U.S. WHEY PROTEINS IN SPORTS NUTRITION

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Whether it is to out-perform the competition or maximize personal potential, athletes are competitive by nature. This drive to succeed, and a growing awareness that nutritional choices can influence athletic performance, has fueled an explosion in the interest of nutritional ergogenic aids; dietary compounds that enhance athletic performance.

Very few nutritional ergogenic aids that are marketed to athletes possess scientific evidence. However, an ever-increasing amount of research demonstrates that whey proteins provide the athlete with a number of exclusive benefits. Whey proteins promote efficient recovery, stronger immunity and better results from exercise training. Some clinical trials show direct improvements in athletic performance by incorporating whey proteins into the diet.

THE PERFECT PROTEIN FOR SPORTS PEOPLE

Exercise training is merely a metabolic stress, a signal to our physiology to adapt in a specific manner. Competitive athletes must undergo progressive increases in training stress to bring about physical and psychological adaptations that improve performance. However, these increases in training stress can exceed the athlete's ability to adapt, leading to decrements in performance, injury or re-occurring illness. For example, the response to exercise can be positive, such as an improvement in functionality or performance. The overall effect of exercise can also be negative if the immune system or general health is compromised. Uninterrupted progress is vital to achieving fitness goals and most athletes will be aware that even medically harmless infections can result in a significant decrement in performance.[21]

Whey protein is a collective term that encompasses a range of soluble protein fractions found in milk. Whey protein products are classified into several categories based on their macronutrient ratios that suit a variety of food manufacturing purposes (see whey product descriptions in Reference Manual for U.S. Whey and Lactose Products). However, an ever-increasing amount of research suggests that whey protein concentrates (WPC 80) and isolates (WPI) are ideally suited to people who engage in regular exercise.

WPC 80 and WPI not only provide a pure source of high quality protein with minimal fat, carbohydrate and lactose, they are biochemically tailored to promote strong immunity, efficient muscle recovery and extend the overall health benefits of physical activity. This monograph describes the functions and presents potential mechanisms by which whey proteins may enhance physical status of people involved in sports and athletic training.

WHEY PROTEINS: TAILORED TO PROMOTE BETTER RECOVERY AND ATHLETIC PERFORMANCE

At the molecular level, stimulating protein synthesis and minimizing protein breakdown are the two processes essential to efficient recovery after exercise.[47] The ability of a protein to promote these characteristics resides in its digestibility and the composition of its amino acids.[58] In comparison to other protein sources, whey proteins are shown in research to be most effective at promoting the mechanisms that underline efficient recovery and better results from exercise training.

- Whey's amino acid profile is almost identical to that of skeletal muscle. Whey protein provides all the correct amino acids (the building blocks of protein) in approximate proportion to their ratios in skeletal muscle.[24]
- Whey protein supplements such as WPC 80 and WPI generally contain a higher dose (per 100 g) of the essential amino acids than other protein sources.[8] The essential amino acids are indispensable for stimulating a high rate of protein synthesis within adult muscle.[54]
- These whey protein supplements are also the richest known source of branched chain amino acids (BCAAs); leucine, isoleucine and valine.[8] For the athlete, the BCAAs play a pivotal role in muscle metabolism (see: The pivotal role of BCAAs in sports nutrition). The BCAAs serve as direct precursors for muscle energy production and fuel for the immune system as well as activate the mechanisms that underline recovery.[1,27,55]

Table 1. Approximate Amino Acid Profile of Various Types of Commercially Available Protein (g/100 g protein)

Ingredient	Whey Protein Concentrate (80%)	Ion-Exchange Whey Protein Isolate	Cross-Flow Microfiltration Whey Protein Isolate
Alanine	4.82	5.60	5.60
Arginine*	3.18	3.00	1.70
Aspartic Acid	12.26	12.30	12.70
Cystine	2.28	1.90	2.50
Glutamic Acid	15.41	17.70	19.70
Glycine	2.00	1.90	2.00
Histidine*	2.41	2.00	1.80
Isoleucine[H]*	6.41	5.40	6.80
Leucine[H]*	11.60	13.50	10.90
Lysine*	9.83	10.90	9.50
Methionine*	2.35	3.50	3.10
Phenylalanine*	3.56	3.40	2.50
Proline	6.28	4.80	6.30
Serine	6.24	4.50	5.30
Threonine*	8.44	5.30	8.30
Tryptophan*	1.80	1.50	2.00
Tyrosine	3.26	3.90	3.10
Valine[H]*	6.09	5.40	6.40
Total BCAA[H]	24.10	24.30	24.10
Total EAA*	55.67	53.90	53.00

