



Nutrition Research Summit



Agenda

- Overview and history of Mushroom Council research investments
- Current research update: 3 mushroom nutrition studies
- Expert roundtable: current consumer nutrition landscape and top opportunities for future mushroom nutrition research and promotion

Over 50 Studies | ~\$6M Invested

2001-2005

Composition analysis,
preclinical studies on
immune function

2005-2019

Weight/satiety
Sensory substitution
and nutrient benefits
UV technology

2019-2024

Food pattern
modeling, clinical
trials on health
promotion, immunity,
cognition, and
bioactive analysis

Expert **G**uests

Research Advisory Panel

- Roger Clemens, DrPH
- Tanya Ditschun, PhD
- Johanna Dwyer, DSc, RD
- Mark Wach, PhD

Invited Experts

- Katherine Phillips, PhD
- Wayne Campbell, PhD
- Barbara Shukitt-Hale, PhD
- Leslie Bonci, MPH, RDN, CSSD, LDN, FAND





Components of Successful Nutrition Research Programs

1. **Composition**
Analysis of nutrients and bioactives

2. **Consumption**
Preclinical and clinical studies to demonstrate benefits and health outcomes

3. **Communication**
Communication of results to increase collaborative opportunities among other researchers, institutions, organizations and government entities to attract funding thereby enhancing the body of scientific evidence supporting consumer messaging

