Rethinking the synergies between exercise and protein

A collaboration between researchers at JAPAN'S AJINOMOTO CO., INC. and the UNIVERSITY OF TORONTO IN CANADA uses a novel technique to track how amino acids affect protein metabolism and improve the health of both elite athletes and the general public

Since antiquity, athletes have added protein to their diets to gain a competitive edge — Milo of Croton, a six-time wrestling champion at the ancient Olympic Games, reportedly consumed close to 10 kilograms of meat each day. Today's active individuals can take a more sophisticated route to muscle growth and recovery with protein supplements such as whey powder or amino-acid powder, but these additives often push protein intake far beyond recommended daily allowances. Now, a technique that tags amino acids with heavy atoms has revealed that protein intake should be tailored to specific sporting events and fitness types to maximize its impact on health and performance.

Bulking up on protein metabolism

Although protein is arguably the most widely used meal supplement, exercise physiologists and nutritionists have struggled to define the optimum amounts needed by athletes. That's because how much protein an athlete needs depends on the type of training they do and their goals, which can be wide ranging. In addition, the amino acids needed to rebuild and repair muscle damaged from exercise are found throughout the body, making the effect of any one dietary aid tough to quantify.

AJINOMOTO SENT HIROYUKI KATO, ONE OF THEIR TOP SPORT-SCIENCE RESEARCHERS, TO TORONTO FOR A TWO-YEAR IMMERSION IN THE UNIVERSITY'S RESEARCH ENVIRONMENT

Recently, an 'indicator amino acid oxidation' approach has emerged that makes it simpler to understand protein metabolism. Pioneered by a team centred at the University of Toronto and the University of Alberta in Canada, this method involves using an amino acid tagged so that it a bit heavier than those normally found in the diet and then using sensitive mass spectroscopy to track where it goes after being ingested. If athletes consume a low-protein diet, for example, the indicator amino acid may be used for energy and then the label will appear in the breath as carbon dioxide.

"The major storage spot for amino acids in the body is in muscle," says Daniel Moore (right, at left), a professor in kinesiology at the University of Toronto. "If we see less of our label in the breath, we know we've made more protein, including muscle, or repaired it, at a faster rate in response to what we've done nutritionally."

As the world's largest manufacturer of amino acid crystals, the Ajinomoto Group has taken a keen interest in understanding the importance of these complexes to nutrition, exercise and regenerative medicine. Part of this group's mandate is to leverage their research and development expertise with global partners in academia and industry through an open-access grant programme, the Ajinomoto Innovation Alliance Program. When approached by Moore to fund an innovative, isotope-based study into the protein needs of active populations — ranging from children to adult athletes — Ajinomoto jumped at the opportunity. They also agreed to send Hiroyuki Kato (above, at right), one of their top sport-science researchers, to Toronto for a two-year immersion in the university's research environment.

Studying a cross-section of the community

Kato was excited to work with Moore at Toronto's newly opened Goldring Centre for High Performance Sport (far right, top). As an expert in investigating how essential amino acids stimulate muscle growth, he had helpful insights into the equipment and procedures needed to quantify protein use in humans. In return, he gained know-how into isotope techniques and access to real-world runners. "Dan has great expertise, and this clinic has great facilities for studying amino acids," says Kato. "That's why we were happy to collaborate."

Ira Jacobs (above, at centre), dean of the Faculty of Kinesiology, notes that although amino-acid metabolism in active individuals has not received as much attention from researchers as other macronutrients such as fat and carbohydrates, the University of Toronto has many

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advantages when it comes to finding synergies between nutrition and physical activity.

"Exercise studies on fuels used or stored by muscles used to be very invasive and uncomfortable, but with isotope techniques we can determine exactly how many grams of protein are incorporated into skeletal muscle mass, just from eating or drinking something," says Jacobs. "We also have the capacity to apply these research techniques to a university-wide nutrition research programme, and our engagement with the community will facilitate studies across a wide spectrum, including on athletes, non-athletes, children and the elderly, who likely all have very different protein needs."

Elite runners need more protein than recommended

Kato and Moore's experiments put six athletes on a strict, two-day diet and exercise regime to establish a baseline metabolism and then subjected them to a 20 kilometre run on a treadmill as an exercise stimulus. Afterwards, they were fed custom-made meals that contained varying doses of all 20 known amino acids and used an isotope-labeled phenylalanine as an indicator amino acid. Then, a special mask collected carbon dioxide exhaled by the participants, looking for the isotope label to appear in the breath. Signs of the label would provide information on when new body proteins (including muscle) had been synthesized and indicate how much protein had been needed.

The team's trials suggested that the actual protein requirements of the endurance athletes were 28 to 50% higher than existing recommendations — elite runners need close to 1.8 grams of protein per kilogram of body weight to shift the natural balance towards building body and muscle.

"Contrary to what people think, endurance athletes who may be very lean actually need relatively high amounts of protein — sometimes as much as bodybuilders," explains Moore. "This is because of their high metabolic rate and the fact they're using some of their amino acids as fuel when they train, which means they have to replenish them from their diets."

Formulating the perfect supplement

Although Kato has since returned to his laboratory at Ajinomoto in Japan, the international collaboration is continuing into a new phase: designing blends of amino acids that, with the right ratio of components, might be more helpful than whole food.

"We mimicked egg proteins in our meal, and they're high quality but not optimal — extra amino acids are left over that don't get turned into protein," says Kato. "Also, current protein recommendations come from mixed sources, and so we're not sure exactly which amino acids were used. Do we need all twenty or just the nine essential acids that our body can't produce? Defining the best compositions is our next challenge."

Jacobs notes that having an industrial partner who wants to translate this new knowledge into real product development is gratifying in many ways. "Nutrition and physical activity act in synergy to support healthy, active living throughout your lifespan, so it's exciting to be in a position to shed light on how protein needs change for different groups and ages," he says. "For Ajinomoto to fund someone to come here and learn these techniques, that's really innovative and enlightened." ■