Adapted from Bucci LR and Unlu LM.[7]
[H]Branched Chain Amino Acids (BCAAs)
*Essential Amino Acids (EAA)

- Additionally, the high concentration of the BCAA, leucine within whey protein (10-14 g per 100 g) is of particular interest to sports scientists.[24] Recent studies confirm that leucine plays a key role in igniting the muscle DNA translation pathways of protein synthesis.[1] An abundant supply of leucine to muscle after exercise may promote more efficient recovery at the molecular level to speed the adaptation process of exercise training.
- WPC 80 and WPI are a rich, rare source of bioavailable cysteine; at least a 4-fold higher concentration (per 100 g of protein) compared to other high quality protein sources such as casein and soy.[8] Cysteine is known as a conditionally essential amino acid as it plays a number of indispensable roles in human metabolism.[18] An adequate supply of cysteine is essential to the preservation of lean body tissue (muscle), particularly during exercise.[32] Cysteine is also the rate limiting amino acid of the body's antioxidant defense systems.[59] Boosting the body's stores of cysteine is shown to enhance antioxidant capacity, reduce oxidative stress and improve exercise performance.[50]
- Whey proteins are unique in that they are digested differently than other dietary proteins. Whey proteins are absorbed rapidly, deliver more amino acids to tissues and stimulate a higher rate of protein synthesis that results in a higher net gain of protein within the body.[17,36,40,45] Aside from being easily assimilated, whey proteins are soluble and mix easily in any liquid. Therefore, whey is the ideal protein to consume before, during or after exercise or sports events. Athletes can add whey proteins to their pre- and post-exercise beverages and liquid meal replacements to optimize recovery and enhance subsequent performance.

WHEY PROTEINS: SUPPORT STRONG IMMUNITY DURING EXERCISE TRAINING

The immune system is highly influenced by exercise. Whereas the immune response is enhanced by moderate exercise, it maybe suppressed after exercise of high intensity or long duration. This temporary suppression of the immune system can last from 6 to 48 hours and predisposes the individual to an increased risk of infection.[42,43] In comparison to other protein sources, research shows that whey proteins are unique in their ability to optimize a number of key aspects of immune function that promote strong immunity.[14]

- Whey protein encompasses a range of fractions including the major bovine proteins α-lactalbumin and β-lactoglobulin, and minor fractions such as serum proteins, lactoferrin, as well as a series of immunoglobulins.[57] Individually, these fractions are established immune-enhancing constituents that modulate a range of immune functions.[57] They are implicated in a range of bioactive functions such as prebiotic effects, promotion of tissue repair, maintenance of intestinal integrity, destruction of pathogens and elimination of toxins.[11,20,57] WPC 80 and WPI are a rich, hetrogenous mixture of these proteins. Collectively, whey proteins are one of very few nutritional materials shown in research to modulate both specific and non-specific aspects of immune function using proven in vitro and in vivo models. Often, these improvements have correlated with a measurable improvement in immune mediated health.[14]

- Via its rich concentration of cysteine, whey protein is the only dietary protein shown in research to boost glutathione production.[33,37,39] Glutathione (GSH) is the centerpiece of the body's antioxidant and immune defense systems.[18] The concentration of GSH within various cells regulates many facets of immune function and the body's ability to maintain health and avoid disease.[59] Animal and human studies have shown that in comparison to other protein sources, whey proteins are exclusive in their ability to boost GSH production that optimizes many aspects of immune function.[14]

- Muscle is the primary synthesis site of glutamine.[48] This amino acid is the essential fuel of the immune system, cellular replication and many other indispensable functions.[38] There is evidence that suggests periods of intense metabolic stress such as exercise training may exceed the body's capacity to synthesize glutamine.[48,56] This may lead to impaired immune function, reoccurring illness, infections and prolonged poor performance.[32,48,56] Whey proteins are the richest known source of the amino acids used exclusively for glutamine synthesis within muscle.[57] These are the BCCAs (26%) and glutamate (6%).[55] Therefore, over one-third of whey proteins entire amino acid profile is devoted to preserving the muscle glutamine reservoir. For all of these reasons, whey proteins provide active people with an array of benefits that promote strong immunity and protect health during exercise training.