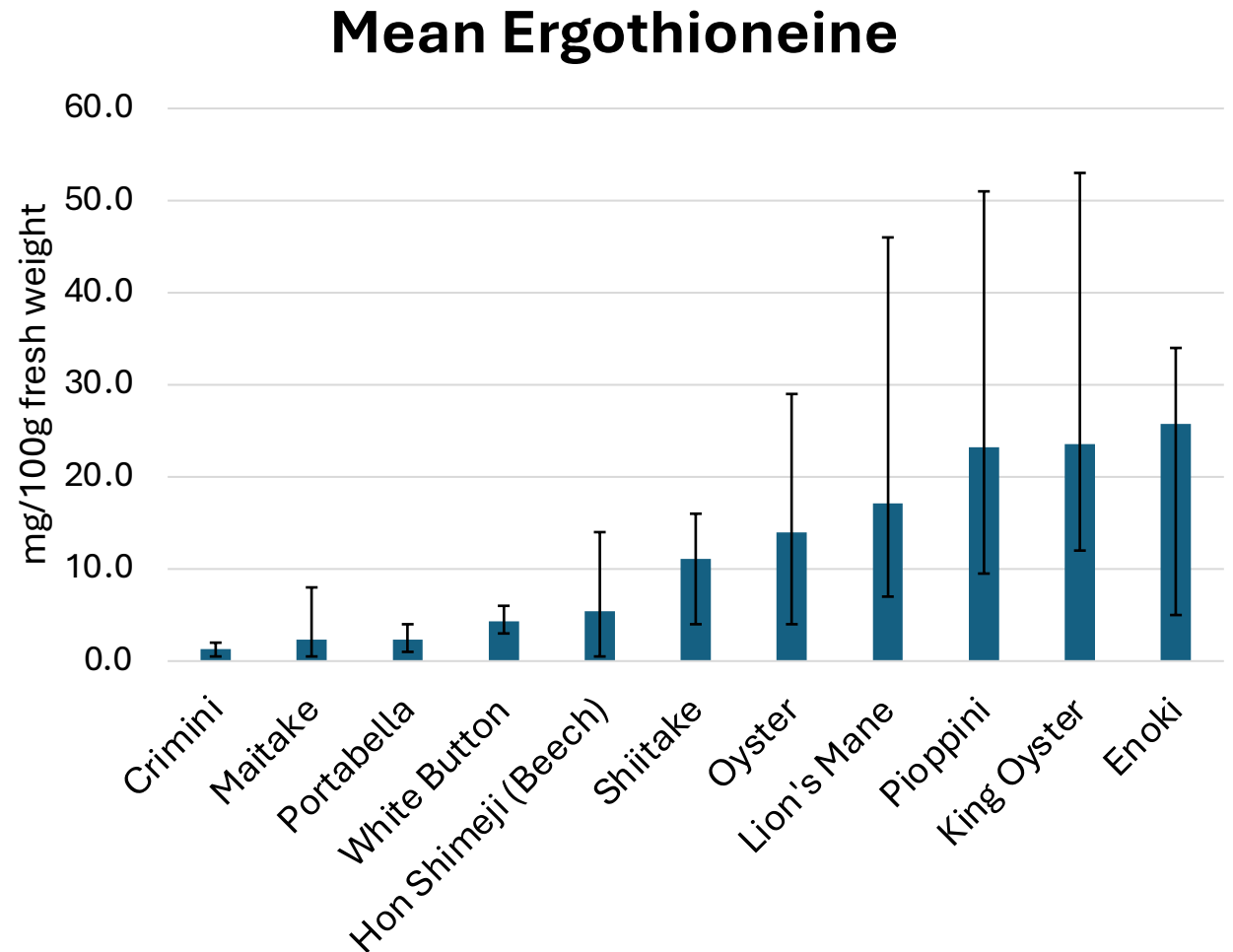
Current Research Update

- **Bioactive analyses** – Katherine Phillips, Virginia Tech
- **Role in health promotion** – Wayne Campbell, Purdue University
- **Role in cognition** – Barbara Shukitt-Hale, Tufts University USDA Human Nutrition Research Center and Claire Williams, University of Reading



Ergothioneine in 11 Types of Mushrooms

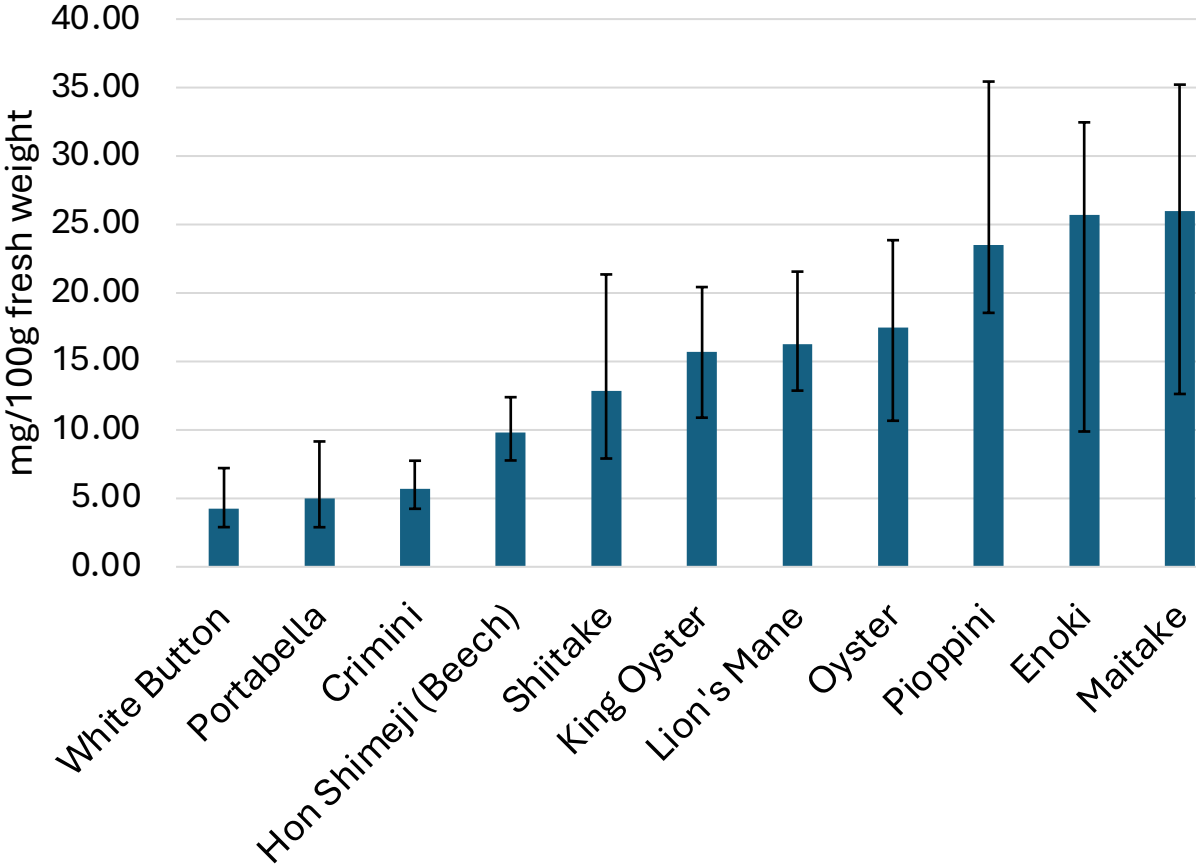
- 8 samples per type (6 per type for *Agaricus* and enoki)
- *Agaricus*, maitake, and Hon Shimeji overall low ergothioneine content relative to others (mean 3.2 mg/100g FW)
- Pioppini, enoki, oyster on average higher (mean 24 mg/100g FW)
- Pioppini and enoki (along with maitake) were also among the mushroom types highest in glutathione
- Range in mean ergothioneine for other mushroom types 11 – 17 mg/100g FW
- Very wide range among individual samples within type (8 - 42 mg/100g FW) for all but *Agaricus* (range ≤ 3 mg/100g FW)
- Average ergothioneine content by mushroom type other than *Agaricus*, based on limited sampling, may not accurately reflect the content in any given sample



