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File: ■ Turmeric (*Curcuma longa*)
■ Curcumin
■ Muscle Soreness

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RE: Curcumin Formulation Reduces Delayed Muscle Soreness after Eccentric Exercise

Drobnic F, Riera J, Appendino G, et al. Reduction of delayed onset muscle soreness by a novel curcumin delivery system (Meriva®): a randomised, placebo-controlled trial. *J Int Soc Sports Nutr*. June 18, 2014;11:31. doi: 10.1186/1550-2783-11-31.

Eccentric exercise refers to forced muscle elongation during muscle contraction. This form of exercise may lead to mild muscle damage and delayed onset muscle soreness (DOMS), the generation of reactive oxygen species (ROS), and subsequent inflammation. Curcumin, a compound isolated from turmeric (*Curcuma longa*) root, has been shown to have anti-inflammatory activity[1] by attenuating the modulators of inflammation, including nuclear factor kappa B (NF-κB) and cyclooxygenase-2 (COX-2)[2,3]; curcumin has also been reported to activate endogenous antioxidant response modulator nuclear factor erythroid 2-related factor 2 (Nrf2).[4] This randomized, placebo-controlled, single-blind trial investigated the potential of curcumin product Meriva® (Indena S.p.A.; Milan, Italy), formulated with soy (*Glycine max*) lecithin to enhance bioavailability, to alleviate muscle injury, ROS damage, and inflammation due to eccentric exercise.

This study enrolled 20 healthy men that engaged in aerobic exercise for 4 hours per week or more. Included subjects did not smoke, had no diseases of the musculoskeletal system, and had a maximal oxygen consumption (VO_2max) of 35 ml/kg or greater during a treadmill exercise test. Those taking anti-inflammatory, analgesic, or antioxidant medications in the past month; with liver or kidney problems; or with current inflammation or disease were excluded. Subjects were randomly assigned to either 1 g of Meriva 2 times per day at breakfast and dinner, for a total curcumin dosage of 400 mg daily, or placebo. Meriva contains curcumin (20%), soy lecithin in a 1:2 weight ratio, and 2 parts of microcrystalline cellulose. Contents of the placebo were not described. Treatments were given 48 hours before downhill-run testing and continued for 24 hours following the testing for a total of 4 days.

Subjects underwent a baseline treadmill exercise test at a 3% grade starting at 6 km/h, raised by 1 km/h per minute until either VO_2max was steady or began to decrease, or

muscle fatigue occurred. VO_2max, maximum speed (Spd_{max}), and speed at anaerobic threshold (Spd_{at}) was determined. After 2 days of curcumin, to induce eccentric muscle injury, a downhill running test was conducted, consisting of a 10-minute warm-up and a downhill run at constant speed on a treadmill at -10% for 45 minutes. At 7 and 5 days before the curcumin intake began, subjects had conducted 10-minute exercise regimes to practice the study protocol and ensure a consistent baseline of muscle tone. Additionally, subjects were given a "nutritional supplement" of 25-30 g of carbohydrates and 2-4 g of protein 1 hour before the downhill running test. Subjects were given access to water ad lib during the downhill running test after consuming 500 ml of mineral water 30 minutes before the test began.

Magnetic resonance imaging (MRI) was used to gauge thigh muscle damage, and muscle biopsies were taken 48 hours after the downhill running test to assess for muscle myeloperoxidase (MPO) activity, albumin, and cluster of differentiation 3 (CD3) positive cells using immunohistochemistry (all markers of muscle injury or inflammation). A week before the test, blood cell and blood chemistry parameters had been assessed. Blood was also taken right before the downhill running test, and 2 and 24 hours after the test, to measure markers of both oxidative stress and inflammation. Pain was also measured 48 hours after the test by a scale ranging from 0 (no pain) to 4 (disabling pain) while climbing up or down stairs.

Of the 20 subjects enrolled, 1 subject randomly assigned to the Meriva group dropped out for personal reasons prior to the test, leaving 9 subjects in the Meriva group. Between the placebo and Meriva groups, no significant differences were noted in Spd_{max} (13.7 ± 1.8 km/h vs. 14.8 ± 1.1 km/h) or downhill running speed (10.9 ± 1.2 km/h vs. 11.4 ± 0.9 km/h). According to the MRI measurements, a significantly less percentage of subjects had muscle damage in the Meriva group as compared to the placebo group in the posterior (44.4% vs. 90%, P=0.0329) or medial (33.3% vs. 80%, P=0.0397) areas of the right thigh. Results were similar in the left thigh (33.3% vs. 80%, P=0.0397, and 33.3% vs. 90%, P=0.0106, respectively).

Overall, the difference in pain experienced by the Meriva group as compared to the placebo group approached significance (23.3 ± 7.9 vs. 30.6 ± 7.9, P=0.06). When analyzing the anterior thigh area, both right and left comparisons showed significantly less pain in the Meriva group (right=4.4 ± 2.5 vs. 7.8 ± 3.9, left=4.4 ± 2.4 vs. 8.2 ± 4.6, P<0.05 for both). Also, at the 2-hour post-exercise test, interleukin-8 (IL-8, a marker of inflammation) was significantly lower in the Meriva group as compared to the control (196.8 ± 66.1 pg/ml vs. 274.7 ± 70.7 pg/ml, P<0.05). Markers of oxidant stress were not significantly different between groups at any time. Muscle biopsy endpoints (n=4 from the Meriva group, and n=5 from the placebo group) were not significantly different between groups.

This study showed a significant reduction in muscle damage, pain in certain areas, and IL-8 concentrations associated with Meriva consumption during eccentric exercise, pointing to its potential use in preventing DOMS. No effect was noted on markers of oxidative stress; this suggests that curcumin likely attenuates inflammation as opposed to oxidant damage. The authors mention that curcumin may activate endogenous antioxidant regulatory cellular mechanisms and may also act as an analgesic. Limitations of this study include the short duration, single type of aerobic exercise employed, the overall small amount of oxidative damage, and the limited amount of

biopsy samples. Ideally, future studies will focus on specific mechanism of action during use with exercise.

—Amy C. Keller, PhD

References

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Referenced article can be found at http://www.jissn.com/content/11/1/31.