

Ergothioneine in Mushrooms-Nature's Best Source of a New Human Vitamin?



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L-ERGO

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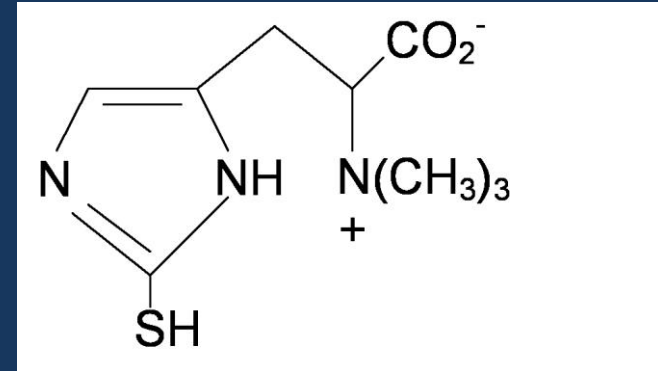
History

- L-ergothioneine (ERGO) is a naturally occurring dietary antioxidant whose name is derived but the fact that it was first identified in the sclerotia of the ergot fungus (Tauret, 1909)
- Ergo is not synthesized by higher plants or animals but is taken up from the soil by various plants and then is consumed in the diet by animals (Melville, 1958; Audley and Tan, 1968)
- ERGO is biosynthesized only by fungi and mycobacteria (Melville, 1958)

History

- ERGO became a popular focus of study when it was discovered in red blood cells of animals (Hunter, 1928)
- Due to its accumulation in the erythrocytes and its natural antioxidant properties, ERGO was proposed as a possible therapeutic treatment for red blood cell disorders which were predisposed to oxidative damage (Hartmen et al, 1988)

L-ergothioneine (ERGO)

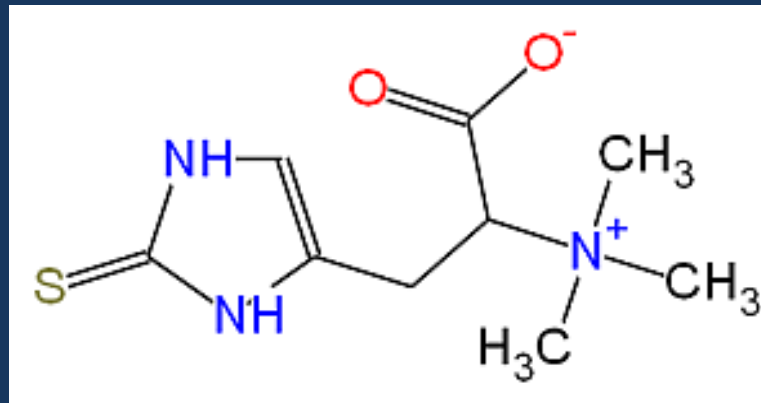


- Unique antioxidant and cellular protector found in the body
 - scavenger and quencher of strong oxidants
 - may have physiological effects in many of the inflammatory diseases
 - has its own unique transport system in mammals
(Grundemann et al., 2005)
- Cannot be synthesized by humans and is only available from dietary sources
- Produced only by fungi and a few mycobacteria
- Concentrated in mushrooms

