed by previtamin D2, lumisterol2 and tachysterol2 in order of decreasing abundance. The significance of these photoproducts on human health outcomes remains to be determined (Kalaras et al., 2012).

A study with 30 healthy adults (6 male, 19 female, mean age 35.2 years) of the bioavailability of vitamin D2 in mushrooms compared with the bioavailability of vitamin D2 or vitamin D3 in a supplement revealed that ingestion (once per day over a 3 month winter period) of 2000 International Units (IUs) of vitamin D2 in mushrooms was as effective as ingesting 2000 IUs of vitamin D2 or vitamin D3 in a supplement in raising and maintaining blood levels of 25-hydroxyvitamin D, which is a marker for vitamin D status. Therefore, mushrooms are a rich source of vitamin D2, that when consumed, can increase and maintain blood levels of 25-hydroxyvitamin D in a healthy range. Ingestion of mushrooms may also provide the consumer with a source of vitamin D3 and vitamin D4 (Keegan et al., 2013, Bogusz et al., 2013, Williams et al., 2013).

As mentioned above, mushrooms exposed to UVB radiation contain a significant amount of vitamin D2, although there is some doubt that vitamin D2 is not only less effective than vitamin D3 in maintaining total serum 25(OH)D concentrations, but that the ingestion of vitamin D2 can ultimately result in a decrease in total 25(OH)D concentrations. A randomised controlled trial of 38 adults consuming ergocalciferol from *Agaricus bisporus* or supplements for 6 weeks reported that ergocalciferol was absorbed and metabolized to 25-hydroxyergocalciferol (25(OH)D2) but did not affect vitamin D status, because 25-hydroxycholecalciferol (25(OH)D3) decreased proportionally in serum (Stephensen et al., 2012).

A further study with 90 volunteers (age range 40–65 years) that were randomly assigned to one of two 4-week studies: mushroom study (15 µg vitamin D2 or placebo mushroom powder) and capsule study (15 µg vitamin D3 or placebo capsules) has also reported that vitamin D2 from enhanced mushrooms was bioavailable and increased serum 25(OH)D2 concentration with no significant effect on 25(OH)D3 or total 25(OH)D (Stepien et al., 2013). An interesting aspect of this study was the significant reduction in high sensitivity C-reactive protein, a systemic inflammation marker in the vitamin D2 enhanced mushroom group. Inflammatory markers are not generally affected by vitamin D supplementation, so this observed effect of vitamin D2 from mushrooms warrants further research.

A single-blinded, randomized, placebo-controlled trial in 26 young subjects with serum 25-hydroxyvitamin D (25OHD) < 50 nmol/l undertaken over a 5 week period has demonstrated the bioavailability of vitamin D2 from UV-B-irradiated button mushrooms in healthy adults deficient in serum 25-hydroxyvitamin D. Furthermore, the bioavailability of vitamin D2 from vitamin D2-enhanced button mushrooms via UV-B irradiation was effective in improving vitamin D status and not different to a vitamin D2 supplement (Urbain et al., 2011).

These results are consistent with animal model studies, that have demonstrated that vitamin D2 from light-exposed edible mushrooms is safe and bioavailable (Calvo et al., 2013), with a recent study also demonstrating that rats fed UVB-exposed mushrooms had significantly higher plasma total 25OHD levels that were associated with increased innate immune response and anti-inflammatory effects (Babu et al., 2014).

EFFECTS OF MUSHROOMS AND MUSHROOM COMPONENTS ON HUMAN HEALTH

ADJUVANTS TO CANCER THERAPY

The first systematic review to evaluate the clinical effects of Ganoderma lucidum in cancer treatment has been undertaken by Jin and co-workers (Jin et al., 2012). The inclusion criteria for this Cochrane review included Randomised Clinical Trials (RCTs) comparing the efficacy of G. lucidum medications to active or placebo control in patients with cancer that had been diagnosed by pathology, and all types and stages of cancer were included. This systematic review, which included 5 RCTs, did not find sufficient evidence to justify the use of G. lucidum as a first-line treatment for cancer, and therefore it remains uncertain whether G. lucidum is able to help prolong long-term cancer survival. However, G. lucidum could be administered as an alternative adjuvant to conventional treatment in light of its potential of enhancing tumour response and stimulating host immunity. G. lucidum was generally well tolerated by most participants with only a small number of minor adverse events. No major toxicity was observed across the studies. The authors reported that the methodological quality of the included primary studies was generally "unsatisfying" and the results were reported inadequately in many aspects. This Cochrane review will be updated every 2 years.

A systematic review and meta-analysis of 13 randomized, placebo-controlled, double-blind trials that assessed the efficacy of Coriolus Versicolor (Yun Zhi) for survival in cancer patients reported that Yun Zhi treatment provided a significant survival advantage compared to standard conventional anti-cancer treatment (chemotherapy) alone equating to a 9% reduction in 5-year mortality. This effect was reported as being more evident in patients with breast cancer, gastric cancer, or colorectal cancer, but not in esophageal cancer and nasophayngeal carcinoma (Eliza et al., 2012).

The safety and effectiveness of a mushroom product, activated hexose correlated compound (AHCC), on chemotherapy-induced adverse effects and quality of life (QOL) in 24 patients with cancer has recently been described (Ito et al., 2014). The cancer patients received their first cycle of chemotherapy without AHCC and subsequently received their second cycle with AHCC and during this time, weekly blood tests, a questionnaire, and DNA levels of herpes virus type 6 (HHV-6) in saliva were undertaken. HHV-6 is frequently reactivated by physical and psychological stresses and is shed into saliva. Reactivation is also associated with serious human health outcomes such as chronic

fatigue syndrome. HHV-6 DNA levels increased during the first course of chemotherapy, but decreased significantly at the end of the second course in conjunction with improved QOL scores and improved hematotoxicity and hepatotoxicity. The authors concluded that the dose of AHCC had no harmful effect on patients with cancer undergoing chemotherapy and may have some beneficial immune-boosting effects on chemotherapy-induced adverse effects, and the level of HHV-6 DNA levels may be a useful biomarker of QOL in patients receiving chemotherapy. A mechanism of action for AHCC derived from shiitake mushrooms has recently been suggested to involve a stimulation of immune function via attenuated concentrations of stress hormones and catecholamines (Love et al., 2013).

Another study has also recently described improvements in quality of life factors (based on a questionnaire on physical and mental components) in cancer patients (n=67, 6 month open study) in remission following the consumption of a Agaricus blazei Murill mushroom extract (Ohno et al., 2013). Similar improvements in quality of life scores have been reported in cancer patients (n=10) receiving a combination of immunotherapy and oral administration of Lentinula edodes mycelia extract (1,800 mg/day) (Tanigawa et al., 2012). Interferon (IFN)-gamma secretion from peripheral blood cells was increased during the period with Lentinula edodes mycelia extract administration suggesting an immunostimulatory effect.

A small pilot study of 7 patients undergoing post-operative cancer chemotherapy has reported that the concomitant administration of Lentinula edodes mycelia extract with chemotherapy is safe and improves the quality of life and immune function of patients, although these potential effects remain to be confirmed by larger trials (Yamaguchi et al., 2011).

However, in contrast to the above studies, a prospective cohort study of 481 terminally ill cancer patients at 11 university hospitals in Korea reported that complementary and alternative medicine (including mushroom intake) users had clinically significant worse changes than non-users of complementary and alternative medicine in some health-related quality of life scores (Yun et al., 2013) although it is important to note that these were terminally ill patients and 466 of the 481 patients evaluated had deceased.

Several reviews on the use of mushroom intake, primarily as an adjuvant to conventional cancer therapy (e.g. chemotherapy) have been published. The effects of Active Hexose Correlated Compound (AHCC) from Lentinula edodes (Shah et al., 2011) and the use of Phellinus linteus as

complementary therapies in patients with cancer have been reviewed (Sliva, 2010), as have the anti-cancer properties of five commonly-consumed edible mushrooms: button mushrooms (Agaricus bisporus), A. blazei, Oyster mushrooms (Pleurotus ostreatus), Shiitake mushrooms (Lentinus edodes), and Maitake (Grifola frondosa) mushrooms (Xu et al., 2012). The use of mushrooms as anti-cancer therapeutics has also been reviewed (Patel and Goyal, 2012, Petrova, 2012, Soumya et al., 2011), as have the levels of evidence from human trials of mushroom intake (Roupas et al., 2012).

BREAST CANCER

A meta-analysis of observational studies has recently been undertaken to evaluate the level of evidence on the association of dietary mushroom intake with breast cancer risk and to quantify its dose-response relationship (Li et al., 2014). Observational studies with relative risks (RRs) or hazard ratios (HRs) or odd ratios (ORs) and 95% confidence intervals (CIs) of breast cancer for three or more categories of mushroom intake were eligible for inclusion with 8 case-control studies and 2 cohort studies with a total of 6890 cases meeting the inclusion criteria. The dose-response analysis indicated that there was no evidence of a non-linear association between mushroom consumption and breast cancer risk (P = 0.337) and a 1 g/d increment in mushroom intake conferred a RR of 0.97 (95% CI: 0.96-0.98) for breast cancer risk, with moderate heterogeneity (I2 = 56.3%, P = 0.015). While the data suggest that mushroom intake may be inversely associated with risk of breast cancer, some limitations of the study deserve highlighting. The number of included studies was small (insufficient), only 2 of the 10 included studies were prospectively designed, and there was considerable heterogeneity between studies, based on demographics, reproductive status (menopause) and heterogeneous effects of different mushroom types (different species from different countries) that may have had an impact on the outcomes. Nevertheless, the meta-analysis suggested that increased mushroom intake may be associated with a lower risk of breast cancer, therefore highlighting a need for well-designed, sufficiently powered, clinical trials to confirm such potential effects.

A number of direct intervention trials of mushroom consumption by patients with breast cancer have been described. A Phase 1 clinical trial of Trametes versicolor in women with breast cancer (n=11) has concluded that up to 9 grams/day of a Trametes versicolor preparation is safe and

tolerable in women with breast cancer in the post-primary treatment setting i.e. post-radiation. This dose of Trametes versicolor preparation may improve immune status in immune-compromised breast cancer patients (Torkelson et al., 2012).

The effect of an extract of Lentinula edodes mycelia (LEM) has been studied on the quality of life (QOL) and immune response in 20 breast cancer patients undergoing post-operative adjuvant hormone therapy. The patients received only hormone therapy in the first 4 weeks followed by hormone therapy and LEM during the following 8 weeks. No changes in QOL or cytokines were noted after the first 4 weeks. In contrast, during the following combined therapy period, improvements were noted in QOL and cytokine levels. Although a future large-scale investigation is necessary to confirm these results, these data suggest that the concomitant use of LEM with post-operative adjuvant hormone therapy may improve the QOL and immune function of patients with breast cancer (Suzuki et al., 2013).

A further randomized, placebo-controlled, double-blind, clinical trial with 46 patients with Stage II and III breast cancer has also reported that dietary supplementation with Agaricus sylvaticus (2.1 g/day) improved nutritional status and significantly reduced abnormal bowel functions, nausea, vomiting, and anorexia in patients with breast cancer receiving chemotherapy (Valadares et al., 2013).

An epidemiological study of women with histologically confirmed breast cancer has identified that daily intake and the average consumption frequency of mushrooms were inversely associated with breast cancer risk, and a strong inverse association was found in post-menopausal women, but not in pre-menopausal women (Hong et al., 2008), which is in contrast to another epidemiological study that has suggested a decreased risk of breast cancer from mushroom consumption by pre-menopausal women (Shin et al., 2010). In this latter study, mushroom intake and breast cancer risk were examined among 358 Korean breast cancer patients and 360 cancer-free controls. Intake of mushrooms was assessed using a quantitative food frequency questionnaire. Greater mushroom intake was related to lower risk of breast cancers among premenopausal women with the association being stronger for premenopausal women with estrogen receptor (ER)+/progesterone receptor (PR)+ tumours than those with ER/PR tumours. The results suggested that high consumption of mushrooms may be related to a lower risk for breast cancer among premenopausal women, and the association may be more robust among women with hormone receptor positive tumours.

A possible mechanism for this effect may be via an inhibition of aromatase activity, described in both *in vitro* and animal trials (Grube et al., 2001, Chen et al., 2006), and more recently in a human trial of postmenopausal women diagnosed with breast cancer (Palomares et al., 2011) for *Agaricus bisporus*. A subsequent reduction in estrogen, affecting estrogen receptor positive tumors was reported in animal trials. Some evidence suggests that the anti-aromatase compound in *Agaricus bisporus* is conjugated linoleic acid (CLA) (Kanaya et al., 2011), although mushroom extracts containing beta-glucans have also been suggested to inhibit aromatase activity and have direct effects on estrogen receptors (Aleem, 2013).

However, an *in vitro* study using water-based extracts of *Coprinellus sp., Coprinus comatus, Flammulina velutipes*, significantly inhibited growth of both estrogen-receptor positive (ER+) and estrogen-receptor negative (ER-) breast cancer cells, induction of rapid apoptosis on both ER+ and ER- cells, and significantly inhibited MCF-7 tumor colony formation *in vitro*. These activities were dose-dependent, regardless of the hormone receptor status of the cancer cells (Gu and Leonard, 2006).

Higher dietary intake of mushrooms decreased breast cancer risk in both pre- and postmenopausal women and an additional decreased risk of breast cancer was observed from a synergistic effect of mushrooms and green tea in a case-controlled study (Zhang et al., 2009). Vitamin D2 could be one of the protective phytonutrients against breast cancer as mushrooms are rich in ergosterol, generating vitamin D2 when exposed to ultraviolet B (UVB) light and ergocalciferol being bioavailable and increasing serum 25(OH) vitamin D2 levels in humans (Furlanetto, 2009). While the human trial appears promising, it should be noted that this was not a direct intervention trial and mushroom consumption was assessed via quantitative food frequency questionnaires, which can be affected by recall bias.

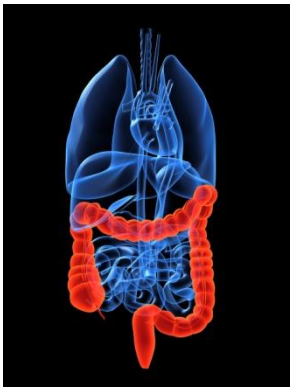
A review of the use of mushrooms as adjuvant treatments in breast cancer has reported that mushroom intake is associated with improvements in the immunological and hematologic parameters of breast cancer, as well as in the quality of life of breast cancer patients (Novaes et al., 2011).

CERVICAL, OVARIAN AND ENDOMETRIAL CANCERS

The association between mushroom consumption and risk of epithelial ovarian cancer in southern Chinese women has been studied in a hospital-based case-control study in Guangzhou, Guangdong Province, from 2006 to 2008 with 500 incident patients with epithelial ovarian cancer and 500 controls, with a mean age of 59 ± 6 years. Habitual mushroom consumption data was obtained by face-to-face interview using a validated food frequency questionnaire. The study reported that patients with ovarian cancer consumed less mushrooms (28.48 ± 37.45 g/d) than did controls (30.75 ± 41.85 g/d). Apparent reductions in cancer risk were found at high levels of intake, particularly for the common white button mushroom with adjusted odds ratios 0.68 (95% confidence interval, 0.52-0.89) for women that consumed more than 2 g per day relative to those who consumed less than this amount (P = 0.005). Decreases in risk at high levels of mushroom intake were also observed for serous and mucinous sub-types of epithelial ovarian tumours. The study concluded that intake of mushrooms, particularly white button mushrooms, seemed to be inversely associated with the incidence of epithelial ovarian cancer in this population group (Lee et al., 2013).

The effect of consumption of an extract from Agaricus blazei Murill Kyowa (ABMK), on immunological status and quality of life has been studied in cancer patients undergoing chemotherapy. One hundred cervical, ovarian, and endometrial cancer patients were treated either with carboplatin plus VP16 or with carboplatin plus taxol every 3 weeks for at least three cycles, with or without oral consumption of ABMK. The authors observed that natural killer cell activity was significantly higher in the ABMK-treated group compared to the non-treated placebo group (n = 61). However, no significant difference in lymphokine-activated killer and monocyte activities was observed. Chemotherapy-associated side effects such as appetite loss, alopecia, emotional instability, and general weakness were all reported to be improved by ABMK treatment in these patients (Ahn et al., 2004).

COLORECTAL CANCER



A randomized, double-blind, placebo-controlled clinical trial carried out in Brazil over a six month period with 56 patients has studied quality of life of postsurgical patients with colorectal cancer after supplementation of the diet twice daily with Agaricus sylvaticus (30 mg/kg/day). After six months of treatment, benefits were reported in haematological and immunological parameters and reduced glycemic levels in patients with colorectal cancer (Fortes et al., 2009). The supplemented group also had increased physical activity, improved disposition and mood, reduced complaints of pain and reduced alterations of sleep such as insomnia and restless sleep, with increased appetite, reduced constipation, diarrhea, alternate diarrhea/constipation, flatulence, flatus retention, pyrosis, postprandial fullness, nausea, abdominal distention and abdominal pain, indicators which were not observed in the placebo group (Fortes et al., 2010).

A further evaluation of the same patients reported that the Agaricus sylvaticus group had significantly reduced fasting plasma glucose, total cholesterol, creatinine, aspartate aminotransferase, alanine aminotransferase, IgA, IgM, systolic blood pressure and diastolic blood pressure, all effects that were not observed in the placebo group. The data suggest that dietary supplementation with Agaricus sylvaticus was capable of providing metabolic benefits to the biochemical, enzymatic and blood pressure parameters of these patients with colorectal cancer in the post-surgical phase (Fortes and Novaes, 2011).

Polysaccharide krestin (PSK), an extract from Trametes versicolor, has been reported to reduce toxicity of current treatments used in patients with metastatic colorectal cancer (Shibata et al., 2011). The effects of PSK in cancer therapy and the possible mechanism of action have been reviewed (Sun et al., 2012). Two meta-analyses of randomised clinical trials have suggested that adjuvant immunochemotherapy with PSK from mushrooms can improve the survival of, and disease-free survival of, patients with curatively resected colorectal cancer (Oba et al., 2007, Sakamoto et al., 2006). The reduction of death rate by 29% and of recurrence by 28% by PSK immunochemotherapy over standard oral fluorinated pyrimidine based chemotherapy may have been due to restoration of immunity in patients who could have been immunosuppressed due to surgery and chemotherapy (Sakamoto et al., 2006). The mechanism of this effect is possibly via action of PSK on a toll-like receptor initiating a signalling cascade involving T helper 1 cells which induce IL-2 and IFN-γ and then

activate natural killer cells. This sequence of signalling cascades has been described in the modulation of innate immunity of *Agaricus blazei* (Ab) (Hetland et al., 2011), although intake of 5% Ab over 4 weeks by male Wistar rats did not confirm chemopreventive activity on the initiation stage of rat colon carcinogenesis (Ziliotto et al., 2008, Ziliotto et al., 2009).

A clinical study of healthy volunteers reported that *Ganoderma lucidum* did not affect their immune functions, but a subsequent open-labeled study (i.e. not double-blind or placebo controlled) evaluating water-soluble *G. lucidum* polysaccharides (Ganopoly®) in patients with advanced colorectal cancer reported that treatment with Ganopoly® tended to increase mitogenic reactivity to phytohemagglutinin. Larger double-blind trials are required to validate this effect and further studies are needed to determine the mechanism of action, efficacy, and safety of the water-soluble *G.lucidum* polysaccharides in cancer patients (Gao et al., 2005).

These data suggest that mushrooms may have an immune-stimulatory effect on immune-compromised patients, but not in a normal, healthy population.

GASTRIC CANCER

A retrospective study of 349 patients with stage II/III gastric cancer who had undergone adjuvant therapy following curative resection has evaluated the expression of MHC class I in gastric cancer patients who received polysaccharide K (PSK), a glycoprotein purified from Coriolus versicolour, as post-operative adjuvant immunochemotherapy, and investigated the correlation between MHC class I expression and clinical outcomes (Ito et al., 2012). Patients received either oral chemotherapy (chemotherapy-only group) or chemotherapy plus PSK (PSK group). The groups did not differ in MHC class I expression. The PSK group had a longer survival rate, with expression-negative cases having a 3-year recurrence-free survival (RFS) rate of 65% in the PSK group and 47% in the chemotherapy-only group. For the 82 expression-negative cases with pN2 or greater, the recurrence-free survival rates were 68% in the PSK group and 28% in the chemotherapy-only group, representing a significant difference. The study showed survival-prolonging effects when PSK was included in the therapy for gastric cancer patients who had undergone curative resection and were at high risk of

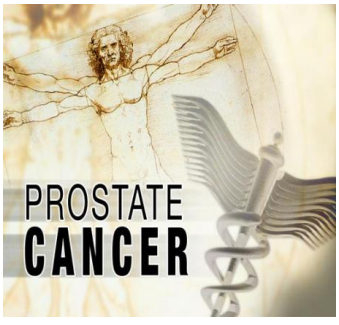
recurrence due to the presence of lymph node metastasis and the absence of MHC class I expression.

A meta-analysis of the effect of immunochemotherapy with lentinan compared to chemotherapy alone has been evaluated in patients with advanced gastric cancer across five randomised controlled trials. Lentinan significantly prolonged overall survival but was possibly more effective in patients with lymph-node metastasis than in non-node metastasis patients (Oba et al., 2009).

PANCREATIC CANCER

To date, only one single trial on the effects of a mushroom-derived compound on pancreatic cancer in humans has been reported. A Phase I trial and pharmacokinetic study of irofulven, a mushroom-derived cytotoxin has been carried out in 46 patients with advanced solid malignancies. While the highest dose used was not well tolerated (grade 4 neutropenia and renal toxicity), the authors recommended a lower dose of irofulven (10.64mg/m^2) as a 5-minute intravenous infusion daily for 5 days every 4 weeks. The preliminary anti-tumor activity documented in a patient with advanced pancreatic cancer and the positive pre-clinical anti-tumor effects observed on intermittent dosing schedules support a need for further trials on irofulven. It should be noted that the source of this compound (*Omphalotus olearius*) is not an edible mushroom (Eckhardt et al., 2000).

PROSTATE CANCER



Human trials to date have shown that mushrooms and their extracts to be ineffective in the treatment of clinical prostate cancer, although the treatments have been well-tolerated. A Phase II clinical trial has assessed the efficacy and safety of mushroom mycelium extracts (4.5 g/day for 6 months) in 74 patients with early stage prostate cancers. Patient ingestion compliance was maintained near 100% during the

course of the trial. The mushroom mycelium extract was ineffective in reducing the patient prostate specific antigen values by 50% or more (Sumiyoshi et al., 2010).

A 6 month open-label study in 51 patients with prostate cancer that ingested either Senseiro, containing extracts from the Agaricus blazei Murill mushroom, or Rokkaku Reishi, containing the Ganoderma lucidum mushroom, has reported no serious adverse effects, and no significant anticancer effects were observed with the intake of these two mushroom supplements (Yoshimura et al., 2010).

Trials with *Ganoderma lucidum* (Noguchi et al., 2008a, Noguchi et al., 2008b) and with a polysaccharide/oligosaccharide complex obtained from a Shiitake mushroom extract (White et al., 2002) showed no effect on prostate-specific antigen levels in patients with either lower urinary tract symptoms or patients with prostate cancer respectively.

These human trial outcomes do not support *in vitro* mechanistic studies, where several mushrooms and their extracts have been reported to inhibit proliferation of human prostate cancer cell lines.

SUMMARY OF ANTI-CANCER PROPERTIES

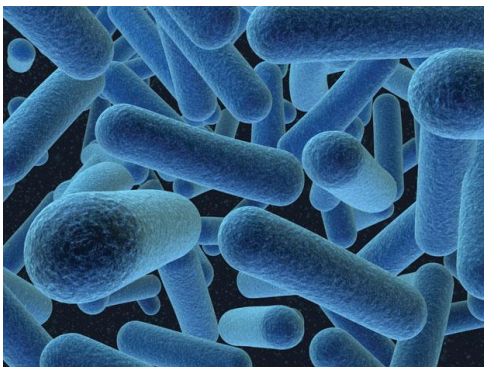
Anti-tumor effects, primarily in human cell lines, have been reported for polysaccharides extracted from various mushrooms. The polysaccharides generally belong to the beta-glucan family of compounds and appear to exert their anti-tumorigenic effects via enhancement of cellular immunity, although more recent data have also suggested that beta-glucans may also have more direct effects (e.g. on estrogen receptors and aromatase activity in breast cancer). Apoptosis and/or anti-proliferative effects on carcinomas and cell lines are also mechanisms shared by several mushrooms and their extracts in studies of anti-cancer effects.

Anti-tumor effects of proteoglycan fractions from a variety of mushrooms, including *Agaricus bisporus*, involve the elevation of natural killer (NK) cell numbers and the stimulation of inducible nitric oxide (NO) synthase gene expression, which is then followed by NO production in macrophages via activation of the transcription factor, NF-kappaB. Activation of NK cells is likely via interferon-gamma and interleukin mediated pathways. In addition to the apoptotic and anti-

proliferative effects, the anti-inflammatory and anti-microbial / viral effects may also contribute to the anti-carcinogenic effects of mushrooms and their extracts, although such direct links have not been established to date. While studies in human cell lines provide supporting evidence, well-designed human clinical trials are required before the anti-cancer mechanisms and health outcomes in humans can be validated.

In contrast to promising data from human trials describing physiological and quality of life benefits of mushroom consumption by patients affected by a variety of cancers, the data from studies with patients with prostate cancer have not shown any clinically-relevant benefits from mushroom consumption, although the treatments have been well tolerated.

ANTI-MICROBIAL PROPERTIES



Initial studies in humans suggested anti-microbial properties of extracts from *Agaricus blazei* Murill and *Ganoderma lucidum,* although these studies did not have adequate controls in the experimental design, and therefore such effects have not yet been scientifically validated in humans.

A prospective controlled trial in humans (n=52) has evaluated the *in vivo* efficacy of the mushroom Tremella mesenterica Ritz.:Fr. (higher Basidiomycetes) on eradication of Helicobacter pylori. Ten-day treatment was not found to be effective *in vivo* in eradicating Helicobacter pylori, whether given with or without omeprazole, although the brief treatment period was a limitation of the study (Lachter et al., 2012).

A very small one-year open-label (not double-blind or placebo-controlled) pilot study reported that intake of *Agaricus blazei* Murill (AbM) extract (1500 mg daily) over 12 months improved liver function in patients with hepatitis B, determined by a decrease in the mean level of aspartate aminotransferase and alanine aminotransferase decreased from 246.0 to 61.3 IU/L and 151.0 to 46.1 IU/L, respectively (Hsu et al., 2008). The initial observation seems to indicate a potential benefit of AbM extract in normalizing liver function of patients with hepatitis B, although clearly larger and

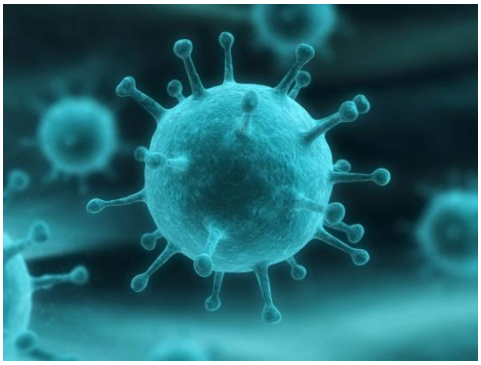
controlled studies are required to confirm such effects.

Patients on dialysis are at high risk of infection, including fungal infections. Anti-beta-glucan antibody participates in the immune response to fungal cell wall beta-glucan. The anti-beta-glucan antibody titer has been shown to be lower in dialysis patients than in healthy volunteers, and long-term dialysis patients showed lower anti-beta-glucan antibody titers than short-term dialysis patients. The titer of anti-beta-glucan antibody as a recognition molecule of beta-glucan was low in dialysis patients compared to healthy volunteers, which may in part explain the sensitivity to infection of dialysis patients. Although not proven, there is a possibility that mushroom consumption may assist in a preventative role for fungal infection in dialysis patients (Ishibashi et al., 2011).

SUMMARY OF ANTI-MICROBIAL PROPERTIES

Anti-microbial effects of a large number of mushroom varieties and mushroom components on both gram-positive and gram-negative bacteria have been confirmed via *in vitro* studies. A small number of studies in animals have been undertaken and the data suggest that the anti-microbial effects *in vivo* may be mediated by effects of the immune system. A very small number of human studies have been completed, but the anti-microbial effects of mushroom consumption remain to be confirmed in humans.

