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.

MAY 2010 ISSUE #10

Mary Jo Feeney, Editor *info@mushroomsandhealth.com*

▶ Table of Contents

News from the initiative - Mary Jo Feeney

▶ Mushrooms and Health website now online!

Click on http://www.mushroomsandhealth.com - and visit the website dedicated to providing the latest credible scientific information on the health benefits of eating mushrooms.

Link your organization or company website to the Mushrooms and Health website.

The website houses the CSIRO (Commonwealth Scientific and Industrial Research Organization, Food Science Australia) report "Mushrooms and Health", current and past issues of the *Bulletin*, a Research News section that highlights newly published studies on mushrooms and health, and a section listing various national mushroom industry organizations.

Under the ISMS banner, the Mushrooms and Health website provides this information as a resource to the mushroom industry, scientists, health professionals and health writers seeking summaries and abstracts of peer-reviewed articles linking mushrooms and health. Initiative Team members

provided an introductory perspective on the various topics to help interpret some of the research findings.

If possible, link your organization or company website to the Mushrooms and Health website and encourage the media to generate stories about mushrooms using the information provided.

▶ From the Strategic Communications Group

Strategic Communications Group member Elizabeth O'Neil provided a research article that estimated the economic burden and premature death rate in Canada linked to low serum levels of vitamin D. According to Ms. O'Neil: "This is one of the first studies to actually quantify the effects of improving vitamin D levels in the Canadian population (especially relevant considering the latitude at which most of the population lives). It signals to me that there is a growing interest in elevating awareness levels about the need for vitamin D and therefore a growing opportunity for those of us in the mushroom industry". Read the article on page 7.

▶ From Bulletin readers

Franc Pohleven, PhD, Biotechnical Faculty, University of Ljubljana, Slovenia, notes that the 6th International Conference on Polysaccharides-Glycoscience, will be held 29 September – 1 October, Prague, Czech Republic. See http://polysaccharides.csch.cz/program.html. The conference focuses on industrial production and use of polysaccharides; abundance, properties and structure of biologically active polysaccharides and derivatives of polysaccharides.

▶ Resource you can use:

Nutrition Research e-newsletter from the U.S. National Cancer Institute

The Nutritional Science Research Group, Division of Cancer Prevention at the U.S. National Cancer Institute (NCI) issues a quarterly electronic newsletter, *Nutrition Frontiers*. The newsletter highlights emerging evidence linking diet to cancer prevention and tumor behavior. *Nutrition Frontiers* showcases recent findings that advances the understanding about who will likely benefit most from dietary change. This newsletter is for anyone interested in learning more about basic emerging science and clinical studies including information on conferences, workshops, and funding opportunities in the nutrition and cancer prevention community.

For more information, go to: http://prevention.cancer.gov/programs-resources/groups/ns/nutrition-frontiers.

Mushroom research

▶ Immunomodulatory effects of Ganoderma lucidum

Rubel R, Dalla Santa HS, et al. "*Ganoderma lucidum* (Leyss: Fr) Karst. triggers immunomodulatory effects and reduces nitric oxide synthesis in mice." *JMed Food.* 2010 Feb;13(1):142-8.

The researchers investigated the effect of *Ganoderma lucidum* supplementation on lymphocytes and peritoneal macrophages from mice. Results show that *G. lucidum in vivo* was able to increase interferon-gamma (IFN-gamma) concentration but reduced CD3(+) and CD8(+) spleen lymphocytes. *Ex vivo*, IFN-gamma; and interleukin-10 levels were increased and the tumor necrosis

factor-alpha (TNF-alpha) level was reduced by peritoneal macrophages from mice fed with *G. lucidum*.

In the absence of stimuli, nitric oxide production was reduced in mice fed with *G. lucidum*, and with lipopolysaccharide stimulation nitric oxide production was increased but was lower than control values ($P < .05$). *G. lucidum* was grown by solid-state culture in wheat grain, and a chow containing 10% *G. lucidum* mycelium was formulated (G10). Swiss male mice were divided into two groups, termed G10 and control groups according to the diet, and fed for 3 months. Peritoneal macrophages were obtained and investigated with regard to phagocytosis, lysosomal volume, hydrogen peroxide, superoxide anion, and cytokines *ex vivo*. Concentrations of cytokines were investigated in the plasma; and subsets of CD3(+), CD4(+), CD8(+), and CD19(+) lymphocytes were determined in the spleen.

▶ Mushrooms modulate alpha-defensins 1-3 and protect against infection

Kuvibidila S, Korlagunta K. "Extracts from culinary medicinal mushrooms increase intracellular alpha-defensins 1-3 concentration in HL60 cells." *International Journal of Medicinal Mushrooms.* 12(1):33–41(2010).