THE PIVOTAL ROLE OF BCAAs IN SPORTS NUTRITION

For the athlete, the branched chain amino acids (BCAAs) leucine, isoleucine and valine play a pivotal role in the recovery/adaptation process from exercise training. The BCAAs appear to be indispensable for stimulating a high rate of protein synthesis in muscle[1] (a key mechanism that underlines recovery and regeneration of tissue). However, they are also required exclusively for the manufacture of glutamine within muscle.[27] Muscle glutamine is the primary fuel that powers an array of indispensable cellular functions including the immune response and the replication of most cells.[56] The body's demand for glutamine is ravenous; without the constant de novo synthesis of glutamine from BCAAs within its muscles, the body's glutamine supply would be depleted within hours.[48] Additionally, the BCAAs are also metabolized for energy within muscles during exercise.[55]

Through this action, they help increase carbohydrate bioavailability, delay fatigue and counteract muscle protein breakdown. Therefore, in an attempt to meet all these demands the BCAAs are metabolized extensively during periods of metabolic stress such as illness, infection, calorie restriction and exercise training.[27] An inadequate supply of BCAAs during exercise training may compromise immune function or the ability to recover quickly from exercise. In comparison to other dietary sources, whey proteins are the richest known source of naturally occurring BCAAs; they contain up to 26% BCAAs.[8] Therefore, on a gram for gram basis, whey proteins are a rich, economical source of BCAAs in comparison to amino acid supplements.

SPORTS-SPECIFIC RECOMMENDATIONS: HOW TO USE WHEY PROTEINS TO OPTIMIZE PERFORMANCE

Whey proteins are one of very few nutritional supplements that have been shown in well-controlled studies to enhance either athletic performance or improve physiological adaptations during training.

Research involving the application of whey proteins to optimize health and sports performance is still in its infancy; more clinical trials need to be completed before clear recommendations can be made. However, the following suggestions are research-based guidelines for active people that wish to incorporate whey proteins into their diet to optimize health and athletic performance.

TO ENHANCE AEROBIC (ENDURANCE) PERFORMANCE

The maintenance of GSH status within the body is critical to endurance performance.[49] In a group of highly trained cyclists, a dose of 1 g/kg/day prevented a decline in blood glutathione concentrations during 6 weeks of intense road cycling training.[39] The athletes in this study performed 4 sessions per week (30-70 minutes each) that consisted of moderate intensity (50-70% of max heart rate) and high intensity (80%+ of max heart rate) exercise. Therefore, endurance athletes who perform a greater volume of training may require a higher dose of whey protein each day to maintain GSH status.

TO ENHANCE ANAEROBIC CAPACITY, SPEED AND STRENGTH IN POWER-BASED SPORTS

Sports events and exercise of high intensity utilize anaerobic energy pathways. Anaerobic exercise training generally involves shorter, repeated bouts of high intensity activity such as repeated sprints, circuit and resistance training. Many competitive athletes incorporate this form of exercise into their training programs. However, anaerobic fitness training, (only 3 times a week for 4-8 weeks), has been shown to lower blood GSH and glutamine concentrations as well as suppress immune function in adults, despite the consumption of a healthy diet.[26,32] Taken together, the results of these studies demonstrate a cause and effect relationship between the intensity of an exercise training program and a decrease in the constituents that provide competent immune function. The addition of 20 grams of whey protein to the daily diet has been shown to improve anaerobic performance without exercise training. Athletes that undertake multiple anaerobic training sessions each week may require a daily dose of up to 1-1.5 grams of whey protein/kg/day to maintain strong immunity.

TO OPTIMIZE RECOVERY AFTER TRAINING

The consumption of a protein and carbohydrate liquid supplement immediately after exercise is shown to provide more effective glycogen restoration, a higher stimulation of protein synthesis rates and anabolic hormones as well as prevent exercise-induced immune suppression.[21,53] This simple strategy may also boost performance in a subsequent bout of exercise by up to 24%.[29]

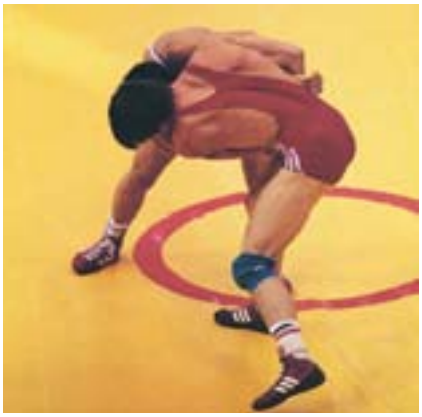
Whey proteins' immune-enhancing properties, excellent amino acid profile and rapid digestion kinetics make it the ideal protein to consume after exercise. To promote efficient recovery from any type of vigorous exercise, athletes should consume a 20 to 50 gram dose of whey protein combined with an easily absorbed carbohydrate source (such as glucose), mixed in plenty of water immediately after exercise. The all important post-workout meal should be consumed 30-60 minutes after exercise.

