Green tea extract boosts exercise endurance 8-24 percent, utilizing fat as energy source

January 27 2005

Swimming endurance improvement comes from equivalent of four cups of tea a day over 10 weeks

Now that even baseball players may need to seek new, more natural performance aids, will Japanese green tea sets become standard in dugouts and athletic training tables around the world?
A new study tested the effect of regularly taking green tea extract (GTE) and found that over 10 weeks, endurance exercise performance was boosted up to 24% with 0.5% GTE supplementation, and 8% with 0.2% by-weight addition to food.

Reporting in the online edition of the American Journal of Physiology-

Regulatory, Integrative and Comparative Physiology researchers at the Biological Sciences Laboratories of Kao Corp., Tochigi, Japan, said the 8-24% increase in swimming time-to-exhaustion was "accompanied by lower respiratory quotients and higher rates of fat oxidation."

The results "indicate that GTE is beneficial for improving endurance capacity and support the hypothesis that the stimulation of fatty acid utilization is a promising strategy for improving endurance capacity," according to the study entitled, "Green tea extract improves endurance capacity and increases muscle lipid oxidation in mice." Research was conducted by Takatoshi Murase, Satoshi Haramizu, Akira Shimotoyodome, Azumi Nagasawa and Ichiro Tokimitsu, working at Kao Corp., a Japanese maker of healthcare products, including green tea beverages.

Results came from the equivalent of about 4 cups of tea a day

Although it's difficult to extrapolate from mice eating GTE as a food supplement to a major leaguer or Olympic swimmer sipping green tea, the study's lead author, Takatoshi Murase said: "We estimate that an athlete weighing 75 kilograms (165 pounds) would have to drink about four cups (0.8 liter) of green tea daily to match the effect in our experiments."

"One of our important findings," Murase pointed out, "was that a single high-dose of GTE or its active ingredients didn't affect performance. So it's the long-term ingestion of GTE that is beneficial." (Murase based his calculations of mouse-to-human tea/GTE consumption equivalents on work his lab is doing on the anti-obesity effects of GTE on mice and humans.)

In an era when professional and amateur athletes are always looking for ways to improve performance, and most people want to improve their health and exercise capabilities, "the efficacy of dietary interventions is still controversial," the authors acknowledge. They note that green tea and cacao contain a class of polyphenols called catechins, which consist mainly of epigallocatechin gallate (EGCG), epicatechin gallate and gallocatechin gallate. Catechins have been reported to have various physiological and pharmacological properties over the years.

The Kao lab "recently demonstrated that the long-term consumption of tea catechins was beneficial in counteracting the obesity-inducing effects of a high-fat diet, and that their effects may be attributed, at least in part, to the activation of hepatic lipid catabolism" in mice. "Overall," the authors said, "observations so far suggest that thermogenesis and fat oxidation are stimulated by the intake of catechins."

Working hypothesis and study methods

"To confirm our hypothesis that catechins affect endurance exercise capacity (i.e. time to exhaustion) by increasing lipid utilization, in this study we examined the effect of catechin-rich GTE intake on the endurance capacity of Balb/c mice swimming in an adjustable-current water pool. We also analyzed changes in energy metabolism, especially lipid metabolism. We demonstrated that GTE intake improved endurance capacity and this was accompanied by an increase in lipid catabolism. Our results support the hypothesis that stimulation of lipid metabolism is a promising strategy for improving the capacity for endurance training."

The ideas for the experiment come from the fact that "skeletal muscles utilize carbohydrates, lipids and amino acids as energy sources, but the ratio in which they are used varies with the intensity of exercise and the level of fitness" as well as the type of exercise involved. For instance

"during endurance exercise, excess glucose is undesirable because it induces insulin secretion, which in turn simultaneously inhibits lipid metabolism and stimulates lactate production. Conversely, enhanced availability and utilization of free fatty acids are considered to reduce carbohydrate utilization, which in turn spare glycogen and suppresses lactate production and results in an increase in endurance."