Exotic mushrooms have long been used in Asia for the treatment and prevention of diseases, including infections, due to their capacity to modulate immunity. However, their effect on the production of antimicrobial peptides alpha-defensins 1-3, an important component of innate immunity, has not been previously investigated.

Alpha-defensins 1-3 (α-defensins 1-3) are cationic short peptides primarily synthesized by neutrophils and therefore are called human neutrophil peptides 1-3. Neutrophils, the most predominant phagocytes in the blood of mammals, play a crucial role in innate immunity because they participate in pathogen killing through the production of various toxic factors, including α-defensins.

The investigators measured α-defensins 1-3 by ELISA in cell lysates of promyelocytic HL60 cells incubated with 0–10 µg/mL extracts of *Agaricus bisporus* (white strain and portabella), *Grifola frondosa*, and *Lentinus edodes* (prepared by ethanol precipitation), with and without lipopolysaccharides (2.5 µg/mL LPS), for 48 h. In LPS-treated and untreated cultures, the extracts increased cellular alpha-defensins levels by 131%–350% ($p < 0.05$, ANOVA). Boiling mushrooms for 10 or 30 min did not abrogate alpha-defensins induction, suggesting that the bioactive active compounds are heat stable. The mechanism of α-defensins 1-3 upregulation has yet to be investigated. The investigators speculate that it is unlikely related to higher HL60 cell proliferation because mushroom extracts reduced 3H-thymidine uptake by up to 66% ($p < 0.005$). It also was not due to endotoxin because the levels were low (<0.06 EU/mL) and LPS did not increase α-defensins. This is the first time that culinary-medicinal mushrooms are shown to modulate α-defensins 1-3 production and data suggest that the induction of α-defensins 1-3 may contribute to the protective effect of mushrooms from infection.

Induction of α-defensins 1-3 may contribute to the protective effect of mushrooms from infection.

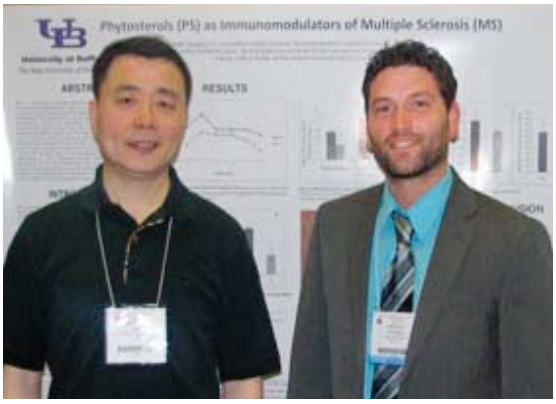
▶ Dietary mushroom intake, breast cancer risk and hormone receptor status in Korean women

Shin A, Kim J, Lim SY, et al. "Dietary mushroom intake and the risk of breast cancer based on hormone receptor status". *Nutr Cancer.* 2010 May 62(4):476-83.

This study evaluated the association between mushroom intake and the risk of breast cancer according to hormone receptor status among Korean women. Mushroom intake and breast cancer risk were examined among 358 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 (odds ratio [OR] = 0.35, 95% confidence interval [CI] = 0.13-0.91 for the highest vs. the lowest quartile intake). The association was stronger for premenopausal women with estrogen receptor (ER)+/progesterone receptor (PR) + tumors (OR = 0.30, 95% CI = 0.11-0.79 for the highest vs. the lowest quartile intake) than those with ER-/PR- tumors. Results suggest that high consumption of mushrooms might be related to lower risks for breast cancers among premenopausal women; this association may be more robust among women with hormone receptor positive tumors.

Mushroom industry research presented at Experimental Biology

Over 10,000 scientists in the fields of nutrition, anatomy, physiology, biochemistry, molecular biology, pathology, pharmacology and immunity attend the annual meeting of the Federation of American Societies for Experimental Biology (FASEB or Experimental Biology). Most of these scientists represent university and academic institutions, government agencies, nonprofit organizations and private corporations.



At the April 24-28 meeting, held in Anaheim, California, researchers presented several studies funded by the mushroom industry. In addition, the Australian Mushroom Growers Association and the U.S. Mushroom Council (Council) helped sponsor the nutritional immunology research section student presentations. In the photo, Dr. Dayong Wu, Chair of the Nutritional Immunology Research Interest Section, congratulates Michael Valerio, State University of New York at Buffalo, who won the student competition with his research on phytosterols as immunomodulators of multiple sclerosis.

