Mushrooms and Health Global Initiative Bulletin

"An ISMS Global Initiative"

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Mary Jo Feeney, Editor info@mushroomsandhealth.com

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Send Us YOUR Ideas and Comments

The Initiative Project Team (Team) welcomes comments about what's happening in your country in mushroom research and communication. In this issue, we showcase the Mushroom Bureau's (United Kingdom) efforts that extend research message on the calorie savings potential of mushroom substitution in diets into cost saving ingredient substitutions in recipes. Send examples of how you are using information in the *Bulletin* to the Editor, info@mushroomsandhealth.com. And don't forget, ISMS posts the *Bulletin* on its website so you can refer others to this important resource: http://www.isms.biz/.

Initiative Project Team

- *Greg Seymour*, President, ISMS General Manager AMGA, Australia; Manager, Mushrooms and Health Global Initiative
- *Bart Minor*, President, Mushroom Council, United States
- *William Stevens,* Executive Vice President, Mushrooms Canada
- *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
- *Margo Kraus*, Senior Account Supervisor, Edelman, United States

Mushrooms – the Magic Ingredient

In its July newsletter, the Mushroom Bureau headlined how substituting mushrooms for meat can cut calories, play a role in tackling the obesity epidemic AND help cut the cost of feeding a family of four in the United Kingdom where food inflation is in the double digits.

Research from the Johns Hopkins Bloomberg School of Public Health (Baltimore, MD, USA) discovered that on days in which mushrooms were substituted for meat, study participants consumed on average 420 fewer calories. An important finding was that participants did not compensate for the lower calorie mushroom meal by eating more food later. If consumers made such substitutions regularly every week, they could potentially save 84,000 kJs (20,000 calories) a year – which would be equivalent to slightly more than a 2.3 kg (5 lb) weight loss.

Substituting one food for another in familiar recipes may be more appealing to dieters who find it difficult to make dramatic or restrictive changes in their food choices. Building on this recipe substitution idea, the Mushroom Bureau showed how to cut the cost of an average meal by more than half simply by substituting mushrooms for meat in a variety of classic dishes such as stroganoff, tangines and burgers.

Andrew Middlebrook, chairman of the Mushroom Bureau which is responsible for generic publicity of fresh cultivated mushrooms sold in Britain, shares research information with the Bureau's public relations firm and then uses the scientific and marketing expertise of the Bureau's members to verify accuracy of any statements prior to release. To read the e-newsletter, visit: http://www.mushroom-uk.com/NewResearch.html

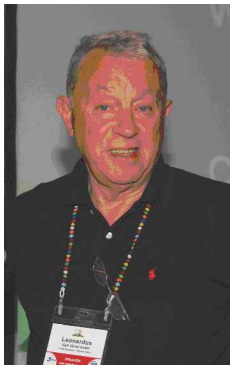
NOTE: The research, "Lack of energy compensation over 4 days when white button mushrooms are substituted for beef" appeared in *Appetite*. 2008;51:50-57. http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6WB2-4R8HHNC-1&_user=10&_coverDate=07%2F31%2F2008&_rdoc=1&_fmt=high&_orig=browse&_sort=d&view=c&_acct=C000050221&_version=1&_url

Version=0&_userid=10&md5=ce99f4e10ad528dd458fbc488343b011.

Pro-oxidative Properties of Medicinal Mushroom Extracts

Glenn Cardwell interviewed Professor Leo Van Griensven at the 17th ISMS International Congress, Cape Town, South Africa. Dr. Van Griensven, faculty at the University of Wageningen, the Netherlands, serves on the Editorial Board of the International Journal of Medicinal Mushrooms.

Prof Leo Van Griensven gave a very insightful presentation at ISMS on the possible reason that mushrooms help to prevent cancer and maintain health. He said that mushroom extracts had proven benefits in the prevention of disease, although mainly in the animal model.



He believed that one of the active compounds in mushrooms was the combination of polysaccharides, such as glucans, and polyphenols. This combination is probably responsible for creating intracellular reactive oxygen species (ROS) that kill both infected cells and cancer cells. He emphasized that ROS are a normal part of cellular metabolism and are important for health.

GC: You said that there has been quite a bit of mushroom research done on laboratory animals, but very little that has been done on humans. Is that likely to change in the near future?

LVG: I certainly hope it is going to be changed. It is easy to work with laboratory animals because the procedures are far easier and the study is much cheaper. Because all these animals are inbred, all the animals are identical, and it easier to get results. But humans, as you know, are outbred and do therefore not obey the results obtained in inbred animals.

GC: As a dietitian I explain to people that many foods have a high antioxidant level, including mushrooms. You have pointed out that pro-oxidant components in foods, like mushrooms, also have a role in human health by encouraging death of abnormal cells.

LVG: That is one of the things that is programmed through the ROS induction with calcium influx into the mitochondria. As a result cytochrome moves out and cells will go into apoptosis (cell death). You want apoptosis if they are cancer cells, but you do not want that if they are healthy cells so there must be a very fine equilibrium that allows the oxidation process to take place within the cell and the antioxidant effect of the polyphenols to counteract that effect.