ANTI-VIRAL PROPERTIES



The effect of supplementation with the mushroom extract Active Hexose Correlated Compound (AHCC) on immune responses of healthy individuals to influenza vaccine has been determined in a randomized controlled study with 30 healthy adults. The AHCC group began supplementation with AHCC (3 g/d) immediately after vaccination. AHCC supplementation increased NKT cells ($P < .1$), and CD8 T cells ($P < .05$) post-vaccination compared to controls. Analysis of antibody

production 3 weeks post-vaccination revealed that AHCC supplementation significantly improved protective antibody titers to influenza B, while the improvement was not significant in the control group (Roman et al., 2013).

Proteins, peptides and polysaccharopeptides from mushrooms have been reported to inhibit human immunodeficiency virus type 1 (HIV-1) reverse transcriptase and protease, the two enzymes of importance to the life cycle of HIV. Inhibitory effects on hepatitis B and herpes simplex virus type 1 have also been reported. The anti-viral effects of mushrooms do not seem to be related to viral adsorption or virucidal effects (i.e. they do not kill the virus), however a number of studies have reported inhibitory effects at the initial stage of virus replication (Faccin et al., 2007).

Two phase I/II placebo-controlled trials in 98 HIV-positive patients have been completed using lentinan, a β-glucan isolated from *Lentinus edodes* (Shiitake mushroom) (Gordon et al., 1998). The studies reported generally good tolerability of lentinan with observed side effects being mainly mild, particularly when infusion was carried out over a 30 minute period. In the first study, where administration was over a 10 minute period, there were 9 side effects severe enough to be reported to the FDA (one case each of anaphylactoid reaction, back pain, leg pain, depression, rigor, fever, chills, granulocytopenia and elevated liver enzymes) with four patients discontinuing therapy because of side effects. In the second study, where infusion was over a 30 minute period, there were no side effects reportable to the FDA but there were four drop-outs due to side effects or personal preference. Most side effects resolved promptly after the discontinuation of medication, and all of them were relieved within 24 hours. The small number of patients in the study groups meant the data on possible increases in CD4 cell and neutrophil activity were inconclusive (Gordon et al., 1998).

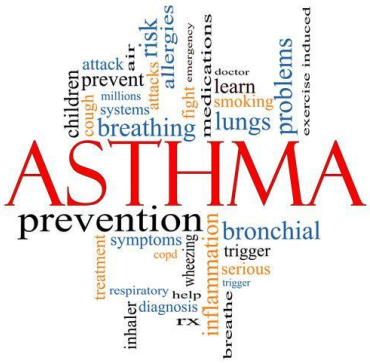
SUMMARY OF ANTI-VIRAL PROPERTIES

Two Phase I/II trials in HIV-positive patients have been undertaken with lentinan, a beta-glucan from Lentinus edodes. Some side effects were observed at the highest dosages used, which were not present when infusion was undertaken over a shorter period. Proteins, peptides and polysaccharopeptides from mushrooms have been reported to be capable of inhibiting human immunodeficiency virus type 1 (HIV-1) reverse transcriptase and protease, the two enzymes of paramount importance to the life cycle of the HIV. Inhibitory effects on hepatitis B and herpes

simplex virus type I have also been reported. The anti-viral effects of mushrooms do not seem to be related to viral adsorption or virucidal effects (i.e. they do not kill the virus), however a number of studies have reported inhibitory effects at the initial stage of virus replication.

The effect of supplementation with the mushroom extract Active Hexose Correlated Compound (AHCC) and a lectin from Pleurotus Ostreatus on immune responses of healthy individuals to influenza and hepatitis B vaccines respectively appear very promising, highlighting potential applications of such mushroom components as vaccine adjuvants.

ASTHMA



A *Cordyceps* extract has been evaluated in asthmatic children during remission stage (Sun et al., 2010). The *Cordyceps* extract inhibited the proliferation and differentiation of Th2 cells and reduced the expression of related cytokines by down-regulating the expression of GATA-3 mRNA and up-regulating the expression of Foxp3 mRNA in peripheral blood mononuclear cells. The extract was able to alleviate the chronic allergic inflammation by increasing the level of interleukin-10.

In contrast, Ogawa and colleagues (Ogawa et al., 2013) retrospectively reviewed the clinical records of 50 adult patients (mean age 55.1 years) with asthma and reported that sensitization to Schizophyllum commune is a risk factor for asthmatic patients with regard to both exacerbation frequency and rapid decline in lung function.

CARDIOVASCULAR HEALTH

A human intervention study has evaluated the cholesterol lowering properties of an Oyster mushroom (Pleurotus ostreatus) diet. Twenty subjects (9 male, 11 female; 20-34 years) were randomized to take either one portion of soup containing 30 g dried oyster mushrooms or a tomato soup as a placebo daily for 21 days. The Oyster mushroom soup decreased triacylglycerol concentrations (0.44 mmol/L) and oxidized low density lipoprotein levels (7.2 U/mL) significantly, and showed a significant tendency in lowering total cholesterol values (0.47 mmol/L; p = 0.059). No effects on low density lipoprotein and high density lipoprotein levels were observed (Schneider et al., 2011). Oyster mushroom consumption by 89 diabetic patients has also been reported to significantly reduce systolic and diastolic blood pressure, total cholesterol and triglycerides, with no significant change in body weight and no deleterious effects on liver or kidney function (Khatun et al., 2007).

A study in 90 female volunteers has demonstrated a weight-controlling and hypolipidemic effect of protein-bound polysaccharides from the mycelia of *Agaricus blazei* and *Lentinus edodes*, via a mechanism involving absorption of cholesterol (Kweon et al., 2002). However, a double-blind, placebo-controlled, cross-over intervention study in adults (n=18; ages 22–52 years) of a commercially available encapsulated Lingzhi preparation (equivalent to 13.2g fresh mushroom/d) over 4 weeks failed to show any change in biomarkers for coronary heart disease risk (Wachtel-Galor et al., 2004).

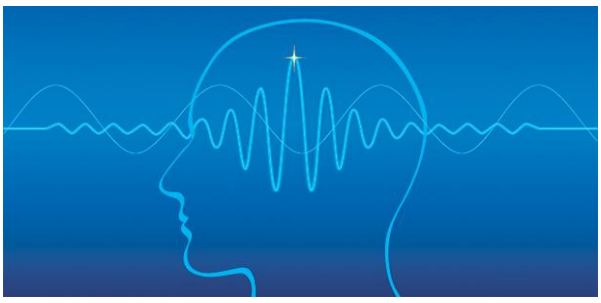
The bioavailability of ergothioneine from Agaricus bisporus, that functions as an antioxidant in mushrooms has been determined in a pilot study in healthy men (n=10) using a randomized, cross-over, dose-response, postprandial time-course design. Ergothioneine was bioavailable after consuming mushrooms (8g and 16g) and a trend in the postprandial triglyceride response indicated that there was a blunting effect after both the 8g and 16g ergothioneine doses were compared with the control (0g dose). Ergothioneine from A. bisporus mushrooms was therefore bioavailable as assessed by red blood cell uptake postprandially, and consumption was associated with an attenuated postprandial triglyceride response (Weigand-Heller et al., 2012).

A single-arm, open-label, proof-of-concept study of 8 weeks duration was completed which assessed the safety and efficacy of Pleurotus ostreatus (15 g/day orally) in HIV-infected individuals taking antiretroviral therapy that induced hyperlipidemia. Pleurotus ostreatus at the concentration taken in this study did not lower non-HDL cholesterol in HIV patients with antiretroviral treatment-induced hypercholesterolemia. Small changes in HDL and triglycerides were not of a clinical magnitude to warrant further study (Abrams et al., 2011).

SUMMARY OF CARDIOVASCULAR HEALTH

Plasma cholesterol in animal models has been shown to be reduced by mushroom consumption. The hypocholesterolemic effect appears to be due partly to an increased rate of low density lipoprotein (LDL) and high-density lipoprotein (HDL) catabolism. While some studies have postulated eritadenine or angiotensin I – converting enzyme inhibitory peptides as the hypocholesterolemic agents, similar effects on cholesterol, and other biomarkers of cardiovascular risk, have been demonstrated by consumption of mushroom (e.g. *Agaricus bisporus*) fibre. Such a cholesterol-lowering effect has also recently been reported in humans, although further studies are required to confirm the magnitude and clinical relevance of this effect.

COGNITION / BRAIN HEALTH



Although preliminary, data showing protective effects of mushrooms (*Hericium erinaceum)* on beta-amyloid peptide toxicity (Kawagishi and Zhuang, 2008) in the brain and mild cognitive impairment (both precursors to dementia) appeared promising. Preliminary human trials with *Hericium erinaceum* derivatives showed efficacy in patients with dementia in improving the Functional Independence Measure (FIM) score or retarding disease progression (Kawagishi and Zhuang, 2008), while a double-blind, parallel-group, placebo-controlled trial with oral administration of Yamabushitake (*Hericium erinaceus*) to 50 to 80-year-old Japanese men and women diagnosed

with mild cognitive impairment reported significantly increased cognitive function scores compared to placebo during intake, although it is worth noting that the scores decreased significantly following cessation of the intake (Mori et al., 2009).

A large epidemiological study (The Hordaland Health Study) of 2031 elderly subjects (aged 70-74 years; 55% women) recruited from the general population in Western Norway examined the relationship between intake of different plant foods and cognitive performance in elderly individuals in a cross-sectional study design. The cognitive test battery covered several domains (Kendrick Object Learning Test, Trail Making Test - part A, modified versions of the Digit Symbol Test, Block Design, Mini-Mental State Examination and Controlled Oral Word Association Test). A validated and self-reported food frequency questionnaire was used to assess habitual food intake. Subjects with intakes of >10th percentile of fruits, vegetables, grain products and mushrooms performed significantly better in cognitive tests than those with very low or no intake, with the dose-dependent association being linear for mushrooms (Nurk et al., 2010).

A case-controlled study of 249 patients with diagnosed Parkinson's Disease (PD) and controls without neurodegenerative diseases (n = 368) has assessed dietary intake during the preceding 1 month using a validated, self-administered diet history questionnaire. Three dietary patterns were identified: 'Healthy', 'Western' and 'Light meal' patterns. After adjustment for potential non-dietary confounding factors, the Healthy pattern, characterized by a high intake of vegetables, seaweed, pulses, mushrooms, fruits and fish, was inversely associated with the risk of PD with a border-line statistical significance (P = 0.06). No associations with PD were detected for the other two dietary patterns (Okubo et al., 2012). While the data from this case-control study suggest a dietary pattern consisting of high intakes of vegetables, seaweed, pulses, mushrooms, fruits and fish may be associated with a decreased risk of PD, the strength of the association is modest and any such effects would need to be confirmed in other studies with greater statistical power in the study designs.

A human study of 30 females has investigated the clinical outcomes of 4 weeks of intake of Hericium erinaceus cookies versus placebo cookies on menopause, depression, sleep quality and indefinite complaints, using the Kupperman Menopausal Index (KMI), the Center for Epidemiologic Studies Depression Scale (CES-D), the Pittsburgh Sleep Quality Index (PSQ1), and the Indefinite Complaints Index (ICI). Each of the CES-D and the ICI score after the H. erinaceus intake was significantly lower than at the start of the trial. "Concentration", "irritating" and "anxious" tended to be lower than the

placebo group (Nagano et al., 2010, Shimizu et al., 2010). While the results point towards a possible reduction of depression and anxiety in the study group with H. erinaceus intake, larger studies with greater statistical power are required to confirm such outcomes.

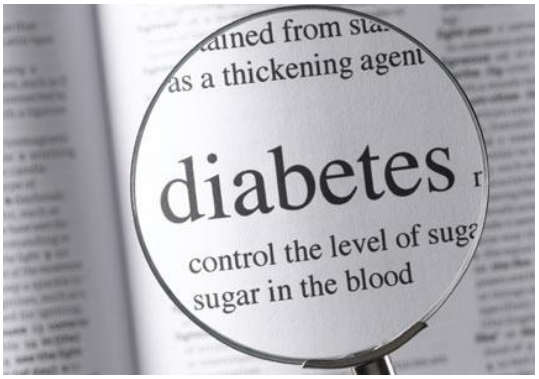
SUMMARY OF COGNITION / BRAIN HEALTH

The above epidemiological studies and one direct intervention trial in humans have provided suggestive evidence for possible effects of mushroom intake on some aspects of brain health, however, to date, there is insufficient evidence from human studies to confirm clinically-relevant outcomes on brain health parameters. Although very preliminary, new data showing protective effects of mushrooms on beta-amyloid peptide toxicity in the brain and mild cognitive impairment (both precursors to dementia) are very exciting and warrant further research on the ability of mushroom consumption to potentially delay the onset of dementia / Alzheimer's disease.

CONSTIPATION

Constipation is one of the most prevalent gastrointestinal complaints and high fiber intake is recommended as an initial therapy for constipation. Ear mushrooms (*Auricularia*) are known to have higher fiber contents (by ~50%) than other mushroom varieties. In patients with functional constipation, fiber supplements using ear mushrooms have been shown to significantly improve constipation related symptoms without serious side effects (Kim et al., 2004).

DIABETES



A randomized, double-blinded, and placebo-controlled clinical trial (n=72) showed that *Agaricus blazei* Murill supplementation in combination with metformin and gliclazide improved insulin resistance in these subjects. An increase in adiponectin concentration after *Agaricus blazei* Murill extract consumption for 12 weeks may be the mechanism that resulted in the reported effect (Hsu et al., 2007). Clinical investigation in diabetic patients (n=89) has also shown that Oyster mushroom consumption significantly reduced systolic and diastolic blood pressure, lowered plasma glucose, total cholesterol and triglycerides significantly, with no significant change in body weight, and no deleterious effects on liver or kidney function (Khatun et al., 2007). These results in humans mirror the decreases in plasma glucose, cholesterol and triglyceride concentrations following *Agaricus bisporus* consumption observed in rats (Jeong et al., 2010) and the reduction in blood pressure in Zucker fatty rats following oral administration of Maitake mushroom fractions (Talpur et al., 2002).

The consistency between the effects of the mushroom extracts in diabetic animal models and preliminary data from human trials, which mirror decreases in plasma glucose, blood pressure, cholesterol and triglyceride concentrations, strengthens the level of evidence for anti-diabetogenic effects of the studied mushrooms and their extracts.

Selenium (Se) levels in humans are very dependent on the Se-content of consumed food. The selenium content of different, common varieties of *Agaricus bisporus* can be very high, particularly if sodium selenite is added to the growth substrate. Pounis and co-workers (Pounis et al., 2014) have recently evaluated the relationship between mushroom and dietary selenium intakes and blood glucose levels in a free-living adult Italian population (6879 men and 6891 women, mean age 53.1+/-11.0 years). An increase of one portion/week in mushroom consumption was associated with a 0.43-0.55 mmol/L increase in fasting blood glucose at different levels of adjustment ($P < 0.05$) in men. In both men and women, dietary selenium was positively associated with blood glucose in both unadjusted and fully adjusted models ($P < 0.05$ for all). Both mushroom and dietary selenium intakes were independently associated with blood glucose on multivariate analyses, and high intakes of both

were associated with higher diabetes prevalence in men and women (OR > 1, P < 0.05). The study suggested an association of mushroom and selenium intakes with fasting blood glucose and that mushroom and selenium intake may each independently increase the risk of diabetes. However, it should be noted that a food frequency questionnaire was used for dietary assessment which can be affected by recall bias, and therefore, direct intervention trials would be needed to establish such a relationship. This result is in contrast to direct intervention trials of mushroom consumption in humans and a large number of *in vivo* animal studies that have reported consistent anti-diabetogenic effects of mushroom intake.

SUMMARY OF ANTI-DIABETOGENIC PROPERTIES

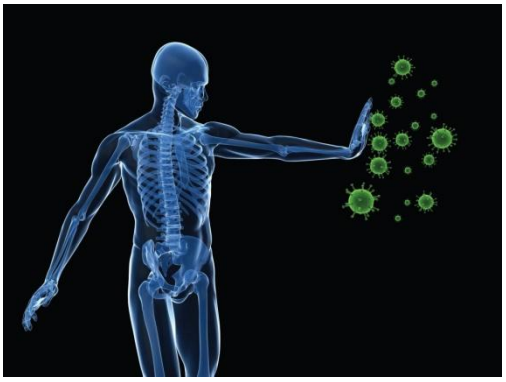
A large number of animal studies, in both normal and diabetic animal models, have confirmed the hypoglycaemic effects of mushrooms and mushroom components. The hypoglycaemic effects appear to be mediated via mushroom polysaccharides (possibly both alpha- and beta-glucans) via a direct interaction with insulin receptors on target tissues, although this mechanism remains to be confirmed. The efficacy of medicinal mushrooms (as a whole rather than for individual varieties) for glucose control in diabetes, including the inhibition of glucose absorption, protection of beta-cell damage, increase of insulin release, enhancement of antioxidant defence, attenuation of inflammation, modulation of carbohydrate metabolism pathway, and regulation of insulin-dependent and insulin independent signalling pathways have been reviewed (Lo and Wasser, 2011).

DNA DAMAGE

The antioxidant properties of Ganoderma lucidum (Lingzhi or Reishi) and its effects on DNA damage and repair in lymphocytes have been evaluated in a small cross-over human intervention study with 7 healthy adults. Plasma total antioxidant power and the effect on lymphocyte DNA damage and repair were assessed before and after each treatment of a single dose (3.3 g) of G. lucidum or

water (control). G. lucidum caused an acute increase in plasma antioxidant power, but did not significantly affect the level or rate of repair in lymphocytic DNA suggesting that the bioavailable antioxidants absorbed from G. lucidum had no effect on DNA resistance to oxidative stress or repair *in vivo* (Wachtel-Galor et al., 2010).

IMMUNE FUNCTION



A systematic review of human clinical trials concluded that numerous dietary polysaccharides, particularly glucans, appear to elicit diverse immunomodulatory effects in animal tissues, including the blood, gastrointestinal tract and spleen. Structure-function relationships of beta-glucans are of particular importance in their immunomodulatory effects (Thompson et al., 2010). Glucan extracts from the Trametes versicolor mushroom have been shown to improve survival and immune function in human randomised clinical trials of cancer patients. Glucans, arabinogalactans and fucoidans elicited immunomodulatory effects in controlled studies of healthy adults and patients with canker sores and seasonal allergies. This systematic review provides a high level of evidence for these effects (Ramberg et al., 2010).

A polysaccharide extract from *Grifola frondosa* (Maitake extract) has shown immunomodulatory effects in a phase I/II dose escalation trial in post-menopausal breast cancer patients (n=34). No dose-limiting toxicity was encountered and there was a statistically significant association between Maitake and immunologic function. The dose-response curves for many endpoints were non-monotonic with intermediate doses having either immune enhancing or immune suppressing effects in peripheral blood compared with both high and low doses (Deng et al., 2009). Another clinical trial in breast cancer patients (n=82) evaluating the immunomodulatory effects of Yunzhi-Danshen capsules (Yunzhi (*Coriolus versicolor*); Danshen (*Salvia miltiorrhiza*)) showed significantly elevated B-lymphocytes in patients with breast cancer after taking Yunzhi-Danshen capsules, while plasma sIL-2R concentration was significantly decreased (Wong et al., 2005).

A randomized, double-blind, placebo-controlled trial has evaluated the effects of Agaricus blazei

Murrill intake (900 mg/day for 60 days) on serum levels of interleukin-6 (IL-6), interferon-gamma (IFN-gamma) and tumour necrosis factor-alpha (TNF-alpha) in 57 community-living elderly women. After 60 days, no changes from baseline were detectable for any parameter in either the placebo (n=29) or the mushroom (n=28) group (Lima et al., 2012). An extract (AndoSan) from Agaricus blazei Murill (AbM) has also been shown to reduce blood cytokine levels in healthy volunteers after 12 days of ingestion, pointing to an anti-inflammatory effect. This extract also modulated cytokines in patients with ulcerative colitis (UC, n=10) and Crohn's disease (CD, n=11) in which baseline concentrations for the (17) cytokines evaluated in the UC and CD patient groups were largely similar. Faecal calprotectin (a marker for inflammatory bowel disease (IBD) was reduced in the UC group. Ingestion of an AbM-based medicinal mushroom by patients with IBD resulted in decreased levels of pathogenic cytokines in blood and calprotectin in faeces, suggesting anti-inflammatory effects (Forland et al., 2011). The mechanisms for such effects are unclear, although an *in vitro* study by the same authors with monocyte-derived dendritic cells showed that AbM did not induce increased synthesis of Th2 or anti-inflammatory cytokines or the Th1 cytokine IL-12. but the AbM-based extract resulted in increased production of proinflammatory, chemotactic and some Th1-type cytokines (Forland et al., 2010).

Prolonged and exhausting physical activity causes numerous changes in immunity and sometimes transient increases in the risk of upper respiratory tract infections (URTIs). A double blind, placebo-controlled study has investigated the effect of pleuran, an insoluble beta-(1,3/1,6) glucan from mushroom Pleurotus ostreatus, on selected cellular immune responses and incidence of URTI symptoms in athletes. Fifty athletes were randomized to pleuran or placebo, taking pleuran or placebo supplements during 3 months. Incidence of URTI symptoms together with characterization of changes in phagocytosis and natural killer (NK) cell count was monitored.P leuran significantly reduced the incidence of URTI symptoms and increased the number of circulating NK cells. In addition, the phagocytosis process remained stable in pleuran group during the study in contrast to placebo group where significant reduction of phagocytosis was observed. These findings indicate that pleuran may serve as an effective nutritional supplement for athletes under heavy physical training. The mechanisms of pleuran function are yet to be determined (Bergendiova et al., 2011).

In a similar double-blind pilot study, 20 elite athletes were randomized to beta-glucan (n=9) or placebo (n=11); these groups consumed 100 mg of beta-glucan (Imunoglukan) or placebo supplements, respectively, once per day for 2 months. At the end of the supplementation period, the athletes underwent a 20 min intensive exercise session. A 28% reduction in natural killer (NK)

cell activity below baseline was observed in the placebo group during the recovery period (1 h after exercise), whereas no significant reduction in NK cell activity was found in the beta-glucan group, and no significant decrease in NK cell count was measured in the beta-glucan group during the recovery period. Immune cell counts did not differ significantly between the groups. These results indicate that insoluble beta-glucan supplementation from P. ostreatus may play a role in modulating exercise-induced changes in NK cell activity in intensively training athletes (Bobovcak et al., 2010).

Discrepancies in results have been reported between *ex-vivo* and *in vivo* studies. After stimulation of whole blood from healthy volunteers *ex vivo* with 0.5-5.0% of a mushroom extract, mainly containing *Agaricus blazei* Murill (AbM), a dose-dependent increase in all the cytokines studied was seen, ranging from two to 399-fold (TNFα). However, *in vivo,* in eight volunteers who completed a daily intake (60 ml) of the AbM extract for 12 days, a significant reduction was observed in levels of IL-1-β (97%), TNF-α (84%), IL-17 (50%) and IL-2 (46%). Another nine cytokines remained unaltered (Johnson et al., 2009). The discrepancy in cytokine release *ex vivo* and *in vivo* may partly be explained by the antioxidant activity of AbM *in vivo* and limited absorption of its large β-glucans across the intestinal mucosa to the reticuloendothelial system and blood.

A double-blind randomized trial undertaken in mildly hypercholesterolemic subjects (n=56) to examine the effects of α-glucans from *Agaricus bisporus* reported that consumption of *A. bisporus* α-glucans lowered lipopolysaccharide-induced TNFα production by 69% compared to the control group, whereas no effect on IL-1β and IL-6 was observed. The authors suggested that *in vivo*, alpha-glucans had lost their efficacy to stimulate the immune response as observed in an *in vitro* mouse model (Volman et al., 2010).

In healthy adults over 50 years of age, active hexose correlated compound (AHCC) enhanced CD4(+) and CD8(+) T cell immune responses, taking at least 30 days to obtain such an effect, with the effect continuing up to 30 days after discontinuing treatment with AHCC (Yin et al., 2010). AHCC also promotes T helper (Th) 17 and 1 cell responses via inducing IL-1beta production from monocytes in humans (Lee et al., 2012).

The synergistic effects of *Cordyceps sinensis* with the drug cyclosporine A in preventing allograft rejection was reported in rats (Ding et al., 2009a) while a retrospective study by the same group has also evaluated the immunoregulatory effect of a dry powder preparation of *Cordyceps sinensis* mycelia on humans after renal transplantation (Ding et al., 2009b). While there was no significant

difference in graft survival rate or occurrence of reject reaction, treatment did effectively protect the liver and kidney, stimulate hemopoietic function, improve hypoproteinemia, as well as reduce the incidence of infection and the dosage of the drugs cyclosporine A and tacrolimus used, and therefore, it may be useful for immunoregulation after organ transplantation.

The effect and safety of a soluble beta-glucan from Lentinus edodes mycelium, Lentinex (R), in 42 healthy, elderly subjects has been evaluated in a double blind, crossover, placebo-controlled trial (Gaullier et al., 2011) where two groups were given either 2.5 mg/day Lentinex (R) orally or placebo for 6 weeks; then after a washout period of 4 weeks, the alternate supplementation was given for 6 weeks. The changes in the number of B-cells were significantly different between the groups. The number of NK cells increased significantly in both groups, but there was no significant difference between the groups. The immunoglobulins, complement proteins and cytokines measured were not altered. The safety blood variables (differential cell count, liver function, kidney function, and other blood chemistry) were not influenced by Lentinex (R), and the number, nature, and severity of adverse events were similar to placebo. Lentinex given orally to elderly subjects was deemed to be safe and induced an increase in the number of circulating B-cells (Gaullier et al., 2011).

Secretory immunoglobulin A (sIgA) acts as the first line of adaptive humoral immune defence at mucosal surfaces. A randomised trial of 24 healthy volunteers has shown that consumption of 100 g of blanched Agaricus bisporus daily with a normal diet for 1 wk significantly accelerated sIgA secretion, thereby indicating its effect on the improvement of mucosal immunity (Jeong et al., 2012).

SUMMARY OF IMMUNE FUNCTION

Numerous studies have described the effects of mushrooms and mushroom extracts on immune function with implications for inhibitory effects on tumour growth. Some of the more efficacious compounds have been reported to be 1,6-branched 1,3-β-glucans which have been reported to inhibit tumour growth by stimulating of the immune system via effects on natural killer (NK) cells, macrophages and via T cells and their cytokine production. More recent work has implicated polysaccharides with varying sugars and some are α- rather than β-glucans. The mechanisms by which these polysaccharides exert their immunomodulatory effects are not entirely clear, although structure-function relationships have been described between anti-tumor activities and structural

characteristics of β-D-glucans. These mushroom polysaccharides generally do not exert cytotoxic effects on tumor cells, but have been shown to enhance host-mediated immunomodulatory responses. Furthermore, mushroom proteins, terpenes and furans have also been implicated in immune function.

The anti-cancer studies described earlier in this report provide a rapidly growing body of evidence that suggests that mushrooms may have an immune-stimulatory effect on immune-compromised patients.

MUSCLE FUNCTION AND EXERCISE CAPACITY

A recent study with National Association for Stock Car Auto Racing (NASCAR) pit crew athletes evaluated the effect of 6-weeks of vitamin D2 supplementation (vitD2, 3800 IU/day) on muscle function, eccentric exercise-induced muscle damage, and delayed onset of muscle soreness (Nieman et al., 2014). Subjects were given Portobello mushroom (Agaricus bisporus) powder with or without vitamin D2 mixed in soymilk powder (non-vitamin D fortified) and ingested one level teaspoon of the product each day (with or without 3800 IU vitamin D2) during breakfast. The participants were randomized to vitD2 (n = 13) and placebo (n = 15), and ingested supplements (double-blind) for six weeks. The high-dose vitamin D2 supplementation amplified exercise-induced muscle damage markers and had no effect on muscle function. Vitamin D2 supplementation increased serum 25(OH)D2 ~8 ng/mL but decreased serum 25(OH)D3 ~7.5 ng/mL, with no significant change in total 25(OH)D.

A similar study from the same research group in high school athletes, also over a 6 week period, and also using mushroom vitamin D2 powder, reported no differences between the groups (placebo or Vitamin D2) in skeletal muscle function and circulating markers of skeletal muscle damage, despite the 600 IU/d vitamin D2 increasing 25(OH)D2 with a concomitant decrease in 25(OD)D3 (Shanely et al., 2014).

These results differ from those of Choi et al. who showed that large-dose vitamin D3

supplementation in rats (i.p. 1000 IU/kg body weight) countered muscle damage and inflammation (Choi et al., 2013), although a major difference was the use of mushroom vitamin D2 powder in the human studies. Another study in a rat model has shown that Ganoderma tsugae possesses anti-apoptotic and hepatoprotective potential after exhaustive exercise (Huang et al., 2013).