An abundance of amino acids circulating within the blood is shown to enhance the anabolic (building) effects of strength training.[3]

Therefore, athletes who desire optimum increases in strength/power output without a significant increase in body mass should incorporate one serving of whey protein (20-50 grams) into their calorie-controlled diet, and this dose should be consumed before any type of resistance exercise.

TO BUILD MUSCLE MASS

Bodybuilders and other people that desire optimum gains in lean (muscle) mass should aim to consume a dose of 1.5 g/kg/day of whey protein during a resistance training program. This dose should be divided into 4 or 5 smaller servings and consumed in mixed macronutrient meals throughout the day. Research shows that the presence of carbohydrates and fats enhances whey proteins anabolic effect on muscle tissue.[17] The consumption of whey protein in mixed-macronutrient meals is shown to provide a higher net protein gain in both young and older adults compared to other high quality proteins such as casein.[17]



TO IMPROVE BODY COMPOSITION

Whey proteins can be incorporated into the diet to improve body composition, strength and power without large gains in body mass. Research suggests that the consumption of whey protein before exercise will promote the maintenance of lean tissue while increasing the utilization of body fat for fuel.[5] To promote the preservation of lean mass and a reduction in fat mass, a dose of whey proteins (20-50 grams) should be consumed within the hour before exercise.

Table 2. Typical Composition of Whey Protein Concentrate 80% and Whey Protein Isolate (percentage)

Component	Whey Protein Concentrate (80%)	Whey Protein Isolate
Protein	80.0–82.0	92.0
Lactose	4.0–8.0	0.5
Lipid	1.0–6.0	1.0
Minerals	3.0–4.0	2.0
Moisture	3.5–4.5	4.5

WHEY PROTEINS, SPORTS PERFORMANCE AND THE ROLE OF GLUTATHIONE (GSH)

The principal role of the GSH antioxidant system is to protect cells against oxidative damage caused by pollution, toxins, exercise and UV exposure. GSH does this by directly neutralizing free radicals but also by donating its components to other antioxidant compounds like vitamins C & E and key antioxidant enzymes.[59] GSH not only regulates antioxidant capacity and the body's ability to maintain health and avoid disease; a direct link between GSH and exercise performance has been established.

Exercise dramatically increases oxygen flux through tissues. This results in the high generation of free radicals that can lead to oxidative stress. While exercise training improves the body's antioxidant defenses, oxidative stress can still occur in trained individuals.[49] Oxidative stress damages cells and tissues and is thought to be a major contributor to muscular fatigue and poor athletic performance.[50] Low GSH concentrations within various cells correlate with excessive free radical production and poor athletic performance; muscles low in GSH suffer far more oxidative damage.[49] However, maintaining GSH status is shown to minimize oxidative stress and boost athletic performance.[50]

Exercise creates a demand that can deprive immune cells of the capacity to replenish GSH. This has lead some researchers to suggest that a competition for a limited supply of GSH between working muscles and the immune system can create a state of imbalance that may lead to prolonged poor performance and increased susceptibility to illnesses such as chronic fatigue syndrome.[4] Unlike other dietary proteins such as soy, whey proteins are shown in research to boost GSH production or provide a favorable impact on GSH status within the body. In some clinical trials, this has resulted in direct improvements in athletic performance.

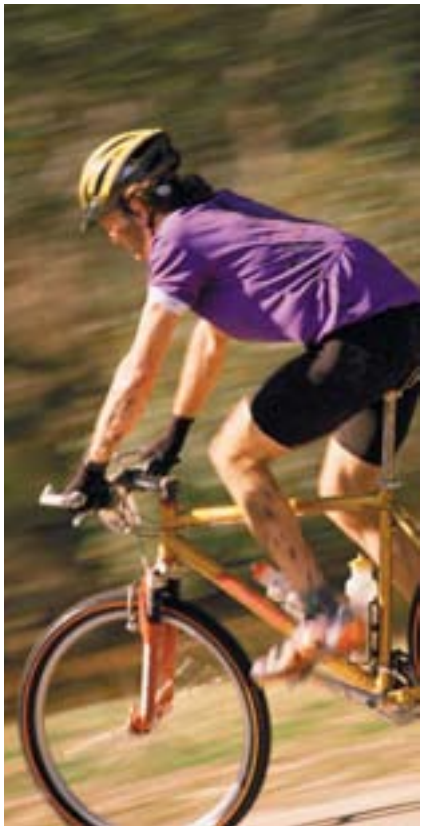
Boost antioxidant capacity and enhance performance