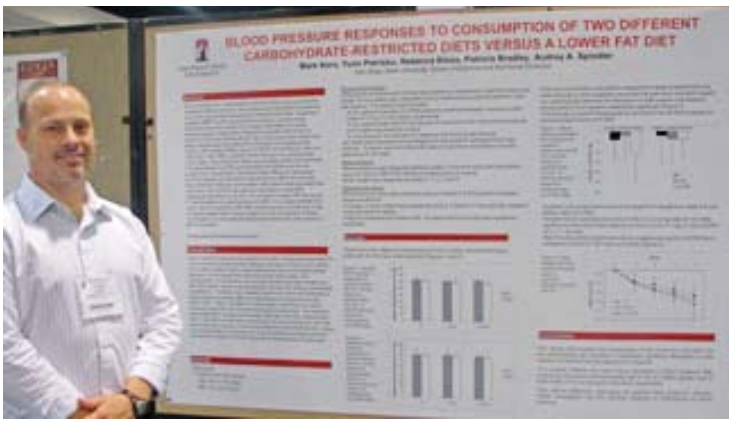
To raise its profile in the nutrition science community and among members of the American Society for Nutrition (ASN, a sponsoring organization of Experimental Biology), the Council joined Experimental Biology as a Sustaining Member for 2010. Membership enables the Council to increase awareness of the depth of its nutrition research and resources to this influential group of scientists. One issue of *Nutrition Notes Daily*, the newsletter distributed during

Experimental Biology, contained 3 pages of information on mushroom nutrition and research. Bart Minor, Mushroom Council President commented: "Recent Mushroom Council research has revealed exciting findings related to a variety of health topics, including breast and prostate cancer, immunity and vitamin D insufficiency. Working with ASN will foster the exploration of further research with mushrooms, one of nature's hidden treasures."

The following research projects funded by the Mushroom Council/industry were presented at Experimental Biology and appear in print in the *FASEB Journal*.

"Blood pressure responses to consumption of two different carbohydrate-restricted diets versus a lower fat diet." Mark Kern (in photo), Yumi Petrisko, Rebecca Kloss, Patricia Bradley, Audrey Spindler. School of Exercise and Nutritional Sciences, San Diego State University, San Diego, California. *FASEB J.* LB 343.

During weight loss, carbohydrate-restricted diets produce favorable metabolic effects; however, few studies have evaluated the potential role of the type of food consumed in these fat-rich diets. Eighteen obese subjects (BMI=30-38) consumed three diets in a randomized, balanced cross-over design for 4 weeks separated by 4-week washout periods.



Diets provided 1600 kcals for women (n=14) and 2200 kcals for men (n=4) to promote weight loss. Diets included approximately 61% of energy from carbohydrate (CHO), 18% protein (PRO), and 21% fat for the low fat (LF) diet and 10% CHO, 30% PRO, and 60% fat for the very low carbohydrate (VLC) diets. One of the VLC diets was primarily plant and mushroom (170 g/d) based (VLCPM) and the other provided more fat and protein from animal foods.

Significant main effects for decreased ($p<0.05$) systolic and diastolic blood pressures (BPs) for the trials were detected. Post-hoc examination with paired t-tests revealed that only within the VLCPM trial were the decreases in both BPs statistically significant ($p<0.05$). The change in systolic BP during the LF diet bordered on significance ($p=0.065$). It is unclear whether the more robust decreases in BP after consuming the VLCPM diet is due to slightly greater loss of body weight or a diet component. Further investigation into the potential influence of plants and mushrooms on BP is warranted.

"Vitamin D2-enriched mushrooms stimulate innate immunity in LPS-challenged rats." U.S. Babu, L.H. Garthoff and M.S. Calvo, Office of Applied Research and Safety Assessment, U.S. Food and Drug Administration, Laurel, Maryland. *FASEB J.* 24: 332.3

The researchers investigated whether higher vitamin D2 content of UVB exposed edible mushrooms is bioavailable and functional in modulating innate immune response in rats acutely challenged with lipopolysaccharide (LPS). Three hundred weanling female rates were fed 1 of 5 diets for 10 weeks all based on AIN93G to contain:

1. Control levels of vitamin D
2. No vitamin D
3. No vitamin D plus 5% unexposed mushrooms
4. No vitamin D plus 2.5% UVB exposed mushrooms
5. No vitamin D plus 5% UVB exposed mushrooms

After vitamin D analysis, dry powdered mushroom was added at the expense of non-nutritive fiber. At 10 weeks, the rats were challenged with either saline as the control or LPS. Necropsies were performed at 3, 24 and 72 hours when spleen cells were evaluated for changes in natural killer cell activity (NK). NK activity was assessed by ^{51}Cr release assay using YAC-1 cells as target cells and rat splenocytes as the effector cells. Independent of the saline or LPS challenge, NK activity was higher in rats fed the highest level (5%) of vitamin D enhanced mushrooms compared to the control fed or vitamin D deficient diets with 5% unexposed or no mushrooms. Based on the findings, the researchers maintain that vitamin D2 from UVB exposed white button mushrooms is bioavailable and effectively functions in innate immunity to stimulate NK activity in a rat model.