The antioxidant and anti-inflammatory activity of a shiitake (Lentinus edodes) extract in healthy men (n=14, mean age 21 years) exposed to exercise-induced skeletal muscle damage has been studied in a placebo controlled and cross-over study (Zembron-Lacny et al., 2013). The results showed that the shiitake extract at a dose of 1400 mg daily for 10 days did not affect the inflammatory response but demonstrated antioxidant activity through the regulation of nitric oxide concentration and thiol redox status.

OBESITY / BODY COMPOSITION

A 1-year, randomized clinical trial in free-living obese adults (n=73, 64 women, 9 men) on the effect of substituting mushrooms for red meat on weight loss and maintenance has shown that those in the mushroom diet group lost weight and showed improvements in body composition, and maintained these changes for 6 months after losing weight in comparison to those on a standard (meat) diet. In addition, blood pressure (lower systolic and diastolic pressure (-7.9 and 2.5 mmHg), total cholesterol, LDL-cholesterol, HDL-cholesterol and inflammation markers showed positive changes in the obese adults when mushrooms replaced red meat in this trial (Poddar et al., 2013).

ORAL HEALTH

An aqueous extract of a low molecular mass (LMM) fraction of Lentinus edodes (Shiitake) has previously been evaluated as an oral mouth rinse in a clinical trial with 30 volunteers over 11 days. The mushroom extract was evaluated against Listerine and a placebo (water). Statistically significant differences were obtained for the plaque index on day 12 in subjects treated with mushroom versus placebo, while for the gingival index significant differences were found for both mushroom versus placebo and mushroom versus Listerine. Decreases in total bacterial counts and in counts of specific oral pathogens were observed for both mushroom extract and Listerine in comparison with placebo. The data suggested that this mushroom extract may prove beneficial in controlling dental caries and/or gingivitis/periodontitis (Signoretto et al., 2011). A fraction from Shiitake has also been shown to have a strong inhibitory effect on dentin demineralization and induce microbial shifts that could be associated with oral health (Zaura et al., 2011).

Frequent rinses with a low molecular weight fraction of shiitake mushroom has also been shown to reduce the metabolic activity of dental plaque in a double-blind, three-leg, cross-over, randomized, controlled clinical trial (n=65), but no reduction of plaque scores and or inhibition of the production of organic acids in plaque was found, suggesting that the shiitake extract had moderate anti-cariogenic potential (Lingstrom et al., 2012).

More recent work from the same group has also shown that this low molecular mass (LMM) fraction from mushroom (Lentinus edodes) homogenate interfered with binding of *Streptococcus mutans to hydroxyapatite and Prevotella* intermedia to gingival cells, and inhibition of biofilm formation of both odonto- and periodonto-pathogenic bacteria and detachment from preformed biofilms by this fraction have also been described. Binding of a sub-fraction of this mushroom extract to 15 cell wall associated proteins and teichoic acid of *S. mutans*, and outer membrane proteins and lipopolysaccharide of *P. intermedia* has been reported, raising the possibility that binding of this sub-fraction to surface molecules of *Streptococcus mutans* or *Prevotella* intermedia may result in inactivation of their physiological functions. The results suggest an effect via bacterial surface alterations affecting adhesion and biofim formation (Signoretto et al., 2014).

REPRODUCTIVE HEALTH

An open trial with 80 patients with polycystic ovary syndrome at three clinics in Japan has been undertaken. Seventy-two patients were randomly assigned to receive Maitake extract (SX-fraction: MSX) or clomiphene citrate (CC) monotherapy for up to 12 weeks. Eighteen patients who did not respond to MSX or CC were subjected to combination therapy of MSX and CC for up to 16 weeks. Eight patients with documented history of failure to CC received combination therapy from the beginning. Twenty-six patients in the MSX group and 31 in the CC group were evaluated for ovulation. The ovulation rates for MSX and CC were: 76.9% (20/26) and 93.5% (29/31), respectively by the patients (NS), and 41.7% (30/72) and 69.9% (58/83), respectively, by the cycles. In the combination therapy, 7 of 7 patients who failed in MSX monotherapy and 6 of 8 patients who failed in CC monotherapy showed ovulation. The data suggest that the Maitake extract described in this study may induce ovulation in patients with polycystic ovary syndrome and may be useful as an adjunct therapy for patients who had failed first-line treatment with clomiphene citrate (Chen et al., 2010a).

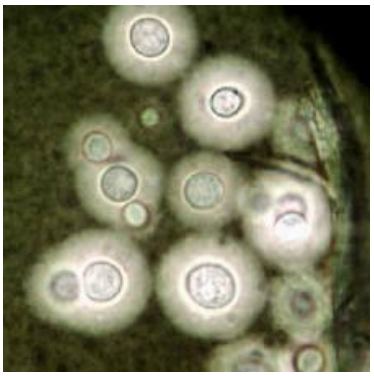
RESPIRATORY TRACT INFECTIONS

A randomised, multicentre, double blind, placebo-controlled study, has investigated the clinical effect and immunomodulatory activity of Imunoglukan P4H® (pleuran, insoluble β-glucan isolated from Pleurotus ostreatus combined with vitamin C) in a group of 175 children (aged 5.65 +/- 2.39 years) with more than 5 respiratory infections that occurred during the 12 months prior to the beginning of the study. The authors stated that they used an active placebo (vitamin C) mainly for ethical reasons, in this “vulnerable” population of children. While vitamin C has some confirmed immunomodulatory activities, the most randomised placebo-controlled studies have been unable to clearly demonstrate that vitamin C, as a monotherapy, has the ability to prevent respiratory tract infections. In the active

group, 36% of the children did not suffer from any respiratory infections throughout the treatment, compared to 21% in the placebo group ($p<0.05$). Imunoglukan P4H(R) significantly decreased the frequency of flu and flu-like disease and the number of lower respiratory tract infections and provided a statistically significant modulation of humoral and cellular immunity (Jesenak et al., 2013).

Human trials that have evaluated the effects of beta-glucans of different origin and properties have reported differences in the ability to prevent or reduce the incidence of upper respiratory tract infections in athletes. Pleuran, an insoluble beta-glucan from Pleurotus ostreatus, significantly reduced the incidence of upper respiratory tract infection symptoms in athletes, increased the number of circulating natural killer cells and prevented reduction of natural killer cell activity. Interestingly, soluble oat beta-glucan supplementation did not alter the incidence of upper respiratory tract infection symptoms in endurance athletes, suggesting that the immunomodulatory capacity of beta-glucans is likely to be dependent on solubility and structural factors such as backbone structure and degree of branching (Majtan, 2012).

HYPERSENSITIVITY TO MUSHROOMS IN HUMANS



Chronic hypersensitivity pneumonitis induced by *Lentinula edodes* (Shiitake) mushrooms in long-term mushroom industry workers appears to be characterised by a tendency toward increasing lymphocytes and high CD4/CD8 ratio in bronchoalveolar lavage fluids. Treatment with steroids seems to have a limited effect, while avoidance of the antigen is important (Kai et al., 2008). Similarly, hypersensitivity pneumonitis in a mushroom industry worker due to *Pholiota nameko* spores has been reported (Nakazawa and Tochigi, 1989), and hypersensitivity pneumonitis to spores of *Pholiota nameko* has been reported in a mushroom farmer, while separation from the antigen along with corticosteroid therapy, resulted in the symptoms and inflammatory effects quickly subsiding (Inage et al., 1996).

An individual case study has reported hypersensitivity pneumonitis induced by Shiitake mushroom spores in a worker involved in mushroom production where pulmonary function tests showed a mild

restrictive pattern, Chest CT scan revealed reticulo-nodular shadows, slight ground glass opacities, liner atelectasis, and subpleural opacities in both lung fields (Ampere et al., 2012). Serum precipitins to the Shiitake mushroom spores were positive. The diagnosis of hypersensitivity pneumonitis due to inhalation of Shiitake mushroom spores was established as a result of the improvement of all of the clinical symptoms of the patient, i.e., cough, weight loss, bilateral fine crackles, mild restrictive pattern of pulmonary function, and reticulo-nodular shadows on chest CT, once exposure was eliminated.

Another hypersensitivity study involving Shiitake has been conducted with 10 people where each participant ingested 4g of Shiitake powder daily for 10 weeks (trial 1), and the protocol was repeated in the same subjects after 3 to 6 months (trial 2). Gastrointestinal symptoms coincided with eosinophilia in two subjects. Symptoms and eosinophilia resolved after discontinuing Shiitake ingestion. The authors reported that daily ingestion of Shiitake mushroom powder in five of 10 healthy persons provoked blood eosinophilia, increased eosinophil granule proteins in serum and stool, and increased gastrointestinal symptoms (Levy et al., 1998).

Shiitake dermatitis after the ingestion of raw Shiitake mushrooms has been reported, primarily in Japan, and it has been suggested that this dermatitis may be photosensitive as nearly half of the patients studied developed the dermatitis on skin exposed to sunlight (Hanada and Hashimoto, 1998). A study in Korea has also reported dermatitis effects, but contrary to the previous reports in Japan, cases with Shiitake dermatitis occurred after eating boiled or cooked Shiitake mushrooms suggesting that a non-thermolabile factor/component may be involved (Ha et al., 2003).

Skin and respiratory symptoms developed within 2 months of exposure in a patient involved in the commercial production of Shiitake mushrooms. A diagnosis of contact urticaria and allergic contact dermatitis from Shiitake mushrooms was confirmed by prick and patch tests. The respiratory symptoms, their timing, the presence of precipitating IgG antibodies to Shiitake spores and increased amounts of inflammatory cells and T lymphocytes in bronchoalveolar lavage indicated allergic alveolitis (mushroom worker's disease) (Tarvainen et al., 1991).

Hypersensitivity pneumonitis induced by *Pleurotus eryngii* spores has been reported in a worker in an Eringi (*Pleurotus eryngii*) mushroom factory who had worked there for 6 years. Chest radiography showed diffuse fine nodular shadows. Chest computed tomography demonstrated centrilobular

nodules and increased attenuation in both lungs. The patient suffered from hypoxemia while breathing room air. The lymphocyte count in the bronchoalveolar lavage fluid was increased, and transbronchial lung biopsy specimens showed lymphocyte alveolitis with epithelioid cell granulomas in the alveolar spaces. After admission, the patient's symptoms improved rapidly without medication. However, on his return to work, fever and hypoxemia appeared again. The lymphocyte stimulating test was positive against extracts of Eringi spores. Precipitins against the extracts of Eringi spores were detected by the double immunodiffusion test. The diagnosis was hypersensitivity pneumonitis (HP) caused by Eringi spores. In Japan, more than 30 cases of HP induced by mushroom spores have been reported and therefore this is an occupational health and safety issue, related to air quality in mushroom factories that needs to be addressed. The symptoms appear to improve rapidly without medication (Miyazaki et al., 2003).

Spores of *Pleurotus pulmonarius*, a species of Oyster mushroom, are airborne components and established as causes of respiratory allergies. A study has shown that spores of the oyster mushroom *P. pulmonarius* can induce delayed-type reactions consistent with an acute eczema in atopic individuals, particularly in those with atopic dermatitis (Fischer et al., 2002).

Low trehalase activity in a small number of patients has been reported to be associated with abdominal symptoms caused by edible mushrooms. Trehalose maldigestion can cause symptoms similar to those of lactose maldigestion and intolerance (Arola et al., 1999). A recent study has also described a mushroom intolerance in some patients with Crohn’s disease (Petermann et al., 2009).

Bunashimeji-related hypersensitivity pneumonitis has been reported in workers who cultivate this mushroom in indoor facilities. An evaluation of protective measures concluded that complete cessation was the best treatment for hypersensitivity pneumonitis. The use of a mask was ineffective for patients with a high serum Krebs von der Lungen-6 (KL-6), surfactant protein-D (SP-D) concentration and severe ground-glass opacity on chest high-resolution computed tomography. Initial treatment with oral prednisolone was recommended for patients with high levels of total cell counts in bronchoalveolar lavage fluid (Tsushima et al., 2006), while occupational hypersensitivity pneumonitis (HP) caused by *Grifola frondosa* (Maitake) mushroom spore has been successfully treated with an extra-fine aerosol corticosteroid; beclomethasone dipropionate (BDP) dissolved in hydrofluoroalkane-134a (HFA)(Tanaka et al., 2004).

A case of mucoid impaction of the bronchi due to a hypersensitivity reaction to the monokaryotic

mycelium of *Schizophyllum commune* has been reported. The patient was hospitalized because of mild asthma attacks, persistent cough, peripheral eosinophilia, and "gloved finger" shadows on a chest roentgenogram. Cultures of the mucous plugs and sputum samples yielded white, felt-like mycelial colonies that were later identified as the monokaryotic mycelium of *S. commune*. Bronchoscopies were effective in removing the mucous plugs and relieving the patient's symptoms (Amitani et al., 1996). Two further cases of hypersensitivity to Schizophyllum commune have been reviewed (Chowdhary et al., 2013). Ogawa and colleagues (Ogawa et al., 2013), who retrospectively reviewed the clinical records of 50 patients (mean age 55.1 years) with asthma have also reported that sensitization to Schizophyllum commune is a risk factor for asthmatic patients with regard to both exacerbation frequency and rapid decline in lung function.

SUMMARY OF HYPERSENSITIVITY STUDIES

Spores of mushrooms are airborne components and can be the cause of hypersensitivity / respiratory allergy. The small number of cases reported, primarily in Japan, usually involve workers in the commercial production of mushrooms, where air-quality may be poor, and hence this condition has been referred to as ‘mushroom worker’s disease’. The symptoms for this condition usually improve rapidly, either without medication, when the affected person is removed from the factory environment, or after corticosteroid administration via a nasal spray.

FOOD SAFETY STUDIES

A Phase I Clinical Trial of the dietary supplement, Agaricus blazei Murill (ABM), in cancer patients in remission has recently been completed. Cancer survivors took 1.8, 3.6, or 5.4 g ABM granulated powder per day orally for 6 months. Seventy-eight patients were assessed for safety of ABM (30/24/24 subjects at 1/2/3 packs per day, respectively). Adverse events were observed in 9 patients (12%), with most being digestive in nature such as nausea and diarrhoea, and

one patient developed a liver dysfunction-related food allergy, drug lymphocyte product. However, none of the adverse events occurred in a dose-dependent manner. The study showed that ABM does not cause problems in most patients within laboratory parameters at the dosages tested over 6 months, supporting previous studies that the ABM product is generally safe, excluding possible allergic reaction (Ohno et al., 2011). A further study from the same group has also recently described improvements in quality of life factors (physical and mental components) in cancer patients in remission following the consumption of the Agaricus blazei Murill mushroom extract (Ohno et al., 2013).

The European Food Safety Authority (EFSA) has carried out a safety assessment for Lentinex, an aqueous mycelial extract of Lentinula edodes (Shiitake mushroom), as a novel food ingredient in the context of Regulation (EC) No 258/97. Lentinex consists of approximately 98 % water and 2 % dry matter (beta-glucan lentinan, free glucose and N-containing constituents). The proposed intake of 2.5 mL Lentinex containing 1 mg lentinan (beta-glucan)/mL corresponds to 41.7 mug/kg body weight for a 60 kg person. The intake of beta-glucan resulting from the proposed use is low compared to the intake estimated from the consumption of the mushroom Lentinula edodes and of other beta-glucan sources. The animal and human studies provided by the applicant to EFSA were primarily carried out to determine the efficacy of the novel food ingredient; they were supporting but of limited value regarding a safety assessment. Owing to the fermentative production of the novel food ingredient from the mycelium and the final application of a heat-induced sterilisation step in various food products, adverse effects reported after the consumption of the fruiting body of the Shiitake mushroom were not considered relevant. Although an allergenic risk cannot be excluded for sensitive subjects, EFSA concluded that such a risk was expected not to be higher than that resulting from the normal consumption of the fruiting body of Lentinula edodes. EFSA noted the presence of soy peptides in the culture medium. The safety of Lentinex as a novel food ingredient was established at the proposed conditions of use and the proposed levels of intake (EFSA Panel on Dietetic Products and Allergies, 2010).

Clinical effects and safety evaluation of *Agaricus Blazei* Condensed Liquid (Agaricus Mushroom Extract; ABCL) administered to human volunteers (10 male, 10 female) with chronic C-type hepatitis orally twice per day for 8 weeks reported no toxicological or other side effects (Inuzuka and Yoshida, 2002). A series of trials have evaluated *Ganoderma lucidum* on cancer, Type II diabetes, coronary heart disease, chronic hepatitis B, and neurasthenia. Treatment with Ganopoly® for 12 weeks showed hypoglycemic activity and produced some anti-viral and liver protective effects in patients

with chronic hepatitis B infection. However, the same treatment regimen did not result in any objective response in late-stage cancer patients (Zhou et al., 2005). Overall, the findings suggest that Ganopoly® may have some pharmacological activities, although clinical proof is lacking.

An issue regarding significant amounts of nicotine in dried wild mushrooms (mainly *Boletus edulis* from China) was reported to the European Commission which resulted in the European Food Safety Authority (EFSA) proposing temporary maximum residue levels of 0.036 mg/kg for fresh wild mushrooms and 1.17 mg/kg for dried wild mushrooms (2.3 mg/kg for dried ceps only). The EFSA also highlighted the necessity for a monitoring and testing programme to be launched by food business operators at the start of the 2009 harvest season. An LC-MS/MS system has been described and validated that provides a quick and sensitive analytical method for routine analysis of nicotine in fresh and dried mushrooms (Cavalieri et al., 2010).

A double-blind, placebo-controlled, cross-over intervention study has investigated the effects of 4 weeks Lingzhi (*Ganoderma lucidum*) supplementation on a range of biomarkers for antioxidant status, cardiovascular disease (CHD) risk, DNA damage, immune status, and inflammation, as well as markers of liver and renal toxicity. The study was performed as a follow-up to a study that showed that antioxidant power in plasma increased after Lingzhi ingestion, and that 10 day supplementation was associated with a trend towards an improved CHD biomarker profile. Fasting blood and urine from healthy, consenting adults (n=18; aged 22-52 years) was collected before and after 4 weeks supplementation with a commercially available encapsulated Lingzhi preparation (1.44g Lingzhi/d; equivalent to 13.2g fresh mushroom/d) or placebo. No significant change in any of the variables was found, although a slight trend toward lower lipids was seen, and antioxidant capacity in urine increased. The results showed no evidence of liver, renal or DNA toxicity with Lingzhi intake (Wachtel-Galor et al., 2004).

Ukawa and colleagues (Ukawa et al., 2007) have described the oral administration of *Lyophyllum decastes* Sing.(Hatakeshimeji) to adults (n=11) for two weeks, during which blood tests, urine tests, blood pressure and body measurement checks were assessed. There were no clinical problems observed with regard to blood test results, hepatic and renal functions, glucose and lipid metabolisms, and blood pressure. Similarly, analysis of agaritine from hot-water extracts of Hatakeshimeji showed no clinical effects suggesting that the extract of Hatakeshimeji was a safe food product.

HUMAN TRIALS IN PROGRESS

The following table provides a listing of currently registered human trials that involve direct interventions of mushroom intake. The listing of clinical trials includes a number of trials that have recently been completed. The clinical trial and names of the principal investigator have been cross-checked against the published literature, and where available, the subsequent published papers or preliminary presentation of conference abstracts have been identified in the final column on the status of each trial.

Table 7.Registered Clinical Trials – mushrooms and health.

Study	**Mushroom**	**Title**	**Function/ disease state**	**Duration**	**Status**
ACTRN12613000891729 Bennett, 2013	White button Agaricus bisporus	Effects of Vitamin D-enriched mushrooms, Vitamin D and mushroom controls on cognition and mood in older adults	Cognition, mood	6 months	Recruiting
SLCTR/2013/021 Suresh, 2013	Pleurotus ostreatus, Pleurotus cystidiosus	Oral hypoglycaemic activity of Pleurotus mushrooms on diabetic subjects	Diabetes mellitus	Single dose	Not recruiting
NCT00131287 Hsu, 2005	Agaricus blazei Murril	Effects of the extract of Agaricus blazei Murril on Type II Diabetes Mellitus	Type II Diabetes Mellitus	12 weeks	Completed J Altern Complement Med. 2007, **13** (1), 97-102
ACTRN12606000485538 Klupp, 2006 (last updated 2013)	Ganoderma lucidum, Cordyceps sinensis	A randomised controlled trial to evaluate the effectiveness of Ganoderma lucidum for treatment of hyperglycemia in persons with metabolic syndrome	Metabolic syndrome	6 months	Recruitment complete
JPRN-UMIN000008088 Eguchi, 2012	Enokitake	A randomized control trial of mushroom ice and mushroom extract for hypertension	Hypertension	12 weeks	No longer recruiting
NCT00069524 Abrams 2003	Oyster	Antihyperlipidemic effects of oyster mushrooms	Hyperlipidaemia in HIV	8 weeks	Completed BMC Complement Altern Med. 2011, **11**, 60

NCT00636103 Sung, 2008	Cordyceps sinensis Sacc.	Efficacy study of herbal formula CUF2 to treat childhood asthma	Childhood asthma	6 months	Completed (not yet published)
JPRN-UMIN000011196 Yoshida, 2013	Shiitake	Effect of Lentinula edodes (Shiitake mushroom) for allergic rhinitis and atopic dermatitis	Allergic rhinitis, atopic dermatitis	4 weeks	Recruiting
NCT017367787 Chae, 2012	Cauliflower mushroom (Sparassis)	Efficacy and safety of cauliflower mushroom extract on promotion of immunity	Immunity	12 weeks	Recruiting
NCT00677027 Ofjord, 2008 (last updated 2008)	Shiitake	Dose escalation safety study of MM-10-001 in healthy subjects	Immunity	2 weeks	Active, not recruiting
NCT01398176 Percival, 2011 (last updated 2013)	NS	Immune benefits for mushroom consumption	Immune function	4 weeks	Completed (not yet published)
NCT01099917 Wesa, 2010	Maitake	Maitake mushroom extract for enhancement of hematopoiesis in myelodysplastic patients	Immune function	12 weeks	Active, Phase 2
NCT01496053 Johnson, 2011 (last updated 2012)	Agaricus blazei murill	Anti-inflammatory effect of agaricus blazei murill in inflammatory bowel disease	Inflammatory bowel disease	21 days	Recruiting
NCT01106742 Forland, 2009	Agaricus blazei murill	Agaricus blazei murill (ABM) in patients with inflammatory bowel disease	Inflammatory bowel disease	12 days	Completed Scand J Immunol. 2011, **73** (1) 66-75.
NCT01414010 Kelly, 2011 (last updated 2012)	Trametes versicolor	Effects of pre-, pro and antibiotics on gut microflora	Gut microbiota	14 days	Completed, not yet published

NCT00276445 Yamada, 2006	Japanese	Alleviation of cedar pollen induced allergic symptoms by orally taken superfine beta-1,3-glucan	Allergic Conjunctivitis	NS	Terminated
NCT01017068 Iyawe, 2009	Oyster	Aqueous mushroom extract and intraocular pressure	Glaucoma	3 months	Completed (not yet published)
NCT01815411 Johnson, 2013	NS	Effect of Andosan™ in patients with rheumatoid arthritis	Rheumatoid arthritis	21 days	Not yet recruiting
NCT02075892 Smith-Ryan, 2014	Cordyceps	Mushroom blend on oxygen utilisation	Oxygen utilisation, oxygen kinetics	21 days	Newly registered
NCT01402115 Kim, 2011 (last updated 2012)	Aureobasidium pullulans	Efficacy and safety of polycan on bone metabolism	Osteoporosis	12 weeks	Completed (not yet published)
NCT00709020 Palomares, 2008	White button Agaricus bisporus	Mushroom extract in preventing the recurrence of breast cancer in postmenopausal breast cancer survivors	Breast cancer	85 days	Completed J Clin Oncol. 2011, **29** (15) Meeting Abstract: 1582, May 20
NCT00647075 Gascon, 2008 (last updated 2010)	Yunzhi	Yunzhi as dietary supplement in breast cancer (YUNZHI-BC)	Breast cancer	6 months	Unknown
NCT00680667 Torkelson, 2008	Trametes Versicolor	Clinical trial of Trametes Versicolor in women with breast cancer	Breast cancer	6 weeks	Completed J Soc Integr Oncol. 2008, **6** (3), 122-8

NCT00687843 Iwasaki, 2008 (last updated 2012)	Trametes (Coriolus) versicolor	Study of TS-1 or TS-1 + PSK for gastric cancer patients (Phase 3)	Gastric cancer	11months	Ongoing, not recruiting
NCT00970021 Tangen, 2009 (last updated 2014)	Agaricus blazei murill	Agaricus blazei murill in patients with multiple myeloma	Multiple myeloma	7 weeks	Completed (not yet published)
NCT00575926 Shing, 2007	Ganoderma lucidum (Lingzhi)	Lingzhi for cancer children	Paeditatric cancers	1 year	Completed J Clin Oncol. 2008, **26** (15) Meeting Abstract: 14021
NCT01685489 Higano, 2012	NS	A phase 1b dose escalation trial of PSK®/placebo With docetaxel to treat metastatic castration-resistant prostate cancer	Prostate cancer	12 weeks	Recruitment suspended pending funding
NCT00779168 Twardowski, 2008 (last updated 2014)	White button Agaricus bisporus	Mushroom extract in treating patients with recurrent prostate cancer after local therapy	Prostate cancer	1 year	Active, Phase 1 J Clin Oncol. 2013, **31** (6) Supplement: S Meeting Abstract 142 Feb 20
NCT00269555 Hackman, 2005	Shiitake	Effects of Genistein combined polysaccharide (GCP) on prostate cancer	Prostate Cancer	Not stated	Completed Nutr Cancer. 2010, **62** (8), 1036-43

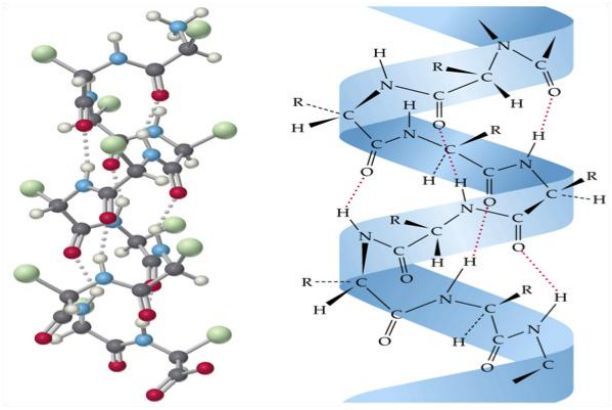
DRKS00004994 Schwarz, 2013	Wild edible	Does a whole-food, vegan diet provide the body with a sufficient supply of vitamin B12 and vitamin D? A follow-up study	Nutrition status	8 months	Not recruiting
NCT00564811 Carlos, 2007	Agaricus Blazei (Murrill) ss. Heinemann	Effect of Agaricus Blazei (Murrill) ss. Heinemann (Sun mushroom) as a nutritional supplement for hepatitis C patients	Nutritional status	6 months	Completed (not yet published)
NCT01815437 Holick, 2012	NS	Evaluating vitamin D content in mushrooms	Vitamin D status	12 weeks	Recruiting
ISRCTN16158244 Brennan, 2011		Effect of introducing vitamin D2 enriched mushrooms in the diet	Vitamin D status	4 weeks	Completed Journal of Nutritional Science. 2013, **2**, (e29) 1-9.
NCT01488734 Uribarri, 2011 (last updated 2013)	NS	Bioavailability and biological effects of Vitamin D2 contained in mushrooms	Vitamin D status	4 months	Completed (not yet published)
NCT01443897 Stephensen, 2011	Button Agaricus bisporus	Effect of consumption of Post-harvest UV-B Treated mushrooms on Vitamin D Status of Healthy Adults	Vitamin D status	6 weeks	Completed J Nutr. 2012, 142 (7) 1246-1252
DRKS00000195 Urbain, 2009	Agaricus bisporus	Effect of UVB-irradiated white button mushrooms and a vitamin D2 supplement on the 25(OH)D levels in healthy adults.	Vitamin D status	4 weeks	Completed European Journal of Clinical Nutrition. 2011, 65, 965-971;

NCT01825616 Nieman, 2012	Portobello	Vitamin D2, muscle damage, NASCAR pitcrew	Muscle function, muscle soreness, vitamin D status	6 weeks	Completed Nutrients. 2013, **6** (1) 63-75.
CTRI/2012/10/003064 Kumar Panda, 2012	Flammulina Velutipes Sing	Efficacy and safety of a novel enoki mushroom (Flammulina Velutipes Sing, Chitoglucan Extract) on weight management in healthy volunteers	Weight management	4 months	Not recruiting
NCT01177085 Cheskin, 2008	NS	Substituting mushrooms for meat to control body weight	Weight loss and control	12 months	Completed Appetite. 2013, **71**, 379-387
NCT00198770 Cheskin, 2008	White button Agaricus bisporus	Dietary compensation with substitution of meat products with white button mushrooms	Weight loss	2 weeks	Completed Appetite. 2008, **51** (1) 50-7.
NCT00465595 Griffiths, 2007 (last updated 2014)	NS	Psychopharmacology of Psilocybin in cancer patients	Psychological effects in cancer patients	7 hrs	Recruiting
NCT00979693 Kumar, 2009 (last updated 2011)	NS	Psilocybin-Assisted Psychotherapy for Anxiety in People With Stage IV Melanoma	Anxiety	2 doses	Suspended

NS; not stated

BIOACTIVE COMPOUNDS AND PROPOSED MECHANISMS OF ACTION

ANTI-CANCER MECHANISMS



A cellular and molecular mechanism has recently been proposed for the reported anticancer effects of Ganoderma lucidum extracts. A water extract of (G. lucidum) has been shown to increase natural killer (NK) cell cytotoxicity by stimulating secretion of perforin and granulysin. The mechanism of activation involved an increased expression of NKG2D and natural cytotoxicity receptors (NCRs), as well as increased phosphorylation of intracellular Mitogen Activated Protein Kinase (MAPKs) which resulted in activation of NKG2D/NCR receptors and MAPK signaling pathways, resulting in exocytosis of perforin and granulysin (Chang et al., 2014).