Glutathione in 11 Types of Mushrooms

- 8 samples per type (6 per type for *Agaricus* and enoki)
- *Agaricus* overall low relative to others (mean 5 mg/100g FW)
- Pioppini, enoki, maitake on average higher (mean 25 mg/100g FW)
- Range in mean glutathione for other mushroom types 10 – 17 mg/100g FW
- Very wide range among individual samples within type: 9 – 23 mg/100g FW for all but *Agaricus* and Hon Shimeji (range <5 mg/100g FW)
- Average glutathione content by mushroom type, based on limited sampling, may not accurately reflect the content in any given sample

Mean Glutathione



The Unique Properties of Dietary Mushrooms and Their Effects on Indexes of Human Health

Wayne Campbell, PhD, Purdue University

Metabolomics Profiling Cardiometabolic Disease Risk Factors Brain Health and Cognitive Function

Total Compounds			
Mushroom Variety	Total Detected*^	Total annotated	Not annotated
Detected in all 7	1344	520 (39%)	824 (61%)
UNIQUE TO:			
White button	62	13 (21%)	49 (79%)
Crimini	29	4 (14%)	25 (86%)
Portabella	128	13 (25%)	115 (75%)
Lion's Mane	854	211 (30%)	643 (70%)
Maitake	692	206 (19%)	486 (81%)
Oyster	674	126 (10%)	548 (90%)
Shiitake	472	126 (27%)	346 (73%)
Sum	4255	1219 (29%)	3036 (71%)

*Includes hydrophobic and hydrophilic fractions
^After filtering for presence in 4 of 6 replicates

An Assessment of Mushroom Consumption on Cardiometabolic Disease Risk Factors and Morbidities in Humans: A Systematic Review

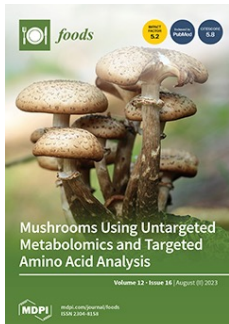
Uffelman, et al. *Nutrients*, November 2023

Consuming Mushrooms When Adopting a Healthy Mediterranean-Style Dietary Pattern Does Not Influence Short-Term Changes of Most Cardiometabolic Disease Risk Factors in Healthy Middle-Aged and Older Adults

Uffelman, et al. *J Nutr*, February 2024

Effects of Consuming White Button and Oyster Mushrooms within a Healthy Mediterranean-Style Dietary Pattern on Changes in Subjective Indexes of Brain Health or Cognitive Function in Healthy Middle-Aged and Older Adults

Uffelman, et al. *Foods*, July 2024



Uffelman, et al.
Foods, August 2023

A review of the effects of mushrooms on mood and neurocognitive health across the lifespan

