Post-exercise caffeine helps muscles refuel

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Recipe to recover more quickly from exercise: Finish workout, eat pasta, and wash down with five or six cups of strong coffee.

Glycogen, the muscle's primary fuel source during exercise, is replenished more rapidly when athletes ingest both carbohydrate and caffeine following exhaustive exercise, new research from the online edition of the *Journal of Applied Physiology* shows. Athletes who ingested caffeine with carbohydrate had 66% more glycogen in their muscles four hours after finishing intense, glycogen-depleting exercise, compared to when they consumed carbohydrate alone, according to the study, published by The American Physiological Society.

The study, "High rates of muscle glycogen resynthesis after exhaustive exercise when carbohydrate is co-ingested with caffeine," is by David J. Pedersen, Sarah J. Lessard, Vernon G. Coffey, Emmanuel G. Churchley, Andrew M. Wootton, They Ng, Matthew J. Watt and John A. Hawley. Dr. Pedersen is with the Garvan Institute of Medical Research in Sydney, Australia, Dr. Watt is from St. Vincent's Institute of Medical Research, Fitzroy, Victoria, Australia. All others are with the Royal Melbourne Institute of Technology University (RMIT) in Bundoora, Victoria, Australia.

Caffeine aids carbohydrate uptake

It is already established that consuming carbohydrate and caffeine prior to and during exercise improves a variety of athletic performances. This is the first study to show that caffeine combined with carbohydrates

following exercise can help refuel the muscle faster.

"If you have 66% more fuel for the next day's training or competition, there is absolutely no question you will go farther or faster," said Dr. Hawley, the study's senior author. Caffeine is present in common foods and beverages, including coffee, tea, chocolate and cola drinks.

The study was conducted on seven well-trained endurance cyclists who participated in four sessions. The participants first rode a cycle ergometer until exhaustion, and then consumed a low-carbohydrate dinner before going home. This exercise bout was designed to reduce the athletes' muscle glycogen stores prior to the experimental trial the next day.

The athletes did not eat again until they returned to the lab the next day for the second session when they again cycled until exhaustion. They then ingested a drink that contained carbohydrate alone or carbohydrate plus caffeine and rested in the laboratory for four hours. During this post-exercise rest time, the researchers took several muscle biopsies and multiple blood samples to measure the amount of glycogen being replenished in the muscle, along with the concentrations of glucose-regulating metabolites and hormones in the blood, including glucose and insulin.

The entire two-session process was repeated 7-10 days later. The only difference was that this time, the athletes drank the beverage that they had not consumed in the previous trial. (That is, if they drank the carbohydrate alone in the first trial, they drank the carbohydrate plus caffeine in the second trial, and vice versa.)

The drinks looked, smelled and tasted the same and both contained the same amount of carbohydrate. Neither the researchers nor the cyclists knew which regimen they were receiving, making it a double-blind,

placebo-controlled experiment.

Glucose and insulin levels higher with caffeine ingestion

The researchers found the following:

-- one hour after exercise, muscle glycogen levels had replenished to the same extent whether or not the athlete had the drink containing carbohydrate and caffeine or carbohydrate only
-- four hours after exercise, the drink containing caffeine resulted in 66% higher glycogen levels compared to the carbohydrate-only drink
-- throughout the four-hour recovery period, the caffeinated drink resulted in higher levels of blood glucose and plasma insulin
-- several signaling proteins believed to play a role in glucose transport into the muscle were elevated to a greater extent after the athletes ingested the carbohydrate-plus-caffeine drink, compared to the carbohydrate-only drink

Dr. Hawley said it is not yet clear how caffeine aids in facilitating glucose uptake from the blood into the muscles. However, the higher circulating blood glucose and plasma insulin levels were likely to be a factor. In addition, caffeine may increase the activity of several signaling enzymes, including the calcium-dependent protein kinase and protein kinase B (also called Akt), which have roles in muscle glucose uptake during and after exercise.

Lower dose is next step

In this study, the researchers used a high dose of caffeine to establish that it could help the muscles convert ingested carbohydrates to glycogen more rapidly. However, because caffeine can have potentially negative

effects, such as disturbing sleep or causing jitteriness, the next step is to determine whether smaller doses could accomplish the same goal.

Hawley pointed out that the responses to caffeine ingestion vary widely between individuals. Indeed, while several of the athletes in the study said they had a difficult time sleeping the night after the trial in which they ingested caffeine (8 mg per kilogram of body weight, the equivalent of drinking 5-6 cups of strong coffee), several others fell asleep during the recovery period and reported no adverse effects.

Athletes who want to incorporate caffeine into their workouts should experiment during training sessions well in advance of an important competition to find out what works for them.

A fuller audio interview with Dr. Hawley is available in Episode 11 of the APS podcast, Life Lines, at www.lifelines.tv. The show also includes an interview with Dr. Stanley Schultz, whose physiological discovery of how sugar is transported in the gut led to the development of oral rehydration therapy and sports drinks such as Gatorade.

Source: American Physiological Society