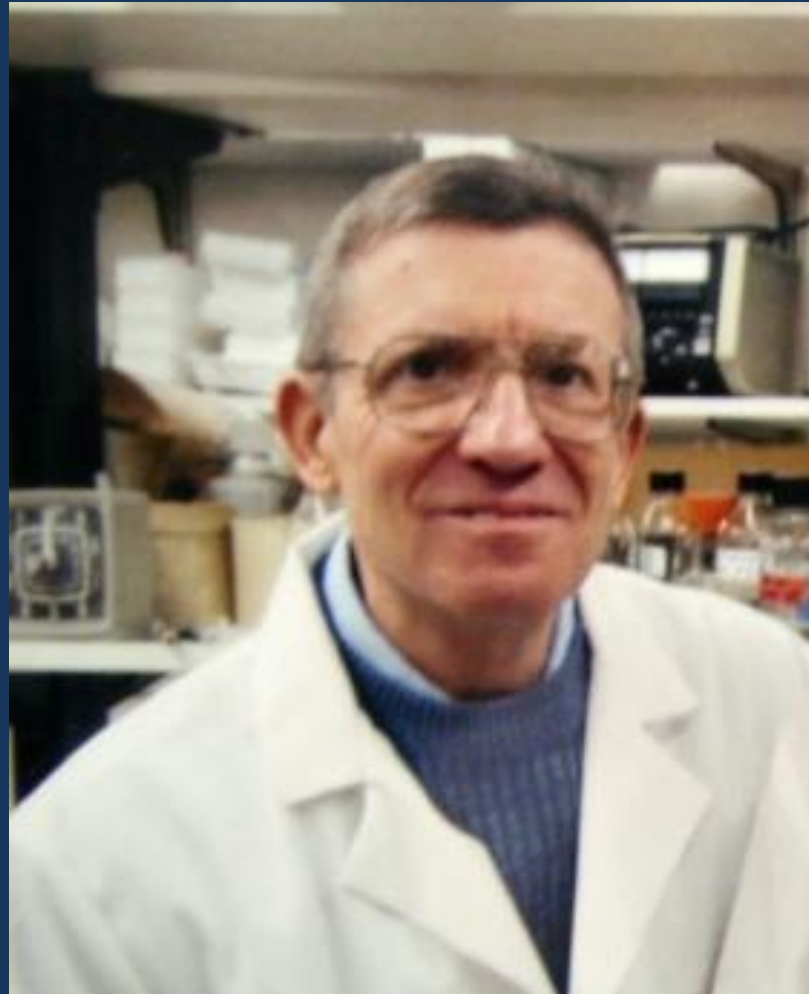
- “The existence of a specific transporter suggests that ERGO is advantageous to our long-term health”
- “The primary function of ERGO can be considered as protecting erthrocytes against damage related to ferryl hemoglobin”
- “a lack of ERGO may represent a precipitating factor in the genesis of chronic inflammatory diseases”
- “supplementation of ERGO could provide a new therapeutic strategy for chronic inflammatory diseases.”