Vitamin D2 from UVB exposed white button mushrooms is bioavailable.

"Differential effects of white-button and shiitake mushroom-fortified diets on liver fat content in C57BL/6 female mice." Lawrance Christopher, Djibril Traore and Solo Kuvibidila, Department of Nutritional Sciences, College of Human Environmental Sciences, Oklahoma State University, Stillwater, Oklahoma. *FASEB J.* 24:335.7.

Shiitake mushrooms (SM) are frequently used in Asia for treatment/prevention of chronic diseases and reduction of blood cholesterol. The mechanisms of reduced blood cholesterol are unknown and may involve impaired synthesis or release to blood.

Previously the researchers observed that 5% SM-fortified diet increased IL-6 plasma levels in DBA mice. Considering IL-6 plasma levels are usually elevated in fatty liver disease, the investigators assessed the effect of a SM-fortified diet on liver fat content. Two month-old C57BL/6 female mice were fed control, SM or white button mushrooms (WBM)-fortified diets (5%) for 6 weeks (n=9). At euthanasia, livers were removed and stained with Hematoxyline & Eosin. Oil O Red, PAS staining and Trichrome staining were done to demonstrate the presence of fat droplet, glycogen content and fibrosis respectively.

Shiitake mushrooms may decrease blood lipid by blocking liver fat release – but the health implications of increased liver fat requires more research.

SM and WBM had no effect on liver weights. Compared to WBM and control groups, mice fed the SM-fortified diet showed significant increased number of vacuolated hepatocytes suggesting fatty liver ($p<0.05$). Oil O red staining confirmed the presence of fat droplets. SM did not induce fibrosis or affect glycogen content. WBM increased glycogen but not fat content. Data suggest that one of the mechanisms by which SM decrease blood lipid is likely by blocking liver fat release. The long term health implication of increased liver fat by SM requires further investigation.

News from Canada - Elizabeth O'Neil

▶ Canadians are at high risk for vitamin D deficiency

Researchers have estimated the economic burden and premature deaths due to vitamin D deficiency in Canada. Canadians are at high risk for vitamin D deficiency as most of the population lies north of 43°N., making producing vitamin D from solar exposure nearly impossible for 4-5 months of the year. The Canadian diet provides about 5 µg (200 IU) from food – insufficient to maintain serum 25-hydroxyvitamin D levels [25 (OH)D] in the 100 nmol/L range compatible with health benefits. Canadian health survey data indicates that Canadians aged 6-79 years have a mean annual serum 25(OH)D level around 67 nmol/L. About 5% of the population is at or below with severe deficiency. Low levels of vitamin D have been linked to many conditions beyond osteoporosis, including some types of cancer, autoimmune diseases, and cardiovascular disease.

Low levels of vitamin D have been linked to many health conditions.

The researchers sought to estimate how the economic burden of disease could change if the mean serum 25(OH)D levels of Canadians was increased from 67 to 105 nmol/L. Noting the limited number of randomized controlled trials, the investigators nevertheless suggest that the death rate could fall by 37,000 deaths (range 22,300-52,300) representing 16.2% of annual deaths (range 9.7–22.7%). The economic burden could fall about 7% or about $14B.

Canadian health organizations have begun recommending higher vitamin D intake from supplements – 1,000 IU a day during the fall and winter; and adults at higher risk of having lower vitamin D levels should have intake levels of 1,000 IU year round.

The article by Grant, Schwalfenberg, Genuis and Whiting appeared in *Molecular Nutrition and Food Research* 2010; 54:1-10.

News from Australia - Glenn Cardwell

▶ Healthy Food & Lifestyle Show Melbourne

The Healthy Food and Lifestyle Show (HFLS) held early April in Melbourne was another great opportunity to promote mushrooms and their nutritional and health benefits to around 17,000 members of the public that attended. The enthusiasm from the public was quite overwhelming at times as they clamoured for a taste of mushrooms with Brazilian spice mix, taking recipes, joining the Mushroom Lovers Club and asking many questions. The most frequent comment was: "I love mushrooms", - they would then point to their favourite mushrooms and recount their favourite way to prepare them. Quite a few people stated that they were vegetarian or vegan and this was their reason that they were eating more mushrooms.

