



# MUSHROOMS AND HEALTH GLOBAL INITIATIVE BULLETIN

An ISMS Global Initiative to increase the worldwide consumption of mushrooms through the collection, evaluation and dissemination of scientifically validated information.

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### News from the Initiative - Mary Jo Feeney

#### ► Mushrooms and Health 2010 – your resource for mushroom health information

The World Health Organisation states that more than 346 million people worldwide have diabetes and projects that diabetes deaths will double between 2005 and 2030 (<http://www.who.int/mediacentre/factsheets/fs312/en/>). People with diabetes usually have a pancreas that does not produce adequate insulin or a body that does not respond adequately to circulating insulin, both leading to high blood glucose. Elevated blood glucose levels cause long-term damage to cells in the kidneys and eyes and increase the risk of heart disease. It is widely agreed that prevention of diabetes can be achieved in many cases by being active, being a healthy weight and eating a healthy diet.

*Mushrooms and Health 2010*, your resource for mushroom health information, reviewed the science on the anti-diabetogenic properties of mushrooms. A small clinical trial with *Agaricus blazei* Murrill along with oral anti-diabetic medications suggested a positive affect of mushrooms on insulin resistance and therefore potentially a positive affect in the treatment of type 2 diabetes. 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. For additional abstracts and summaries of the science linking mushrooms and health, visit the [Mushrooms and Health](#) website and click on the [Mushrooms and Health Report](#) tab.

#### ► Conferences and meetings

There are many opportunities to attend conferences and seminars that stimulate exchange of new ideas between growers and scientists around the world. The [International Society for Mushroom Science](#) (ISMS) sponsors a major international congress on mushrooms every 3-5 years, such as the upcoming one in Beijing in 2012. Because it isn't possible for the *Bulletin* to list all the many meetings and events, click on the [National Mushroom Associations](#)

tab on the Mushrooms and Health website to find out about conferences in your country. Another listing of meetings and exhibits can be found through [Mushroom Business](#).

## Mushroom Research

### ► Chemopreventive effect of PSP

Luk S-U, Lee TK-W, Liu J, Lee DT-W, Chiu Y-T, et al. [Chemopreventive effect of PSP through targeting of prostate cancer stem cell-like population](#). PLoS ONE 6 (5): e19804. doi:10.1371/journal.pone.0019804.

According to recent evidence, prostate cancer stem/progenitor cells (CSC) are responsible for cancer initiation as well as disease progression. Conventional therapies are only effective in targeting the more differentiated cancer cells and spare the CSCs. In this article the researchers report that polysaccharide peptide (PSP), an active component extracted from the Turkey tail mushroom (*Coriolus versicolor*), is effective in targeting prostate CSCs and found that treatment of the prostate cancer cell line PC-3 with PSP led to the down-regulation of CSC markers (CD133 and CD44) in a time and dose-dependent manner. PSP treatment not only suppressed the ability of PC-3 cells to form prostaspheres under non-adherent culture conditions, but also inhibited their tumorigenicity *in vivo*. To investigate if the anti-CSC effect of PSP may lead to prostate cancer chemoprevention, transgenic mice (TgMAP) that spontaneously develop prostate tumors were orally fed with PSP for 20 weeks. Whereas 100% of the mice fed with water only developed prostate tumors at the end of experiment, no tumors could be found in any of the mice fed with PSP. According to the researchers, the results not only demonstrated the intriguing anti-CSC effect of PSP, but also revealed the chemopreventive property of oral PSP consumption against prostate cancer.

### ► Bioactive proteins review paper

Xu X, Yan H, Chen J, and Zhang X. [Bioactive proteins from mushrooms](#). *Biotechnology Advances* 2011; doi 10.1016/j.biotechadv.2011.05.003.

Various mushroom proteins, such as lectins, fungal immunomodulatory proteins, ribosome inactivating proteins, ribonucleases, laccases and other proteins have interesting biological activities. These have become popular sources of natural antitumor, antiviral, antimicrobial, antioxidative and immunomodulatory agents. This review updated the present status of bioactive proteins in mushrooms and discussed their biomedical potential.

### ► *Agaricus blazei* Murill and immune system – integrative review

Lima CU, Cordova CO, Nobrega OdeT, Funghetto SS, Karnikowski MG. [Does the \*Agaricus blazei\* Murrill mushroom have properties that affect the immune system? An integrative review](#). *J Med Food* 2011; 14 (1-2): 2-8.