ERGO Is A Very Stable Antioxidant

- ERGO mainly exists in the thione form in aqueous solutions

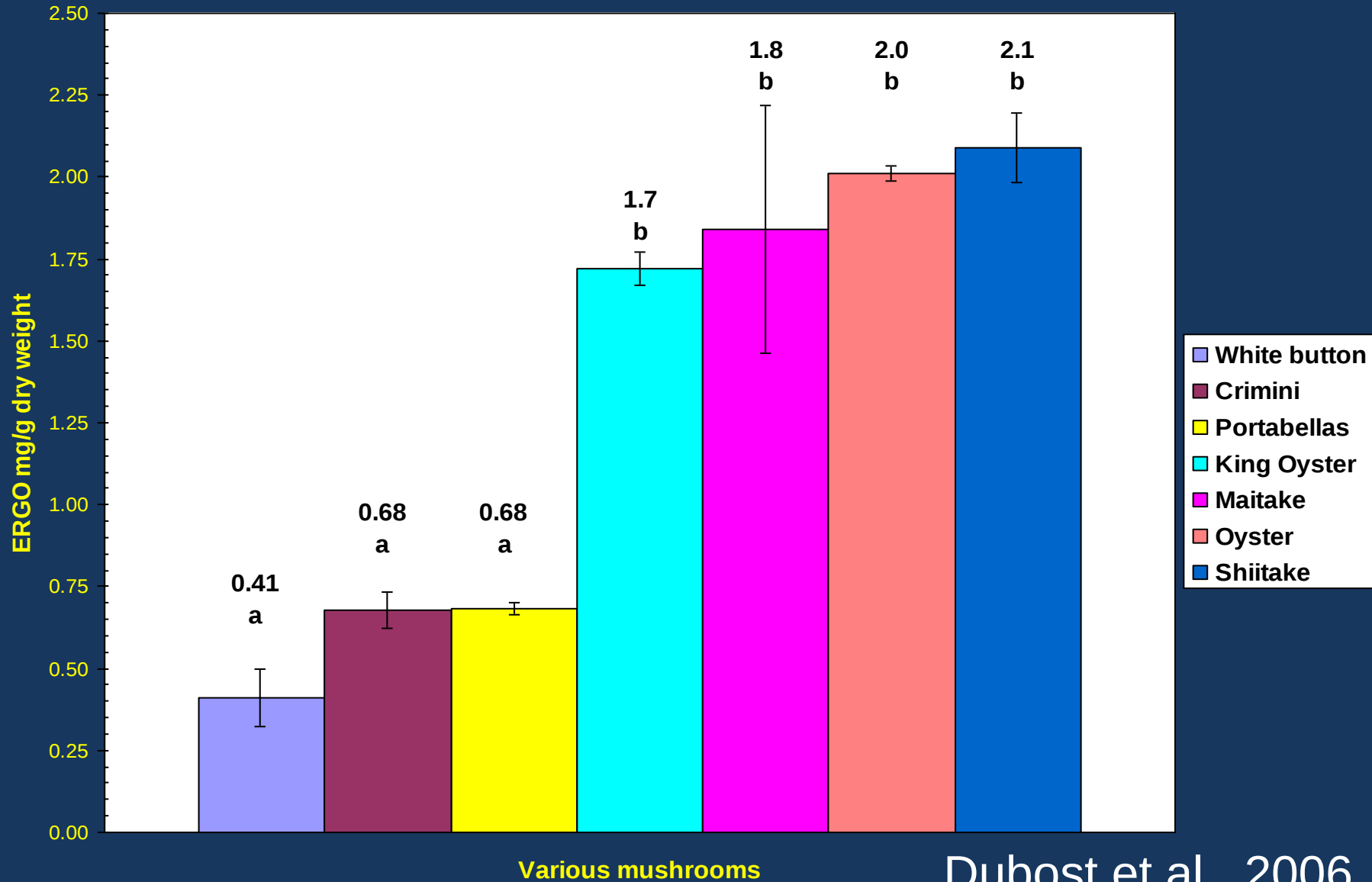


- Therefore ERGO is a very stable antioxidant with unique properties
 - Does not auto-oxidize at physiological pH
 - Does not promote generation of hydroxyl radical from H_2O_2 and Fe^{2+} ions (Grigat et al, 2007)