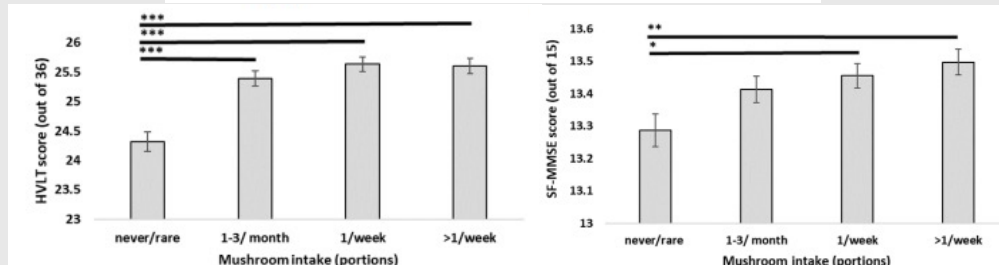
Sara Cha ^a, Lynne Bell ^a, Barbara Shukitt-Hale ^b, Claire M Williams ^a

Show more

- **Significant benefit of dietary patterns that include mushrooms of any species (up to 2 portions/week) on cognition and mood in both healthy and cognitively compromised populations.**
- Intervention trials have, to date, shown mixed results, prompting the need for further acute and chronic human intervention using adequate sample sizes, employing appropriately sensitive neurocognitive tests, and investigating a range of common dietary mushrooms.

The Relationship between Mushroom Intake and Cognitive Performance: An Epidemiological Study in the European Investigation of Cancer—Norfolk Cohort (EPIC-Norfolk)

Sara Cha, Lynne Bell and Claire M. Williams

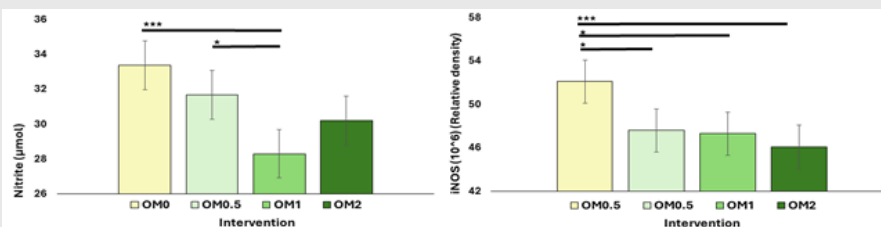
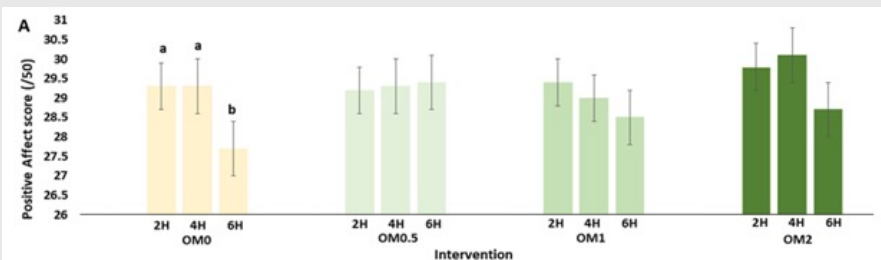
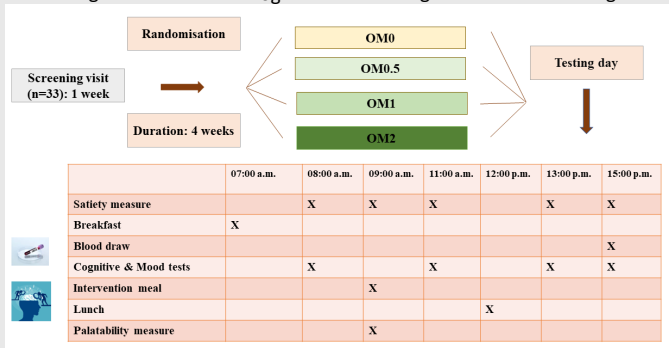


Mushroom consumers displayed better cognitive performance than non-consumers across multiple cognitive domains with those consuming 1 or more portions per week showing the highest cognitive scores.