BREAST CANCER

Studies in animal models and human cell lines have provided insights into the possible mechanisms involved for the effects of mushrooms and their components on breast cancer, and several studies have shown that mushroom extracts are able to suppress the proliferation of breast cancer cell lines, without affecting the proliferation of normal (non-cancer) cell lines (Israilides et al., 2008, Jedinak and Sliva, 2008).

An *in vitro* study using an aqueous extract of *Agaricus bisporus* identified suppression of aromatase activity and estrogen production as key mechanisms (Grube et al., 2001), which is supported by an animal model study that has reported that the major active compounds (in *Agaricus bisporus*) are unsaturated fatty acids such as linoleic acid, linolenic acid, and conjugated linoleic acid (CLA) which have been shown to inhibit aromatase activity (Chen et al., 2006).

Aromatase converts androgens to estrogens and aromatase expression occurs in breast tumours. Mushroom extracts containing beta-glucans have also been suggested to inhibit aromatase activity

(Aleem, 2013) with Grube and co-workers (Grube et al., 2001) demonstrating suppression of aromatase activity and cell proliferation in an aromatase-transfected breast cancer cell line by an aqueous extract of *Agaricus bisporus.* The potential effects of beta-glucans on estrogen receptors and aromatase activity in breast cancer remain to be confirmed by well-designed clinical trials using purified beta-glucans, as to date the studies have been done with beta-glucan containing extracts, primarily from mushrooms and yeasts, and therefore, other components in these extracts may also play a role in the observed effects. These studies however, suggest that beta-glucans may have physiologically relevant effects which are separate from their immunomodulatory effects (Aleem, 2013).

Inhibition of proliferation of human breast cancer cell lines has also been suggested to be mediated via downregulation of Akt/NF-kappaB (transcription factor) signalling in several mushroom varieties (Jiang et al., 2004a, Jiang et al., 2006, Jin et al., 2008), with a suggestion that the active components in mushrooms in these effects may be hydroxylated triterpenes (Jiang et al., 2008). Suppression of the transcription factors NF-kappaB and AP-1 has also been demonstrated by *Ganerderma lucidum* (Thyagarajan et al., 2006).

Polysaccharide K (Krestin, PSK), extracted from *Coriolus versicolor* strain CM-101, is a non-specific immunomodulatory polysaccharide which induces interleukin 2 (IL-2) and interferon (IFN) γ, thereby stimulating lymphokine activated killer cells and enhancing natural killer cells (Sakamoto et al., 2006). Oral administration of PSK has been shown to significantly inhibit breast cancer growth in tumor-bearing neu transgenic mice (Lu et al., 2011), with the indication that PSK is a specific Toll-like receptor 2 (TLR2) agonist and exerts its anti-tumor effects via stimulation of both innate and adaptive immune pathways. PSK has also been demonstrated to activate dendritic cells *in vitro* and *in vivo* and may have an application as a vaccine adjuvant (Engel et al., 2013), with another recent study also reporting that lectin purified from Pleurotus Ostreatus, used as an adjuvant, enhanced immunogenicity of hepatitis B virus DNA vaccination, suggesting a possible use a vaccine adjuvant (Gao et al., 2013).

While the earlier work outlined above, on the potential mechanisms involved in the effects of mushroom and their components on breast cancer cell lines had identified the suppression of aromatase activity and estrogen production, via mushroom polysaccharide induced stimulation of both innate and adaptive immune pathways and via apoptotic effects, recent work has now also reported the suppression of breast tumoral phenotype (by Maitake D-Fraction) in breast cancer

cells through a putative molecular mechanism modifying the expression of certain genes (such as IGFBP-7, ITGA2, ICAM3, SOD2, CAV-1, Cul-3, NRF2, Cycline E, ST7, and SPARC) that are involved in apoptosis stimulation, inhibition of cell growth and proliferation, cell cycle arrest, blocking migration and metastasis of tumoral cells, and inducing multidrug sensitivity (Alonso et al., 2013). Apoptopic effects in human breast cancer cell lines (Wan et al., 2008) have also been attributed to mushroom polysaccharopeptides.

The degree of branching of β-glucan has also been reported to play a significant role in its antitumor effect and the antitumor effect could possibly be enhanced by modulating critical branching structure of beta-glucan (Bae et al., 2013). When the degree of branching in Chamsong-I mushrooms (67% degree of branching) was reduced enzymatically to ~ 32%, the inhibitory activities against MCF-7 human breast cancer cells and Sarcoma 180 tumor cells were improved and the generation of nitric oxide was also enhanced.

COLORECTAL CANCER

The use of mushroom beta-glucans in the treatment of colon cancer has recently been reviewed (Chen et al., 2013). Beta-glucans have been reported to decrease the magnitude of xenografted colon cancer tumours via the stimulation of the immune system and direct cytotoxicity, and can have synergistic effects with chemotherapeutic agents and other enhancers of the immune system. Furthermore, beta-glucans have been used to deliver nanoparticles containing chemotherapeutic agents to the site of the colon cancer with a resulting improvement in efficacy of treatment.

Several *in vitro* studies in HT-29 human colonic carcinoma cells with extracts from *Ganoderma lucidum* (Hong et al., 2004), *Agaricus bisporus* lectin (ABL) (Yu et al., 1993) and other mushrooms have reported pro-apoptotic effects with no associated cytotoxicity. It has been suggested that the pro-apoptotic effects in HT-29 cells is induced by an increase in the activity of caspase-3 (Hong et al., 2004). More recent studies have suggested the pro-apoptotic effects and inhibition of the growth of HT-29 colonic cancer cells is mediated through up-regulation of the expression of pro-apoptotic proteins and down-regulation of anti-apoptotic proteins (Lee et al., 2009). The inhibition of proliferation has been shown to be reversible after removal of (*Agaricus bisporus*) lectin (Yu et al., 1993) and the reversibility of the anti-proliferative effect was associated with the release of the lectin from cancer cells after internalization (Yu et al., 2000).

CERVICAL, OVARIAN AND ENDOMETRIAL CANCERS

Very little is known about the mechanisms involved in the effects of mushrooms or mushroom extracts in cervical, ovarian and endometrial cancers, with only a small number of reports suggesting anti-proliferative effects (Liu et al., 2009, Chen et al., 2010b) via an induction of apoptosis (Ren et al., 2008).

GASTRIC CANCER

Natural polysaccharides isolated from *Phellinus gilvus* (PG) have been shown to decrease cell proliferation and increase cell apoptosis in a dose-dependent manner *in vitro* in a model of human gastric adenocarcinoma and also to lead to a marked inhibition of tumor growth and a significant decrease in the incidence of peritoneal carcinomatosis (Bae et al., 2006). Anti-proliferative (Chen et al., 2008) and pro-apoptotic effects (Shomori et al., 2009) in human gastric cell lines also were reported for several mushroom extracts with both caspase-3 - dependent (Jin et al., 2006) (Shomori et al., 2009) and independent signalling cascades being implicated (Shomori et al., 2009).

Lentinan, the backbone of beta-(1, 3)-glucan with beta-(1, 6) branches, purified from Shiitake mushrooms has been approved as a biological response modifier for the treatment of gastric cancer in Japan. Clinical trials have reported that chemo-immunotherapy using Lentinan as an adjunct to chemotherapy, prolonged the survival of patients with advanced gastric cancer, compared to chemotherapy alone, with Lentinan possible having a synergistic effect with anti-cancer monoclonal antibodies to activate complement systems through the mechanism of antibody-dependent cellular cytotoxicity and complement dependent cytotoxicity (Ina et al., 2013).

PROSTATE CANCER

An *Agaricus blazei* extract (with a high ratio of beta-glucan) has been shown to inhibit cell proliferation in both androgen-dependent and androgen-independent prostate cancer cell lines via

an apoptotic pathway, with activities of caspase 3 and DNA fragmentation being enhanced the most in androgen-independent PC3 cells (Yu et al., 2009). Beta-glucan from *Grifola frondosa* (Maitake) has a cytotoxic effect on human androgen-independent prostatic cancer PC-3 cells *in vitro*, leading to apoptosis (Fullerton et al., 2000), while a more recent study has also suggested that a *Phellinus linteus* extract is able to sensitize advanced prostate cancer cells to apoptosis in athymic nude mice (Tsuji et al., 2010).

Inhibition of proliferation in a dose- and time-dependent manner and induction of apoptosis in PC-3 human prostate cancer cells by *Ganoderma lucidum* (Jiang et al., 2004b) has been reported to be caused by the inhibition of constitutively active AP-1 in prostate cancer cells, resulting in the down-regulation of secretion of vascular endothelial growth factor and transforming growth factor beta (TGF-beta1) from PC-3 cells, and *G. lucidum* inhibits prostate cancer-dependent angiogenesis by modulation of MAPK (mitogen activated protein kinase) and Akt signaling (Stanley et al., 2005).

The mechanisms by which mushrooms and their extracts affect prostate cancer cells appear to be multi-modal with gene network analysis of studies with *Agaricus bisporus* identifying alterations in networks involved in apoptosis, growth and proliferation, lipid metabolism, the TCA cycle and immune responses (Adams et al., 2008).

It should be noted however, that the outcomes of human clinical trials to date, have not supported the demonstrated effects of mushrooms and their extracts on prostate cancer cells *in vitro*.

CARDIOVASCULAR HEALTH

Plasma cholesterol in animal models has been shown to be reduced by mushroom consumption. The hypocholesterolemic effect appears to be due partly to an increased rate of low density lipoprotein (LDL) and high-density lipoprotein (HDL) catabolism. While some studies have postulated eritadenine or angiotensin I – converting enzyme inhibitory peptides as the hypocholesterolemic agents, similar effects on cholesterol, and other biomarkers of cardiovascular risk, have been demonstrated by consumption of mushroom (e.g. *Agaricus bisporus*) fibre. Such a cholesterol-lowering effect has also recently been reported in humans. The effects of mushroom consumption on biomarkers of cardiovascular disease risk have been reviewed (Guillamon et al., 2010).

IMMUNE FUNCTION

Reviews have been carried out on the immunobiology of mushrooms (Borchers et al., 2008), on the immunomodulatory activities of mushroom polysaccharides (Cheung et al., 2011), and on the health effects of beta-glucans in mushrooms (Rop et al., 2009, Rondanelli et al., 2009). The effects of beta-glucans on different immune and cancer cell lines have also recently been reviewed (Sze and Chan, 2012, Vannucci et al., 2013).

A systematic review of immunomodulatory dietary polysaccharides concluded that glucan extracts from *Trametes Versicolor* improved survival and immune function in human randomised controlled trials of cancer patients (Ramberg et al., 2010). The immunomodulatory effects of Agaricus blazei Murill and resultant impacts on an array of health outcomes have also been reviewed (Hetland et al., 2011, Lima et al., 2011). A mini-review on how the immunomodulatory actions of mushroom polysaccharides impact tumor cells has also been published (Wong et al., 2011).

Numerous studies have described the effects of mushrooms and mushroom extracts on immune function with implications for inhibiting tumor growth. Some of the more efficacious compounds reported are the 1,6-branched 1,3-β-glucans, thought to inhibit tumor growth by stimulating the immune system via effects on NK cells, macrophages and via T cells and their cytokine production. More recent work has implicated polysaccharides with varying sugars and some are α- rather than β-glucans. Furthermore, mushroom proteins, terpenes and furans have also been implicated in immune function.

Many of the potential therapeutic effects of mushrooms and mushroom components on a variety of diseases appear to be directly or indirectly mediated by enhancing natural immunity of the host via effects on natural killer (NK) cells, macrophages, via balance of T cells and their cytokine production, and via the activation of Mitogen Activated Protein Kinase (MAPK) pathways (Kim et al., 2007, Lin et al., 2009). It has also been suggested that branching of the β-glucan chain is a requirement for immunostimulatory activity (Volman et al, 2010b).

The immunostimulatory effects induced by Agaricus-derived polysaccharides appear to be mediated

in part, via dectin-1 in combination with granulocyte-macrophage colony-stimulating factor (Yamanaka et al., 2012). This is based on data which has shown that polysaccharide-induced cytokine production was significantly reduced in bone marrow-derived dendritic cells derived from dectin-1-deficient mice, and that the Agaricus-derived polysaccharides can be recognized by dectin-1, a receptor for 1,3-beta-glucan.

NEURODEGENERATIVE DISEASES

One area that is receiving increasing attention revolves around the use of mushrooms and mushroom components to address age-related neurological and cognitive outcomes, including those associated with Alzheimer's and Parkinson's diseases. A recent review (Phan et al., 2014) has discussed studies on over 20 culinary and medicinal mushrooms and their bioactive secondary metabolites on neurodegenerative outcomes. The mushrooms (either extracts from basidiocarps/mycelia or isolated compounds) have been reported to reduce beta amyloid-induced neurotoxicity and had anti-acetylcholinesterase activity, stimulated neurite outgrowth, nerve growth factor (NGF) synthesis, and other neuroprotective, antioxidant, and anti-(neuro)inflammatory effects. It should be noted however, that this evidence comes from *in vitro* data and the potential pharmacological effects (positive or negative) of these mushrooms are not well established even though many of the mushrooms described are edible.

A study using an Alzheimer's disease transgenic mouse model has reported that in comparison to mice on a control diet, Vitamin D2-enriched mushroom-fed wild type and Alzheimer's disease transgenic mice displayed improved learning and memory, had significantly reduced amyloid plaque load and glial fibrillary acidic protein, and elevated interleukin-10 in the brain. These data raise the possibility that Vitamin D2-enriched mushrooms may provide a dietary source of Vitamin D2 and other bioactives for preventing memory-impairment in dementia (Bennett et al., 2013), although such health outcomes need to be confirmed by well-designed human studies. Such human trials have now been registered and are underway (see Section on *Human Trials in Progress*).

OBESITY / BODY COMPOSITION

Shiitake mushroom intake has been reported to lower plasma lipids and prevent body weight gain in animal models. A recent study has attempted to determine the mechanism of Shiitake mushroom powder in lowering plasma triacylglycerol (TAG) in rats fed a high fat diet (HFD). The results showed a positive association between mushroom powder dosage, liver TAG, and liver ballooning histology. A negative association was found between the mushroom powder dosage and the ratio of liver phosphatidylcholine (PC) to phosphatidylethanolamine (PE). This study suggested that the mechanism of high-dose Shiitake mushroom intake by rats (6% (wt/wt) for 6 weeks) in preventing obesity was by increasing TAG accumulation in the liver, rather than adipose tissue (Handayani et al., 2014). The clinical relevance and impact of such a redistribution of TAG remains to be confirmed.

The change in the concentration of liver phospholipids was possibly via eritadenine from Shiitake mushrooms lowering lipid levels by changing the number and species of phospholipids in the liver, as earlier studies have shown that eritadenine derived from Shiitake mushrooms is able to induce PC deficiency in rats fed a choline-deficient diet. Other studies have also reported that such a PC deficiency is able to be prevented by the addition of choline chloride in the rat diet. The increase in fat (TAG) accumulation in the liver resulted in severe hepatic steatosis in this study, however, in other studies, this effect has been reported to be reversible (in mice) when they are withdrawn from Shiitake mushroom consumption. TAG is not normally stored in the liver and is released as the lipoprotein very low-density lipoprotein (VLDL). Adequate choline in a Shiitake mushroom enriched diet would not impair the release of VLDL, as other studies reported that eritadenine from Shiitake mushrooms neither increased the TAG concentration of the liver nor decreased the plasma concentration.

The effects of mushroom supplementation on liver weight, liver TAG levels and fat droplets appears to depend on the variety of mushroom. Mushrooms containing eritadenine can induce liver TAG accumulation when choline chloride is insufficient in the diet by altering the homeostasis of phospholipid synthesis and storage (Handayani et al., 2014). The imbalance of phospholipid levels in the liver will affect the level of plasma TAG.

CONCLUDING REMARKS

In general, the growing amount of data from human clinical trials suggests that the mushrooms and mushroom extracts tested are safe and generally well-tolerated. The most promising data appear to be those indicating an inverse relationship between mushroom consumption and breast cancer risk. It has been previously suggested that an inhibition of aromatase activity, and a subsequent reduction in estrogen, may affect estrogen receptor positive tumors which provides a physiologically-relevant mechanism for these effects of mushrooms in breast cancer treatment. New research has also suggested that beta-glucans may be responsible for this action on aromatase activity and possibly via direct effects on estrogen receptors, which are separate from their previously described immunomodulatory effects.

There is a rapidly growing body of evidence that suggests that mushroom intake may have an immune-stimulatory effect on immune-compromised patients. Some of these effects are substantiated to a point where Lentinan, the backbone of beta-(1, 3)-glucan with beta-(1, 6) branches, purified from Shiitake mushrooms, has now been approved as a biological response modifier for the treatment of gastric cancer in Japan.

Epidemiological studies and one direct intervention trial in humans have provided suggestive evidence for possible effects of mushroom intake on some aspects of brain health, however, to date, there is insufficient evidence from human studies to confirm clinically-relevant outcomes on brain health parameters. Although preliminary, new data showing protective effects of mushrooms on beta-amyloid peptide toxicity in the brain and mild cognitive impairment (both precursors to dementia) are noteworthy and warrant further research on the ability of mushroom consumption to potentially delay the onset of dementia / Alzheimer's disease.

Preventative health effects of mushrooms and their components on respiratory tract infections have now been demonstrated in multiple clinical trials in different population/age groups, significantly strengthening the level of evidence for an effect of mushroom beta-glucan(s) on respiratory tract infections. The use of mushroom components as vaccine adjuvant(s) in humans also appears promising with supporting in vitro, in vivo animal trials, and human studies demonstrating positive immune-stimulatory effects post-vaccination.

ABOUT THE AUTHORS

Dr Peter Roupas

Dr Roupas obtained his PhD from the Department of Medicine at Monash University, Melbourne, Australia in 1988 and completed his postdoctoral research at the University of Michigan Medical School, USA. During his 3 years at the University of Michigan, he was awarded fellowships from the American Diabetes Association (Michigan) and the Juvenile Diabetes Foundation International (New York). On his return to Australia, to the Department of Clinical Biochemistry at the Royal Children's Hospital, Melbourne, he was awarded the 1991 Eli Lilly Diabetes Fellowship and a 4-year fellowship from the National Health and Medical Research Council (NHMRC) of Australia. For the past 18 years, Dr Roupas has been a Research Team Leader at CSIRO and a Project Leader of projects for the CSIRO Food Futures Flagship, the Preventative Health Flagship, and the National Centre of Excellence in Functional Foods relating to the scientific substantiation of health messages for dietary guidelines and health claims for food standards / regulatory applications. Dr Roupas has been an editorial reviewer for 8 scientific journals, an author of 46 papers in peer-reviewed scientific journals, 30 conference papers and 7 book chapters. Dr Roupas is also a Scientific Editor for Elsevier Science UK, a member of the Editorial Board of the *Journal of Functional Foods* and the Editorial Board of the *Joanna Briggs Institute (JBI) Library of Systematic Reviews and Implementation Reports*, and a member of the *Society of Editors*. Dr Roupas is the Deputy Director of CSIRO Food and Health, an Affiliate Centre of the Joanna Briggs Institute (JBI) which is an international collaboration of JBI Centres in 40 countries focused on evidence-based healthcare and practice. Dr Roupas is also accredited as a Systematic Scientific Reviewer by the Joanna Briggs Institute.

Debra Krause

Ms Krause has a Bachelor of Science degree from Deakin University, Melbourne with over 30 years experience in food research organisations. Ms Krause is currently the research coordinator of the Joanna Briggs Institute (JBI) Centre of Food and Health within CSIRO Animal, Food and Health Sciences, undertaking scientific literature searches and evidence-based reviews for a range of projects and project proposals. Ms Krause is accredited as a Systematic Scientific Reviewer by the JBI, an international collaboration of JBI Centres in 40 countries focussed on evidence-based healthcare and practice.

Ms Krause has also had 10 years dairy and meat research and extension experience, 3 years business development experience, 10 years experience in confectionery research and applications, including 5 years concurrent experience in milkfat research and extension activities. Ms Krause has held Secretariat roles for Dairy Australia's Ingredients by Design program and for CSIRO's Innovative Foods Centre (IFC) 'Advanced processing and innovative foods program', where she has organised and participated in industry days and conferences, prepared fact sheets, industry awareness articles, annual and final reports, liaised with stakeholders from government, universities, research directors, researchers and companies to deliver outcomes of the $9.8M IFC program.

Pennie Taylor

Ms Taylor is an Accredited Practising Dietitian with a Masters of Nutrition and Dietetics from Flinders University, Adelaide and has 16 years experience in the health and medical industry. This includes 7 years experience in food and nutrition research where she is currently the Senior Research Dietitian for the CSIRO Nutrition and Health Clinic, CSIRO Animal, Food and Health Sciences. Ms Taylor's role includes providing dietetic expertise to senior scientists to develop and deliver designer diets for clinical trials, analysis of dietary intake and dietary pattern data and assisting in preparing scientific and commercial publications which include nutritional profiling of food components. Ms Taylor is currently the invited allied health committee member *for the Obesity Surgery Society Australia and New Zealand* where she has participated in developing and delivering national roadshows, liaised with government stakeholders and industry partners to further establish awareness for national bariatric dietary guidelines. Ms Taylor is currently a core member of the CSIRO / Joanna Briggs Institute (JBI) Affiliate Centre of Food and Health and is accredited as a Systematic Scientific Reviewer by the JBI, an international collaboration of JBI Centres in 40 countries focussed on evidence-based healthcare and practice.

APPENDIX – COMPOSITIONAL TABLES: RAW, COOKED AND DRIED MUSHROOMS

Mushroom Nutrient Summary - Notes on Nutrient Tables

Definitions

RDI (Recommended Dietary Intake)

The average daily dietary intake level that is sufficient to meet the nutrient requirements of nearly all (97–98 per cent) healthy individuals in a particular life stage and gender group. For individuals, usual intakes at or above this level has a low probability of inadequacy. RDI's are not for assessment of groups.

AI (Adequate Intake) -used when an RDI cannot be determined

The average daily nutrient intake level based on observed or experimentally-determined approximations or estimates of nutrient intake by a group (or groups) of apparently healthy people that are assumed to be adequate. For individuals, usual intake at or above this level has a low probability of inadequacy. When the AI is based on median intakes of healthy populations this assessment is made with lesser confidence. For groups, Mean usual intake at or above this level implies a low prevalence of inadequate intakes. When AI is based on median intakes of healthy populations, this assessment is made with less confidence.

Definitions for RDI/ AIs Taken from The Australian Government, National Health and Medical Research Councils - Nutrient Reference Values for Australia and New Zealand [Last Accessed online 27th May 2014] Available at http://www.nrv.gov.au

% RDI = an average of the international figures on *Agaricus bisporus*

NA = Not available

Mushroom information (Nutrient data, spelling, names and species) has been entered into the tables exactly as they are shown in references sources. No attempt has been made to standardize them.

Database and Reference Sources

Note: For the purpose of this 2014 review, the most recent national nutrient databases available for each country were revised and resource details updated.

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Summary Tables for RAW COMMON MUSHROOMS (Agaricus bisporus) providing >10% RDI/AI for fibre/100g

Nutrient	Fibre (g)	Males 19 years and over	Females 19 years and over
	AI	30	25
Agariscus bisporus white (Matilla 2002)	1.5		
Agariscus bisporus brown (Matilla 2002)	1.6		
Mushrooms white Agaricus bisporus (USDA)	1		
Mushrooms, raw (UK)	1.2		
India (Goyal 2006)	1		
Champignon fresh bisporus (Fin)	1.5		
Common mushroom (Jap)	2		
Mushroom Agaricus bisporus (Den)	1.7		
Mushroom Agaricus bisporus sing SFK (Ger)	2.03		
Mushroom honey (Ger)	5.51	18.4%	22.0%
Mushroom Common Agaricus bisporus (Aust)	1.5		
Mushroom, white, raw (Can)	1		
Mushroom Portabella raw Agaricus bisporus (USDA)	1.3		
Mushroom Portabella (Portobello), raw (Can)	1.3		
Mushroom Brown Italian or Crimini raw Agaricus bisporus (UDSA)	0.6		
Mushroom Brown Italian (Crimini) raw (Can)	0.6		
Mushroom Portabella exposed to UV light raw bisporus (USDA)	1.3		

Summary Tables for RAW COMMON MUSHROOMS (inc Agaricus bisporus) providing >10% RDI/AI of key vitamins/100g

Nutrient	Riboflavin (B2) (mg)	Males 19-70 years	Males over 70 years	Females 19-70 years	Females over 70 years	Niacin equivalents (B3) (mg)	Males 19 years and over	Females 19 years and over	Folate (mcg)	Males 19 years and over	Females 19 years and over
	RDI	1.3	1.6	1.1	1.3	RDI	16	14	RDI	400	400
Agariscus bisporus white (Matilla 2002)	0.39	30.0%	24.4%	35.5%	30.0%	3.3	20.6%	23.6%	36		
Agariscus bisporus brown (Matilla 2002)	0.33	25.4%	20.6%	30.0%	25.4%	4.1	25.6%	29.3%	46	11.5%	11.5%
Mushrooms white Agaricus bisporus (USDA)	0.402	30.9%	25.1%	36.5%	30.9%	3.607	22.5%	25.8%	17		
Mushrooms, raw (UK)	0.27	20.8%	16.9%	24.5%	20.8%	2.5	15.6%	17.9%	40	10.0%	10.0%
India (Goyal 2006)	N/A					N/A			N/A		
Champignon fresh bisporus (Fin)	0.42	32.3%	26.3%	38.2%	32.3%	6.1	38.1%	43.6%	35		
Common mushroom (Jap)	0.29	22.3%	18.1%	26.4%	22.3%	3	18.8%	21.4%	28		
Mushroom Agaricus bisporus (Den)	0.44	33.8%	27.5%	40.0%	33.8%	6.05	37.8%	43.2%	41	10.3%	10.3%
Mushroom Agaricus bisporus sing SFK (Ger)	0.42	32.3%	26.3%	38.2%	32.3%	5.2	32.5%	37.1%	25		
Mushroom honey (Ger)	N/A					N/A			N/A		
Mushroom Common Agaricus bisporus (Aust)	0.369	28.4%	23.1%	33.5%	28.4%	3.72	23.3%	26.6%	18		
Mushroom, white, raw (Can)	0.402	30.9%	25.1%	36.5%	30.9%	4.19	26.2%	29.9%	16		
Mushroom Portabella raw Agaricus bisporus (USDA)	0.13	10.0%		11.8%	10.0%	4.494	28.1%	32.1%	28		
Mushroom Portabella (Portobello), raw (Can)	0.13	10.0%		11.8%	10.0%	5.077	31.7%	36.3%	22		
Mushroom Brown Italian or Crimini raw Agaricus bisporus (UDSA)	0.49	37.7%	30.6%	44.5%	37.7%	3.8	23.8%	27.1%	25		
Mushroom Brown Italian (Crimini) raw (Can)	0.49	37.7%	30.6%	44.5%	37.7%	4.258	26.6%	30.4%	14		
Mushroom Portabella exposed to UV light raw bisporus (USDA)	0.13	10.0%		11.8%	10.0%	4.494	28.1%	32.1%	28		

Summary Tables for RAW COMMON MUSHROOMS (inc Agaricus bisporus) providing >10% RDI/AI of key vitamins/100g