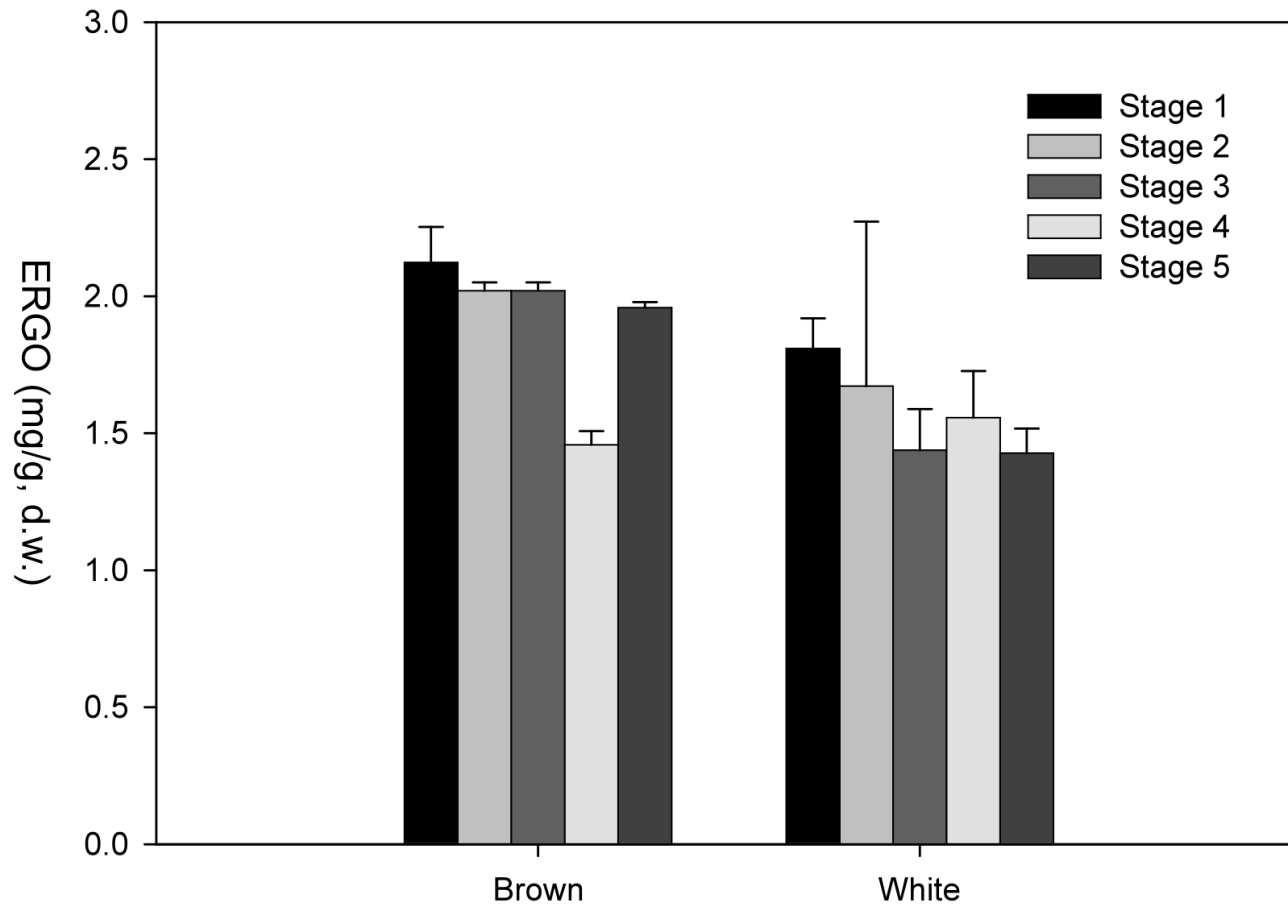


Dr. Al Phillips
Professor Emeritus of Biochemistry

Concentration of ERGO in various mushrooms. Data is expressed as means. Bars on the columns represent standard deviation. Graphics with different letters differ significantly ($p=0.05$).