A randomized controlled study to investigate the acute cognitive, mood and metabolic effects of oyster mushroom intervention in older adults (OYSACO Study)

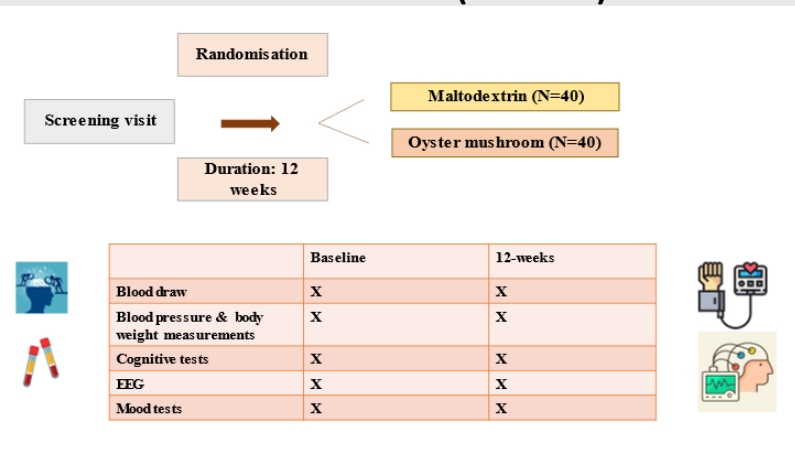


OM0 0g, OM0.5 4.70g, OM1 9.39g, OM2 18.78g



Results show that one portion per day has some benefits, therefore we used this portion in the long-term study.

A randomized controlled trial to investigate the chronic cognitive, mood, anti-inflammatory and metabolic effects of a mushroom powder intervention in older adults (OYSCOG)



This study should provide information on which cognitive domains are most sensitive to mushroom intervention, as well as possible mechanisms behind their beneficial effects. Future studies should explore different clinical populations and species of mushrooms.

Benefits and Biggest Wins

- Mushroom reputation and media coverage
- RDs/experts carrying/amplifying messages
- Key messages approved by USDA



REAL SIMPLE

3 Benefits of Eating Mushrooms—and Recipes to Get You Started

Mushrooms are more than tasty fungi.

By [Melissa Kravitz Hoeffner](#) | Updated on January 17, 2024

🌿 Medically reviewed by [Kristy Del Coro, MS, RDN, LDN](#)



Nutritional Benefits

"Mushrooms are my personal go-to for optimal wellness today, and the nutrients in them help protect against disease risk for tomorrow," says [Pam Smith](#), RDN, president and founder of Shaping America's Plate, In

Mushrooms support cognitive and bone health.

"Fresh mushrooms contain the minerals and phytochemicals that can support [cognitive](#) and [bone health](#)," says Smith, "and are important for feeding the immune system with nutrients such as B vitamins and selenium, [essential antioxidants](#), and in some instances, vitamin D."

Eat This, Not That!

HEALTHY EATING

✓ Expert-Recommended

10 Superfoods Men Should Eat Every Day, Say Dietitians

These superfoods can help combat the risks of heart disease and other diseases common among men.



By Samantha Boesch / Published on September 30, 2023 | 8:30 AM

5. Mushrooms



You may want to start adding mushrooms to your meals, whether it's sautéing them with other vegetables or adding them to your salad, because "Mushrooms are another superfood that can significantly contribute to men's health," says Manaker.

For one, "They are sources of nutrients like vitamin D, selenium, and antioxidants, which are vital for maintaining good health, and the presence of antioxidants in mushrooms aids in reducing the risk of chronic diseases by combating harmful free radicals."

Most opportunistic areas and potential for unique “win”

Benefits Consumers Want from Food

- 43% less fatigue/more energy
- 40% healthy aging
- 37% weight management
- 36% digestive/gut health
- 30% cardiovascular health
- 28% brain health

Other Trends

- 82% consider wellness a top or important priority in their everyday lives
- 55% follow a vegan/vegetarian or plant-based diet to be healthier
- 64% are trying to consume more fiber



Expert Roundtable

As you look at the current consumer nutrition landscape, what stands out as the strongest opportunities for future mushroom research and promotion?



Q&A





Thank You

**For more information,
contact Mary Jo Feeney, MS**

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Research Advisory Panel

Roger Clemens, DrPH, USC Mann School of Pharmacy and Pharmaceutical Sciences Department of Regulatory and Quality Sciences

Dr. Clemens' expertise includes food and drug toxicology, food science, regulations of foods and dietary supplements, and chemical manufacturing controls. Dr. Clemens serves on several editorial boards and as a reviewer for many journals having published more than 80 original manuscripts and commentaries. He is a respected communicator in the nutrition and health arena and has served as an expert panel member for the food industry, scientific organizations, trade associations, and regulatory agencies in the United States, Canada, and Europe. Dr. Clemens received an AB in Bacteriology, an MPH in Nutrition, and a DrPH in Public Health Nutrition and Biological Chemistry from the University of California, Los Angeles.