This integrative review of indexed publications between 2000-2009 used as a guideline: "What evidence can be found in the literature regarding the influence of *A. blazei* Murrill on the immune system?" Fourteen studies verified *in vitro* and *in vivo* research demonstrating this mushroom's influence on the immune system. *A. blazei* Murrill functions through bioactive compounds and mechanisms that are not yet entirely clear although it has been shown that *A. blazei* Murrill promotes action on innate and adaptive immunological response. All research

was characterized as evidence level 7 (preclinical studies/animals/*in vitro*). Randomized clinical trials are needed for the mushroom to be put into clinical practice.

► **Antioxidant properties and compounds of Maitake extracts**

Yeh J-Y, Hsieh L-H, Wu K-T and Tsai C-F. [Antioxidant properties and antioxidant compounds of various extracts from the edible basidiomycete \*Grifola Frondosa\* \(Maitake\)](#). *Molecules* 2011; 16: 3197-3211.

Ethanollic, cold-water and hot water extracts of *Grifola frondosa* were prepared and their antioxidant properties investigated for radical-scavenging activity by DPPH, scavenging ability on superoxide anion, chelating ability on ferrous ions and reducing power. The various extracts examined displayed potent antioxidative properties.

► **Anti-inflammatory activity of oyster mushroom**

Jedinak A, Dudhgaonkar S, Wu Q-l, Simon J, and Sliva D. [Anti-inflammatory activity of edible oyster mushroom is mediated through the inhibition of NF Kappa B and AP-1 signaling](#). *Nutrition Journal* 2011; 10:52.

The investigators evaluated anti-inflammatory properties of oyster mushroom (*Pleurotus ostreatus*) *in vitro* and *in vivo*. RAW264.7 murine macrophage cell line and murine splenocytes were incubated with the oyster mushroom concentrate (OMC, 0-100 µg/ml) in the absence or presence of lipopolysaccharide (LPS) or concanavalin A (ConA), respectively. Cell proliferation was determined by MTT assay. Expression of cytokines and proteins was measured by ELISA assay and Western blot analysis, respectively. DNA-binding activity was assayed by the gel-shift analysis. Inflammation in mice was induced by intraperitoneal injection of LPS. OMC suppressed LPS-induced secretion of tumor necrosis factor-alpha (TNF-alpha), interleukin-6 (IL-6), and IL-12p40 from RAW264.7 macrophages. OMC inhibited LPS-induced production of prostaglandin E2 (PGE2) and nitric oxide (NO) through the down-regulation of expression of COX-2 and iNOS, respectively. OMC also inhibited LPS-dependent DNA-binding activity of AP-1 and NF kappa B in RAW264.7 cells. Oral administration of OMC markedly suppressed secretion of TNF-alpha and IL-6 in mice challenged with LPS *in vivo*. Anti-inflammatory activity of OMC was confirmed by the inhibition of proliferation and secretion of interferon-γ (IFN-γ), IL-2, and IL-6 from concanavalin A(ConA)-stimulated mouse splenocytes. This study suggests that oyster mushroom possesses anti-inflammatory activities and could be considered a dietary agent against inflammation. Oyster mushrooms' health benefits warrant further clinical studies.

Oyster mushrooms have anti-inflammatory activities and their health benefits warrant further clinical trials.

► **Bioavailability of vitamin D<sub>2</sub> from UV-B-irradiated button mushrooms**

Urbain P, Singler F, Ihorst G, Biesalski H-K, and Bertz H. [Bioavailability of vitamin D<sub>2</sub> from UV-B-irradiated button mushrooms in healthy adults deficient in serum 25-hydroxyvitamin D: A randomized controlled trial](#). *European Journal of Clinical Nutrition* 2011; doi:10.1038/ejcn.2011.53.

Although mushrooms contain little or any vitamin D<sub>2</sub>, they are abundant in ergosterol which can be converted into vitamin D<sub>2</sub> upon exposure to ultraviolet (UV) irradiation. The researchers investigated the bioavailability of vitamin D<sub>2</sub> from D<sub>2</sub> enhanced mushrooms by UV-B and compared it with a vitamin D<sub>2</sub> supplement in young subjects (N=26) with serum 25-hydroxyvitamin D (25OHD) levels of < 50 nmol/l. In the 5-week trial during winter, subjects were

Bioavailability of vitamin D<sub>2</sub> from D<sub>2</sub>-enhanced button mushrooms improved vitamin D status similar to a vitamin D<sub>2</sub> supplement.