GC: Your research pointed out that it is the polysaccharides and the polyphenols in mushrooms, working in concert, that were providing the protection against autoimmune disease.

LVG: Yes, this we call immunomodulation and it all depends on recognition by receptors and subsequent signaling events in the cell. I think the complex is recognized by the receptor on the cell wall. It is not just the carbohydrates or the polyphenol. There is a very specific, but not very large, molecule consisting of phenol and carbohydrate.

GC: Many people like to reduce nutrition and health down to single molecules and you are pointing out it is not a single molecule providing the potential benefits.

LVG: It is not a single molecule because you can easily demonstrate that the polysaccharides on their own have no effect, that phenols on their own have no effect, apart from being an antioxidant, but in immunomodulation, and where ROS plays an important role for apoptosis, you need them working together.

Mushrooms the Hidden Superfood

A symposium at the Institute of Food Technologists 2008 Annual Meeting and Food Expo (New Orleans, LA, USA) focused on the bioactive components of mushrooms of nutritional or medicinal importance in functional foods. The session included four presentations:

- Beta-glucans and chitin in cultivated mushrooms and their potential importance to human health; Lana Zivanoivic, University of Tennessee, Knoxville

- Anti-carcinogenic compounds in cultivated mushrooms, Shiuan Chen, Beckman Research Institute, City of Hope, Duarte, CA
- Ergothioneine and polyphenols as important antioxidants in cultivated mushrooms, Joy Dubost, PepsiCo, Valhalla, NY
- Overview of nutritional composition of cultivated mushrooms with emphasis on potential for enrichment with selenium and ergocalciferol, Robert Beelman, Penn State University, University Park.

(For more information, see: http://www.newswise.com/articles/view/542247)

Breast and Prostate Cancer Clinical Trials

After showing that mushroom extract slows breast cancer growth in mice, City of Hope, Duarte, CA researchers are taking findings about mushrooms' cancer-fighting properties from the lab to clinical trials.

In June, Team members Seymour, Minor and Feeney visited Shiuan Chen, PhD, Director, Surgical Research, City of Hope to discuss two clinical trials: Phase I Breast Cancer Prevention Study with White Button Mushroom Extract; and Phase Ib Trial of Mushroom Powder in Biochemically Recurrent, Hormone Naïve Prostate Cancer. The Australian Mushroom Growers Association and the Mushroom Council along with other health organizations are funding these studies.

Dr. Shiuan Chen (bottom right)
G. Seymour, B. Minor, and M.J. Feeney along with Dr. Chen's team.

Chen's initial work with mushrooms began with his lab's discovery that compounds in mushrooms – subsequently identified as conjugated linoleic acid – suppressed the effects of aromatase, and enzyme responsible for estrogen conversion in the body. Blocking aromatase reduces circulating estrogen levels among postmenopausal women – important because about 75 percent of postmenopausal women with breast cancer have tumors that depend on estrogen to grow.

"We've seen that aromatase-inhibiting drugs are helpful in preventing recurrence in postmenopausal women with breast cancer," said Melanie Palomares, M.D., M.S., a member of Chen's team and assistant professor of medical oncology and population sciences, "and breast cancer survivors were found to develop fewer new breast cancers too."

Physicians currently recommend that postmenopausal women with hormone-responsive breast cancer take these drugs for two to five years. However, "At the end of this period, women can feel unsure about what to do next," Chen said. "If mushrooms can reduce (the) risk, perhaps we can tell them to eat mushrooms instead."

This is the idea behind the phase I clinical trial led by Palomares, which will recruit 24 postmenopausal breast cancer survivors diagnosed with breast cancer five or more years ago and who remain free of disease. Participants will be randomly assigned to take between five and 13 grams of freeze-dried white button mushrooms in tablet form daily for 12 weeks.

Researchers will monitor aromatase activity and female hormones in participants, as well as levels of conjugated linoleic acids, a group of compounds in the mushrooms that appear to be responsible for their anticancer properties. They also will study effects on the immune system, cholesterol and bone health, and monitor eating habits during the trial.

The second trial will investigate mushrooms' potential in prostate cancer under the direction of Przemyslaw W. Twardowski, M.D. According to Dr. Twardowski, physicians have no clear answer on how to treat men who were treated for prostate cancer and appear to be cancer-free on imaging scans, but whose prostate-specific antigen (PSA) levels have begun to rise. Cancer usually returns in these patients.

Laboratory research has shown that mushroom extract can lower levels of 5-alpha reductase, an enzyme linked to male hormones involved in prostate cancer. "There

is much interest in a natural product that could intervene in this early stage and at least delay the need for other toxic therapies," Twardowski said.

Researchers plan to monitor aromatase activity, male hormone levels, levels of conjugated linoleic acids and other substances, as well as effects on the immune system. They also potentially may check for circulating tumor cells in the blood.

Dr. Chen and his team are proud that these studies are translating research into clinical practice by involving the community in recruitment - with the potential of having a much larger impact on health promotion and disease prevention worldwide.