Three days at the Health Food and Lifestyle Show was a resounding success in promoting mushrooms and their health benefits to the public.

During the three days of the show 710 people joined the online Mushroom Lovers Club (www.mushroomloversclub.com.au). Each evening we drew out a winner for the daily prize of the George Foreman grill, including an AMGA cookbook, a mushroom bag and some barbecue tongs.

The aroma of stir-fried mushrooms and Brazilian spice mix permeated the exhibition hall and attracted many visitors. Consumers enjoyed sharing their favourite ways to cook mushrooms, learning about the different types of mushrooms and picking up recipe leaflets.

Australian Mushroom Growers Association (AMGA) dietitian, Glenn Cardwell, gave two 40 minute presentations to the public. These were well attended by enthusiastic mushroom lovers, who asked lots of questions after the seminar, which drove more people to our cooking demonstrations and information booth. We had over half a dozen dietitians attend these seminars, many of them commenting that they had learned quite a lot about mushrooms. Of course, the story about mushrooms and vitamin D is the one that always quickly gets their attention. When one dietitian realised that mushrooms can have high levels of vitamin D she asked: "What other vegetables have vitamin D?" This suggests that we have still a long way to go in educating health professionals about where mushrooms fit in both biology and nutrition. On the other hand, one nurse knew that mushrooms had vitamin D because she was involved in the regular vitamin D testing of many patients.

In addition to the cooking demonstration at the AMGA booth, chef Caroline Westmore also gave three very popular cooking shows over the three days highlighting recipes from our mushroom cookbook. The AMGA stand was one of four booths that offered freshly cooked food. The aroma meant that many people just followed their nose to our booth.

▶ Public Health Association of Australia conference presentation, Canberra 21 April 2010

AMGA dietitian, Glenn Cardwell, was given a wonderful opportunity to present at the Public Health Association of Australia national conference in Canberra. Key policy makers and opinion leaders from around Australia attended and heard that the mushroom has nutrient characteristics that differ to vegetables.

A brief description of Australian research on the B12 content of button mushrooms led to a more detailed account of local and international research regarding the influence of light on the vitamin D content of mushrooms. This generated many questions on the bioavailability of mushroom vitamin D and when these mushrooms would be available from retail outlets. The interest in the uniqueness of the mushroom was very encouraging.

Health policy makers hear how mushrooms can provide the daily needs of vitamin D.

It was a delight to have Dr Min Zhang (photo at right) from the University of Western Australia present a poster on her research on breast cancer risk in

women consuming mushrooms and green tea. Her research had generated a lot of media interest last year (*Int J Cancer* 2009; 124: 1404-1408).

News from the United States - Heidi Gengler

▶ Expert sheds light on mushrooms and vitamin D

As mushrooms are the only item in the produce aisle to contain the "sunshine vitamin", and one of the only food sources, the U.S. Mushroom Council partnered with a leading global vitamin D expert, Dr. Michael Holick, to educate consumers and health influencers about the connection between mushrooms and vitamin D. On April 1, Dr. Holick released his latest book, *The Vitamin D Solution: A 3-Step Strategy to Cure Our Most Common Health Problem*. Founded on more than 30 years of research, Holick's plan for rebuilding and maintaining optimal D levels combines a sensible amount of sun exposure, supplementation, and foods rich in vitamin D – mushrooms in particular.

The Council is working with Dr. Holick as a resource for health editors and reporters across broadcast, print, online and social media outlets. In a preliminary interview with the *New York Times* magazine, Holick identified mushrooms as a source of vitamin D. Future plans outside traditional media include a radio tour, guest blog columns on the MushroomChannel.com, and interactive polls and contests related to vitamin D hosted Facebook and Twitter to engage consumers.

Mushrooms are the only item in the produce aisle to contain the "sunshine" vitamin.

Additionally, over the next few months, Dr. Holick will attend 14 professional conferences to discuss the importance of vitamin D and will be featuring mushroom messaging in his presentations. These conferences, attended by top health professionals, include Experimental Biology, state dietetic association meetings, the Endocrine Society Annual Meeting and the American College of Physicians Annual Meeting.

▶ 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

- Franz Schmaus - Germany
- Francois Marche - France
- Ignace Deroo, Evy Detroch - Belgium
- Jose Antonio Jimenez Hernandez - Spain
- Kent Stenvang - Denmark
- Raymond van Buuren - Netherlands
- Elizabeth O'Neil - Canada