Nutrient	Vit B6 (mg)	Males 19-50 years	Males over 50 years	Females 19-50 years	Females over 50 years	Pantothenic acid (mg)	Males 19 years and over	Females 19 years and over	Biotin (mcg)	Males 19 years and over	Females 19 years and over
	RDI	1.3	1.7	1.3	1.5	AI	6	4	AI	30	25
Agariscus bisporus white (Matilla 2002)	N/A					N/A			N/A		
Agariscus bisporus brown (Matilla 2002)	N/A					N/A			N/A		
Mushrooms white Agaricus bisporus (USDA)	0.104					1.497	25.0%	37.4%	N/A		
Mushrooms, raw (UK)	0.1					2.38	39.7%	59.5%	11.7	39.0%	46.8%
India (Goyal 2006)	N/A					N/A			N/A		
Champignon fresh bisporus (Fin)	0.18	13.8%	10.6%	13.8%	12.0%	N/A			N/A		
Common mushroom (Jap)	0.11					1.54	25.7%	38.5%	N/A		
Mushroom Agaricus bisporus (Den)	0.06					2	33.3%	50.0%	16	53.3%	64.0%
Mushroom Agaricus bisporus sing SFK (Ger)	0.065					2.1	35.0%	52.5%	16	53.3%	64.0%
Mushroom honey (Ger)	N/A					N/A			N/A		
Mushroom Common Agaricus bisporus (Aust)	0.02					1.15	19.2%	28.8%	8.9	29.7%	35.6%
Mushroom, white, raw (Can)	0.104					1.497	25.0%	37.4%	N/A		
Mushroom Portabella raw Agaricus bisporus (USDA)	0.148	11.4%		11.4%		1.14	19.0%	28.5%	N/A		
Mushroom Portabella (Portobello), raw (Can)	0.148	11.4%		11.4%		1.14	19.0%	28.5%	N/A		
Mushroom Brown Italian or Crimini raw Agaricus bisporus (UDSA)	0.11					1.5	25.0%	37.5%	N/A		
Mushroom Brown Italian (Crimini) raw (Can)	0.11					1.5	25.0%	37.5%	N/A		
Mushroom Portabella exposed to UV light raw bisporus (USDA)	0.148	11.4%		11.4%		1.14	19.0%	28.5%	N/A		

Summary Tables for RAW COMMON MUSHROOMS (inc Agaricus bisporus) providing >10% RDI/AI of key vitamins/100g

Nutrient	Vita C (mg)	Males 19 years and over	Females 19 years and over	Vit D (mcg)	Males 19-50 years	Males 51-70 years	Males over 70 years	Females 19-50 years	Females 51-70 years	Females over 70 years
	RDI	45	45	AI	5	10	15	5	10	15
Agariscus bisporus white (Matilla 2002)	N/A			N/A						
Agariscus bisporus brown (Matilla 2002)	N/A			N/A						
Mushrooms white Agaricus bisporus (USDA)	2.1			0.2						
Mushrooms, raw (UK)	1			N/A						
India (Goyal 2006)	N/A			N/A						
Champignon fresh bisporus (Fin)	1.3			0.2						
Common mushroom (Jap)	1			1	20.0%	10.0%		20.0%	10.0%	
Mushroom Agaricus bisporus (Den)	3.1			0						
Mushroom Agaricus bisporus sing SFK (Ger)	4.9	10.9%	10.9%	1.9	38.0%	19.0%	12.7%	38.0%	19.0%	12.7%
Mushroom honey (Ger)	5	11.1%	11.1%	N/A						
Mushroom Common Agaricus bisporus (Aust)	1			N/A						
Mushroom, white, raw (Can)	2.1			0.175						
Mushroom Portabella raw Agaricus bisporus (USDA)	0			0.3						
Mushroom Portabella (Portobello), raw (Can)	0			0.3						
Mushroom Brown Italian or Crimini raw Agaricus bisporus (UDSA)	0			0.1						
Mushroom Brown Italian (Crimini) raw (Can)	0			0.1						
Mushroom Portabella exposed to UV light raw bisporus (USDA)	0			11.2	224.0%	112.0%	74.7%	224.0%	112.0%	74.7%

Table 1 Average[24] %RDI/AI content for each Key Vitamin /100g

Vitamin	Average %	Recommended Dietary Intake	Comments
Riboflavin (B2)	M 25.4% F 28.5%	1.3mg male 19-7 : 1.6mg men>70 1.1mg Female 19-70:1.3mg female>70	# > 10% RDI Provided by 15 of 17 mushrooms for M and F, • Range male 19 and over – 10-37.7% • Range female 19 and over – 10-44.5% Mushroom Brown Italian (Crimini) Raw (USDA) and (Can) providing the greatest amount
Niacin (B3)	M 26.6% F 30.4%	16mg male 19 and over 14mg female 19 and over	#>10% RDI Provided for 15 of 17 for M and F, • Range male 19 and over – 16.6-38.1% • Range female 19 and over – 17.9-43.6% Champignion Fresh (A.Bisporus) (Fin) providing the greatest amount
Folate	M and F 10.9%	400mcg male and female 19 and over	# >10%RDI provided by 3 of 17 mushrooms for M and F • Range male and female 19 and over – 10.3-11.5% Agaricus bisporus brown (Matilla 2002) providing the greatest amount
Vitamin B6	M 11.7% F 12.0%	1.3mg male 19-50 yrs : 1.7mg male >70 1.3 Females 19-50 : 1.5 female > 50 years	#>10% RDI provided by 4 of the 17 for M and F over 50yr and 1 of the 17 for M and F .50. • Range male 19 and over – 10.6 -13.8% • Range female 19 and over – 11.4-13.8% Champignion Fresh (A. Bisporus. (Fin) providing the greatest amount
Pantothenic acid	M 25.8% F 38.7%	6mg male 19 and over 4mg female 19 and over	#>10% AI provided by 12 of the 17 for M and F • Range male 19 and over – 19 – 39.7% • Range female 19 and over – 28.5-59.5% Mushroom Agaricus bisporus SFK (Ger) and Mushroom, Agaricus Bisporus (Den) providing the greatest amount

[24] Average values taken from mushroom data providing greater than or equal to 10%RDI/AI

Biotin	M 43.8% F 52.6%	30mg male 19 and over 25mg female 19 and over	#>10% AI provided by 4 of the 17 for M and F • Range male 19 and over – 29.7 – 53.3% • Range female 19 and over – 35.6 -64% Mushroom agaricus bisporaus (Den) and Mushroom Agaricus Bisporus SFK (Ger) providing the greatest amount
Vitamin C	M and F 11.0%	45mg male and female 19 and over	#>10% RDI provided by 2 of 17 mushrooms for M and F • Range for Male and Female 19 and over – 10.9-11.1% • 11.1% Mushroom Agaricus Bisporus SFK (Ger)
Vitamin D	M and F 63.8%	5mcg Male and female 19-50: 10mcg male and female 51-70: 15mcg male and female >70	# >10% AI provided by 3 of 17 mushrooms for M and F • Range male and female 19 – 50: 20–224% • Range male and female 51-70: 10–112% • Range male and female 70 and over: 12.9-74.7% *Mushroom Portabella exposed to UV light raw A. bisporus (USDA) providing the greatest amount at 11.2mcg/100g*

Summary Table for RAW COMMON MUSHROOMS (inc Agaricus bisporus) providing >10% RDI/AI of key minerals /100g

Nutrient	Copper (mg)	Males 19 years and over	Females 19 years and over	Phosphorus (mg)	Males 19 years and over	Females 19 years and over	Potassium (mg)	Males 19 years and over	Females 19 years and over	Selenium (mcg)	Males 19 years and over	Females 19 years and over
	AI	1.7	1.2	RDI	1000	1000	AI	3800	2800	RDI	70	60
Agariscus bisporus white (Matilla 2002)	0.22	12.9%	18.3%	98			364		13.0%	11	15.7%	18.3%
Agariscus bisporus brown (Matilla 2002)	0.27	15.9%	22.5%	101	10.1%	10.1%	359		12.8%	25	35.7%	41.7%
Mushrooms white Agaricus bisporus (USDA)	0.318	18.7%	26.5%	86			318		11.4%	9.3	13.3%	15.5%
Mushrooms, raw (UK)	0.28	16.5%	23.3%	94			378		13.5%	17	24.3%	28.3%
India (Goyal 2006)	N/A			N/A			N/A			N/A		
Champignon fresh bisporus (Fin)	N/A			98			364		13.0%	11	15.7%	18.3%
Common mushroom (Jap)	0.32	18.8%	26.7%	100	10.0%	10.0%	350		12.5%	N/A		
Mushroom Agaricus bisporus (Den)	0.42	24.7%	35.0%	85.1			363		13.0%	6.47		10.8%
Mushroom Agaricus bisporus sing SFK (Ger)	0.35	20.6%	29.2%	129	12.9%	12.9%	390	10.3%	13.9%	7	10.0%	11.7%
Mushroom honey (Ger)	0.119			121	12.1%	12.1%	427	11.2%	15.3%	9.2	13.1%	15.3%
Mushroom Common Agaricus bisporus (Aust)	0.342	20.1%	28.5%	110	11.0%	11.0%	310		11.1%	15.4	22.0%	25.7%
Mushroom, white, raw (Can)	0.318	18.7%	26.5%	86			318		11.4%	9.3	13.3%	15.5%
Mushroom Portabella raw Agaricus bisporus (USDA)	0.286	16.8%	23.8%	108	10.8%	10.8%	364		13.0%	18.6	26.6%	31.0%
Mushroom Portabella (Portobello), raw (Can)	0.286	16.8%	23.8%	108	10.8%	10.8%	364		13.0%	18.6	26.6%	31.0%
Mushroom Brown Italian or Crimini raw Agaricus bisporus (UDSA)	0.5	29.4%	41.7%	120	12.0%	12.0%	448	11.8%	16.0%	26	37.1%	43.3%
Mushroom Brown Italian (Crimini) raw (Can)	0.5	29.4%	41.7%	120	12.0%	12.0%	448	11.8%	16.0%	26	37.1%	43.3%
Mushroom Portabella exposed to UV light raw bisporus (USDA)	0.286	16.8%	23.8%	108	10.8%	10.8%	364		13.0%	18.6	26.6%	31.0%

Summary Table for RAW COMMON MUSHROOMS (Agaricus bisporus) providing >10% RDI/AI of key minerals /100g

Nutrient	Zinc (mg)	Males 19 years and over	Females 19 years and over	Iron (mg)	Males 19 years and over	Females 19-50 years	Females over 50 years	Iodine (mcg)	Males 19 years and over	Females 19 years and over
	RDI	14	8	RDI	8	18	8	RDI	150	150
Agariscus bisporus white (Matilla 2002)	N/A			N/A				N/A		
Agariscus bisporus brown (Matilla 2002)	N/A			N/A				N/A		
Mushrooms white Agaricus bisporus (USDA)	0.52			0.5				N/A		
Mushrooms, raw (UK)	0.56			0.21				2		
India (Goyal 2006)	N/A			N/A				N/A		
Champignon fresh bisporus (Fin)	0.5			0.4				1		
Common mushroom (Jap)	0.4			0.3				N/A		
Mushroom Agaricus bisporus (Den)	0.477			0.31				1		
Mushroom Agaricus bisporus sing SFK (Ger)	0.52			1.2	15.0%		15.0%	18	12.0%	12.0%
Mushroom honey (Ger)	0.767			0.89	11.1%		11.1%	N/A		
Mushroom Common Agaricus bisporus (Aust)	0.56			0.27				0		
Mushroom, white, raw (Can)	0.52			0.5				N/A		
Mushroom Portabella raw Agaricus bisporus (USDA)	0.53			0.31				N/A		
Mushroom Portabella (Portobello), raw (Can)	0.53			0.31				N/A		
Mushroom Brown Italian or Crimini raw Agaricus bisporus (UDSA)	1.1		13.8%	0.4				N/A		
Mushroom Brown Italian (Crimini) raw (Can)	1.1		13.8%	0.4				N/A		
Mushroom Portabella exposed to UV light raw bisporus (USDA)	0.53			0.31				N/A		

Table2 Average %RDI/AI content for each Key MINERAL /100g

Mineral	Average %	Recommended Dietary Intake	Comments
Copper	M 19.7% F 28%	1.7mg male 19 and over 1.2mg female 19 and over	# >10% AI provided by 14 of 17 mushrooms for M and F • Range male 19 and over – 12.9- 29.4% • Range female 19 and over – 18.3 - 41.7% Mushroom, brown Italian (Crimni) raw (Can) providing the greatest amount
Phosphorous	M and F 11.3%	1000mg male 19 and over 1000mg Female 19 and over	# >10% RDI provided by 10 of 17 mushrooms for M and F • Range male and female 19 and over – 10-12.9% Mushroom Agaricus Bisporus SFK (Ger) providing the greatest amount
Potassium	M 11.3% F 13.2%	3800 mg male 19 and over 2800mg female 19 and over	# >10% AI provided by M 4 and F 16 of 17 Mushrooms • Range male 19 and over – 10.3-11.8% • Range female 19 and over – 11.1-16% Mushroom Brown Italian or Crimini raw Agaricus bisporus (UDSA) and (Can) at 11.8% providing the greatest amount
Selenium	M 22.7% F 25.4%	70mcg male 19 and over 60mcg female 19 and over	# >10% RDI provided by 14 M and 15 of 17 mushrooms for F • Male 19 and over – 10% – 37.1% • Female 19 and over – 10.8%-43.3% Mushroom Brown Italian or Crimini raw Agaricus bisporus (UDSA) and (Can) providing the greatest amount
Zinc	F 13.8% only	14mg male 19 and over 8mg females 19 and over	# >10% RDI provided by 2 of 17 Mushrooms for Females 19 years : Mushroom Brown Italian or Crimini raw Agaricus bisporus (UDSA) and (Can)

Iron	M and F (over 50) 13.1 % only	8mg male 19 and over 18mg females 19-50 and over 8mg females over 50	# >10% RDI provided by 2 of 17 mushrooms Mushroom Agaricus bisporus SFK (Ger) at 15 % and Mushroom, honey (Ger) at 11.1%
Iodine	M and F 12%	150mcg Male 19 and over 150mcg female 19 and over	# >10% RDI provided by 1 of 17 mushrooms being provided by, Mushroom Agaricus bisporus SFK (Ger)

Summary Table for RAW CULINARY SPECIALTY MUSHROOMS providing >10% AI for protein and fibre /100g

Nutrient	Protein (g)	Males 19-70 years	Males over 70 years	Females 19-70 years	Females over 70 years	Fibre (g)	Males 19 years and over	Females 19 years and over
	RDI	64	81	46	57	AI	30	25
Shitake Nama-shiitake (Jap)	3					3.5	11.7%	14.0%
Shiitake dong gwoo (Fin)	1.8					3.3	11.0%	13.2%
Shiitake (Log grown)	1.5					0.6		
Mushroom shiitake raw Lentinus edodes (USDA)	2.24					2.5		10.0%
Shimej Bunashimeji (Jap)	2.7					3.7	12.3%	14.8%
Oyster, Eringii, raw (Jap)	3.6					4.3	14.3%	17.2%
Oyster, Usuhiratake, raw (Jap)	6.1			13.3%	10.7%	3.8	12.7%	15.2%
Oyster (Jap)	3.3					2.6		10.4%
Oyster (USDA)	3.31					2.3		
Boletus edible (Ger)	3.77					6.02	20.1%	24.1%
Oyster Pleurotte (Fin)	2					2.4		
Boletus edible (Fin)	3.2					6	20.0%	24.0%
Mushroom Boletus, Russula (Fin)	1.8					1.9		
Chantarelle (Fin)	1.8					1.9		
False Morel (Fin)	1.8					1.9		
Milk-cap Northern (Fin)	2.1					1.5		
Oyster Pleurotus spp SFK-Ger	2.31					5.85	19.5%	23.4%

Summary Table for RAW CULINARY SPECIALTY MUSHROOMS providing >10% AI for protein and fibre /100g *continued*

Nutrient	**Protein (g)**	Males 19-70 years	Males over 70 years	Females 19-70 years	Females over 70 years	**Fibre (g)**	Males 19 years and over	Females 19 years and over
	RDI	**64**	**81**	**46**	**57**	**AI**	**30**	**25**
Mushroom Oyster, raw (Can)	3.31					2.3		
Enoki (USDA)	2.66					2.7		10.8%
Mushroom Enoki, raw (Can)	2.56					2.7		10.8%
Winter Mushrooms (Jap)	2.7					3.9	13.0%	15.6%
Nameko, raw (Jap)	1.7					3.3	11.0%	13.2%
Maitake, raw (Jap)	3.7					2.7		10.8%
Yanagimatsutake, raw (Jap)	2.4					3	10.0%	12.0%
Shimeji Honshimeji, raw (Jap)	2.1					3.3	11.0%	13.2%
Numeisugitake, raw (Jap)	2.3					2.5		10.0%
Tamogitake, raw (Jap)	3.6					3.3	11.0%	13.2%
Shimeji Hatakeshimeji, raw (Jap)	3.1					3.5	11.7%	14.0%
Kuroawabitake, raw (Jap)	3.7					4.1	13.7%	16.4%
Matsutake, raw (Jap)	2					4.7	15.7%	18.8%
Maitake (USDA)	1.94					2.7		10.8%
Chanterelle, raw (USDA)	1.49					3.8	12.7%	15.2%
Morel, raw (USDA)	3.12					2.8		11.2%
Maitake, raw (Can)	1.94					2.7		10.8%

- 100g of fresh culinary specialty mushrooms provide an average of 13.6 % of the AI[25] for fibre for male and 14.3% for females aged 19 years and over whereas the common variety mushroom provides an average of 5.7%
- NEW: 100g of the fresh culinary specialty mushroom variety, Oyster, Usuhiratake, raw (Jap) provides 13.3% of RDI for Protein for Males and 10.7% for females aged 19-70yrs.

[25] AI for fibre males 19yeas and over equals 30g and for females 19 years and over equals 25g; RDI for Protein in males 19-70yrs 57g ; females 19-70yrs 46g

Summary Table for RAW CULINARY SPECIALTY MUSHROOMS providing >10% RDI/AI of key vitamins /100g

Nutrient	Thiamin (B1) (mg)	Males 19 years and over	Females 19 years and over	Riboflavin (B2) (mg)	Males 19-70 years	Males over 70 years	Females 19-70 years	Females over 70 years	Niacin equivalents (B3) (mg)	Males 19 years and over	Females 19 years and over
	RDI	1.2	1.1	RDI	1.3	1.6	1.1	1.3	RDI	16	14
Shitake Nama-shiitake (Jap)	0.1			0.19	14.6%	11.9%	17.3%	14.6%	3.8	23.8%	27.1%
Shiitake dong gwoo (Fin)	0.05			0.15	11.5%		13.6%	11.5%	2.6	16.3%	18.6%
Shiitake (Log grown)	0.4	33.3%	36.4%	0.4	30.8%	25.0%	36.4%	30.8%	4.5	28.1%	32.1%
Mushroom shiitake raw Lentinus edodes (USDA)	0.015			0.217	16.7%	13.6%	19.7%	16.7%	3.887	24.3%	27.8%
Shimej Bunashimeji (Jap)	0.16	13.3%	14.5%	0.16	12.3%	10.0%	14.5%	12.3%	6.6	41.3%	47.1%
Oyster, Eringii, raw (Jap)	0.14	11.7%	12.7%	0.28	21.5%	17.5%	25.5%	21.5%	8.1	50.6%	57.9%
Oyster, Usuhiratake, raw (Jap)	0.3	25.0%	27.3%	0.41	31.5%	25.6%	37.3%	31.5%	6.9	43.1%	49.3%
Oyster (Jap)	0.4	33.3%	36.4%	0.4	30.8%	25.0%	36.4%	30.8%	10.7	66.9%	76.4%
Oyster (USDA)	0.125	10.4%	11.4%	0.349	26.8%	21.8%	31.7%	26.8%	4.956	31.0%	35.4%
Boletus edible (Ger)	0.03			0.37	28.5%	23.1%	33.6%	28.5%	4.9	30.6%	35.0%
Oyster Pleurotte (Fin)	0.07			0.2	15.4%	12.5%	18.2%	15.4%	5.2	32.5%	37.1%
Boletus edible (Fin)	0.03			0.37	28.5%	23.1%	33.6%	28.5%	8.4	52.5%	60.0%
Mushroom Boletus, Russula (Fin)	0.1			0.4	30.8%	25.0%	36.4%	30.8%	5.9	36.9%	42.1%
Chantarelle (Fin)	0.1			0.4	30.8%	25.0%	36.4%	30.8%	5.9	36.9%	42.1%
False Morel (Fin)	0.1			0.4	30.8%	25.0%	36.4%	30.8%	5.9	36.9%	42.1%
Milk-cap Northern (Fin)	0.1			0.42	32.3%	26.3%	38.2%	32.3%	6.1	38.1%	43.6%
Oyster Pleurotus spp SFK-Ger	0.191	15.9%	17.4%	0.285	21.9%	17.8%	25.9%	21.9%	10	62.5%	71.4%

Summary Table for RAW CULINARY SPECIALTY MUSHROOMS providing >10% RDI/AI of key vitamins /100g *continued*

Nutrient	Thiamin (B1) (mg)	Males 19 years and over	Females 19 years and over	Riboflavin (B2) (mg)	Males 19-70 years	Males over 70 years	Females 19-70 years	Females over 70 years	Niacin equivalents (B3) (mg)	Males 19 years and over	Females 19 years and over
	RDI	1.2	1.1	RDI	1.3	1.6	1.1	1.3	RDI	16	14
Mushroom Oyster, raw (Can)	0.125	10.4%	11.4%	0.349					5.456		
Enoki (USDA)	0.225	18.8%	20.5%	0.2	15.4%	12.5%	18.2%	15.4%	7.032	44.0%	50.2%
Mushroom Enoki, raw (Can)	0.179	14.9%	16.3%	0.162	12.5%	10.1%	14.7%	12.5%	6.372	39.8%	45.5%
Winter Mushrooms (Jap)	0.24	20.0%	21.8%	0.17	13.1%	10.6%	15.5%	13.1%	6.8	42.5%	48.6%
Nameko, raw (Jap)	0.07			0.12			10.9%		5.1	31.9%	36.4%
Maitake, raw (Jap)	0.25	20.8%	22.7%	0.49	37.7%	30.6%	44.5%	37.7%	9.1	56.9%	65.0%
Yanagimatsutake, raw (Jap)	0.27	22.5%	24.5%	0.34	26.2%	21.3%	30.9%	26.2%	6.1	38.1%	43.6%
Shimeji Honshimeji, raw (Jap)	0.08			0.5	38.5%	31.3%	45.5%	38.5%	9	56.3%	64.3%
Numeisugitake, raw (Jap)	0.16	13.3%	14.5%	0.34	26.2%	21.3%	30.9%	26.2%	5.9	36.9%	42.1%
Tamogitake, raw (Jap)	0.17	14.2%	15.5%	0.33	25.4%	20.6%	30.0%	25.4%	12	75.0%	85.7%
Shimeji Hatakeshimeji, raw (Jap)	0.12	10.0%	10.9%	0.49	37.7%	30.6%	44.5%	37.7%	6.1	38.1%	43.6%
Kuroawabitake, raw (Jap)	0.21	17.5%	19.1%	0.22	16.9%	13.8%	20.0%	16.9%	2.9	18.1%	20.7%
Matsutake, raw (Jap)	0.1			0.1					8	50.0%	57.1%
Maitake (USDA)	0.146	12.2%	13.3%	0.242	18.6%	15.1%	22.0%	18.6%	6.585	41.2%	47.0%
Chanterelle, raw (USDA)	0.015			0.215	16.5%	13.4%	19.5%	16.5%	4.085	25.5%	29.2%
Morel, raw (USDA)	0.069			0.205	15.8%	12.8%	18.6%	15.8%	2.252	14.1%	16.1%
Maitake, raw (Can)	0.146	12.2%	13.3%	0.242	18.6%	15.1%	22.0%	18.6%	6.941	43.4%	49.6%

Summary Table for RAW CULINARY SPECIALTY MUSHROOMS providing >10% RDI/AI of key vitamins /100g

Nutrient	Folate (mcg)	Males 19 years and over	Females 19 years and over	Vit B6 (mg)	Males 19-50 years	Males over 50 years	Females 19-50 years	Females over 50 years	Pantothenic acid (mg)	Males 19 years and over	Females 19 years and over
	RDI	400	400	RDI	1.3	1.7	1.3	1.5	AI	6	4
Shitake Nama-shiitake (Jap)	42	10.5%	10.5%	0.11					1.08	18.0%	27.0%
Shiitake dong gwoo (Fin)	25			0.29	22.3%	17.1%	22.3%	19.3%	N/A		
Shiitake (Log grown)	N/A			N/A					N/A		
Mushroom shiitake raw Lentinus edodes (USDA)	13			0.293	22.5%	17.2%	22.5%	19.5%	1.5	25.0%	37.5%
Shimej Bunashimeji (Jap)	28	7.0%	7.0%	0.08					0.86	14.3%	21.5%
Oyster, Eringii, raw (Jap)	80	20.0%	20.0%	0.18	13.8%	10.6%	13.8%	12.0%	1.61	26.8%	40.3%
Oyster, Usuhiratake, raw (Jap)	100	25.0%	25.0%	0.23	17.7%	13.5%	17.7%	15.3%	2.44	40.7%	61.0%
Oyster (Jap)	92	23.0%	23.0%	0.1					2.4	40.0%	60.0%
Oyster (USDA)	38			0.11					1.294	21.6%	32.4%
Boletus edible (Ger)	N/A			N/A					2.7	45.0%	67.5%
Oyster Pleurotte (Fin)	51	12.8%	12.8%	0.11					N/A		
Boletus edible (Fin)	35			0.18	13.8%	10.6%	13.8%	12.0%	N/A		
Mushroom Boletus, Russula (Fin)	25.5			0.22	16.9%	12.9%	16.9%	14.7%	N/A		
Chantarelle (Fin)	21			0.04					N/A		
False Morel (Fin)	21			0.22	16.9%	12.9%	16.9%	14.7%	N/A		
Milk-cap Northern (Fin)	35			0.18	13.8%	10.6%	13.8%	12.0%	N/A		
Oyster Pleurotus spp SFK-Ger	N/A			0.088					N/A		

Summary Table for RAW CULINARY SPECIALTY MUSHROOMS providing >10% RDI/AI of key vitamins /100g *continued*

Nutrient	Folate (mcg)	Males 19 years and over	Females 19 years and over	Vit B6 (mg)	Males 19-50 years	Males over 50 years	Females 19-50 years	Females over 50 years	Pantothenic acid (mg)	Males 19 years and over	Females 19 years and over
	RDI	400	400	RDI	1.3	1.7	1.3	1.5	AI	6	4
Mushroom Oyster, raw (Can)	27			0.11					1.294	21.6%	32.4%
Enoki (USDA)	48	12.0%	12.0%	0.1					1.35	22.5%	33.8%
Mushroom Enoki, raw (Can)	52	13.0%	13.0%	0.081					1.067	17.8%	26.7%
Winter Mushrooms (Jap)	75	18.8%	18.8%	0.12					1.4	23.3%	35.0%
Nameko, raw (Jap)	58	14.5%	14.5%	0.05					1.25	20.8%	31.3%
Maitake, raw (Jap)	60	15.0%	15.0%	0.07					0.79	13.2%	19.8%
Yanagimatsutake, raw (Jap)	33			0.11					2.61	43.5%	65.3%
Shimeji Honshimeji, raw (Jap)	38			0.13	10.0%		10.0%		1.97	32.8%	49.3%
Numeisugitake, raw (Jap)	19			0.08					1.77	29.5%	44.3%
Tamogitake, raw (Jap)	80	20.0%	20.0%	0.12					1.32	22.0%	33.0%
Shimeji Hatakeshimeji, raw (Jap)	25			0.12					2.48	41.3%	62.0%
Kuroawabitake, raw (Jap)	65	16.3%	16.3%	0.09					1.32	22.0%	33.0%
Matsutake, raw (Jap)	63	15.8%	15.8%	0.15	11.5%		11.5%	10.0%	1.91	31.8%	47.8%
Maitake (USDA)	21			0.056					0.27		
Chanterelle, raw (USDA)	2			0.044					1.075	17.9%	26.9%
Morel, raw (USDA)	9			0.136	10.5%		10.5%		0.44		11.0%
Maitake, raw (Can)	29			0.056					0.27		

Summary Table for RAW CULINARY SPECIALTY MUSHROOMS providing >10% RDI/AI of key vitamins /100g