randomly assigned into three groups and received 28,000 IU (700 µg) via D<sub>2</sub> enhanced mushrooms; 28,000 IU vitamin D<sub>2</sub> via a supplement; or placebo. After 2 weeks, serum 25OHD was significantly higher in the mushroom than in the placebo group. Serum 25OHD concentrations in the mushroom and supplement groups rose significantly and similarly over the study period. The investigators state that the bioavailability of vitamin D<sub>2</sub> from D<sub>2</sub>-enhanced button mushrooms via UV-B irradiation was effective in improving vitamin D status and not different to a vitamin D<sub>2</sub> supplement.

#### ► Vitamin D and sterol composition

Phillips KM, Ruggio DM, Horst RL, et al. [Vitamin D and sterol composition of 10 types of mushrooms from retail suppliers in the United States](#). *J. Agric. Food Chem.* 2011; DOI: 10.1021/jf104246z.

To update the United States Department of Agriculture (USDA) Nutrient Database for Standard Reference (<http://www.nal.usda.gov/fnic/foodcomp/search/>) Vitamin D<sub>2</sub> (ergocalciferol) and sterols were analyzed in mushrooms sampled nationwide in the United States. Vitamin D<sub>2</sub> was assayed using HPLC with [<sup>3</sup>H]-vitamin D<sub>3</sub> internal standard and sterols by GC-FID mass spectrometric (MS) confirmation. Vitamin D<sub>2</sub> was low (0.1–0.3 µg/100 g) in *Agaricus bisporus* (white button, crimini, portabella) and enoki, moderate in shiitake and oyster (0.4–0.7 µg/100 g), and high in morel, chanterelle, maitake (5.2–28.1 µg/100 g) and UV-treated portabella (3.4–20.9 µg/100 g), with significant variability among composites for some types. Ergosterol (mg/100 g) was highest in maitake and shiitake (79.2, 84.9) and lowest in morel and enoki (26.3, 35.5); the range was <10 mg/100 g among white button composites but 12–50 mg/100 g among samples of other types. All mushrooms contained ergosta-5,7-dienol (22,23-dihydroergosterol) (3.53–18.0 mg/100 g) and (except morel) ergosta-7-enol. Only morel contained brassicasterol (28.6 mg/100 g) and campesterol (1.23–4.54 mg/100 g) and no ergosta-7,22-dienol. MS was critical in distinguishing campesterol from ergosta-7,22-dienol.

#### ► Folate composition of 10 types of mushrooms

Phillips KM, Ruggio DM and Haytowitz DB. [Folate composition of 10 types of mushrooms determined by liquid chromatography-mass spectrometry](#). *Food Chemistry* Volume 129, Issue 2, 15 November 2011, Pages 630-636 2011; doi:10.1016/j.foodchem.2011.04.087. Online ahead of print.

White button, crimini, shiitake, maitake, enoki, oyster, chanterelle, morel, portabella, and UV-treated portabella mushrooms were sampled from retail outlets and major producers in the United States. These mushrooms were analyzed for three naturally occurring forms of the vitamin folate by a validated analytical method: Folate [5-methyltetrahydrofolate (5-CH<sub>3</sub>-H<sub>4</sub>folate), 10-formyl folate (10-HCO-folate), 5-formyltetrahydrofolate (5-HCO-H<sub>4</sub>folate)]. Four composites of each product, including an in-house mushroom control composite and a reference material (BCR 485 Lyophilised Mixed Vegetables) were analyzed. Chanterelle and morel had the lowest total folate (2–6 µg/100g), oyster had the highest (mean, 44.2 µg/100g); other types contained 12.4 µg/100g (shiitake) to 29.8 µg/100g (vitamin D-enhanced portabella). Enoki and oyster had almost exclusively 5-CH<sub>3</sub>-H<sub>4</sub>folate. Morel and chanterelle contained predominately formyl folates. Other species had similar amounts of 5-CH<sub>3</sub>-H<sub>4</sub>folate and formyl folates. Enoki, oyster, and shiitake, unlike all others, had low to non-detectable

10-HCO-folate ( $<1\mu\text{g}/100\text{g}$ ). Data on the composition of folate vitamers in different types of mushrooms will facilitate assessment of the dietary contribution of naturally occurring folate.