For example, supplementation with whey proteins (20 grams per day for 12 weeks) in healthy young men and women enhanced GSH concentrations in blood lymphocytes but also improved peak power output and total work capacity during a sprint cycling test.[33] In another trial, after 70 days of supplementation with various proteins, the only participants that demonstrated a clear reduction in oxidative damage, improved resistance to muscle fatigue and enhanced selenium status were those given WPI.[10] In terms of endurance performance, a dose of 1 g/kg/day (grams per kilogram of body weight per day) of WPI was shown to prevent a decline in both whole blood and mononuclear cell glutathione concentrations that was seen in a placebo-supplemented group during 6 weeks of intense road cycling training.[39]

THE ROLE OF WHEY PROTEINS AND CALCIUM IN SPORTS PERFORMANCE

For athletes, an adequate supply of calcium for optimum performance is vital. Calcium is not only essential to bone maintenance, it is indispensable to nerve conduction, muscle contraction and a myriad of other physiological functions. Everyday that calcium intake is inadequate, the body draws upon its own reserves within bone, to meet these demands.[2] Recent reports show that the average intake of calcium in U.S. citizens is only approximately 750 mg/day; way below the recommended intake of 1,200 mg.[6] Athletes maybe even more deficient because bone mineralization increases in response to the stress of exercise.[31] Additionally, accurate assessment of calcium status is difficult as blood calcium concentrations are maintained within a tightly controlled, physiological range so that normal values are preserved even when intake is poor. The benefits of months or even years of training can be lost due to stress fractures from weak bones. Therefore, athletes should be aware of the best nutritional sources of calcium.

Whey protein-based products can contain between 500-2,000 mg of dairy calcium. Dairy calcium is the most bioavailable form of calcium.[23] The bioavailability of a nutrient in a particular food is the actual amount of the nutrient that is absorbed during digestion. Studies have shown that calcium absorption from non-dairy sources, such as fortified soy milk are 25% less than that seen from dairy foods.[23] Therefore, whey protein-based products are a cost-effective, high quality source of calcium that is readily absorbed by the body.



THE BENEFITS OF LACTOFERRIN FOR ATHLETES

The fundamental principal of sports nutrition is to build a better, healthier body that can excel in athletic performance. In this regard, lactoferrin; a protein fraction exclusive to whey, has several important benefits for athletes. Bovine lactoferrin is absorbed intact in adult humans,[52] and its beneficial effects include potent antibacterial and antiviral properties, prevention of the growth of pathogenic organisms in the gut, stimulation of the immune system and modulation of inflammation caused by tissue damage.[20] The biological roles of lactoferrin are still emerging from science. However, its influential role in iron and bone metabolism should be of particular interest to athletes.

The iron status of an athlete is critical as this mineral is indispensable in the transportation of oxygen throughout the body. Iron constitutes the receptor at the core of hemoglobin; the cellular transporter of oxygen. Lactoferrin (a member of the transferrin family) provides the essential function of binding iron to cells within the blood; it sequesters and solubilizes iron, thus controlling the amount of iron available for gut metabolism.[57] Therefore, lactoferrin would appear to play an important role in maintaining healthy regulation of red blood cells, hemoglobin and oxygen transport.

The lactoferrin found in whey has also been shown to provide a direct beneficial impact on bone metabolism.[12,22] In cell culture research lactoferrin was shown to stimulate the proliferation of osteoblasts and cartilage cells at physiological concentrations. The magnitude of this effect exceeded that observed in response to other skeletal growth factors such as IGF-1 and TGFb. These beneficial effects were then confirmed in mammals, leading the researchers to conclude that lactoferrin has an anabolic (building) effect on bone metabolism and therefore may have an important role in bone health and the prevention of osteoporosis.[12,22]

Whey proteins improve body composition

Athletes who participate in a range of sports not only strive to increase their muscle strength but also their muscle mass. In sports where an increase in weight is not desired, an improvement in body composition (lean body mass to fat mass ratio) is always beneficial. The relationship between GSH and body composition changes has been demonstrated clearly in a variety of unrelated conditions such as cancer and HIV as well as healthy adults undertaking exercise training programs.[18,25,32] Low GSH levels within various cells in the body forecast immune suppression and muscle loss whereas maintaining GSH status underlines the preservation of muscle tissue and a reduction in body fat.[18,25,32] These effects are thought to be due to the positive, regulatory effect of cysteine and GSH on whole body protein metabolism[18,25] but also their ability to directly reduce muscle breakdown via the inhibition of the ubiquitin-proteasome pathway.[28]