Nutrient	Vit C (mg)	Males 19 years and over	Females 19 years and over	Vitamin A (Retinol Equivalents) (mcg)	Males 19 years and over	Females 19 years and over	Vit D (mcg)	Males 19-50 years	Males 51-70 years	Males over 70 years	Females 19-50 years	Females 51-70 years	Females over 70 years
	RDI	45	45	RDI	900	700	AI	5	10	15	5	10	15
Shitake Nama-shiitake (Jap)	10	22.2%	22.2%	0			2	40.0%	20.0%	13.3%	40.0%	20.0%	13.3%
Shiitake dong gwoo (Fin)	2.1			0			0.1						
Shiitake (Log grown)	N/A			N/A			N/A						
Mushroom shiitake raw Lentinus edodes (USDA)	N/A			N/A			0.4						
Shimej Bunashimeji (Jap)	7	15.6%	15.6%	0			2	40.0%	20.0%	13.3%	40.0%	20.0%	13.3%
Oyster, Eringii, raw (Jap)	0			0			2	40.0%	20.0%	13.3%	40.0%	20.0%	13.3%
Oyster, Usuhiratake, raw (Jap)	0			0			6	120.0%	60.0%	40.0%	120.0%	60.0%	40.0%
Oyster (Jap)	10	22.2%	22.2%	0			1	20.0%	10.0%		20.0%	10.0%	
Oyster (USDA)	0			2			0.7	14.0%			14.0%		
Boletus edible (Ger)	2.5			N/A			3.1	62.0%	31.0%	20.7%	62.0%	31.0%	20.7%
Oyster Pleurotte (Fin)	1.6			0			<0.1mcg						
Boletus edible (Fin)	2.5			0			2.9	58.0%	29.0%	19.3%	58.0%	29.0%	19.3%
Mushroom Boletus, Russula (Fin)	5	11.1%	11.1%	0			4.4	88.0%	44.0%	29.3%	88.0%	44.0%	29.3%
Chantarelle (Fin)	5	11.1%	11.1%	110.3	12.3%	15.8%	12.8	256.0%	128.0%	85.3%	256.0%	128.0%	85.3%
False Morel (Fin)	5	11.1%	11.1%	0			4.4	88.0%	44.0%	29.3%	88.0%	44.0%	29.3%
Milk-cap Northern (Fin)	1.3			0			5.5	110.0%	55.0%	36.7%	110.0%	55.0%	36.7%
Oyster Pleurotus spp SFK-Ger	0.6			N/A			N/A						

Summary Table for RAW CULINARY SPECIALTY MUSHROOMS providing >10% RDI/AI of key vitamins /100g *continued*

Nutrient	Vit C (mg)	Males 19 years and over	Females 19 years and over	Vitamin A (Retinol Equivalents) (mcg)	Males 19 years and over	Females 19 years and over	Vit D (mcg)	Males 19-50 years	Males 51-70 years	Males over 70 years	Females 19-50 years	Females 51-70 years	Females over 70 years
	RDI	45	45	RDI	900	700	AI	5	10	15	5	10	15
Mushroom Oyster, raw (Can)	0			2			0.9	18.0%			18.0%		
Enoki (USDA)	0			N/A			0.1						
Mushroom Enoki, raw (Can)	0			0			0.1						
Winter Mushrooms (Jap)	1			0			1	20.0%	10.0%		20.0%	10.0%	
Nameko, raw (Jap)	Tr mg			0			Tr mcg						
Maitake, raw (Jap)	0			0			3	60.0%	30.0%	20.0%	60.0%	30.0%	20.0%
Yanagimatsutake, raw (Jap)	Tr mg			0			1	20.0%	10.0%		20.0%	10.0%	
Shimeji Honshimeji, raw (Jap)	Tr mg			0			4	80.0%	40.0%	26.7%	80.0%	40.0%	26.7%
Numeisugitake, raw (Jap)	1			0			1	20.0%	10.0%		20.0%	10.0%	
Tamogitake, raw (Jap)	0			0			2	40.0%	20.0%	13.3%	40.0%	20.0%	13.3%
Shimeji Hatakeshimeji, raw (Jap)	0			0			1	20.0%	10.0%		20.0%	10.0%	
Kuroawabitake, raw (Jap)	Tr mg			0			1	20.0%	10.0%		20.0%	10.0%	
Matsutake, raw (Jap)	2			0			4	80.0%	40.0%	26.7%	80.0%	40.0%	26.7%
Maitake (USDA)	0			0			28.1	562.0%	281.0%	187.3%	562.0%	281.0%	187.3%
Chanterelle, raw (USDA)	N/A			N/A			5.3	106.0%	53.0%	35.3%	106.0%	53.0%	35.3%
Morel, raw (USDA)	N/A			0			5.1	102.0%	51.0%	34.0%	102.0%	51.0%	34.0%
Maitake, raw (Can)	0			0			29.5	590.0%	295.0%	196.7%	590.0%	295.0%	196.7%

Table 3 Average %RDI/AI content for each Key Vitamin /100g

Vitamin	Average %	Recommended Dietary Intake	Comments
Thiamine (B1)	M 17.4% F 18.9%	1.2mg male 19 years and over 1.1mg Female 19 years and over	# >10% RDI provided by 19 of the 34 mushrooms for M and F • Range male 19 and over – 10 – 33.3% • Range female 19 and over – 10.9-36.4% Shiitake (Log grown) providing the greatest amount
Riboflavin (B2)	M 21.5% F 25.4%	1.3mg male 19-70 : 1.6mg men>70 1.1mg Female 19-70: 1.3mg female>70	# >10% RDI provided by M 31 and F 32 of 34 mushrooms • Range male 19 and over – 10 – 38.5% • Range female 19 and over – 10.9- 45.5% Shimeiji Hatakeshimeiji raw (Jap) providing the greatest amount
Niacin	M 39.5% F 45.2%	16mg male 19 and over 14mg female 19 and over	# >10% RDI provided by 31 of 34 mushrooms for M and F • Range male 19 and over – 14.1-75% • Range female 19 and over – 16.1-85.7% Tamogitake, raw (Jap) providing the greatest amount
Folate	M and 16.7%	400mcg male and female 19 and over	# >10% RDI provided by 14 of 34 mushrooms for M and F • Range male and female 19 and over – 10.5-25% Oyster, Usuhiratake, raw (Jap)
Vitamin B6	M 14.5% F 15.0%	1.3mg male 19-50: 1.7mg men>50 1.3mg Female 19-50: 1.5mg female>50	# >10% RDI provided by 11 of 33 mushrooms for M and F • Range male and female 19 and over – 10-22.5% Mushroom, Shiitake raw Lentinus edodes (USDA) providing the greatest amount
Pantothenic acid	M 26.9% F 39.1%	6mg male 19 and over 4mg female 19 and over	# >10% AI provided by M 22 and F 23 of 34 mushrooms • Range male 19 and over 13.2–45% • Range female 19 and over 11 –67.5% Boletus, Edible (Ger) providing the greatest amount
Vitamin C	M and F 15.6%	45mg male and female 19 and over	# >10% RDI provided by 6 of 34 mushrooms for M and F • Range male and females 19 and over 11.1-22.2%

			Shiitake Nama-shiitake (Jap) and Oyster (Jap) providing the greatest amount
Vitamin D	M and F 71.1%	5mcg Male and female 19-50 10mcg male and female 51-70 15mcg male and female >70	# >10% AI provided by 26 of 34 mushrooms for M and F • Range male and female 19 – 50: 14–590% • Range male and female 51-70: 10–295% • Range male and female 70 and over: 13.3-197% Maitake, Raw (Can) being the greatest contributor providing 29.5mcg per 100g
Vitamin A (Retinol Equiv)	M 12.3% F 15.8%	900 RE male 19 and over 700RE female 19 and over	# >10% RDI provided by 1 of 34 mushrooms for M and F Chantarelle (Fin) providing the greatest amount

Summary Table for RAW CULINARY SPECIALTY MUSHROOMS providing >10% RDI/AI of key minerals /100g

Nutrient	Copper (mg)	Males 19 years and over	Females 19 years and over	Phosphorus (mg)	Males 19 years and over	Females 19 years and over	Manganese (mg)	Males 19 years and over	Females 19 years and over
	AI	1.7	1.2	RDI	1000	1000	AI	5.5	5
Shitake Nama-shiitake (Jap)	0.05			73			0.23		
Shiitake dong gwoo (Fin)	N/A			73			N/A		
Shiitake (Log grown)	N/A			39			N/A		
Mushroom shiitake raw Lentinus edodes (USDA)	0.142		11.8%	112	11.2%	11.2%	0.23		
Shimej Bunashimeji (Jap)	0.06			100	10.0%	10.0%	0.12		
Oyster, Eringii, raw (Jap)	0.15		12.5%	120	12.0%	12.0%	0.07		
Oyster, Usuhiratake, raw (Jap)	0.15		12.5%	110	11.0%	11.0%	0.11		
Oyster (Jap)	0.15		12.5%	100	10.0%	10.0%	0.16		
Oyster (USDA)	0.244	14.4%	20.3%	120	12.0%	12.0%	0.113		
Boletus edible (Ger)	0.279	16.4%	23.3%	82			0.112		
Oyster Pleurotte (Fin)	N/A			110	11.0%	11.0%	N/A		
Boletus edible (Fin)	N/A			47			N/A		
Mushroom Boletus, Russula (Fin)	N/A			72			N/A		
Chantarelle (Fin)	N/A			72			N/A		
False Morel (Fin)	N/A			72			N/A		
Milk-cap Northern (Fin)	N/A			55			N/A		
Oyster Pleurotus spp SFK-Ger	0.12		10.0%	67			0.16		

Summary Table for RAW CULINARY SPECIALTY MUSHROOMS providing >10% RDI/AI of key minerals /100g*continued*

Nutrient	**Copper (mg)**	Males 19 years and over	Females 19 years and over	**Phosphorus (mg)**	Males 19 years and over	Females 19 years and over	**Manganese (mg)**	Males 19 years and over	Females 19 years and over
	AI	**1.7**	**1.2**	**RDI**	**1000**	**1000**	**AI**	**5.5**	**5**
Mushroom Oyster, raw (Can)	0.244	14.4%	20.3%	120	12.0%	12.0%	0.113		
Enoki (USDA)	0.107			105	10.5%	10.5%	0.075		
Mushroom Enoki, raw (Can)	0.091			109	10.9%	10.9%	0.079		
Winter Mushrooms (Jap)	0.1			110	11.0%	11.0%	0.07		
Nameko, raw (Jap)	0.11			66			0.06		
Maitake, raw (Jap)	0.27	15.9%	22.5%	130	13.0%	13.0%	0.05		
Yanagimatsutake, raw (Jap)	0.2	11.8%	16.7%	110	11.0%	11.0%	0.08		
Shimeji Honshimeji, raw (Jap)	0.36	21.2%	30.0%	75			0.1		
Numeisugitake, raw (Jap)	0.19	11.2%	15.8%	65			0.05		
Tamogitake, raw (Jap)	0.32	18.8%	26.7%	85			0.06		
Shimeji Hatakeshimeji, raw (Jap)	0.14		11.7%	70			0.17		
Kuroawabitake, raw (Jap)	0.15		12.5%	100	10.0%	10.0%	0.07		
Matsutake, raw (Jap)	0.24	14.1%	20.0%	40			0.12		
Maitake (USDA)	0.252	14.8%	21.0%	74			0.059		
Chanterelle, raw (USDA)	0.353	20.8%	29.4%	57			0.286		
Morel, raw (USDA)	0.625	36.8%	52.1%	194	19.4%	19.4%	0.587	10.7%	11.7%
Maitake, raw (Can)	0.252	14.8%	21.0%	74			0.059		

Summary Table for RAW CULINARY SPECIALTY MUSHROOMS providing >10% RDI/AI of key minerals /100g

Nutrient	Potassium (mg)	Males 19 years and over	Females 19 years and over	Selenium (mcg)	Males 19 years and over	Females 19 years and over	Zinc (mg)	Males 19 years and over	Females 19 years and over	Iron (mg)	Males 19 years and over	Females 19-50 years	Females over 50 years
	AI	3800	2800	RDI	70	60	RDI	14	8	RDI	8	18	8
Shitake Nama-shiitake (Jap)	280		10.0%	N/A			0.4			0.3			
Shiitake dong gwoo (Fin)	224			0.3			0.8		10.0%	0.3			
Shiitake (Log grown)	N/A			N/A			N/A			0.7			
Mushroom shiitake raw Lentinus edodes (USDA)	304		10.9%	5.7			1.03		12.9%	0.41			
Shimej Bunashimeji (Jap)	380	10.0%	13.6%	N/A			0.5			0.4			
Oyster, Eringii, raw (Jap)	460	12.1%	16.4%	N/A			0.7			0.3			
Oyster, Usuhiratake, raw (Jap)	220			N/A			0.9		11.3%	0.6			
Oyster (Jap)	340		12.1%	N/A			1		12.5%	0.7			
Oyster (USDA)	420	11.1%	15.0%	2.6			0.77			1.33	16.6%		16.6%
Boletus edible (Ger)	327		11.7%	187	267.1%	311.7%	1.5	10.7%	18.8%	1	12.5%		12.5%
Oyster Pleurotte (Fin)	298		10.6%	1.2			0.7			0.4			
Boletus edible (Fin)	270			11	15.7%	18.3%	0.9		11.3%	0.8	10.0%		10.0%
Mushroom Boletus, Russula (Fin)	340		12.1%	14.1	20.1%	23.5%	0.6			2.7	33.8%	15.0%	33.8%
Chantarelle (Fin)	340		12.1%	18	25.7%	30.0%	0.8		10.0%	2.7	33.8%	15.0%	33.8%
False Morel (Fin)	340		12.1%	39	55.7%	65.0%	0.7			2.7	33.8%	15.0%	33.8%
Milk-cap Northern (Fin)	290		10.4%	1.2			0.6			1	12.5%		12.5%
Oyster Pleurotus spp SFK-Ger	254			N/A			0.87			1.2	15.0%		15.0%

Summary Table for RAW CULINARY SPECIALTY MUSHROOMS providing >10% RDI/AI of key minerals /100g *continued*

Nutrient	Potassium (mg)	Males 19 years and over	Females 19 years and over	Selenium (mcg)	Males 19 years and over	Females 19 years and over	Zinc (mg)	Males 19 years and over	Females 19 years and over	Iron (mg)	Males 19 years and over	Females 19-50 years	Females over 50 years
	AI	3800	2800	RDI	70	60	RDI	14	8	RDI	8	18	8
Mushroom Oyster, raw (Can)	420	11.1%	15.0%	2.6			0.77			1.33	16.6%		16.6%
Enoki (USDA)	359		12.8%	2.2			0.65			1.15	14.4%		14.4%
Mushroom Enoki, raw (Can)	368		13.1%	2.2			0.61			1.09	13.6%		13.6%
Winter Mushrooms (Jap)	340		12.1%	N/A			0.6			1.1	13.8%		13.8%
Nameko, raw (Jap)	230			N/A			0.5			0.7			
Maitake, raw (Jap)	330		11.8%	N/A			0.8		10.0%	0.5			
Yanagimatsutake, raw (Jap)	360		12.9%	N/A			0.6			0.5			
Shimeji Honshimeji, raw (Jap)	300		10.7%	N/A			0.8		10.0%	1.1	13.8%		13.8%
Numeisugitake, raw (Jap)	260			N/A			0.4			0.6			
Tamogitake, raw (Jap)	190			N/A			0.6			0.8	10.0%		10.0%
Shimeji Hatakeshimeji, raw (Jap)	280		10.0%	N/A			0.4			0.6			
Kuroawabitake, raw (Jap)	300		10.7%	N/A			0.7			0.5			
Matsutake, raw (Jap)	410	10.8%	14.6%	N/A			0.8		10.0%	1.3	16.3%		16.3%
Maitake (USDA)	204			2.2			0.75			0.3			
Chanterelle, raw (USDA)	506	13.3%	18.1%	2.2			0.71			3.47	43.4%	19.3%	43.4%
Morel, raw (USDA)	411	10.8%	14.7%	2.2			2.03	14.5%	25.4%	12.18	152.3%	67.7%	152.3%
Maitake, raw (Can)	204			2.2			0.75			0.3			

Table 4 **Average %RDI/AI content for each key mineral /100g**

Mineral	Average %	Recommended Dietary Intake	Comments
Copper	M 17.3% F 20.1%	1.7mg male 19 and over 1.2mg Female 19 and over	# >10% RDI provided by M 13 and F 20 of 34 mushrooms • Range male 19 and over – 11.2-36.8% • Range female 19 and over – 10-52.1% Morel, raw (USDA) providing the greatest amount
Phosphorous	M and F 11.7%	1000mg male and female 19 and over	# >10% RDI provided by 15 of 34 mushrooms for M and F • Range male and female 19 and over – 10-19.4% Morel, Raw (USDA) Providing the greatest amount
Manganese	M 10.7 % Only F 11.7% Only	5.5mg male 19 and over 5mg female 19 and over	# >10% AI provided by 1 of 34 mushrooms for M and F • Male 19 and over – 10.7% and 11.7% female Morel, Raw (USDA) Providing the greatest amount
Potassium	M 11.3% F 12.7%	3800mg male 19 and over 2800mg female 19 and over	# >10% RDI provided by M 7 and F 23 of 34 mushrooms • Range male 19 and over – 10-13.3% • Range female 19 years and over – 10-18.1% Chanterelle, Raw (USDA) providing the greatest amount.
Selenium[i]	M 29.3% F 34.2%	70mcg male 19 and over 60mcg female 19 and over	#>10% RDI provided by 5 of 34 mushrooms for M and F • Range male 19 and over – 15.7-267.1% • Range female 19 years and over – 18.311.7% Boletus edible (Ger) providing the greatest amount
Zinc	M 12.6% F 12.9%	14mg males 19 years and over 8mg Females 19 years and over	# >10% RDI provided by M 2 and F 11 of 34 mushrooms • Males 19 and over – 10.7- 14.5% • Range females 19 and over 10-25.4% Morel ,Raw (USDA) provided >10% at 25.4%.

Iron	M 27.2% F 27%	8mg male 19 and over 18mg females 19-50: 8mg female over 50	# >10% RDI provided by M and F 17 of 34 mushrooms • Male 19 and over and females over 50 Range 10-152.3% Morel, Raw (USDA) providing the greatest at 12.2mg/100g

i) The selenium RDI for males 19 and over is 70ug/day and 60ug/day for females. However, Upper Level of allowable intake for selenium is 400ug/day for males and females 19 and over. Limited data on toxicity exits.

Summary Table for COOKED COMMON MUSHROOMS providing >10% AI for protein and fibre /100g

Nutrient	Protein (g)	Males 19-70 years	Males over 70 years	Females 19-70 years	Females over 70 years	Fibre (g)	Males 19 years and over	Females 19 years and over
	RDI	64	81	46	57	AI	30	25
Mushrooms, canned, drained solids (USDA)	1.87					2.4		
Mushrooms, white microwaved (USDA)	3.91					2.5		10.0%
Mushrooms, white microwaved (Can)	3.91					2.5		10.0%
Mushrooms, white, stir fried (USDA)	3.58					1.8		
Mushrooms, cooked, boiled, drained, without salt (USDA)	2.17					2.2		
Mushrooms, cooked, boiled, drained, with salt (USDA)	2.17					2.2		
Mushrooms,stewed (UK)	1.4					2		
Mushrooms,cooked in sunflower oil (UK)	N/A					N/A		
Common Mushroom Boiled (Jap)	3.8					3.3	11.0%	13.2%
Common mushroom, canned in brine solids (Jap)	3.4					3.2	10.7%	12.8%
Matsutake, canned in brine solids (Jap)	1.2					5.5	18.3%	22.0%
Mushroom, canned Agaricus bisporus (Den)	2.5					2.4		
Mushrooms canned (Ger)	2.25					1.5		
Mushroom, common, stir-fried (no oil) Agaricus bisporus (Aust)	6.2			13.5%	10.9%	2.9		11.6%
Mushroom, golden, Asian, canned in brine, drained (Aust)	1.5					3.7	12.3%	14.8%
Mushroom, straw, Asian, canned in brine, drained (Aust)	2.2					3	10.0%	12.0%

Summary Table for RAW CULINARY SPECIALTY MUSHROOMS providing >10% AI for protein and fibre /100g

Nutrient	Protein (g)	Males 19-70 years	Males over 70 years	Females 19-70 years	Females over 70 years	Fibre (g)	Males 19 years and over	Females 19 years and over
	RDI	64	81	46	57	AI	30	25
Champignon, fried Agaricus bisporus (Fin)	2.5					1.8		
Mushroom fried Agaricus bisporus (Fin)	2.3					2.3		
Boletus edible, boiled (Fin)	4.9			10.7%		9.2	30.7%	36.8%
Champignon, canned Agaricus bisphorus (Fin)	2.1					2.4		
Mushroom in vinegar (Fin)	1.6					2.4		
Mushroom, boiled, drained (Can)	2.17					2.2		
Mushroom, boiled, drained with salt (Can)	2.17					2.2		
Mushroom, straw, canned, drained solids (Can)	3.83					2.5		10.0%
Mushroom, white, stir-fried (Can)	3.58					1.8		
Mushroom Canned, drained solids (Can)	1.87					2.8		11.2%
Mushroom Portabella grilled Agaricus bisporus (USDA)	3.28					2.2		8.8%
Mushroom Portabella (Portobello), grilled (Can)	3.28					2.2		8.8%
Mushroom Portabella exposed to UV light grilled bisporus (USDA)	3.28					2.2		
Mushroom, straw, canned, drained solids (USDA)	3.83					2.5		10.0%

Summary Tables for COOKED COMMON MUSHROOMS (Agaricus bisporus) providing >10% RDI/AI of key vitamins /100g

Nutrient	Thiamin (B1) (mg)	Males 19 years and over	Females 19 years and over	Riboflavin (B2) (mg)	Males 19-70 years	Males over 70 years	Females 19-70 years	Females over 70 years	Niacin equivalents (B3) (mg)	Males 19 years and over	Females 19 years and over
	RDI	1.2	1.1	RDI	1.3	1.6	1.1	1.3	RDI	16	14
Mushrooms, canned, drained solids (USDA)	0.085			0.021					1.593	10.0%	11.4%
Mushrooms, white microwaved (USDA)	0.06			0.431	33.2%	26.9%	39.2%	33.2%	5.35	33.4%	38.2%
Mushrooms, white microwaved (Can)	0.06			0.431	33.2%	26.9%	39.2%	33.2%	6	37.5%	42.9%
Mushrooms, white, stir fried (USDA)	0.096			0.463	35.6%	28.9%	42.1%	35.6%	3.987	24.9%	28.5%
Mushrooms, cooked, boiled, drained, without salt (USDA)	0.073			0.3	23.1%	18.8%	27.3%	23.1%	4.46	27.9%	31.9%
Mushrooms, cooked, boiled, drained, with salt (USDA)	0.073			0.3	23.1%	18.8%	27.3%	23.1%	4.46	27.9%	31.9%
Mushrooms,stewed (UK)	0.09			0.26	20.0%	16.3%	23.6%	20.0%	1.8	11.3%	12.9%
Mushrooms,cooked in sunflower oil (UK)	N/A			N/A					N/A		
Common Mushroom Boiled (Jap)	0.05			0.28	21.5%	17.5%	25.5%	21.5%	2.7	16.9%	19.3%
Common mushroom, canned in brine solids (Jap)	0.03			0.24	18.5%	15.0%	21.8%	18.5%	1		
Matsutake, canned in brine solids (Jap)	0.04			0.3	23.1%	18.8%	27.3%	23.1%	2	12.5%	14.3%
Mushroom, canned Agaricus bisphorus (Den)	0.081			0.402	30.9%	25.1%	36.5%	30.9%	4.07	25.4%	29.1%
Mushrooms canned (Ger)	0.02			0.19	14.6%	11.9%	17.3%	14.6%	1.2		
Mushroom, common, stir-fried (no oil) Agaricus bisporus (Aust)	0.042			0.661	50.8%	41.3%	60.1%	50.8%	7.02	43.9%	50.1%
Mushroom, golden, Asian, canned in brine, drained (Aust)	0.23	19.2%	20.9%	0.05					1.55		11.1%

Summary Tables for COOKED COMMON MUSHROOMS (Agaricus bisporus) providing >10% RDI/AI of key vitamins /100g *continued*

Nutrient	Thiamin (B1) (mg)	Males 19 years and over	Females 19 years and over	Riboflavin (B2) (mg)	Males 19-70 years	Males over 70 years	Females 19-70 years	Females over 70 years	Niacin equivalents (B3) (mg)	Males 19 years and over	Females 19 years and over
	RDI	1.2	1.1	RDI	1.3	1.6	1.1	1.3	RDI	16	14
Champignon, fried Agaricus bisphorus (Fin)	0.08			0.43	33.1%	26.9%	39.1%	33.1%	6.1	38.1%	43.6%
Mushroom fried Agaricus bisporus (Fin)	0.12	10.0%	10.9%	0.49	37.7%	30.6%	44.5%	37.7%	7.2	45.0%	51.4%
Boletus edible, boiled (Fin)	0.03			0.46	35.4%	28.8%	41.8%	35.4%	10.3	64.4%	73.6%
Champignon, canned Agaricus bisphorus (Fin)	0.02			0.25	19.2%	15.6%	22.7%	19.2%	5.9	36.9%	42.1%
Mushroom in vinegar (Fin)	0.1			0.38	29.2%	23.8%	34.5%	29.2%	5.1	31.9%	36.4%
Mushroom, boiled, drained (Can)	0.073			0.3	23.1%	18.8%	27.3%	23.1%	4.86	30.4%	34.7%
Mushroom, boiled, drained with salt (Can)	0.073			0.3	23.1%	18.8%	27.3%	23.1%	4.86	30.4%	34.7%
Mushroom, straw, canned, drained solids (Can)	0.013			0.07					0.926		
Mushroom, white, stir-fried (Can)	0.096			0.463	35.6%	28.9%	42.1%	35.6%	4.604	28.8%	32.9%
Mushroom Canned, drained solids (Can)	0.085			0.021					1.943	12.1%	13.9%
Mushroom Portabella grilled Agaricus bisporus (USDA)	0.072			0.403	31.0%	25.2%	36.6%	31.0%	6.255	39.1%	44.7%
Mushroom Portabella (Portobello), grilled (Can)	0.072			0.403	31.0%	25.2%	36.6%	31.0%	7.005	43.8%	50.0%
Mushroom Portabella exposed to UV light grilled bisporus (USDA)	0.072			0.403	31.0%	25.2%	36.6%	31.0%	6.255	39.1%	44.7%
Mushroom, straw, canned, drained solids (USDA)	0.013			0.07					0.224		

Summary Tables for COOKED COMMON MUSHROOMS (Agaricus bisporus) providing >10% RDI/AI of key vitamins /100g

Nutrient	Folate (mcg)	Males 19 years and over	Females 19 years and over	Vit B6 (mg)	Males 19-50 years	Males over 50 years	Females 19-50 years	Females over 50 years	Pantothenic acid (mg)	Males 19 years and over	Females 19 years and over
	RDI	400	400	RDI	1.3	1.7	1.3	1.5	AI	6	4
Mushrooms, canned, drained solids (USDA)	12			0.061					0.811	13.5%	20.3%
Mushrooms, white microwaved (USDA)	16			0.049					1.96	32.7%	49.0%
Mushrooms, white microwaved (Can)	16			0.049					1.96	32.7%	49.0%
Mushrooms, white, stir fried (USDA)	20			0.042					1.45	24.2%	36.3%
Mushrooms, cooked, boiled, drained, without salt (USDA)	18			0.095					2.16	36.0%	54.0%
Mushrooms, cooked, boiled, drained, with salt (USDA)	18			0.095					2.16	36.0%	54.0%
Mushrooms,stewed (UK)	15			0.06					1.29	21.5%	32.3%
Mushrooms,cooked in sunflower oil (UK)	N/A			N/A					N/A		
Common Mushroom Boiled (Jap)	19			0.08					1.43	23.8%	35.8%
Common mushroom, canned in brine solids (Jap)	2			0.01					0.11		
Matsutake, canned in brine solids (Jap)	1			0.01					0.05		
Mushroom, canned Agaricus bisphorus (Den)	23			0.06					1	16.7%	25.0%
Mushrooms canned (Ger)	N/A			0.06					0.8	13.3%	20.0%
Mushroom, common, stir-fried (no oil) Agaricus bisporus (Aust)	27			0.04					2.17	36.2%	54.3%
Mushroom, golden, Asian, canned in brine, drained (Aust)	N/A			N/A					N/A		
Mushroom, straw, Asian, canned in brine, drained (Aust)	N/A			N/A					N/A		

Summary Tables for COOKED COMMON MUSHROOMS (Agaricus bisporus) providing >10% RDI/AI of key vitamins/100g *continued*