► **Anti-breast cancer activity of low molecular weight compounds in wild mushrooms**

Froufe HJ, Abreu RM, and Ferreira IC. [Using molecular docking to investigate the anti-breast cancer activity of low molecular weight compounds present on wild mushrooms](#). *SAR QSAR Environ Res.* 2011; 3: 315-328.

Mushrooms are a source of compounds with anti-tumour and immunostimulating properties, and their intake has been shown to reduce the risk of breast cancer. A large number of low molecular weight (LMW) compounds present in mushrooms have been identified, including phenolic acids, flavonoids, tocopherols, carotenoids, sugars and fatty acids. To evaluate which wild mushroom LMW compounds may be involved in anti-breast cancer activity the investigators selected a representative dataset of 43 LMW compounds and performed molecular docking against three known protein targets involved in breast cancer (aromatase, estrone sulfatase and  $17\beta\text{-HSD-1}$ ) using AutoDock4 as docking software. The estimated inhibition constants for all LMW compounds were determined, and the potential structure-activity relationships for the compounds with the best estimated inhibition constants are discussed for each compound family. 4-O-caffeoylquinic, naringin and lycopene stand out as the top-ranked potential inhibitors for aromatase, estrone sulfatase and  $17\beta\text{-HSD1}$ , respectively, and the 3-D docked conformations for these compounds are discussed in detail.



**News from Australia - Glenn Cardwell**

► **Health professional education**

We continue to educate health professionals around the country through conferences and exhibitions. In May we were able to give four workshops and one seminar to doctors and nurses at the General Practitioners Conference and Exhibition (GPCE) over three days in Sydney. The photo shows our booth with Sue Dodd and Sue Brazel who offered tastings from a range of mushroom recipes.



Nine out of 10 participants gave our presentations full marks.

The evaluations showed that nine out of 10 participants gave our presentations full marks. Although the presentations were not specifically about mushrooms, it was clear from the written comments that delegates understood the health benefits of the mushroom, in particular mentioning a reduced risk of breast cancer and the presence of vitamin D.

This was our second occasion at GPCE in Sydney. Last year delegates often asked why we were at a medical conference; this year it was accepted that mushrooms were promoting good health through eating three mushrooms a day. As usual, Fast Ed, our celebrity chef was very popular as he demonstrated four mushroom dishes over two presentations.

#### ► **Dietitians' breakfast**

Also in May we conducted our, now famous, breakfast at the Dietitians Association of Australia (DAA) annual conference. This is the third successive year we have held the breakfast. We have been told that the Mushroom Breakfast is, out of six breakfasts, the breakfast that gets booked out first. I even have people asking for special permission to attend.

The Mushroom Breakfast is the most popular at the DAA conference.

One reason it is so popular is because it is good fun as well as educational, with Fast Ed once again demonstrating mushroom dishes and being Master of Ceremonies. Dr Manny Noakes gave some highlights from the [CSIRO Mushrooms and Health 2010 Report](#), followed by Glenn Cardwell discussing the vitamin D levels in mushrooms. The feedback has been great and it has generated questions from dietitians and requests for recipes and the health professional booklet. Kate di Prima, consultant dietitian, has featured mushrooms through her magazine contacts since attending the breakfast. The photo features both Celebrity Chef Fast Ed and Ms. Di Prima. The flow-on benefits are always unpredictable.

#### ► **Health professional newsletter**

Now that we have a large database of health professionals we are sending out an electronic quarterly newsletter that gives a brief summary of mushroom research and how it is of practical importance. The newsletter also features a video recipe and some quick links. It is designed to be read in about three minutes.





## News from the United States - Heidi Gengler

### ► Harnessing the influence of supermarket dietitians

United States (U.S.) grocery stores nationwide are adding more nutrition-focused employees to their roster: registered dietitians (RD). According to a [National Grocers Association](#) survey, more than 76 percent of consumers say the availability of nutrition and health information in grocery stores is important. Retailers have responded to consumer demand by employing nutrition and wellness experts as in-store advisors, a growing group referred to as supermarket RDs. This group has the ability to reach customers with credible health information at the point where many Americans' dietary decisions first take place – in the marketplace.

Over the past couple years, the Mushroom Council (Council) has committed to building relationships with this group of retail health professionals through in-person events and social media networking. This spring, the Council met with leading supermarket RDs, consumer affairs directors, nutritionists, and health and wellness retail managers at the Supermarket RD Leadership Symposium in Santa Rosa, CA. During the conference, the Council had the opportunity to learn about their roles and present the Council's nutrition assets and retail best practices to inspire future collaboration with this influential group.