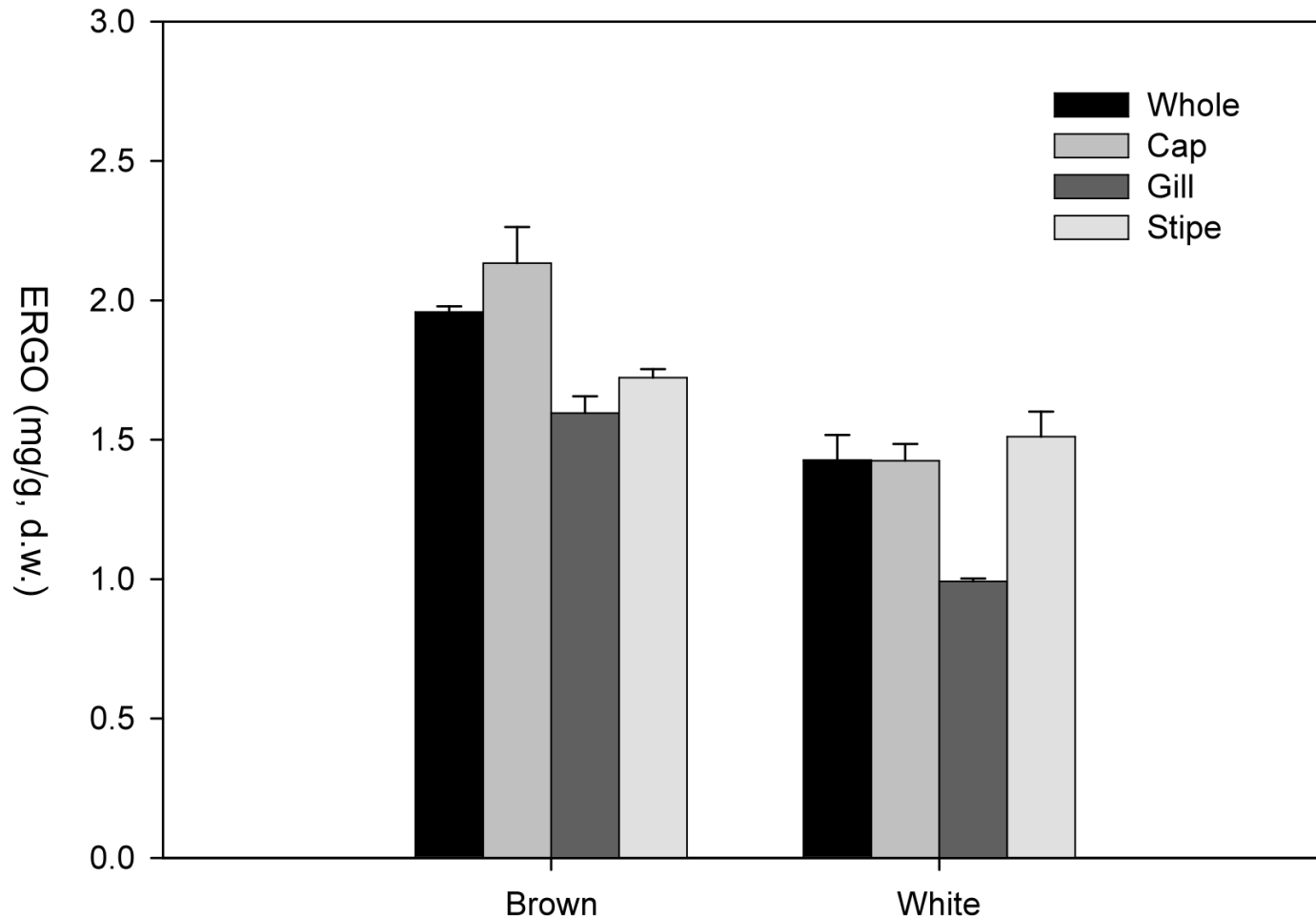


Dubost et al., 2006.



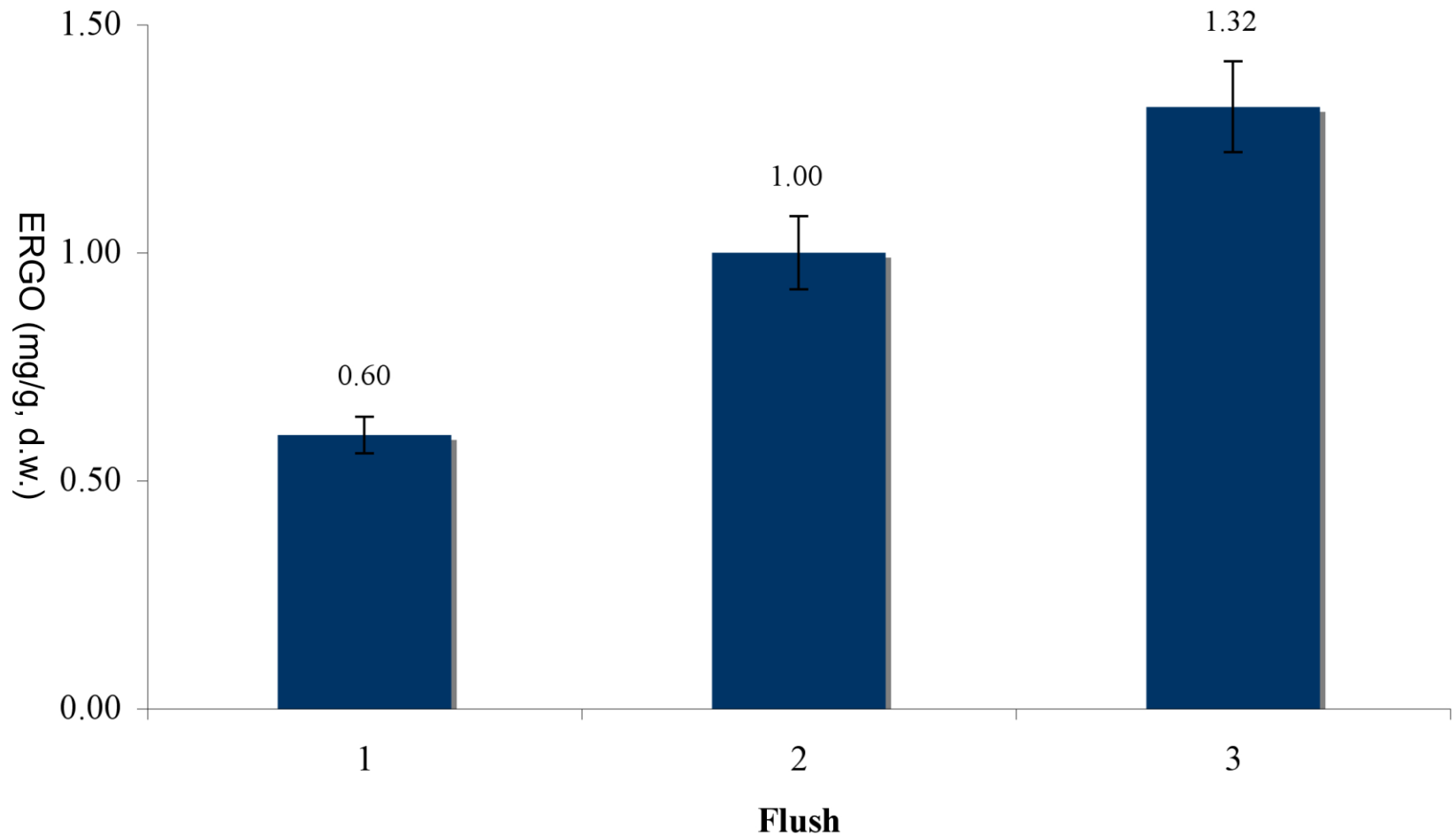
ERGO concentration of brown and white strains of *A. bisporus* mushrooms harvested at different stages of maturity.