Nutrient	Folate (mcg)	Males 19 years and over	Females 19 years and over	Vit B6 (mg)	Males 19-50 years	Males over 50 years	Females 19-50 years	Females over 50 years	Pantothenic acid (mg)	Males 19 years and over	Females 19 years and over
	RDI	400	400	RDI	1.3	1.7	1.3	1.5	AI	6	4
Champignon, fried Agaricus bisphorus (Fin)	29.3			0.21	16.2%	12.4%	16.2%	14.0%	N/A		
Mushroom fried Agaricus bisporus (Fin)	18			0.05					N/A		
Boletus edible, boiled (Fin)	53.8	13.5%	13.5%	0.28	21.5%	16.5%	21.5%	18.7%	N/A		
Champignon, canned Agaricus bisphorus (Fin)	12			0.07					N/A		
Mushroom in vinegar (Fin)	18.9			0.07					N/A		
Mushroom, boiled, drained (Can)	18			0.095					2.16	36.0%	54.0%
Mushroom, boiled, drained with salt (Can)	18			0.095					2.16	36.0%	54.0%
Mushroom, straw, canned, drained solids (Can)	38			0.014					0.412		10.3%
Mushroom, white, stir-fried (Can)	20			0.042					1.45	24.2%	36.3%
Mushroom Canned, drained solids (Can)	12			0.061					0.811	21.0%	20.3%
Mushroom Portabella grilled Agaricus bisporus (USDA)	19			0.122					1.262	21.0%	31.6%
Mushroom Portabella (Portobello), grilled (Can)	19			0.122					1.262	21.0%	31.6%
Mushroom Portabella exposed to UV light grilled bisporus (USDA)	19			0.122					1.262	21.0%	31.6%
Mushroom, straw, canned, drained solids (USDA)	38			0.014					0.412		10.3%

Summary Tables for COOKED COMMON MUSHROOMS (Agaricus bisporus) providing >10% RDI/AI of key vitamins/100g

Nutrient	Biotin (mcg)	Males 19 years and over	Females 19 years and over	Vit C (mg)	Males 19 years and over	Females 19 years and over	Vit A (Retinol Equivalents) (mcg)	Males 19 years and over	Females 19 years and over	Vit D (mcg)	Males 19-50 years	Males 51-70 years	Males over 70 years	Females 19-50 years	Females 51-70 years	Females over 70 years
	AI	30	25	RDI	45	45	RDI	900	700	AI	5	10	15	5	10	15
Mushrooms, canned, drained solids (USDA)	N/A			0			0			0.2						
Mushrooms, white microwaved (USDA)	N/A			0			0			0.3						
Mushrooms, white microwaved (Can)	N/A			0			0			0.3						
Mushrooms, white, stir fried (USDA)	N/A			0			0			0.2						
Mushrooms, cooked, boiled, drained, without salt (USDA)	N/A			4			0			0.2						
Mushrooms, cooked, boiled, drained, with salt (USDA)	N/A			4			0			0.2						
Mushrooms,stewed (UK)	10.9	36.3%	43.6%	0.5			N/A			N/A						
Mushrooms,cooked in sunflower oil (UK)	N/A			N/A			N/A			N/A						
Common Mushroom Boiled (Jap)	N/A			0			0			1	20.0%	10.0%		20.0%	10.0%	
Common mushroom, canned in brine solids (Jap)	N/A			0			0			2	40.0%	20.0%	13.3%	40.0%	20.0%	13.3%
Matsutake, canned in brine solids (Jap)	N/A			Tr mg			0			6	120.0%	60.0%	40.0%	120.0%	60.0%	40.0%
Mushroom, canned Agaricus bisphorus (Den)	16	53.3%	64.0%	2.1			0.833			0						
Mushrooms canned (Ger)	N/A			1.7			N/A			N/A						
Mushroom, common, stir-fried (no oil) Agaricus bisporus (Aust)	16.7	55.7%	66.8%	2			4			N/A						
Mushroom, golden, Asian, canned in brine, drained (Aust)	N/A			3			10			N/A						
Mushroom, straw, Asian, canned in brine, drained (Aust)	N/A			2			9			N/A						

Summary Tables for COOKED COMMON MUSHROOMS (Agaricus bisporus) providing >10% RDI/AI of key vitamins /100g *continued*

Nutrient	Biotin (mcg)	Males 19 years and over	Females 19 years and over	Vit C (mg)	Males 19 years and over	Females 19 years and over	Vit A (Retinol Equivalents) (mcg)	Males 19 years and over	Females 19 years and over	Vit D (mcg)	Males 19-50 years	Males 51-70 years	Males over 70 years	Females 19-50 years	Females 51-70 years	Females over 70 years
	AI	30	25	RDI	45	45	RDI	900	700	AI	5	10	15	5	10	15
Champignon, fried Agaricus bisphorus (Fin)	N/A			0.9			32.6			0.5	10.0%			10.0%		
Mushroom fried Agaricus bisporus (Fin)	N/A			6.1	13.6%	13.6%	145.3	16.1%	20.8%	15.9	318.0%	159.0%	106.0%	318.0%	159.0%	106.0%
Boletus edible, boiled (Fin)	N/A			2.5			0			4.5	90.0%	45.0%	30.0%	90.0%	45.0%	30.0%
Champignon, canned Agaricus bisphorus (Fin)	N/A			1			0			0.2						
Mushroom in vinegar (Fin)	N/A			1.9			N/A			4.8	96.0%	48.0%	32.0%	96.0%	48.0%	32.0%
Mushroom, boiled, drained (Can)	N/A			4			0			0.5	10.0%			10.0%		
Mushroom, boiled, drained with salt (Can)	N/A			4			0			0.2						
Mushroom, straw, canned, drained solids (Can)	N/A			0			0			N/A						
Mushroom, white, stir-fried (Can)	N/A			0			0			0.2						
Mushroom Canned, drained solids (Can)	N/A			1.5			0			0.2						
Mushroom Portabella grilled Agaricus bisporus (USDA)	N/A			0			0			0.3						
Mushroom Portabella (Portobello), grilled (Can)	N/A			0			0			0.3						
Mushroom Portabella exposed to UV light grilled bisporus (USDA)	N/A			0			N/A			13.1	262.0%	131.0%	87.3%	262.0%	131.0%	87.3%
Mushroom, straw, canned, drained solids (USDA)	N/A			0			0			N/A						

Table 5 Average **%RDI/AI content for each key vitamin /100g**

Vitamin	Average %	Recommended Dietary Intake	Comments
Thiamine (B1)	M 14.6% F 15.9%	1.2mg male 19 years and over 1.1mg Female 19 years and over	# >10% RDI provided by 2 of the 30 mushrooms for M and F Mushroom, Golden, Asian, canned in brine, drained (Aust) providing the greatest amount
Riboflavin (B2)	M 25.6% F 30.3%	1.3mg male 19-70: 1.6mg men>70 1.1mg Female 19-70:1.3mg female>70	# >10% RDI provided by 24 of 30 mushrooms for M and F • Range male 19 and over 10.8–50.8% • Range female 19 and over 10.8-60.1% Mushroom, common, stir-fried (no OIL) agaricus bisporus (Aust) providing the greatest amount
Niacin (B3)	M 30.9% F 33.4%	16mg male 19 and over 14mg female 19 and over	# >10% RDI provided by M 23 and F 24 of 30 mushrooms • Range male 19 and over 10–64.4% • Range female 19 and over 11.1 –73.6% Boletus edible, boiled (Fin) providing thte greatest amount
Folate	M & F 13.5%	400mcg male and female 19 and over	# >10% RDI provided by 1 of 30 mushrooms for M and F Boletus edible, boiled (Fin) providing thte greatest amount
Vitamin B6	M 16.6% F 17.6%	1.3mg males 19-50: 1.7mg males 50 and over 1.3mg females19-50; 1.5mg females 50 and over	# >10% RDI provided by 2 of 30 mushrooms for M and F • Range male 19 and over 12.4 – 21.5% • Range female 19 and over 14 -21.5% Boletus edible, boiled (fin) providing the greatest amount
Pantothenic acid	M 25.9% F 35.5%	6mg male 19 and over 4mg female 19 and over	# >10% AI provided by M 18 and F 20 of the 30 mushrooms • Range male 19 and over 13.3–36.2% • Range female 19 and over 10.3 –54.3% Mushroom, common, stir-fried (no OIL) agaricus bisporus (Aust) providing the greatest amount

Biotin	M 48.4% F 58.1%	30mg male 19 and over 25mg female 19 and over	# >10% AI provided by 3 of the 30 mushrooms for M and F • Range male 19 and over 36.3–55.7% • Range female 19 and over 43.6 –66.8% Mushroom, common, stir-fried (no OIL) agaricus bisporus (Aust) providing the greatest amount
Vitamin C	M and F 13.6 % only	45mg male and female 19 and over	# >10% RDI provided by 1 of 30 mushrooms Mushroom, Fried Agaricus Bisporus (Fin)
Vitamin A (retinol equiv)	M 16.1% F 20.8%	900mcg male 19 and over 700mcg female 19 and over	# >10% RDI provided by 1 of 30 mushrooms Mushroom,fried agaricus Bisporus (Fin) providing the greatest amount
Vitamin D	M and F 83.9%	5mcg Male and female 19-50: 10mcg male and female 51-70: 15mcg male and female >70	# >10% RDI provided by 9 of 30 mushrooms for M and F • Range male and female 19 –50: 10–318% • Range male and female 51-70: 10–159% • Range male and female 70 and over: 13.3-106% Mushroom, fried Agaricus Bisporus (Fin) being the greatest contributor

Summary Tables for COOKED COMMON MUSHROOMS (Agaricus bisporus) providing >10% RDI/AI of key minerals /100g

Nutrient	Copper (mg)	Males 19 years and over	Females 19 years and over	Phosphorus (mg)	Males 19 years and over	Females 19 years and over	Sodium (mg)	Males 19 years and over	Females 19 years and over	Potassium (mg)	Males 19 years and over	Females 19 years and over
	AI	1.7	1.2	RDI	1000	1000	AI	460	460	AI	3800	2800
Mushrooms, canned, drained solids (USDA)	0.235	13.8%	19.6%	66			425	92.4%	92.4%	129		
Mushrooms, white microwaved (USDA)	0.37	21.8%	30.8%	127	12.7%	12.7%	17			488	12.8%	17.4%
Mushrooms, white microwaved (Can)	0.37	21.8%	30.8%	127	12.7%	12.7%	17			488	12.8%	17.4%
Mushrooms, white, stir fried (USDA)	0.291	17.1%	24.3%	105	10.5%	10.5%	12			396	10.4%	14.1%
Mushrooms, cooked, boiled, drained, without salt (USDA)	0.504	29.6%	42.0%	87			2			356		12.7%
Mushrooms, cooked, boiled, drained, with salt (USDA)	0.504	29.6%	42.0%	87			238	51.7%	51.7%	356		12.7%
Mushrooms,stewed (UK)	0.35	20.6%	29.2%	75			3			216		
Mushrooms,cooked in sunflower oil (UK)	N/A			N/A			N/A			N/A		
Common Mushroom Boiled (Jap)	0.36	21.2%	30.0%	99			6			310		11.1%
Common mushroom, canned in brine solids (Jap)	0.19	11.2%	15.8%	55			350	76.1%	76.1%	85		
Matsutake, canned in brine solids (Jap)	0.31	18.2%	25.8%	36			130	28.3%	28.3%	2		
Mushroom, canned Agaricus bisphorus (Den)	0.48	28.2%	40.0%	76			5			190		
Mushrooms canned (Ger)	0.135		11.3%	69			320	69.6%	69.6%	110		
Mushroom, common, stir-fried (no oil) Agaricus bisporus (Aust)	0.645	37.9%	53.8%	208	20.8%	20.8%	15			585	15.4%	20.9%
Mushroom, golden, Asian, canned in brine, drained (Aust)	0.06			49			300	65.2%	65.2%	24		
Mushroom, straw, Asian, canned in brine, drained (Aust)	0.04			48			240	52.2%	52.2%	25		

Summary Tables for COOKED COMMON MUSHROOMS (Agaricus bisporus) providing >10% RDI/AI of key minerals /100g *continued*

Nutrient	Copper (mg)	Males 19 years and over	Females 19 years and over	Phosphorus (mg)	Males 19 years and over	Females 19 years and over	Sodium (mg)	Males 19 years and over	Females 19 years and over	Potassium (mg)	Males 19 years and over	Females 19 years and over
	AI	1.7	1.2	RDI	1000	1000	AI	460	460	AI	3800	2800
Champignon, fried Agaricus bisphorus (Fin)	N/A			119.1	11.9%	11.9%	27.3			436.3	11.5%	15.6%
Mushroom fried Agaricus bisporus (Fin)	N/A			90			257.2	55.9%	55.9%	417.3	11.0%	14.9%
Boletus edible, boiled (Fin)	N/A			72.3			9.2			415.4	10.9%	14.8%
Champignon, canned Agaricus bisphorus (Fin)	N/A			76			520	113.0%	113.0%	190		
Mushroom in vinegar (Fin)	N/A			68.4			983	213.7%	213.7%	323		11.5%
Mushroom, boiled, drained (Can)	0.504	29.6%	42.0%	87			2			356		12.7%
Mushroom, boiled, drained with salt (Can)	0.504	29.6%	42.0%	87			238	51.7%	51.7%	356		12.7%
Mushroom, straw, canned, drained solids (Can)	0.133		11.1%	61			384	83.5%	83.5%	78		
Mushroom, white, stir-fried (Can)	0.291	17.1%	24.3%	105	10.5%	10.5%	12			396	10.4%	14.1%
Mushroom Canned, drained solids (Can)	0.235	13.8%	19.6%	66			425	92.4%	92.4%	129		
Mushroom Portabella grilled Agaricus bisporus (USDA)	0.389	22.9%	32.4%	135	13.5%	13.5%	11			437	11.5%	15.6%
Mushroom Portabella (Portobello), grilled (Can)	0.389	22.9%	32.4%	135	13.5%	13.5%	11			437	11.5%	15.6%
Mushroom Portabella exposed to UV light grilled bisporus (USDA)	0.389	22.9%	32.4%	135	13.5%	13.5%	11			437	11.5%	15.6%
Mushroom, straw, canned, drained solids (USDA)	0.133		11.1%	61			384	83.5%	83.5%	78		

Summary Tables for COOKED COMMON MUSHROOMS (Agaricus bisporus) providing >10% RDI/AI of key minerals /100g

Nutrient	Selenium (mcg)	Males 19 years and over	Females 19 years and over	Zinc (mg)	Males 19 years and over	Females 19 years and over	Iron (mg)	Males 19 years and over	Females 19-50 years	Females over 50 years	Iodine (mcg)	Males 19 years and over	Females 19 years and over
	RDI	70	60	RDI	14	8	RDI	8	18	8	RDI	150	150
Mushrooms, canned, drained solids (USDA)	4.1			0.72			0.79				N/A		
Mushrooms, white microwaved (USDA)	18	25.7%	30.0%	0.73			0.33				N/A		
Mushrooms, white microwaved (Can)	18	25.7%	30.0%	0.73			0.33				N/A		
Mushrooms, white, stir fried (USDA)	13.9	19.9%	23.2%	0.57			0.25				N/A		
Mushrooms, cooked, boiled, drained, without salt (USDA)	11.9	17.0%	19.8%	0.87		10.9%	1.74	21.8%		21.8%	N/A		
Mushrooms, cooked, boiled, drained, with salt (USDA)	13.4	19.1%	22.3%	0.87		10.9%	1.74	21.8%		21.8%	N/A		
Mushrooms,stewed (UK)	16	22.9%	26.7%	0.92		11.5%	0.32				N/A		
Mushrooms,cooked in sunflower oil (UK)	N/A			N/A			N/A				N/A		
Common Mushroom Boiled (Jap)	N/A			0.6			0.3				N/A		
Common mushroom, canned in brine solids (Jap)	N/A			1		12.5%	0.8	10.0%		10.0%	N/A		
Matsutake, canned in brine solids (Jap)	N/A			0.7			3.3	41.3%	18.3%	41.3%	N/A		
Mushroom, canned Agaricus bisphorus (Den)	3.3			0.93		11.6%	0.84	10.5%		10.5%	0.5		
Mushrooms canned (Ger)	8.8	12.6%	14.7%	N/A			0.8	10.0%		10.0%	N/A		
Mushroom, common, stir-fried (no oil) Agaricus bisporus (Aust)	29.1	41.6%	48.5%	1.06		13.3%	0.5				0		
Mushroom, golden, Asian, canned in brine, drained (Aust)	N/A			0.4			1	12.5%		12.5%	N/A		
Mushroom, straw, Asian, canned in brine, drained (Aust)	N/A			0.3			1	12.5%		12.5%	N/A		

Summary Tables for COOKED COMMON MUSHROOMS (Agaricus bisporus) providing >10% RDI/AI of key minerals /100g *continued*

Nutrient	Selenium (mcg)	Males 19 years and over	Females 19 years and over	Zinc (mg)	Males 19 years and over	Females 19 years and over	Iron (mg)	Males 19 years and over	Females 19-50 years	Females over 50 years	Iodine (mcg)	Males 19 years and over	Females 19 years and over
	RDI	70	60	RDI	14	8	RDI	8	18	8	RDI	150	150
Champignon, fried Agaricus bisphorus (Fin)	13.1	18.7%	21.8%	0.6			0.5				1.3		
Mushroom fried Agaricus bisporus (Fin)	22	31.4%	36.7%	0.9		11.3%	3.3	41.3%	18.3%	41.3%	14.8		
Boletus edible, boiled (Fin)	16.9	24.1%	28.2%	1.4	10.0%	17.5%	1.2	15.0%		15.0%	1.5		
Champignon, canned Agaricus bisphorus (Fin)	2.9			0.5			0.8	10.0%		10.0%	23	15.3%	15.3%
Mushroom in vinegar (Fin)	32.4	46.3%	54.0%	0.9		11.3%	2.6	32.5%	14.4%	32.5%	0		
Mushroom, boiled, drained (Can)	11.9	17.0%	19.8%	0.87		10.9%	1.74	21.8%		21.8%	N/A		
Mushroom, boiled, drained with salt (Can)	13.4	19.1%	22.3%	0.87		10.9%	1.74	21.8%		21.8%	N/A		
Mushroom, straw, canned, drained solids (Can)	15.2	21.7%	25.3%	0.67			1.43	17.9%		17.9%	N/A		
Mushroom, white, stir-fried (Can)	13.9	19.9%	23.2%	0.57			0.25				N/A		
Mushroom Canned, drained solids (Can)	4.1			0.72			0.79				N/A		
Mushroom Portabella grilled Agaricus bisporus (USDA)	21.9	31.3%	36.5%	0.65			0.4				N/A		
Mushroom Portabella (Portobello), grilled (Can)	21.9	31.3%	36.5%	0.65			0.4				N/A		
Mushroom Portabella exposed to UV light grilled bisporus (USDA)	21.9	31.3%	36.5%	0.65			0.4				N/A		
Mushroom, straw, canned, drained solids (USDA)	15.2	21.7%	25.3%	0.67			1.43	17.9%		17.9%	N/A		

Table 6 **Average %RDI/AI content for each key mineral /100g**

Mineral	Average %	Recommended Dietary Intake	Comments
Copper	M 22.6% F 29.2%	1.7mg male 19 and over 1.2mg Female 19 and over	# >10% AI provided by M 19 and, F 22 of the 30 mushrooms • Range male 19 and over – 11.2- 37.9% • Range female 19 and over – 11.5-53.8% Mushroom Common; stir fried (NO oil) agaricus bisporus (Aust). Provide the greatest amount
Phosphorous	M and F 13.3%	1000mg male and female 19 and over	# >10% RDI provided by 9 of 30 mushrooms • Range male and female 19 and over – 10.5-20.8% Mushroom Common; stir fried (NO oil) agaricus bisporus (Aust). Provide the greatest amount
Sodium	M and F 80.7%	460 mg male and female 19 and over	# >10% AI provided by 14 of 30 mushrooms Range male and female 19 and over – 28.3-213.7% Mushroom in Vinegar (Fin) Provide the greatest amount
Potassium	M 11.8% F 14.4%	3800mg male 19 and over 2800mg female 19 and over	# >10% AI provided by M 11 and F17 of 30 mushrooms • Range male 19 and over – 10.4-15.4% • Range female 19 years and over – 11.1-20.9% Mushroom Common; stir fried (NO oil) agaricus bisporus (Aust). Provide the greatest amount
Selenium	M 24.9% F 29.1%	70mcg male 19 and over 60mcg female 19 and over	# >10%RDI provided by 20 of 30 mushrooms for M and F • Range male 19 and over – 12.6-46.3% • Range female 19 and over – 14.7-54% Mushroom in Vinegar (Fin) Provide the greatest amount
Zinc	M 10% only F 12.0%	14mg males 19 years and over 8mg Females 19 years and over	# >10%RDI provided by M 1 and F 11 of 30 mushrooms • Range 10.9-17.5% - Females only Boletus edible, boiled (Fin) providing the greatest amount
Iron	M 19.9%	8mg male 19 and over 18mg females 19-50 years	# >10%RDI provided by 16 of 30 mushrooms for M and F • Range male 19 and over; 10 – 41.3%

	F 18.8%	8mg females 51 and over	• Range female 19 -50; 14.4-18.3%* Only 3 Mushroom varieties provided >10% RDI for iron • Range over 50 years and over – 10 – 41.3% Mushroom Fried agaricus bisporus (Fin) and Matsutake, canned in brine solids (Jap) Provided the greatest amounts
Iodine	M and F 15.3% only	150mcg male and female 19 and over	Only 1 mushroom from 30 provided >10 RDI this being champignion, canned agaricus bisporus (Fin)

Summary Table for COOKED CULINARY SPECIALTY MUSHROOMS providing >10% RDI/AI for fibre /100g

- 100g of cooked culinary specialty mushrooms provide an average of 18.9 % of the AI[26] for fibre for males and 20.9% of AI for females aged 19 years and over

Nutrient	Fibre (g)	Males 19 years and over	Females 19 years and over
	AI	30	25
Mushrooms Shiitake, Stir fried Lentinus edodes (USDA)	3.6	12.0%	14.4%
Mushrooms, shiitake, cooked without salt (USDA)	2.1		
Mushrooms, shiitake, cooked with salt (USDA)	2.1		
Shitake Hoshi-shiitake boiled (Jap)	7.5	25.0%	30.0%
Shitake Nama-shiitake, boiled (Jap)	4.7	15.7%	18.8%
Tree ears, Kiurage, boiled (Jap)	5.2	17.3%	20.8%
Tree ears, Shiro-kikurage, boiled (Jap)	6.4	21.3%	25.6%
Tree ears, Arage-kikurage, boiled (Jap)	16.3	54.3%	65.2%
Mushroom, shiitake, cooked (Can)	2.1		
Mushroom, shiitake,stir-fried (Can)	3.6	12.0%	14.4%
Nameko boiled (Jap)	2.7		10.8%
Nameko canned in brine (Jap)	2.5		10.0%
Maitake, boiled (Jap)	3.6	12.0%	14.4%
Oyster mushrooms boiled (Jap)	3.7	12.3%	14.8%
Winter mushroom bottled in seasoning (Jap)	4.1	13.7%	16.4%
Winter Mushroom boiled (Jap)	4.5	15.0%	18.0%
Shimeji Bunashimeji boiled (Jap)	4.8	16.0%	19.2%

[26] AI for fibre males 19yeas and over equals 30g and for females 19 years and over equals 25g

Summary Table for COOKED CULINARY SPECIALTY MUSHROOMS providing >10% RDI/AI of key vitamins /100g

Nutrient	Thiamin (B1) (mg)	Males 19 years and over	Females 19 years and over	Riboflavin (B2) (mg)	Males 19-70 years	Males over 70 years	Females 19-70 years	Females over 70 years	Niacin equivalents (B3) (mg)	Males 19 years and over	Females 19 years and over
	RDI	1.2	1.1	RDI	1.3	1.6	1.1	1.3	RDI	16	14
Mushrooms Shiitake, Stir fried Lentinus edodes (USDA)	0.099			0.274	21.1%	17.1%	24.9%	21.1%	3.87	24.2%	27.6%
Mushrooms, shiitake, cooked without salt (USDA)	0.037			0.17	13.1%	10.6%	15.5%	13.1%	1.5		10.7%
Mushrooms, shiitake, cooked with salt (USDA)	0.037			0.17	13.1%	10.6%	15.5%	13.1%	1.5		10.7%
Shitake Hoshi-shiitake boiled (Jap)	0.06			0.23	17.7%	14.4%	20.9%	17.7%	2	12.5%	14.3%
Shitake Nama-shiitake, boiled (Jap)	0.1			0.18	13.8%	11.3%	16.4%	13.8%	3.1	19.4%	22.1%
Tree ears, Kiurage, boiled (Jap)	0.01			0.06					Tr mg		
Tree ears, Shiro-kikurage, boiled (Jap)	0			0.05					Tr mg		
Tree ears, Arage-kikurage, boiled (Jap)	0			0.07					0.1		
Mushroom, shiitake, cooked (Can)	0.037			0.17	13.1%	10.6%	15.5%	13.1%	1.567		11.2%
Mushroom, shiitake,stir-fried (Can)	0.099			0.274	21.1%	17.1%	24.9%	21.1%	4.053	25.3%	29.0%
Nameko boiled (Jap)	0.06			0.11			10.0%		4.7	29.4%	33.6%
Nameko canned in brine (Jap)	0.03			0.07					2.1	13.1%	15.0%
Maitake, boiled (Jap)	0.12	10.0%	10.9%	0.19	14.6%	11.9%	17.3%	14.6%	3.3	20.6%	23.6%
Oyster mushrooms boiled (Jap)	0.3	25.0%	27.3%	0.27	20.8%	16.9%	24.5%	20.8%	7	43.8%	50.0%
Winter mushroom bottled in seasoning (Jap)	0.26	21.7%	23.6%	0.17	13.1%	10.6%	15.5%	13.1%	4.4	27.5%	31.4%
Winter Mushroom boiled (Jap)	0.19	15.8%	17.3%	0.13	10.0%		11.8%	10.0%	3.7	23.1%	26.4%
Shimeji Bunashimeji boiled (Jap)	0.15	12.5%	13.6%	0.12			10.9%		5.2	32.5%	37.1%

Summary Table for COOKED CULINARY SPECIALTY MUSHROOMS providing >10% RDI/AI of key vitamins /100g

Nutrient	Folate (mcg)	Males 19 years and over	Females 19 years and over	Vit B6 (mg)	Males 19-50 years	Males over 50 years	Females 19-50 years	Females over 50 years
	RDI	400	400	RDI	1.3	1.7	1.3	1.5
Mushrooms Shiitake, Stir fried Lentinus edodes (USDA)	14			0.174	13.4%	10.2%	13.4%	11.6%
Mushrooms, shiitake, cooked without salt (USDA)	21			0.159	12.2%		12.2%	10.6%
Mushrooms, shiitake, cooked with salt (USDA)	21			0.159	12.2%		12.2%	10.6%
Shitake Hoshi-shiitake boiled (Jap)	44	11.0%	11.0%	0.1				
Shitake Nama-shiitake, boiled (Jap)	24			0.09				
Tree ears, Kiurage, boiled (Jap)	2			0.01				
Tree ears, Shiro-kikurage, boiled (Jap)	1			0.01				
Tree ears, Arage-kikurage, boiled (Jap)	1			0.01				
Mushroom, shiitake, cooked (Can)	21			0.159	12.2%		12.2%	10.6%
Mushroom, shiitake,stir-fried (Can)	14			0.174	13.4%	10.2%	13.4%	11.6%
Nameko boiled (Jap)	63	15.8%	15.8%	0.04				
Nameko canned in brine (Jap)	13			0.02				
Maitake, boiled (Jap)	28			0.04				
Oyster mushrooms boiled (Jap)	71	17.8%	17.8%	0.06				
Winter mushroom bottled in seasoning (Jap)	39			0.09				
Winter Mushroom boiled (Jap)	30			0.09				
Shimeji Bunashimeji boiled (Jap)	25			0.06				

Summary Table for COOKED CULINARY SPECIALTY MUSHROOMS providing >10% RDI/AI of key vitamins /100g