Supplementation with whey proteins not only boosts GSH, it also provides direct improvements in body composition. Supplementation with only 20 grams of whey protein per day was shown in one study to provide a significant decrease in body fat, without any type of specific exercise training.[33] During exercise training, rodents fed whey protein before exercise training demonstrated lower body fat levels and more lean body mass after the program.[5] This was due to whey proteins ability to promote fat utilization for energy.[5]

Resistance training is thought to be the most effective form of exercise that improves body composition. In a group of resistance-trained men, supplementation with a hydrolyzed WPI (1.5 g/kg/day) resulted in a 2-5 fold better gain in lean (muscle) mass and a reduction in fat mass, compared to matched control groups.[9,15,16] In one of these trials, the capacity of WPI to enhance muscle hypertrophy (size) during resistance training was confirmed at the cellular level; muscle biopsies taken from the men before and after training revealed that supplementation with WPI increased the size of the type-2 muscle fibers by up to 543% compared to a carbohydrate control group.[16] Additionally, the greater increases in muscle fiber size correlated strongly with the superior strength improvements witnessed in the WPI-supplemented groups.[16]

Greater muscle strength

In several trials involving strength training, whey protein supplementation (1.2-1.5 g/kg/day for 6-12 weeks) provided significantly better improvements in muscular strength in a number of assessments in comparison to matched carbohydrate and/or protein control groups.[9,15,16] In two of these trials, WPI supplementation provided considerably better strength increases in key exercises such as the barbell bench press and squat (10-20% better gains than matched control groups).[15,16] Strength improvements in these exercises are thought to enhance the athlete's capacity to improve performance in many power and strength-based events. Therefore, whey supplementation may give the athlete an edge in strength development. However, effective strategies that develop muscular strength, such as combining whey protein supplementation with resistance training, would improve functional capacity in most people, not just athletes.

To date, whey protein is the only source of protein shown in research to reduce markers of muscle damage and speed recovery from resistance training.

Better recovery

Glycogen is the body's storage form of energy that fuels exercise. Low glycogen stores in tissues are associated with fatigue and poor exercise performance.[30] Therefore, it is of considerable importance to athletes that they have adequate stores of glycogen in tissues. The results of one recent study demonstrated that a diet rich in whey proteins during exercise training resulted in significantly higher glycogen storage in the liver.[41] The rodents given whey protein stored considerably more glycogen in the liver than other rodents fed either casein or soy protein.[41] This beneficial effect was due to whey proteins' ability to enhance the regulatory activity of various hepatic enzymes responsible for synthesizing and storing glycogen.[41] This study showed for the first time that the type of protein in the diet can affect liver glycogen content.

In healthy young adults, supplementation with whey proteins is shown to accelerate recovery after intense resistance exercise.[13] Compared to a carbohydrate placebo, supplementation with WPI (1 g/kg/day) after exercise for 14 days resulted in a significantly faster rate of recovery to maximum strength and reduced plasma creatine kinase levels; a marker of muscle damage. These two results combined suggest that supplementation with the WPI product provided faster recovery after intense resistance training.[13]

PROTEIN NEEDS FOR ATHLETIC INDIVIDUALS

More than any other area of sports nutrition, the topic of protein intake for athletes has been a point of much confusion and debate. Much of the controversy surrounding protein recommendations can be contributed to the realization that requirements for various amino acids in adults maybe much more complicated than previously assumed. There are many gaps in our understanding of protein requirements for healthy, active people; this lack of biological understanding has exacerbated the difficulties of resolving the controversies. When athletes determine their daily protein requirements they should consider the following pertinent facts.

- The current laboratory measures used to assess protein requirements are not concerned with optimizing health or enhancing physical performance.[34,51]
- Protein recommendations for healthy populations have been based almost entirely upon nitrogen balance studies. Yet protein metabolism scientists now acknowledge that this method is flawed; this technique overestimates nitrogen (protein) intake and underestimates nitrogen losses.[51]
- Exactly how much protein an athlete needs to optimize results from training is not easy to determine. Individual goals, energy (calorie) intake and exercise intensity, duration and type, as well as training history, gender and age all shape a person's protein requirements.[34]
- Until the various functions of amino acids are understood at both the mechanistic and quantitative level, the current dietary recommendations for both healthy and sick humans are intellectually unsatisfactory empirical values.[46] Scientists in the field of protein metabolism now admit that protein requirements to optimize results from intense exercise training may be higher than previously suspected.[34,46,51]
- While it has been established that athletic individuals require a higher protein intake than sedentary people (up to double the recommended dietary allowance), a more important question is whether some types of protein may improve health and enhance athletic performance better than others. However, this question has not been adequately investigated.[35]
- There is no evidence in the scientific literature that suggests a high protein intake may harm a healthy body.[44] In fact, increasing the ratio of protein in the diet is now considered a safe and effective strategy that provides a number of health benefits such as lower blood lipid concentrations, improved insulin/glucose metabolism and reduction of unwanted body fat.[19] Due to the array of benefits whey proteins provide, it should be one of the first dietary proteins considered when active people choose to increase their protein intake.