Beelman and Lee,



ERGO concentration in button mushrooms harvested fully mature (stage 5) and dissected into cap, gill and stipe tissues.

Beelman and Lee,



Influence of flush of crop cycle on ERGO concentration in white button mushrooms.

Beelman and Lee,

ERGO - Stress Metabolite

- Crop cycle
 - ERGO concentration significantly increased with each flush of the crop cycle
 - White button - 1.32 mg/g dw obtained with 3rd flush
- Dry Substrate
 - ERGO concentration significantly increased with the use of dry substrate
 - Brown – 2.1 mg/g dw at 3rd flush
 - White button – 1.8 mg/g dw at 3rd flush
- Mycelia Structure
 - ERGO concentration significantly increased with breaking the mycelia in the substrate at casing

The unusual amino acid
L-ergothioneine
is a physiologic cytoprotectant

BD Paul and SH Snyder

Cell Death & Differentiation advance online publication

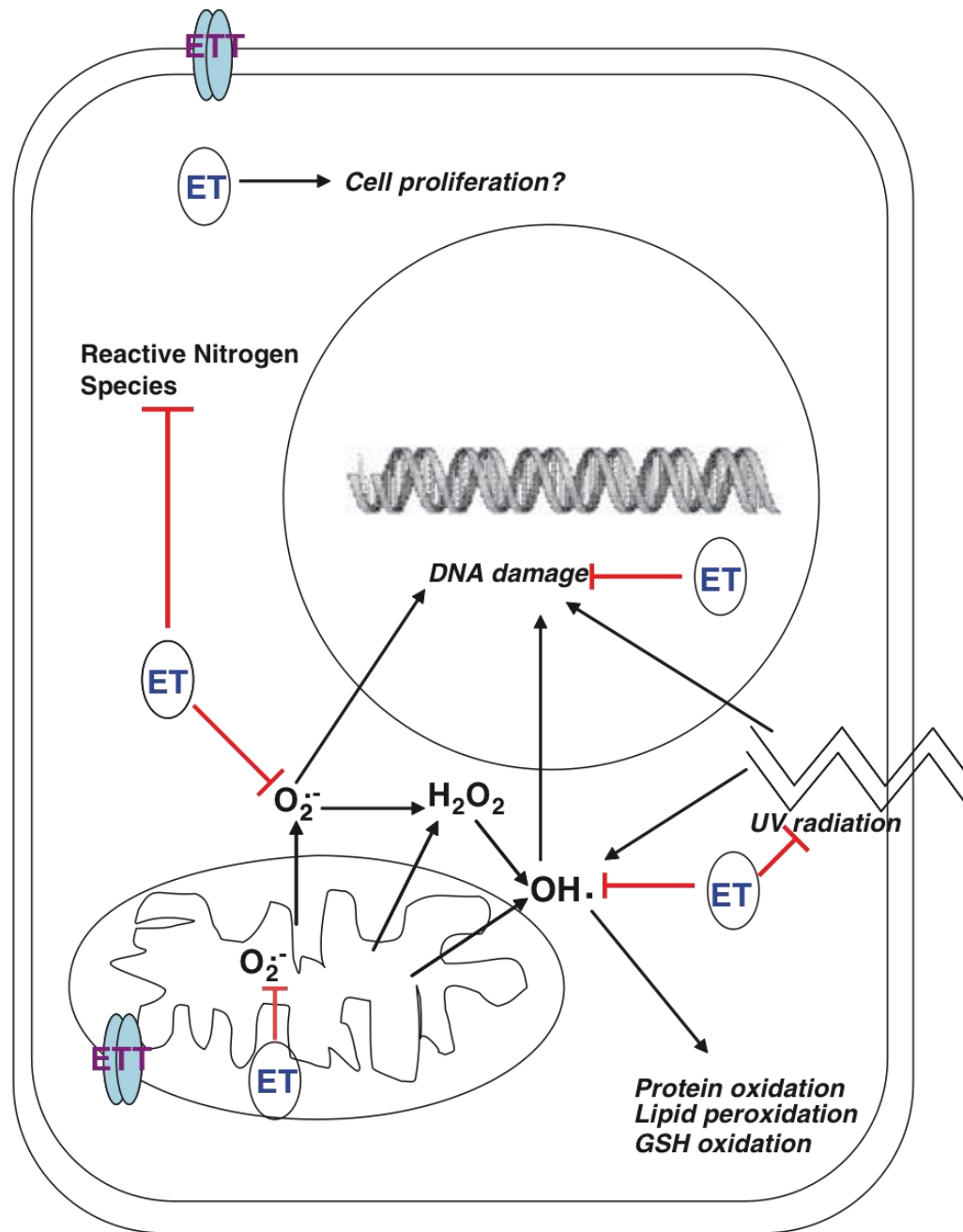
13 November 2009; doi:10.1038/cdd.2009.163

