

# Ergothioneine Supplementation and the Prevention of Delayed Onset Muscle Soreness Following a Bout of Eccentric Exercise

Nolan Hale<sup>1</sup>, Kristin VanHouton<sup>1</sup>, Courtney Miller<sup>1</sup>, Aaron Proefrock<sup>2</sup>, Jessica Pieters<sup>1</sup>, Leah Rothschild<sup>1</sup>, Samantha Curtis<sup>1</sup> and Peter J. Horvath

<sup>1</sup> Department of Exercise and Nutrition Sciences School of Public Health and Health Professions <sup>2</sup> Department of Biomedical Sciences  
University at Buffalo Buffalo, New York

## Abstract

Exercise has been proven to be an essential part of a healthy lifestyle and discourages the onset of disease. When a new physical activity regimen is implemented, compliance is key. Delayed onset muscle soreness (DOMS) is a major deterrent at the onset of a new exercise programs, especially among sedentary individuals. Ergothioneine, an antioxidant most notably recognized for its presence in mushrooms, may reduce muscle soreness. Ergothioneine is not synthesized in humans and is only available from the diet. This study will evaluate the effect of ergothioneine-rich mushroom supplementation on muscle soreness following a bout of eccentric exercise in middle-aged men and women.

This randomized double blind parallel arm study requires participants to walk on a treadmill with a progressive decline in elevation and an increase in speed to induce eccentric muscle damage in the lower limbs before and after supplementation. Participants will be supplemented for ten days with either shiitake mushroom powder (high ergothioneine,) or placebo - white button mushroom powder (low ergothioneine). DOMS will be measured by; physical fitness testing, pain questionnaires, urinary measures, and blood levels of creatine kinase, interleukin-6 and interleukin-2.

## Background

The pain that occurs after exercise (Delayed Onset Muscle Soreness) is a major deterrent to maintaining an exercise training program. Many people begin their training with eccentric exercise, which causes the greatest muscle damage. If the pain caused by eccentric exercise can be decreased, then people will continue to train. One mechanism is to use antioxidants and anti-inflammatories such as ergothioneine found at high levels in mushrooms. It is not biosynthesized by humans (1). Ergothioneine is concentrated in human tissues predisposed to high levels of oxidative stress and inflammation such as liver, kidney, and skeletal muscles (3-5). The antioxidant and anti-inflammatory properties of ergothioneine are related to its ability to neutralize free radicals and reduce inflammation. Shiitake mushrooms have a substantial amount of ergothioneine. Blood ergothioneine levels increase within two hours after mushroom consumption. The effects of ergothioneine supplementation on delayed onset muscle soreness have thus far only been tested on young, healthy individuals. As a result of this study, new exercise programs compliance rates may increase, as pain would no longer be a heavy deterrent.

1. Weigand-Heller AJ, Kris-Etherton PM, Beelman RB. The bioavailability of ergothioneine from mushrooms (*Agaricus bisporus*) and the acute effects on antioxidant capacity and biomarkers of inflammation. *Prev Med* 2012; 54: S75-S78.  
3. Grundemann D, Harflinger S, Goiz S, et al. Discovery of the ergothioneine transporter. *Proc Natl Acad Sci USA* 2005; 102: 5256-5261.  
4. Koepsell H, Lips K, Volk C. Polyspecific organic cation transporters: structure, function, physiological roles, and biopharmaceutical implications. *Pharm Res* 2007; 24: 1227-1251.  
5. Nikodemus D, Lazic D, Bach M, et al. Paramount levels of ergothioneine transporter slc22a4 mRNA in boar seminal vesicles and cross-species analysis of ergothioneine and glutathione in seminal plasma. *J Physiol Pharmacol* 2011; 62: 411-419.



## Objectives

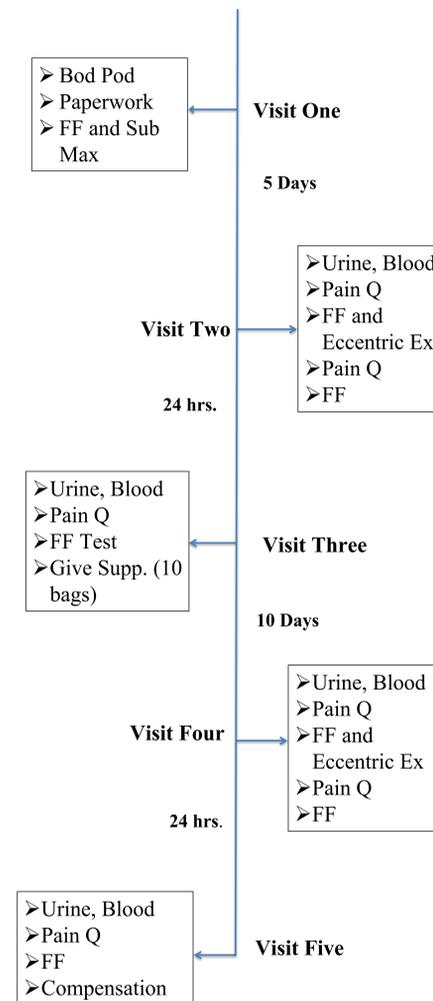
To evaluate the effect of ergothioneine supplementation on muscle soreness following a bout of eccentric exercise in older men and women (ages 35-55).