Johanna Dwyer, DSc, RD , Professor Tufts University Medical School, Adjunct Professor of Nutrition at Tufts University Friedman School of Nutrition Science and Policy

Dr. Dwyer is also Senior Scientist at the Jean Mayer/USDA Human Nutrition Research Center on Aging at Tufts University . She served as Director of the Frances Stern Nutrition Center and Dietetic Internship Director at Tufts Medical Center for many years doing clinical work and studies of diet, chronic disease risk, dietary habits and bioactive constituents in foods resulting in 550 research and review publications. Currently she is also a Senior Nutrition Scientist serving as a contractor to the Office of Dietary Supplements, National Institutes of Health, working on food and supplement ingredient databases and national population-based surveys. Dr. Dwyer has served on the Dietary Guidelines for Americans Committee, many other NIH, USDA and FDA committees, received the Healthy Lion lecture award from the Pennsylvania State University's Department of Food Science. She is a member of the National Academy of Medicine and editor of *Nutrition Today*. Dr. Dwyer received her D.Sc. and M.Sc. from the Harvard School of Public, an MS from the University of Wisconsin and the BS degree with distinction from Cornell University.

Research Advisory Panel

Tanya Ditschun, PhD, DSM Firmenich

Dr. Ditschun is Senior Director of Food Science and Technology at DSM Firmenich with over 20 years of expertise specializing in sensory science in the management of global and matrix-based sensory research projects in flavor and ingredient discovery to support R&D operations including GRAS sensory guidance for new flavor ingredients. She has managed product applications work, including formulations, stability, solubility, quality control, shelf-life testing, and production of samples for sales team demonstrations. Dr. Ditschun received her BSc in food science from the University of Guelph, her MSc and PhD from the University of California Davis.

Mark Wach, PhD, Sylvan Inc.

Dr. Wach currently serves as Chief Innovation Officer for Sylvan International Biotechnology and has over 40 years' experience in the mushroom industry. He directs a multinational team of researchers charged with maintaining Sylvan's position as the premier supplier of mushroom spawn (seed) and related products. In conjunction with this, he has also served in the position of Vice-President and General Manager of Sylvan Bio, a business unit responsible for nutraceutical, pharmaceutical, biopesticide and specialty chemical development and toll manufacturing. Dr. Wach is listed as an inventor on over 10 patents and has authored or contributed to more than 35 scientific publications and countless presentations on mushroom topics both technical and popular. Dr. Wach holds an undergraduate degree in Biology from the University of California at Berkeley, and earned both a Master's degree and Doctorate from Pennsylvania State University.

Investigators Conducting Research

Wayne Campbell, PhD, Purdue University

Dr. Campbell has conducted the largest clinical trials funded by the Mushroom Council investigating the role of mushrooms in cardiometabolic health, inflammation and immunity and brain health using questionnaires and a separate trial on D mushrooms immunity and brain health using questionnaires. He is a Professor of Nutrition Science with advanced training in geriatrics and exercise physiology. He conducts research on healthy eating patterns, protein-rich foods, dietary protein metabolism and requirements, body composition, weight control, and exercise training. Dr. Campbell has served as principal investigator for 50 controlled feeding studies for NIH, USDA, and industry during the past 30 years. Professor Campbell has served as a member of the U.S. federal government 2018 Physical Activity Guidelines Advisory Committee and the 2015 Dietary Guidelines Advisory Committee. Professor Campbell earned Bachelor, Master, and Doctorate degrees in Nutrition Science from the University of Delaware, the University of Maryland, and Tufts University, respectively, and trained as a Post-doctoral Research Scientist at The Pennsylvania State University.