“ET is avidly retained in cells and its tissue concentrations tend to be stable. When acting as an antioxidant, its SH group is oxidized but very rapidly reduced because of the unique tautomeric structure of the molecule. By contrast, glutathione is often almost totally depleted in the face of oxidative stress.”

“Selective damage to mitochondrial DNA by oxidative stress has been implicated in neurodegenerative diseases, especially Parkinson’s Disease. Thus, ET might be uniquely involved in the protection of mitochondrial DNA from the superoxide generated in the course of the electron transport cycle.”

“ET may afford a more stable mode of cytoprotection. It is not metabolized to any notable extent in mammalian tissues, the half-life of dietary ET being approximately 1 month. Its cycling between oxidized and reduced sulfur takes place non-enzymatically and is facilitated by the intrinsically tautomeric structure of the molecule.”

“These properties suggest a role for ET as a bulwark, a final defense for cells against oxidative damage. Its stability may help mitochondria cope with otherwise overwhelming stresses encountered even during relatively physiologic metabolism.”



Paul &
Snyder,
2009.

Summary

- “ET is a most unusual amino acid with substantial antioxidant efficacy. The existence of a physiologic ET transporter is responsible for high tissue levels. Depletion of ETT leads to augmented oxidative stress and cell death.”
- “ET preferentially protects water-soluble proteins from oxidative damage. The high density of ETT in mitochondria implies a unique role in protecting this organelle from the reactive oxygen species that accumulate even with normal oxidative metabolism.”
- “ET protects the cell from damage induced by reactive nitrogen species and UV radiation. For all these reasons ET appears to be an important physiologic cytoprotectant which probably merits designation as a vitamin.”