For best results, an athlete's daily dose of whey protein should be divided into several smaller (20-50 g) servings and consumed in mixed-macronutrient meals (with the addition of carbohydrate and fats). Research shows that whey proteins are utilized more effectively within the body when they are consumed along with a source of carbohydrates and some fats.[17] A dairy milk and fruit smoothie containing a 20-50 g serving of WPC 80 or WPI with added flax oil, for example, is a good example of how to consume whey proteins to ensure best results.

THE UNIQUE BENEFITS OF WHEY PROTEINS IN SPORTS NUTRITION

Whey proteins are naturally occurring dairy protein fractions that are shown in research to promote strong immunity, efficient muscle recovery and extend the overall benefits of physical activity. Whey proteins provide a number of unique benefits to athletes.

- Rapidly digested, easily assimilated source of high quality protein that stimulates a higher rate of protein synthesis and net protein gain in tissues than other protein sources.[17,40]
- Directly enhances a number of key aspects of immune function that protect against illness and infection.[14]
- Richest known source of BCAAs; indispensable for the manufacture of glutamine (the primary fuel of the immune system)[48] and stimulation of protein synthesis in muscle;[1] also provides energy substrates to working muscles.[55]
- Provide a rich source of cysteine that boosts antioxidant capacity and improve exercise performance.[33,39,50]
- Promote higher glycogen levels within the liver; an important storage form of energy for exercise.[41]
- Reduce markers of muscle damage and speed recovery after exercise.[13]
- Provide greater strength gains during resistance training and better muscle size increases during bodybuilding exercise.[9,15]
- Provide a source of bioavailable calcium to help maintain bone health and prevent stress fractures that many athletes experience during training.[23]
- Along with a high solubility, these characteristics make whey proteins an ideal addition to any sports beverages or meal replacement for consumption before, during and after exercise.

Q&A

Q&A WITH DR. DAVID CAMERON-SMITH

Deakin University

Dr. Cameron-Smith, is an Associate Professor in muscle physiology in the School of Exercise and Nutrition Sciences, Deakin University, Melbourne Australia. His research aims are to link the most recent advances in molecular and cell biology to gain a greater understanding on how dietary proteins and strength exercise promote human skeletal muscle growth and repair.

Q *What are some of the latest "whey discoveries" of significance to athletes, in your opinion?*

A For strength athletes two key strategies to improve performance include effective recovery and strength gains. Compelling recent evidence demonstrates that whey protein, when added to a recovery beverage, reduced creatine kinase levels, a marker of muscle damage, in cyclists after an exhaustive endurance ride. Importantly, 12 to 15 hours after the first ride, performance on a repeat cycling endurance test was improved by 36% in the group receiving whey. This recent study highlights how whey proteins may help reduce muscular damage and improve recovery.

For strength gains, increased protein synthesis is needed to make larger and stronger muscle fibers. It is now well established that whey is rapidly digested and promotes muscle protein synthesis when ingested after strength exercise. These findings are complemented by two studies showing increased muscle cross-sectional area (a measure of muscle fiber thickness) in strength athletes ingesting whey protein at the time of exercise.

Q *You conduct research with older citizens too, do they have "lessons to learn" from younger athletes?*

A Our research group is examining the muscular regeneration capacity and inflammation responses of older citizens. Age does not reduce the ability of whey protein to activate the cellular processes controlling protein synthesis in muscle. Therefore, older citizens will also benefit from regular whey ingestion, particularly after exercise, to help maintain muscle mass and strength. Indeed whey may be more important in older citizens as it appears that older muscle is more responsive to fast protein than younger muscle.

Q *Are there relationships between the proven benefits of whey proteins for athletes and their potential role in preventing sarcopenia in a sedentary population?*

A Detailed molecular biology and genetic analysis is providing new clues on the cellular origins of sarcopenia. However, much of the loss of muscle mass can be attributed to reduced protein intake and decreased levels of activity. As with athletes, maintaining an adequate intake of essential and branched chain amino acids is beneficial for muscle protein maintenance, providing whey protein in older citizens will help preserve muscle mass.

