Protein and Minerals in the Athlete's Diet

How the slow and fast digesting proteins found in milk proteins are the most beneficial to athletes

By Philip Connolly

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The goal of every serious athlete is to develop stronger, more enduring muscle tissue through training and exercise. While consistent training will help an athlete improve muscle mass and performance, attention to nutrition is also critical to success. If an athlete does not consume enough protein to stimulate and feed protein synthesis for muscle repair and growth, athletic performance will progress slowly and minimally, no matter how much the athlete trains.

Purpose of Exercise

Think of exercise as a messenger, delivering a message to the body that the muscle needs to be stronger. Exercise causes damage to worked muscle tissue in the form of micro tears and muscle fiber breakdown. After exercise, the body works to repair the damage to the muscle tissue, making the muscle a little bit stronger than it was before, to avoid damaging the muscle the next time it is exercised. When the cycle is completed time and time again, stronger muscles result. However, muscle tissue repair cannot proceed unless sufficient amino acids are present in the blood and tissues to feed the muscle-building mechanism. Proper protein nutrition is essential for a hard training athlete.

Protein in the Diet

Muscle growth can only occur if muscle protein synthesis exceeds muscle protein breakdown. While exercise alone has an anabolic effect by causing an increase in body protein synthesis, in the absence of supplemental protein intake, the overall balance between synthesis and breakdown will remain negative. Numerous studies have shown that optimum muscle growth occurs when the body has an abundance of amino acid building blocks available for synthesis of muscle tissue. To ensure the availability of sufficient amino acids, it is necessary for an athlete to consume enough protein to maintain a positive protein balance throughout the day. For hard training, elite athletes, consuming enough high quality protein through normal meals is difficult, if not impossible. Most experts agree that a hard training athlete requires 1.2 to 2.0 grams of protein every day per Kg of body weight in order to maintain a positive nitrogen balance for repair of muscle tissue damage from training, and to increase muscle tissue strength and size (*International Journal of Sport Nutrition*, 1991; 1:127-145; *Sports Medicine*, 1991; 12:313-323, *Journal of Sports Sciences*, 2004; 22:65-79). For a 200 pound athlete, that means consuming 110 to 180 grams of protein every day to maintain a positive nitrogen balance. This is difficult to accomplish eating normal meals. Therefore, these athletes need to enhance their daily meals with high protein supplements. In order to achieve maximum muscle tissue anabolism, the protein sources should be of high quality and proven to stimulate protein synthesis after consumption, while providing the amino acids necessary for sustaining protein synthesis for a prolonged period of time.

Fast Digesting Protein Versus Slow Digesting Protein

In 1991 Bounous and Gold published the results of their study (*Clinical & Investigative Medicine*, 1991; 14:4:296-309) in which they found that rats fed a laboratory manufactured, highly soluble, undenatured whey protein exhibited higher levels of humoral immune response and higher levels of tissue glutathione than when they consumed other, commercially available whey proteins, or the control for the experiment, casein. The authors concluded that the undenatured conformation of the molecules was a crucial factor in determining the biological activity of dietary whey protein. The paper was widely quoted by many sports nutrition companies, all of whom were marketing conventional whey protein powders, in spite of the telling fact that the study showed a significant difference in biological activity between the laboratory manufactured, undenatured whey protein and commercially available whey proteins manufactured from cheese whey. The Bounous and Gold paper helped whey protein to become the gold standard for sports nutrition protein supplement and demand for whey protein increased exponentially throughout the decade.

Then, in 1997, a group of researchers focused on fast digesting protein (whey proteins) and slow digesting protein (casein) to compare the metabolic fate of each protein's amino acids after consumption (*Proceedings of the National Academy of Sciences USA*, December 1997; 94:14930-14935). In order to accomplish the comparison, the authors first had to find a way to follow the amino acids of each protein throughout the body after ingestion. They were able to devise a method for producing large quantities of milk proteins intrinsically labeled with [^{13}C]leucine (*Journal of Nutrition*, 1995; 125(1):92-98). As most people involved in sports nutrition now understand, leucine is one of the most important amino acids for stimulating muscle protein synthesis (*The Journal of Nutrition*, 2006 (supplement); *American Journal of Clinical Nutrition*, 2011; 94:809-818).