Work currently completed: *Effects of Mushroom Consumption on Cardiometabolic Disease Risk Factors: A Systematic Review of Randomized Controlled Trials.*

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9193450/> : *Metabolomics Profiling of White Button, Crimini, Portabella, Lion's Mane, Maitake, Oyster, and Shiitake Mushrooms Using Untargeted Metabolomics and Targeted Amino Acid Analysis .*

<https://pubmed.ncbi.nlm.nih.gov/37627983/> *Consuming Mushrooms When Adopting a Healthy Mediterranean-Style Dietary Pattern Does Not Influence Short-Term Changes of Most Cardiometabolic Disease Risk Factors in Healthy Middle-Aged and Older Adults*
[https://jn.nutrition.org/article/S0022-3166\(23\)72815-0/fulltext](https://jn.nutrition.org/article/S0022-3166(23)72815-0/fulltext).

Katherine Phillips, PhD, Virginia Tech

Dr. Phillips is a Senior Research Scientist who coordinated the bioactive analysis research on beta glucans, ergothioneine, glutathione and vitamin D on 11 different mushrooms for inclusion in USDA's integrated database FoodData Central. Her lab studies nutrients and phytochemicals in foods and clinical research diets. Dr. Phillips received her Bachelor's degree in Biochemistry, Master's degree in Chemistry, and Doctorate degree in Food Science and Technology at Virginia Tech. In addition to the analyses for FoodData Central, other work with the Mushroom Council includes preparation of a Mixed Mushroom Interlaboratory Control Material which is available to other researchers and studies on increases in vitamin D in mushrooms exposed to sun using a consumer-oriented protocol.

Click on the following link to the FoodData Central database to see the different mushrooms and their nutrient profile: <https://fdc.nal.usda.gov/fdc-app.html#/food-search?type=Foundation&query=mushrooms>. Information on the control material can be found here: <https://www.sciencedirect.com/science/article/abs/pii/S0889157516000041>. Publication on the sun exposure experiment can be found here:

<https://www.researchgate.net/publication/262449985> *A Nutritionally Meaningful Increase in Vitamin D in Retail Mushrooms is Attainable by Exposure to Sunlight Prior to Consumption.*

Investigators Conducting Research

Barbara Shukitt-Hale, PhD Jean Mayer USDA Human Nutrition Research Center on Aging at Tufts University

Drs. Shukitt-Hale and Claire Williams (University of Reading, UK) are investigating the cognitive, neurological, and metabolic effects of oyster mushroom consumption in older adults. Their first study investigated the impact of different doses of oyster mushroom interventions, whilst the current study investigates the effects of 12 weeks regular oyster mushroom intervention on cognition, changes in neural activity through EEG, blood biomarkers of inflammation and levels of brain-derived neurotrophic factor (BDNF) that has an important role in nerve survival and growth. A short-term dose response study with lion's mane mushroom is also planned. Dr. Shukitt-Hale is a USDA Research Psychologist on the Neuroscience and Aging Team investigating motor and cognitive performance changes due to oxidative stress and inflammation and the possible amelioration of these effects with proper nutrition. She received her PhD in Experimental Psychology at Boston University.

Click on the follow link to access work currently completed: *A review of the effects of mushrooms on mood and neurocognitive health across the lifespan*
<https://www.sciencedirect.com/science/article/pii/S0149763424000162?via%3Dihub>

Nutrition Communications Expert

Leslie Bonci, MPH, RDN, CSSD, LDN, FAND, Active Eating Advice

Leslie Bonci is the owner of Active Eating Advice by Leslie, a nutrition consulting company and co-founder of Performance365, a sports nutrition consulting company. Leslie participated in the 2019 Mini-Summit to provide insight into mushrooms' role in sports nutrition. A former spokesperson for the Academy of Nutrition and Dietetics, Leslie is a sought-after industry spokesperson. She was the sports dietitian for the three time Superbowl champions Kansas City Chiefs for 10 years and was the sports dietitian for the Pittsburgh Steelers (21 years), Pittsburgh Penguins, Pittsburgh Pirates, Toronto Blue Jays, and Washington Nationals. She was the sports nutritionist for the Pittsburgh Ballet Theater and an adjunct instructor in the school of dental medicine at the University of Pittsburgh. Leslie is the author of several books on nutrition in addition to authoring chapters for sports medicine and sports nutrition texts. Leslie's undergraduate degree is in Biopsychology from Vassar College and her MPH is in Nutritional Epidemiology from the University of Pittsburgh.