Read more about mushrooms' cancer fighting potential in an article by Alicia Di Rado in the City of Hope *HopeNews*: http://www.cityofhope.org/about/publications/hope-news/2008-vol-3-num-19-june-16/Pages/researchers-study-mushrooms-cancerfighting-potential.aspx.

UV & Vitamin D_2
Commercial Processing Research

Mushrooms, a source of ergosterol which is converted to vitamin D_2 on exposure to light – can help consumers meet current – an anticipated higher – requirement levels for this important nutrient (See "Linking Research to Production: Mushrooms and Vitamin D" MHGI Bulletin #2, May 2008 http://www.isms.biz/MHGIBulletinMay_08.pdf). Research is discovering ways mushroom producers can develop commercial-scale ultraviolet treatment (UV) processes to produce mushrooms with vitamin D and thus contribute to consumer's health while adding value to their crop.

Although the literature[1,2,3] has described the conversion of ergosterol to D_2 by exposure to ultraviolet light, some conditions – particularly time of exposure – have not been considered conductive to commercial adoption. More recently, results from research conducted in Canada, Korea and the U.S. help answer some of the questions on how to control for or minimize some the variables that can affect the target level of vitamin D_2 contained in a serving of mushrooms. These variables include not only the variety of mushroom (*agaricus*, shiitake, oyster, enoki), size, form (whole, sliced) and orientation to the source of UV; but also the amount of ergosterol initially present in the mushroom, time of harvest and time to market. Other variables relate to the UV technology used, the intensity (wattage of bulbs, number of bulbs, lifetime use of the bulbs, distance of the bulbs to the mushrooms) and exposure time.

Research at the Guelph Food Technology Centre (GFTC) studied the dose (Dosage is expressed as (J/cm^2) = Intensity ($mWcm^2$) x Time) to deliver a target level of 10 μg vitamin D_2 per 100 g serving of white or brown (*agaricus* strain) mushrooms. The investigators also measured D_2 degradation over time; conducted sensory evaluation (taste) and microbial tests.

Although it is still difficult to control vitamin D_2 at precise levels, results suggest that:

- The target level of vitamin D_2 (10 μg or 400 IU per 100 gram) can be reached at a low dosage of UVB exposure of approximately 0.1-0.3 J/cm^2
- This UVB dose can be applied at a relatively low intensity (0.8-1.8 mW/cm^2) in 1-3 minutes
- Vitamin D_2 levels fluctuate on storage but the target level can be maintained
- There was no detectable sensory difference between UV treated and untreated white and brown mushrooms.

This GFTC research is anticipated to be published in *Mushroom World* and *Mushroom News.* In addition, copies of the report may be requested from the Canadian Mushroom Growers' Association: cmga@sentex.net.

Research in Korea investigated the effect of UVB on D_2 in shiitake and white button mushrooms. Results suggest that exposing slices of white button mushrooms was a more efficient way to increase vitamin D_2 content than exposing the gill or pileus of whole mushrooms because of the extensive surface area exposed.[4]

Research by the Processed Foods Research Unit, United States Department of Agriculture Agricultural Research Service (USDA-ARS) investigated the effects of UVB treatment of Portabella mushrooms at three intensities (0.5,

0.75 and 1.0mW/cm^2), three doses (0.5, 1.0 and 1.5J/cm^2) and two post-harvest times (1 and 4 days) on D_2 formation and degradation during storage.

Results suggest that within each intensity application, dose had the largest effect where exposure converted more ergosterol to D_2.[5] This study suggests that mushroom producers and processors have some flexibility after harvesting in when to expose mushrooms to UV light. Mushrooms that were treated with UVB one or 4 days post harvest did not differ significantly in D_2 formation. In addition, there was no difference in the retention of vitamin D_2 after two days in refrigerated storage following UV treatment between three day old mushrooms (1-day post-harvest plus 2-days storage) and 6-day old mushrooms (4 day post-harvest treatment plus 2-days storage).

Over 100 percent of the Daily Value (10µg or 400 I.U. in the United States) was present after four days of storage.

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[1] Mau, J.-L. et al. Ultraviolet irradiation increased vitamin D content in edible mushrooms, J. *Agric. Food Chem*. 1998. 46:5269-5272.
[2] Jasinghe, V.J. and Perera, C.O. Distribution of ergosterol in different tissues of mushrooms and its effect on the conversion of ergosterol to vitamin D2 by UV irradiation. *Food Chem.* 2005. 92:541-546.
[3] Jasinghe, V.J. and Perera, C.O. UV irradiation: The generator of vitamin D2 in edible mushrooms. *Food Chem.* 2006. 95:638-643.
[4] Ko, J.A. et al. Effect of UV-B exposure on the concentration of vitamin D2 in sliced shiitake mushroom (Lentinus edodes) and white button mushrooms (Agaricus bisporus). *J Agric Food Chem* 2008. May 28;56(10)3671-4.
[5] Roberts, J.S., et al. Vitamin D2 formation from post-harvest UV-B treatment of mushrooms (Agaricus bisporus) and retention during storage. *J. Agric. Food Chem.* 2008 Published on the web June 4, 2008.