To test what effects GTE and its components would have on endurance exercise, the researchers ran two experiments. In the first, swimming endurance capacity was measured at eight weeks of age and the mice were divided into four groups of 10 each. All subjects had unlimited access to water for exercise. For 10 weeks, controls ate a standardized diet only, while experimental animals had this diet supplemented with 0.2% and 0.5% GTE by weight. During this period experimental mice were exercised in a pool twice a week, but non-exercise mice weren't.

The second experiment was similar to the first but the experimental groups received a diet containing 0.1% to 0.5% EGCG for 10 weeks.

At the beginning of the experiment, the mice swam about 26 minutes until they were exhausted. After 10 weeks on the training regimen, the time-to-exhaustion for the exercise-control mice (no GTE or EGCG supplement) rose to about 33 minutes, showing the effects of unaided practice on endurance capacity. From the first week of the experiment, the mice on GTE showed greater improvement compared with the exercise-controls. By week eight, the improved performance of mice on 0.5% GTE was significantly better (39 minutes) than the exercise-controls (33 minutes) at a 0.05 level, while improvement in weeks 9 and 10 (40 minutes vs. 33 minutes) were significant at the 0.01 level.

GTE effects not matched by EGCG alone suggesting other additional influences

In the global search for enhanced athletic performance (and health and fitness), the Kao team said they "have shown that GTE improved endurance capacity and that the improvement was dose-dependent. A similar effect was observed in mice fed EGCG, a major constituent of GTE, suggesting that the effects of GTE were mediated at least in part by EGCG.

"However, because the effects of EGCG appear weak compared with those of GTE, we cannot rule out a possible contribution from other components of GTE. Although long-term intake of GTE enhanced endurance capacity, no marked effects were observed after a single dose of GTE, suggesting that some biochemical changes induced by habitual GTE intake, such as up-regulation of muscular beta-oxidation, contributed to the improvement in endurance capacity."

The study found that plasma NEFA (non-esterified fatty acid) measured immediately after exercise slightly, but significantly, increased in mice fed tea catechins. Though they concede that the effect of plasma fatty acid level on endurance capacity is controversial, they say that increased supply of circulating fatty acids would "induce the uptake of fatty acids, and thereby stimulate lipid metabolism in muscle."

Indeed, lab results showed that muscular beta-oxidation was higher in GTE-fed mice (compared with non-exercise and exercise-control mice), "suggesting that GTE enhanced the capacity of muscle to catabolize lipids and utilize fatty acids as an energy source." Conversely, GTE lowered plasma lactate concentrations, which would be raised by glycogen breakdown and glycolytic flux, they note.

Taken together the experimental results "suggest that habitual exercise and the intake of GTE enhance fatty acid availability, catabolism and utilization in muscle, and this is accompanied by a reduction in carbohydrate use, which together result in prolonged swimming times to

exhaustion."

Controlling for caffeine

Kao researchers controlled for possible influences of caffeine and possible weight-fat changes that might affect buoyancy.

Aware that previous studies were criticized by the possible role of caffeine on fatty acids and exercise, the Kao researchers reduced the amount of caffeine in supplements. "In addition, we observed no changes in plasma NEFA level under resting conditions, suggesting that caffeine-stimulated lipolysis did not occur under these conditions. Thus our results overall suggest that the effects observed in this study are not attributable to caffeine. In particular, our findings that purified EGCG improved endurance capacity supports this conclusion."

Next steps

-- The "precise molecular mechanism by which GTE stimulates fatty acid metabolism is unclear at present (and) remains to be elucidated."

-- For instance, the researchers wrote, "it is possible that the anti-oxidant properties of tea catechins mediate their effects on endurance capacity."

-- And finally they noted: "Although the clinical efficacy of GTE has not yet been confirmed in human studies, our results suggest that GTE may be a useful tool for improving endurance capacity."

Source: American Physiology Society