Supermarket RDs are tasked with creating magazines, e-newsletters and brochures for their customers which they distribute in-store and through social media, including blogs, Facebook and Twitter. Recipes, photos, cooking tips, nutrition facts and details on industry promotions can all be incorporated into their direct-to-consumer communications. For example, a recent issue of Basha's (a U.S. grocery chain) "Eat Smart" newsletter (see photo) includes a mention of the Mushroom Council's recipe contest and vitamin D messaging.

This RD audience also presents cross-opportunities for the mushroom industry, healthcare professionals and retail category managers. The Council included an interview with the SUPERVALU corporate dietitian for multiple chains in two Mushroom Council newsletters directed toward retailers and health professionals. In addition, she shared her insights with U.S. mushroom sales ambassadors at the sales training conference in June.

The RD audience presents cross-opportunities for the mushroom industry, healthcare professionals and retail category managers.

**A TASTE OF ITALY ON THE GRILL**

When it's hot in the summer time, grilling outdoors is a great way to stay cool AND eat healthy foods! Choose a few simple ingredients to top your pizza that will highlight the delicious, smoky and flaky crust off the grill.

**The Sauce:** tomato sauce, pesto, olive oil, barbeque sauce, guacamole or your favorite Cedar's® Hommus (artichoke kalamata, garlic lovers, red pepper or zesty lemon).

**The Cheese:** mozzarella, ricotta, Laughing Cow® Light Cheese Sun-Dried Tomato Basil or Garlic & Herb wedges, goat cheese, parmesan.

**Helpful Hints for Grilled Pizza Perfection:** Prepare the grill for high heat. Brush the grill lightly with Pompeian® Olive Oil. Dust a baking sheet with flour or cornmeal so the dough won't stick. Shape the dough into 1/2-inch thick rounds, either stretching it by hand or using a rolling pin. Place crust on the grill and cook for 2-3 minutes on each side until it doesn't stick. Take the crust off the grill to arrange your toppings and place back on the grill until toppings are done.

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**Basha's Health Styles** eat smart

**Mushroom Recipe Contest:** Enter the WEEKLY WEBER GRILL GIVE-AWAY (Contest ends August 1, 2011) Details: [www.MushroomInfo.com](http://www.MushroomInfo.com)

**fresh Mushrooms** Did you know that mushrooms are a natural source of vitamin D - important for building strong bones?

**ppings:** getables (mushrooms, eggplant, tomatoes), fresh herbs, fresh arugula, olives, red onions, roasted garlic.

Be sure to visit the Mushrooms and Health website <http://www.mushroomsandhealth.com/>

Send what's happening in your country to communicate the benefits of mushrooms to consumers, shoppers, households, doctors, health professionals and the media to [info@mushroomsandhealth.com](mailto:info@mushroomsandhealth.com).

**Note:** The *Bulletin* provides links to other sites for your convenience and information. These sites contain information created, published, maintained or otherwise posted by organizations independent of the Initiative which does not endorse, approve, certify or control these sites and does not guarantee the accuracy of the information contained on them.

► **Initiative project team**

- Greg Seymour, President, ISMS General Manager AMGA, Australia; Manager, Mushrooms and Health Global Initiative
- Bart Minor, President, Mushroom Council, United States
- John Collier, Group Research and Development Manager, Monaghan Mushrooms Ltd, Republic of Ireland
- Mary Jo Feeney, Mushrooms and Health Global Initiative Operations Manager, Bulletin Editor, United States
- Glenn Cardwell, Accredited Practising Dietitian, Nutrition Impact P/L, Australia
- Chris Rowley, Communications Consultant, Australia
- Heidi Gengler, Vice President, Edelman Public Relations, United States

► **Strategic communications group**

Members of the Strategic Communications Group strengthen the Initiative's communication capability and develop a local public relations presence in each country whose industry is contributing financially to the project. Members of this group help facilitate stories about mushrooms and health appearing in their local media, monitor mushroom nutrition and health research, liaison with scientists, media and other influencers, and provide feedback to the Initiative. They include:

- Michal Slawski - United Kingdom
- Franz Schmaus - Germany
- Francois Marche - France
- Ignace Deroo, Evy Detroch - Belgium
- José Antonio Jiménez Hernandez - Spain
- Kent Stenvang - Denmark
- Dick Roodhuyzen de Vries - Netherlands
- Elizabeth O'Neil - Canada