1. Ergothioneine supplementation will increase blood ergothioneine levels in older men and women.
2. Ergothioneine supplementation will reduce eccentric exercise induced delayed onset muscle soreness.
3. Ergothioneine supplementation will maintain functional fitness performance after eccentric exercise.

## Methods

- The design of the study is a parallel design, where subjects will supplement with either Ergothioneine supplement or Placebo.
- Blood and urine samples will be collected pre and post-exercise to determine baseline creatine kinase, ergothioneine, and urine nitrogen levels.
- The first visit will be the screening including informed consent, health history, blood pressure and heart rate, PARQ physical activity questionnaire, 24 hour food recall administered in the lab by research personnel, functional fitness testing, and a sub max VO2 test. Functional fitness testing includes:
  - 8 ft up and go, 30 second sit to stand, and 30 second 8 lb arm curl, and a 3 minute step test. Five days following participants will return for their second visit which will include a 24 hour food recall, pre blood and urine samples, and a pain questionnaire in relation to the eccentric exercise protocol which will also take place this day.
  - After 10 days of supplementation with either Placebo (White Button) or Ergothioneine, subjects will undergo the same functional fitness and aerobic exercise tests and follow up with DOMS measures (short form McGill Pain Questionnaire), creatine kinase, and ergothioneine levels, immediately post exercise and 24 hours post exercise. Shiitake powder will be provided to participants, they will be required to intake 6 grams of powder per day over the course of 10 days.

## Study Visit Protocol



## Expected Results

**Figure 1. Creatine Kinase levels vs Pain**

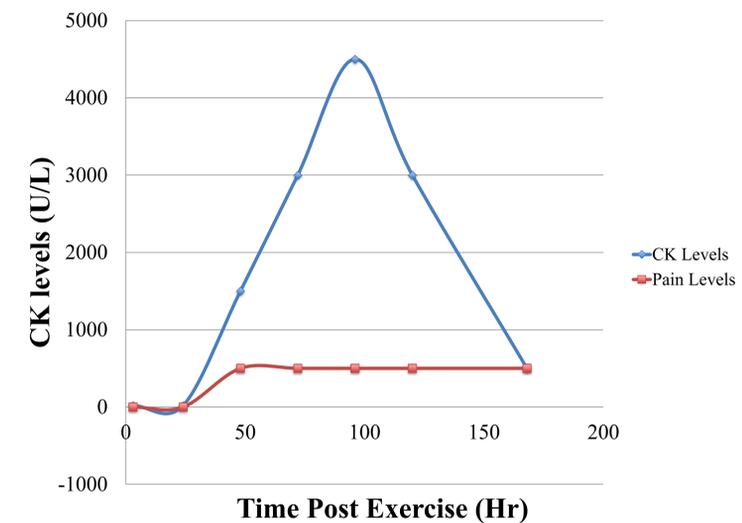


Figure 1: Based on previous data collected by Chen Yamin et al. in *The Journal of Applied Physiology*, creatine kinase levels are expected to increase significantly post exercise. We are expecting subjects pain levels to remain steady at low levels.

## Discussion

We expect ergothioneine to reduce DOMS by reducing systemic inflammation and local inflammation in muscle tissue breakdown. Muscle damage between the shiitake and white button should be similar with lower perceived pain in subjects receiving shiitake. Reduced DOMS may encourage individuals to start or maintain exercise programs, and ultimately lead to better health in the United States. As a result of this study, new exercise programs compliance rates may increase, as pain would no longer be a heavy deterrent. With the ongoing high rates of obesity related comorbidities this would be a welcomed intervention.

## Funding

**CURCA** CENTER FOR UNDERGRADUATE RESEARCH AND CREATIVE ACTIVITIES



Oakshire Mushroom Farm, Inc.

## Methods – Functional Fitness Tests



Eccentric Exercise



30 sec Arm Curl



3 Minute Step Test