Q *Some customers, especially women, are afraid to "bulk up" if consuming whey proteins. Is there a maximum level for women?*

A There is a vast difference in the rate at which women and men increase muscle mass. The reasons are not yet well understood, although clearly sex hormones play an important role. Women consuming whey proteins after exercise will experience many benefits, including reduced muscle soreness and enhanced recovery. Whey, by stimulating protein synthesis may also help improve tone, not bulk. The other key advantage is that whey can reduce appetite, helping reduce hunger pains after exercise for the many women and men, who have added exercise to their lifestyle to help manage body weight.

Q *How much whey proteins is "safe" for a casual exerciser? or for an older consumer?*

A Whey proteins are exceptionally safe, proving an easily digested source of pure proteins, rich in essential and branched chain amino acids. Taking a sports formulation containing whey protein before, during or immediately after exercise will be effective in the infrequent or older exerciser. It is in situations where muscle soreness is likely that whey proteins provide real benefits to reduce the extent of muscle damage and reduce soreness. It is important to broaden the definition of exercise to include all forms of physical activity, such as golf, tennis, hiking, cycling and gardening. Any form of activity that is likely to cause muscle damage and soreness can benefit from whey proteins.

Q&A WITH KIMBERLEE J. BURRINGTON

Dairy Ingredient Applications Laboratory

The Dairy Ingredient Applications Lab, Wisconsin Center for Dairy Research, University of Wisconsin, Madison works together with dairy ingredient manufacturers and food manufacturers to provide hands-on technical support for the development of superior U.S. dairy ingredients and increased utilization of U.S. dairy ingredients in foods.

Q *Choosing the right type of whey protein is increasingly complex for a manufacturer of products for athletes. Which is the best type of whey protein?*

A There is no "ideal" whey protein but rather, an increasingly wider portfolio of protein ingredients to choose from. Processors have strived to offer ingredients with customized composition (lactose-free), functionality (enriched in a specific protein fraction), or application (thermo-resistant or hydrolyzed products). Such variety of ingredients helps manufacturers formulate products that better meet the nutritional needs of various types of athletes. It also helps manufacturers design very unique products with added value. Please contact your U.S. whey protein supplier for assistance on selecting the "best" protein for your application.

Q *Are whey proteins only available as powders?*

A In international markets, whey protein ingredients are typically sold in bags, in powder form. This is cost efficient and guarantees the longest shelf-life for the ingredients. When marketed directly to consumers, whey proteins are generally instantized which makes it easier to dissolve them in liquids. We are starting to see more whey proteins marketed, as an ingredient, in a texturized form (crispy nuggets, "curls"). These can be used as ingredients in sports bars, for example, or simply flavored and marketed as high-protein snacks.

Q *Can whey proteins be used in sports gels?*

A Sports gels are typically low in pH so the high solubility of whey proteins at low pH will allow them to function well in this application. If a clear gel is desired, then a WPI will be the best choice because of its low level of fat and lactose. Low pH gels also tend to be more refreshing and appealing to the consumer who may already be used to carbohydrate gels.

Q *Can whey proteins be formulated into a paste or a spread? (for example to be squeezed out a tube)*

A Pastes or spreads can be formulated with whey proteins with the best performance of the proteins found in products with a low pH. Taking advantage of the enhanced solubility and thermo-stability of whey proteins at a low pH in a paste product will ensure a good shelf-life and high product quality.

Q&A WITH JASON STEPHENS

NextProteins Inc.

The company was established when David Jenkins combined his passion for sports and academic knowledge to create the highest quality whey protein supplements designed to enhance the life of the consumer. The company has invested more than $6.7 million in whey research and clinical testing over the past 15 years. www.nextproteins.com.

Q *I heard amino acids were the best way to get protein. Is this true?*

A No, it's not true, since free-form amino acids are poorly utilized by the body for protein synthesis. To get the amino acids your body needs, consume protein in the form of peptides (the best method) or eat whole, intact protein. In fact, scientists have found that protein in the form of peptides is absorbed much more rapidly – as much as 237% faster – than free form amino acids or intact protein.

Not only does whey protein improve nitrogen retention better than amino acids, research shows it also stimulates protein synthesis 119% better than casein. When 30 grams of whey protein were compared to 43 grams of casein, whey protein increased protein synthesis by 68%, while casein increased it by only 31%.

Q *Will a protein powder give me big muscles?*

A In order to achieve muscle growth while using protein powders you must "weight train" on a regular basis. A recommended workout for obtaining greater muscle definition is to exercise or train 3-4 days a week, rest prudently, avoid overtraining, and eat right. If you stick to this program, you may see results in as short a period of time as six weeks. Continuing this regimen for 48 weeks a year, for at least 3 or 4 years, will provide you the opportunity to attain the "big muscles" or improved muscular definition you are looking for.

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