By following the [^{13}C]leucine throughout the body, the study authors were able to determine speed of absorption of amino acids after ingestion, the effect on postprandial protein synthesis, and effect on protein breakdown and deposition in the body. Both the whey proteins and the casein used in the study were in their natural, undenatured form. The authors purified the casein and whey proteins from skim milk via filtration techniques to yield truly undenatured, fully biologically active, native whey protein and casein in the micelle structure as it is naturally found in milk. The authors selected sixteen young and healthy males aged 24 +/- 4 years and with Body Mass Index (BMI) of 21.0 +/- 1.8 Kg/m^2. The subjects maintained their usual level of physical activity throughout the study. Each subject was fed 30 grams of either micellar casein or native whey protein in one dose and the [^{13}C]leucine was followed through the blood and into tissues for 7 hours after consumption. Results of the study showed that ingestion of native whey proteins induced "a dramatic but short increase of plasma amino acids," while ingestion of casein "induced a prolonged plateau of hyperaminoacidemia" (elevated serum amino acid levels). In addition, protein synthesis was strongly stimulated after ingestion of whey protein and to a lesser extent with the casein meal. Of great interest were the other two findings from the study:

1.) The casein meal inhibited whole body protein breakdown (muscle breakdown included), while the whey proteins had no effect on whole body protein breakdown.
2.) Whole body leucine oxidation over a 7 hour period after ingestion was significantly lower with the casein meal than with the whey protein meal. Therefore, net leucine balance over the 7 hour period after the meal was more positive with casein than with whey protein.

The authors concluded that the two types of proteins "have different metabolic fates and uses. After whey protein ingestion, the plasma appearance of dietary amino acids is fast, high, and transient. This amino acid pattern is associated with an increased protein synthesis and oxidation, and no change in protein breakdown. By contrast, the plasma appearance of dietary amino acids after a casein meal is slower, lower, and prolonged with a different whole body metabolic response. Protein synthesis slightly increases, oxidation is moderately stimulated, but protein breakdown is markedly inhibited. The latter metabolic profile results in a better leucine balance." The authors postulated that casein inhibited protein breakdown while whey protein had no effect on protein breakdown, because of the prolonged period of elevated amino acids in the blood after ingestion of casein. They concluded that the evidence suggested that "a prolonged enough time of hyperaminoacidemia (elevated serum amino acids) would be needed to obtain a significant protein breakdown inhibition". The inhibition of whole body protein breakdown resulted in better leucine retention in the body.

After it was published, the paper created chaos in the sports nutrition industry. Proponents and opponents of the story seemed to miss the point, or ignore the findings that both native whey proteins and casein in its micellar structure serve critical and complementary functions in an athlete's body.

Whey protein marketers tried to find fault with the study rather than focusing on the findings of the study that showed whey proteins to have beneficial anabolic function (stimulation of protein synthesis). Other studies were performed to validate or invalidate the findings of the 1997 study. Subsequent studies confirmed the findings of the original study (*American Journal of Physiology-Endocrinology and Metabolism*, 2001; 280:E340-E348; *American Journal of Clinical Nutrition*, 2006; 84(5): 1070-1079). These studies also concluded that whey proteins significantly stimulated protein synthesis while casein, in its micellar structure, inhibited protein breakdown and resulted in a better post-consumption utilization of dietary nitrogen (protein) and leucine.