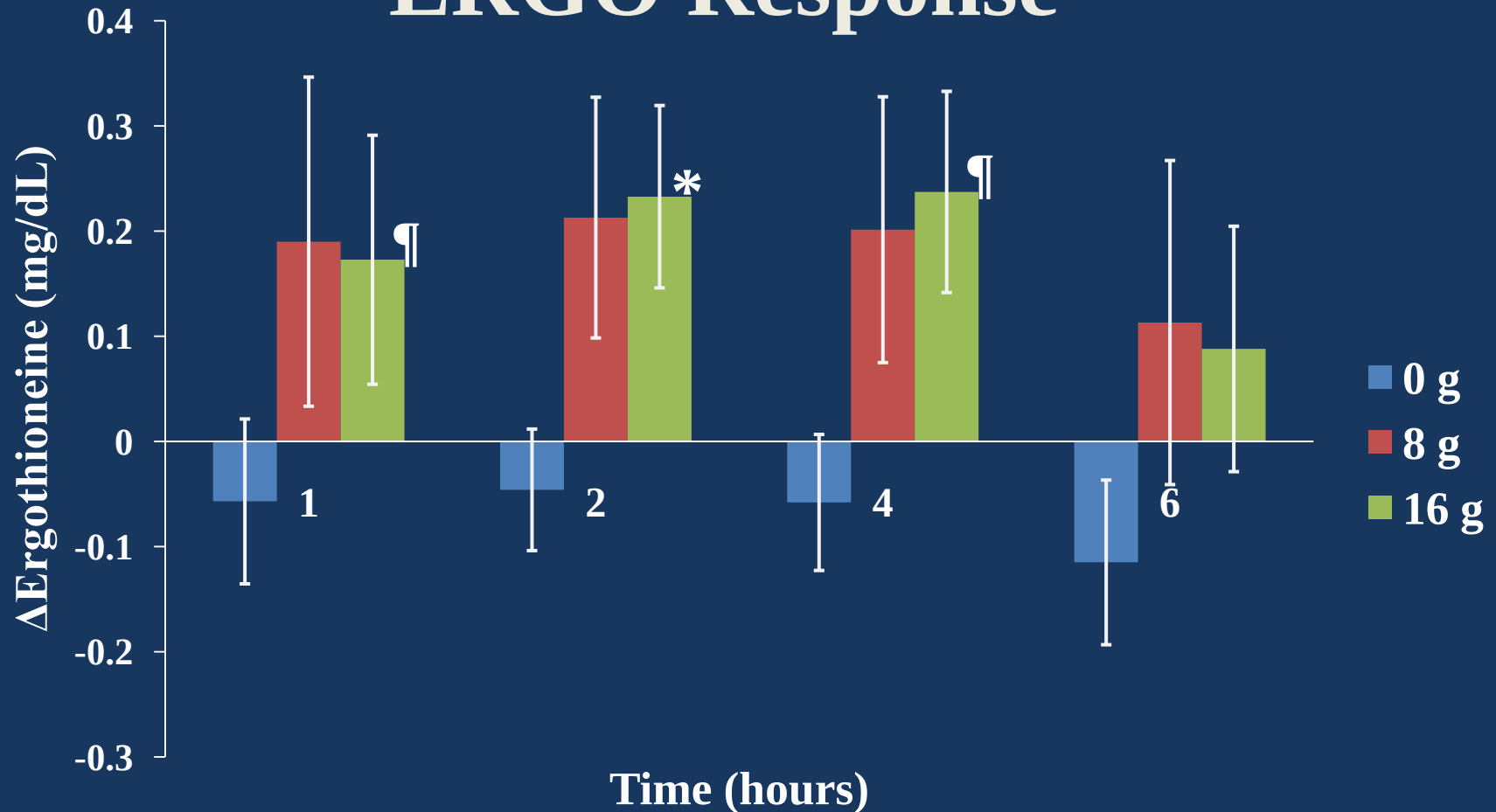
The bioavailability of ergothioneine from mushrooms and the
acute effects on antioxidant capacity and biomarkers of
inflammation in human Participants

AuBrei J. Weigand

Robert Beelman

Penny Kris-Etherton

ERGO Response



* Significant difference from 0 g dose (p<0.05)

¶ Significant difference from 0 g dose (p<0.10)

Center of Excellence in Plant and Mushroom Foods to Improve Health

There is mounting and compelling evidence supporting the health benefits derived from consuming more fruits, vegetables and whole grains especially as it relates to reducing the risk of chronic degenerative diseases like cancer, coronary heart disease and Alzheimer's dementia. Also, there have been an increasing number of discoveries related to the nutritional and medicinal properties of numerous cultivated mushrooms. Pennsylvania is a leading state in the production and processing of numerous foods from plants and mushrooms and Penn State has strong research, education and extension programs supporting this important segment of the Commonwealth's economy. In addition, the Department of Food Science has a strong strategic focus on improving health and wellness with a core faculty interested in the potential of foods from plants and mushrooms to improve human health. Hence, it seems timely and appropriate to create a Center of Excellence in this area within the department.

The objectives of this Center are envisioned as follows:

1. Provide intellectual leadership to the University in this area
2. Foster collaboration within the Department of Food Science, the College of Agricultural Sciences and the University including the College of Medicine
3. Stimulate discovery through basic and applied research
4. Raise funding to support research through government, industry, philanthropic and foundation sources

In order to capitalize on the current strengths and interests of our faculty, this Center will focus on the following areas:

1. Evaluate small molecule bioactive compounds from plants and mushrooms with potential to improve health, such as:
 - polyphenols
 - ergothioneine
 - Vitamin D2
 - unknown compounds – focus on anticarcinogens
2. Biofortification of whole foods from plants and mushrooms with select bioactive compounds with health benefits to consumers
3. Evaluate the complexity of the total food matrix as it relates to bioavailability and function of bioactives in the food
4. Evaluate the role of plant and mushroom foods in an integrative-medicine approach to promoting health

THANK-YOU



QUESTIONS ?