Nutrient	Pantothenic acid (mg)	Males 19 years and over	Females 19 years and over	Vit D (mcg)	Males 19-50 years	Males 51-70 years	Males over 70 years	Females 19-50 years	Females 51-70 years	Females over 70 years
	AI	6	4	AI	5	10	15	5	10	15
Mushrooms Shiitake, Stir fried Lentinus edodes (USDA)	1.36	22.7%	34.0%	0.5	10.0%			10.0%		
Mushrooms, shiitake, cooked without salt (USDA)	3.594	59.9%	89.9%	0.7	14.0%			14.0%		
Mushrooms, shiitake, cooked with salt (USDA)	3.594	59.9%	89.9%	0.7	14.0%			14.0%		
Shitake Hoshi-shiitake boiled (Jap)	1.05	17.5%	26.3%	2	40.0%	20.0%	13.3%	40.0%	20.0%	13.3%
Shitake Nama-shiitake, boiled (Jap)	1.18	19.7%	29.5%	2	40.0%	20.0%	13.3%	40.0%	20.0%	13.3%
Tree ears, Kiurage, boiled (Jap)	0			39	780.0%	390.0%	260.0%	780.0%	390.0%	260.0%
Tree ears, Shiro-kikurage, boiled (Jap)	0			93	1860.0%	930.0%	620.0%	1860.0%	930.0%	620.0%
Tree ears, Arage-kikurage, boiled (Jap)	0			15	300.0%	150.0%	100.0%	300.0%	150.0%	100.0%
Mushroom, shiitake, cooked (Can)	3.594	59.9%	89.9%	0.7	14.0%			14.0%		
Mushroom, shiitake,stir-fried (Can)	1.36	22.7%	34.0%	0.5	10.0%			10.0%		
Nameko boiled (Jap)	1.24	20.7%	31.0%	1	20.0%	10.0%		20.0%	10.0%	
Nameko canned in brine (Jap)	0.52		13.0%	1	20.0%	10.0%		20.0%	10.0%	
Maitake, boiled (Jap)	0.9	15.0%	22.5%	4	80.0%	40.0%	26.7%	80.0%	40.0%	26.7%
Oyster mushrooms boiled (Jap)	2.36	39.3%	59.0%	2	40.0%	20.0%	13.3%	40.0%	20.0%	13.3%
Winter mushroom bottled in seasoning (Jap)	1.04	17.3%	26.0%	1	20.0%	10.0%		20.0%	10.0%	
Winter Mushroom boiled (Jap)	0.96	16.0%	24.0%	1	20.0%	10.0%		20.0%	10.0%	
Shimeji Bunashimeji boiled (Jap)	1.25	20.8%	31.3%	3124	60.0%	30.0%	20.0%	60.0%	30.0%	20.0%

Table 7 Average %RDI/AI content for each key vitamin /100g

Vitamin	Average %	Recommended Dietary Intake	Comments
Thiamine (B1)	M 17% F 18.5%	1.2mg male 19 years and over 1.1mg Female 19 years and over	# >10% RDI provided by 5 of 17 mushrooms for M and F • Range male 19 and over – 10 – 25% • Range female 19 and over – 10.9-27.3% Oyster Mushroom boiled (Jap) Providing the greatest amount
Riboflavin (B2)	M 14.4% F 16.5%	1.3mg male 19-70: 1.6mg men>70 1.1mg Female 19-70:1.3mg female>70	# >10 % RDI provided by M 11 and F 13 of 17 mushrooms • Range male 19 and over – 10 – 21.1% • Range female 19 and over – 10-24.9% Mushroom Shiitake, stir-fried (Can) providing the greatest amount
Niacin (B3)	M 24.7% F 24.5%	16mg male 19 and over 14mg female 19 and over	# >10%RDI provided by M 11 and F 14 of 17 mushrooms • Range male 19 and over – 12.5-43.8% • Range female 19 and over – 10.7-50% Oyster Mushroom, boilded (Jap) Providing the greatest amount
Folate	M and F 14.8%	400mcg male and female 19 yars and over	# >10%RDI provided by 3 of 17 mushrooms for M and F • Range male and female 19 and over – 11 -17.8% Oyster Mushroom, boilded (Jap) Providing the greatest amount
Vitamin B6	M 12.0% F 11.8%	1.3mg males 19-50: 1.7mg males 50 and over 1.3mg females19-50: 1.5mg females 50 and over	# >10%RDI provided by 5 of 17 mushrooms for M and F • Range male 19 and over – 10.2– 13.4% • Range female 19 and over – 10.6-13.4% Mushrooms Shiitake, stir fried lentinus Adodes (USDA) and mushrrom Shiitake, stir-fried (Can).
Pantothenic acid	M 30.1% F 42.9%	6mg male 19 and over 4mg female 19 and over	# >10% AI provided by M 13 and F 14 of 17 mushrooms • Range male 19 and over 15–59.9% • Range female 19 and over 13-89.9% Mushroom, shiitake cooked (Can) Provided the greatet amount

Vitamin D	M and F 163.5%	5mcg Male and female 19-50: 10mcg male and female 51-70: 15mcg male and female >70	## >10% RDI provided by all 17 of 17 mushrooms for M and F * aged 19-50 years • Range male and female 19 –50: 10–1860% • Range male and female 51-70: 10– 930% • Range male and female 70 and over: 13.3-620% Tree Ears, Shiro-Kikurage, boilded (Jap) being the greatest contributor providing 93 mcg per 100g

Summary Table for COOKED CULINARY SPECIALTY MUSHROOMS providing >10% RDI/AI of key minerals /100g

Nutrient	Copper (mg)	Males 19 years and over	Females 19 years and over	Phosphorus (mg)	Males 19 years and over	Females 19 years and over	Manganese (mg)	Males 19 years and over	Females 19 years and over	Sodium (mg)	Males 19 years and over	Females 19 years and over
	AI	1.7	1.2	RDI	1000	1000	AI	5.5	5	AI	460	460
Mushrooms Shiitake, Stir fried Lentinus edodes (USDA)	0.163		13.6%	111	11.1%	11.1%	0.223			5		
Mushrooms, shiitake, cooked without salt (USDA)	0.896	52.7%	74.7%	29			0.204			4		
Mushrooms, shiitake, cooked with salt (USDA)	0.896	52.7%	74.7%	29			0.204			240	52.2%	52.2%
Shitake Hoshi-shiitake boiled (Jap)	0.09			43			0.11			2		
Shitake Nama-shiitake, boiled (Jap)	0.07			67			0.24			2		
Tree ears, Kiurage, boiled (Jap)	0.03			10			0.53		10.6%	9		
Tree ears, Shiro-kikurage, boiled (Jap)	0.01			11			0.12			2		
Tree ears, Arage-kikurage, boiled (Jap)	0.04			11			0.2			10		
Mushroom, shiitake, cooked (Can)	0.896	52.7%	74.7%	29			0.204			4		
Mushroom, shiitake,stir-fried (Can)	0.163		13.6%	111	11.1%	11.1%	0.223			5		
Nameko boiled (Jap)	0.12		10.0%	56			0.05			3		
Nameko canned in brine (Jap)	0.04			39			0.08			8		
Maitake, boiled (Jap)	0.17	10.0%	14.2%	89			0.04			1		
Oyster mushrooms boiled (Jap)	0.11			86			0.15			2		
Winter mushroom bottled in seasoning (Jap)	0.08			150	15.0%	15.0%	0.24			1700	369.6%	369.6%
Winter Mushroom boiled (Jap)	0.06			110	11.0%	11.0%	0.05			2		
Shimeji Bunashimeji boiled (Jap)	0.06			110	11.0%	11.0%	0.13			3		

Summary Table for COOKED CULINARY SPECIALTY MUSHROOMS providing >10% RDI/AI of key minerals /100g

Nutrient	Potassium (mg)	Males 19 years and over	Females 19 years and over	Selenium (mcg)	Males 19 years and over	Females 19 years and over	Zinc (mg)	Males 19 years and over	Females 19 years and over	Iron (mg)	Males 19 years and over	Females 19-50 years	Females over 50 years
	AI	3800	2800	RDI	70	60	RDI	14	8	RDI	8	18	8
Mushrooms Shiitake, Stir fried Lentinus edodes (USDA)	326		11.6%	6.3		10.5%	0.96		12.0%	0.53			
Mushrooms, shiitake, cooked without salt (USDA)	117			24.8	35.4%	41.3%	1.33		16.6%	0.44			
Mushrooms, shiitake, cooked with salt (USDA)	117			24.8	35.4%	41.3%	1.33		16.6%	0.44			
Shitake Hoshi-shiitake boiled (Jap)	220						0.4			0.3			
Shitake Nama-shiitake, boiled (Jap)	250						0.5			0.3			
Tree ears, Kiurage, boiled (Jap)	37						0.2			0.7			
Tree ears, Shiro-kikurage, boiled (Jap)	79						0.3			0.2			
Tree ears, Arage-kikurage, boiled (Jap)	1						0.1			1.7	21.3%		21.3%
Mushroom, shiitake, cooked (Can)	117			24.8	35.4%	41.3%	1.33		16.6%	0.44			
Mushroom, shiitake,stir-fried (Can)	326		11.6%	6.3		10.5%	0.96		12.0%	0.53			
Nameko boiled (Jap)	210						0.4			0.6			
Nameko canned in brine (Jap)	100						0.5			0.8	10.0%		10.0%
Maitake, boiled (Jap)	160						0.7			0.4			
Oyster mushrooms boiled (Jap)	260						1.4	10.0%	17.5%	0.7			
Winter mushroom bottled in seasoning (Jap)	320		11.4%				0.6			0.8	10.0%		10.0%
Winter Mushroom boiled (Jap)	270						0.6			1	12.5%		12.5%
Shimeji Bunashimeji boiled (Jap)	340		12.1%				0.5			0.5			

Table 8 Average %RDI/AI content for each Key MINERAL /100g

Mineral	Average %	Recommended Dietary Intake	Comments
Copper	M 42% F 39.3%	1.7mg male 19 and over 1.2mg Female 19 and over	# >10% RDI provided by M 4 and F 7 of the 17 mushrooms • Range male 19 and over – 10-52.7% • Range female 19 and over – 10-74.7% Mushroom common Shiitake, cooked without Salt (USDA) and Cooked with Salt (USDA) and Mushroom common shiitake, cooked (Can)
Phosphorous	M and F 11.8%	1000mg male and female 19 and over	# >10% RDI provided by 5 of 17 mushrooms M and F Range male and female 19 and over – 11-15% Winter mushroom Bottled in seasoning providing the greatest amount.
Manganese	F 10.6% only	5mg female 19 and over	# >10% AI provided by 1of 17 mushrooms F only by Tree Ears, kiurage, boiled (Jap) providing the greatest amount
Sodium	M and F 210.9%	460mg male and female 19 and over	#>10% AI for 2 of 17 mushrooms for M and F Range Male and female 52.2%-369.6% Winter mushroom bottled in seasoning and Mushroom Shiitake Cooked in salt (USDA) providing the greatest amount (Likely seasoning not mushrooms)
Potassium	F 11.7% only	3800mg male 19 and over 2800mg female 19 and over	# >10% AI provided for females 19 and over only. With only 4 of the 17 mushrooms contributing to >10%. Range female 19 years and over – 11.4-12.1% Shimeji bunashimeji, boiled (Jap) Provided the greatest amount
Selenium	M 35.4% F 29%	70mcg male 19 and over 60mcg female 19 and over	# >10% RDI provided by M 3 and F 5 of 17 mushrooms Male 19 and over – 35.4%

			Female 19 and over range 10.5 -41.3% Mushroom common Shiitake, cooked without Salt (USDA) and Cooked with Salt (USDA) and Mushroom common shiitake, cooked (Can)
Zinc	M 10% only F 15.2%	14mg Male 19 and over 8mg Females 19 years and over	# >10% RDI provided by M 1 and F 6 of 17 mushrooms Range female 19 and over – 12-17.5% Oyster mushroom, boiled (Jap) providing the greatest amount
Iron	M 13.4% F 10.8%	8mg male 19 and over 18mg female 19 and over 8mg females 51 and over	# >10%RDI provided by 4 of 17 mushrooms for M and F Range for male 19 and over and female over 50, 10-21.3% Nil reached >10% RDI for females 19-50 Tree Ears, Arage-kikurage, boiled (Jap) provided the greatest amount

Summary Table for DRIED CULINARY SPECIALTY MUSHROOMS providing >10% RDI/AI for fibre /20g weight

Nutrient	Fibre (g)	Males 19 years and over	Females 19 years and over
	AI	30	25
Mushrooms, shiitake, dried Lentinus edodes (USDA)	2.30		
Shitake Hoshi-shiitake dried (Jap)	8.20	27.3%	32.8%
Mushroom, shiitake, dried (Can)	2.30		
Shiitake, dried (Log grown)	1.10		
Maitake dried (Jap)	8.18	27.3%	32.7%
Mushroom Milk Caps, salted (Fin)	0.58		
Fungi, Cloud ears, dried (Can)	14.02	46.7%	56.1%
Tree ears, Kiurage, dried (Jap)	11.48	38.3%	45.9%
Tree ears, Shiro-kikurage, dried (Jap)	13.74	45.8%	55.0%
Tree ears, Arage-kikurage, dried (Jap)	15.88	52.9%	63.5%
Boletus edible, dried (Ger)	11.06	36.9%	44.2%

- 20g of dried culinary specialty mushrooms provide an average of 39.3 % of the AI[27] for males and 47.2% for females for fibre for ages 19 years and over.

[27] AI for fibre males 19yeas and over equals 30g and for females 19 years and over equals 25g

Summary Table for DRIED CULINARY SPECIALTY MUSHROOMS providing >10% RDI/AI of key vitamins /20g weight

Nutrient	**Thiamin (B1) (mg)**	Males 19 years and over	Females 19 years and over	**Riboflavin (B2) (mg)**	Males 19-70 years	Males over 70 years	Females 19-70 years	Females over 70 years	**Niacin equivalents (B3) (mg)**	Males 19 years and over	Females 19 years and over
	RDI	**1.2**	**1.1**	**RDI**	**1.3**	**1.6**	**1.1**	**1.3**	**RDI**	**16**	**14**
Mushrooms, shiitake, dried Lentinus edodes (USDA)+A10	0.06			0.25	19.5%	15.9%	23.1%	19.5%	2.82	17.6%	20.1%
Shitake Hoshi-shiitake dried (Jap)	0.10			0.28	21.5%	17.5%	25.5%	21.5%	3.36	21.0%	24.0%
Mushroom, shiitake, dried (Can)	0.06			0.25	19.5%	15.9%	23.1%	19.5%	2.92	18.3%	20.9%
Shiitake, dried (Log grown)	0.20	16.7%	18.2%	0.20	15.4%	12.5%	18.2%	15.4%	2.00	12.5%	14.3%
Maitake dried (Jap)	0.25	20.7%	22.5%	0.38	29.5%	24.0%	34.9%	29.5%	12.82	80.1%	91.6%
Mushroom Milk Caps, salted (Fin)	0.02			0.08					1.14		
Fungi, Cloud ears, dried (Can)	0.00			0.17	13.0%	10.6%	15.3%	13.0%	1.59	10.0%	11.4%
Tree ears, Kiurage, dried (Jap)	0.04			0.17	13.1%	10.6%	15.5%	13.1%	0.64		
Tree ears, Shiro-kikurage, dried (Jap)	0.02			0.14	10.8%		12.7%	10.8%	0.44		
Tree ears, Arage-kikurage, dried (Jap)	0.002			0.09					0.34		
Boletus edible, dried (Ger)	N/A			N/A					N/A		

Summary Table for DRIED CULINARY SPECIALTY MUSHROOMS providing >10% RDI/AI of key vitamins /20g weight *continued*

Nutrient	**Folate (mcg)**	Males 19 years and over	Females 19 years and over	**Vit B6 (mg)**	Males 19-50 years	Males over 50 years	Females 19-50 years	Females over 50 years
	RDI	**400**	**400**	**RDI**	**1.3**	**1.7**	**1.3**	**1.5**
Mushrooms, shiitake, dried Lentinus edodes (USDA)+A10	33			0.19	14.8%	11.4%	14.8%	12.9%
Shitake Hoshi-shiitake dried (Jap)	48	12.0%	12.0%	0.09				
Mushroom, shiitake, dried (Can)	33			0.19	14.8%	11.4%	14.8%	12.9%
Shiitake, dried (Log grown)	N/A			N/A				
Maitake dried (Jap)	44	11.0%	11.0%	0.06				
Mushroom Milk Caps, salted (Fin)	4.2			0.04				
Fungi, Cloud ears, dried (Can)	7.6			0.02				
Tree ears, Kiurage, dried (Jap)	17.4			0.02				
Tree ears, Shiro-kikurage, dried (Jap)	15.2			0.02				
Tree ears, Arage-kikurage, dried (Jap)	3			0.02				
Boletus edible, dried (Ger)	N/A			N/A				

Summary Table for DRIED CULINARY SPECIALTY MUSHROOMS providing >10% RDI/AI of key vitamins /20g weight *continued*

Nutrient	**Pantothenic acid (mg)**	Males 19 years and over	Females 19 years and over	**Vit D (mcg)**	Males 19-50 years	Males 51-70 years	Males over 70 years	Females 19-50 years	Females 51-70 years	Females over 70 years
	AI	**6**	**4**	**AI**	**5**	**10**	**15**	**5**	**10**	**15**
Mushrooms, shiitake, dried Lentinus edodes (USDA)+A10	4.38	72.9%	109.4%	0.78	15.6%			15.6%		
Shitake Hoshi-shiitake dried (Jap)	1.59	26.4%	39.7%	3.40	68.0%	34.0%	22.7%	68.0%	34.0%	22.7%
Mushroom, shiitake, dried (Can)	4.38	72.9%	109.4%	0.78	15.6%			15.6%		
Shiitake, dried (Log grown)	N/A			N/A						
Maitake dried (Jap)	0.73	12.2%	18.4%	2.80	56.0%	28.0%	18.7%	56.0%	28.0%	18.7%
Mushroom Milk Caps, salted (Fin)	N/A			1.06	21.2%	10.6%		21.2%	10.6%	
Fungi, Cloud ears, dried (Can)	0.10			0.00						
Tree ears, Kiurage, dried (Jap)	0.23			88	1760%	880%	587%	1760%	880%	587%
Tree ears, Shiro-kikurage, dried (Jap)	0.27			194	3880%	1940%	1293%	3880%	1940%	1293%
Tree ears, Arage-kikurage, dried (Jap)	0.12			14	280%	140%	93%	280%	140%	93%
Boletus edible, dried (Ger)	N/A			N/A						

Table 9 Average %RDI/AI content for each Key Vitamin /20g

Vitamin	Average %	Recommended Dietary Intake	Comments
Thiamine (B1)	M18.7% F 20.4%	1.2mg male 19 years and over 1.1mg Female 19 years and over	# >10%RDI provided by 2 of 11 mushrooms for M and F • Range male 19 and over – 16.7 – 20.7% • Range female 19 and over – 18.2- 22.5% Maitake dried (Jap) providing the greatest amount
Riboflavin (B2)	M 16.6% F 19.4%	1.3mg male 19-70: 1.6mg men>70 1.1mg Female 19-70:1.3mg female>70	# >10% RDI provided by all 8 of the 11 listed mushrooms for M and F • Range male 19 and over – 10.6 -29.5% • Range female 19 and over – 13-34.9% Maitake dried (Jap) Proving the greatest amount
Niacin (B3)	M 26.6 % F 30.4%	16mg male 19 and over 14mg female 19 and over	# >10%RDI provided by all 6 of the 11 listed mushrooms for M and F • Range male 19 and over – 10 - 80.1% • Range female 19 and over – 11.4 - 91.6% Maitake dried (Jap) Proving the greatest amount
Folate	M and F 11.5%	400mcg male and female19 and over	# >10%RDI provided by all 2 of 11 mushrooms for M and F • Range male and female 19 and over – 11 - 12% Shiitake Hoshie-Shiitake dried (Jap) Proving the greatest amount
Vitamin B6	M 13.1% F 13.9%	1.3mg males 19-50: 1.7mg males 50 and over 1.3mg females19-50: 1.5mg females 50 and over	# >10%RDI provided by all 2 of the 11 mushrooms for M and F • Range male 19 and over – 11.4-14.8% • Range female 19 and over – 12.9-14.8% Maitake dried (Can) and Mushrooms, Shiitake, dried Lentinus edodes (USDA) Proving the greatest amount
Pantothenic acid	M 46.1% F 69.2%	6mg male 19 and over 4mg female 19 and over	# >10% AI provided by 4 of 11 mushrooms for M and F • Range male 19 and over 12.2-72.9% • Range female 19 and over 18.4-109.4% Maitake dried (Can) and Mushrooms, Shiitake, dried Lentinus edodes (USDA) Proving the greatest amount
Vitamin D	M and F 586.5%	5mcg Male and female 19-50:	# >10% RDI provided by 8 of 11 mushrooms for M and F • Range male and female 19 –50: 15.6–3880%

*Greatest Increase seen		10mcg male and female 51-70: 15mcg male and female >70	• Range male and female 51-70: 10.6-1940% • Range male and female 70 and over: 18.7 -1293.3% 2 new dried mushroom varieties presented with significantly high Vitamin D levels, these are Tree ears, Kiurage, Dried (Jap) and Tree ears, Shiro-kikurate dried (Jap) contributing 88mcg and 194mcg of vitamin D /20g

Summary Table for DRIED CULINARY SPECIALTY MUSHROOMS providing >10% RDI/AI of key minerals /20g weight

Nutrient	Copper (mg)	Males 19 years and over	Females 19 years and over	Phosphorus (mg)	Males 19 years and over	Females 19 years and over	Magnesium (mg)	Males 19-30 years	Males 31 years and over	Females 19-30 years	Females 31 years and over
	AI	1.7	1.2	RDI	1000	1000	RDI	400	420	310	320
Mushrooms, shiitake, dried Lentinus edodes (USDA)	1.03	60.8%	86.1%	58.8			26.4				
Shitake Hoshi-shiitake dried (Jap)	0.10			62			22				
Mushroom, shiitake, dried (Can)	1.03	60.8%	86.1%	58.8			26.4				
Shiitake, dried (Log grown)	N/A			48			26.4				
Maitake dried (Jap)	0.36	20.9%	29.7%	140	14.0%	14.0%	20				
Mushroom Milk Caps, salted (Fin)	N/A			14.4			1.8				
Fungi, Cloud ears, dried (Can)	0.04			36.8			16.6				
Tree ears, Kiurage, dried (Jap)	0.06			46			42	10.5%	10.0%	13.5%	13.1%
Tree ears, Shiro-kikurage, dried (Jap)	0.02			52			13				
Tree ears, Arage-kikurage, dried (Jap)	0.04			22			22				
Boletus edible, dried (Ger)	N/A			128.4	12.8%	12.8%	N/A				

Summary Table for DRIED CULINARY SPECIALTY MUSHROOMS providing >10% RDI/AI of key minerals /20g weight

Nutrient	Manganese (mg)	Males 19 years and over	Females 19 years and over	Sodium (mg)	Males 19 years and over	Females 19 years and over	Potassium (mg)	Males 19 years and over	Females 19 years and over
	AI	5.5	5	AI	460	460	AI	3800	2800
Mushrooms, shiitake, dried Lentinus edodes (USDA)	0.24			2.6			306.8		11.0%
Shitake Hoshi-shiitake dried (Jap)	0.17			1.2			420	11.1%	15.0%
Mushroom, shiitake, dried (Can)	0.24			2.6			306.8		11.0%
Shiitake, dried (Log grown)	N/A			2.6			306.8		11.0%
Maitake dried (Jap)	0.09			0.6			500	13.2%	17.9%
Mushroom Milk Caps, salted (Fin)	N/A			196.6	42.7%	42.7%	68		
Fungi, Cloud ears, dried (Can)	0.39			7			150.8		
Tree ears, Kiurage, dried (Jap)	1.24	22.5%	24.8%	11.8			200		
Tree ears, Shiro-kikurage, dried (Jap)	0.07			5.6			280		10.0%
Tree ears, Arage-kikurage, dried (Jap)	0.23			9.2			126		
Boletus edible, dried (Ger)	N/A			2.8			400	10.5%	14.3%

Summary Table for DRIED CULINARY SPECIALTY MUSHROOMS providing >10% RDI/AI of key minerals /20g weight

Nutrient	Selenium (mcg)	Males 19 years and over	Females 19 years and over	Zinc (mg)	Males 19 years and over	Females 19 years and over	Iron (mg)	Males 19 years and over	Females 19-50 years	Females over 50 years
	RDI	70	60	RDI	14	8	RDI	8	18	8
Mushrooms, shiitake, dried Lentinus edodes (USDA)	9.22	13.2%	15.4%	1.53	10.9%	19.2%	0.34			
Shitake Hoshi-shiitake dried (Jap)	N/A			0.46			0.34			
Mushroom, shiitake, dried (Can)	9.22	13.2%	15.4%	1.53	10.9%	19.2%	0.34			
Shiitake, dried (Log grown)	N/A			N/A			0.78			
Maitake dried (Jap)	N/A			1.38		17.3%	0.52			
Mushroom Milk Caps, salted (Fin)	7.2	10.3%	12.0%	0.14			0.54			
Fungi, Cloud ears, dried (Can)	8.68	12.4%	14.5%	0.26			1.18	14.7%		14.7%
Tree ears, Kiurage, dried (Jap)	N/A			0.42			7.04	88.0%	39.1%	88.0%
Tree ears, Shiro-kikurage, dried (Jap)	N/A			0.8		10.0%	0.88	11.0%		11.0%
Tree ears, Arage-kikurage, dried (Jap)	N/A			0.16			2.08	26.0%	11.6%	26.0%
Boletus edible, dried (Ger)	N/A			N/A			1.68	21.0%		21.0%

Table 10 Average %RDI/AI content for each key mineral /100g

Mineral	Average %	Recommended Dietary Intake	Comments
Copper	M 47.5% F 67.3%	1.7mg male 19 and over 1.2mg Female 19 and over	# >10% AI provided by 3 of 11 mushrooms for M and F • Range male 19 and over – 20.9 – 60.8% • Range female 19 and over – 29.7 - 86.1% Shiitake Dried Lentinus edodes (USDA) and Mushroom, shiitake, dried (Can) providing the greatest amount
Phosphorous	M and F 13.4% Only	100mg male and female 19 and over	# >10% RDI provided by 2 of 11 mushrooms for M and F • Male and female 19 and over –12.8- 14% Maitake dried (Jap) providing the greatest amount
Sodium	M and F 42.7% only	460mg male and female 19 and over	# >10% AI provided by 1 of 11 mushrooms for M and F • Male and female 19 and over 42.7% Mushroom, milk caps, salted (Fin) providing the greatest amount. Nil other provided >10% AI for sodium
Magnesium	M10.3% F13.3%	400mg male 19-30 420 male 31 and over 310mg female 19-30 320mg female 31 and over	# >10% RDI provided by 1 of 11 mushrooms for M and F • Male 19 and over – 10-10.5% • Female 19 and over 13.1-13.5% Contributed by the new Tree ears, Kiurage dried (Jap)
Manganese	M 22.5% F 24.8%	5.5mg male 19 and over 5 mg Female 19 and over	# >10% RDI provided by 1 of 11 mushrooms for M and F Contributed by the new Tree ears, Kiurage dried (Jap)
Sodium	M and F 42.7%	460 mg male and female 19 and over	# >10% AI provided by 1 of 11 mushrooms Mushroom Milk Caps salted (Fin) Provide the greatest amount which is due to salting of product
Potassium	M 11.6% F 12.9%	3800mg male 19 and over 2800mg female 19 and over	# >10 % AI provided by 3 of 11 mushrooms for M and 7 for F • Range male 19 years and over 10.5-13.2% • Range female 19 years and over – 10-17.9% Maitake dried (Jap) Providing the greatest amount.
Selenium	M 12.3% F 14.3%	70mcg male 19 and over 60mcg female 19 and over	# >10 % RDI provided by 4 of 11 mushrooms • Range male 19 and over – 10.3-13.2% • Range female 19 and over – 12 -15.4% Shiitake Dried Lentinus edodes (USDA) and Mushroom, shiitake, dried (Can) providing the

			greatest amount providing the greatest amount
Zinc	M 10.9% only F 16.4%	14mg males 19 years and over 8mg Females 19 years and over	#>10% RDI provided by 2 and of the 11 mushrooms and 4 for F • Male 19 and over – 10.9% • Range female 19 and over – 10-19.2% Mushrooms, Shiitake dried Lentinus edode (USDA) Mushrooms, Shiitake dried (Can) providing the greatest amount
Iron	M and F 14.7%	8mg male 19 and over 18 female 19-50 : 8mg females 51 and over	# >10 % RDI provided by 5 of 11 mushrooms for M 19 and over and 2 for F 19-50 yrs Range for male 19 and over and female over 50, 11-88% Range for females 19-50 11.6-39.1% Tree Ears, kiurage, dried (Jap) provided the greatest amount providing 7.04mg/20g serve

[1] The selenium RDI for males 19 and over is 70ug/day and 60ug/day for females. However, Upper Level of allowable intake for selenium is 400ug/day for males and females 19 and over. Limited data on toxicity exits.

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