Subsequent studies have shown that a 2X increase in plasma amino acids above baseline levels is required before protein synthesis is stimulated after protein ingestion (*Journal of Clinical Investigation*, 1987; 80:1784-1793; *Diabetes*, 1996; 45:393-399; *Journal of Clinical Investigation*, 1987; 79:1062-1069). A slow digesting protein, such as micellar casein, may not digest fast enough to result in a twofold increase in plasma amino acids and, therefore, may not effectively stimulate protein synthesis if ingested by itself. In contrast, a fast digesting whey protein will release amino acids rapidly, resulting in a significant increase in plasma amino acids and thus, strongly stimulate protein synthesis. The serum amino acids from whey protein, however, also disappear quickly and protein synthesis cannot continue without elevated serum amino acids. Whey proteins stimulate protein synthesis after ingestion, while micellar casein releases elevated serum amino acids for prolonged periods of time after ingestion, thereby allowing protein synthesis to continue for prolonged periods of time.

The Case for Milk Protein Concentrate

Consuming whey proteins and micellar casein together can provide the maximum benefit for an athlete's body by stimulating protein synthesis over a prolonged period of time for maximum repair and growth of muscle tissue.

Milk Protein Concentrate (MPC) contains both the casein and whey protein fractions of skim milk that have been concentrated and purified from skim milk via filtration techniques. Just as in the groundbreaking 1997 study, the casein in MPC is in its micellar structure (micellar casein) and the native whey proteins in MPC are in their natural, undenatured structure (native whey proteins).

Additional Nutrients in Milk Protein Concentrate – Chelated Minerals

It is widely known that milk provides large amounts of calcium and phosphorous. However, not everyone is aware that the bulk of milk calcium and phosphorous are found in the casein micelle structure with a high percentage of the calcium and phosphorous being complexed with the casein. Other milk minerals, such as potassium, zinc, and magnesium can also be found in the casein micelle bound (chelated) to the casein. Athletes need to be concerned about dietary minerals just as much as protein, because the body cannot continue to increase muscle mass without also increasing bone mass to support the muscle mass. The human skeletal system is composed mainly of hydroxyapatite, a calcium phosphorous complex. Bones are manufactured from hydroxyapatite. As muscles contract, such as during exercise, they place a strain on bones. The strain causes the body to strengthen the bones, resulting in an increase in bone mass/density. MPC can provide large amounts of calcium and phosphorous for the body to synthesize bone material for strengthening of bones so that they can support stronger muscles.

In addition, studies have shown that zinc and magnesium, alone or together, can play anabolic roles in hard training athletes by stimulating production of growth hormone and testosterone (*Exercise Immunology Review*, 1998; 4:2-21; *Annals of Nutrition and Metabolism*, 1998; 42: 274-282; *Journal of Exercise Physiology*, 2000; 3 (4): 26-36; *International Journal of Sports Nutrition*, 1999; 9:125-135; *Cardiovascular Drugs Therapy,* 1998; 12:197-202). Minerals that are bound to amino acids are more readily absorbed through the intestinal lining into the blood (*Chelated Mineral Nutrition* by DeWayne Ashmead), making them more bioavailable for use in metabolic processes. The majority of minerals found in MPC are directly bound to amino acids on the caseins in the micelle and are easily absorbed into the blood for use by the body.

Conclusion:
Building muscle is essential for every serious athlete. In addition to the proper physical training, daily intake of high quality protein is a requirement. Studies have shown that the proteins found in Milk Protein Concentrate are most beneficial to athletes. The fast digesting, natural, undenatured whey proteins strongly stimulate whole body and muscle protein synthesis, while slow digesting micellar casein continues to release amino acids into the blood for hours after ingestion. The result is prolonged muscle protein synthesis, inhibition of whole body protein breakdown, and overall better utilization of dietary protein. In addition, the chelated minerals in MPC can help to build a stronger skeletal structure and stimulate production of anabolic hormones.

About the Author:
Owner and President of Commercial Proteins, Philip Connolly is a leading expert in protein development, manufacture, and marketing of milk and vegetable proteins to the food, nutraceutical, and pharmaceutical industries. Mr. Connolly has more than 35 years' experience in development and application of proteins including; over 20 U.S. and Worldwide Patents covering protein manufacture and applications, 13+ years in R&D for the manufacture and application of proteins in food, 3 years as Senior Research Scientist for the New Zealand Dairy Board, and numerous formulations for sports nutrition companies, including EAS and Weider Nutrition.

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