

## Soy Protein and Performance Nutrition

### New Evidence – New Opportunities

The performance nutrition market is a dynamic and growing segment of today’s marketplace, supported by scientific evidence that demonstrates efficacy and also plays a key role in identifying new market opportunities. For over 35 years, The Solae Company has led the industry in supporting research to discover and understand the many health benefits of Supro® brand soy protein. Today, there is a growing body of research providing scientific support for the unique benefits of Supro protein relative to athletic performance and overall health. This growing body of evidence is providing marketers of sports and performance nutrition products new opportunities to introduce products based on these unique benefits.

A broad range of scientific studies demonstrate that Supro® soy protein:

- ▶ Is a high-quality protein
- ▶ Supports the development of lean body mass
- ▶ Aids muscle recovery
- ▶ Provides energy for muscles during exercise
- ▶ Builds muscle strength in conjunction with an exercise program
- ▶ Reduces oxidative stress associated with exercise
- ▶ Maintains healthy hormone levels
- ▶ Sustains energy levels via its impact on glycemic index

Each of these benefits will be discussed in more detail along with the implications of new and compelling research into the *postprandial kinetics of protein*. This area of research has the potential to reshape how experts view the role protein ingestion and the delivery of amino acids plays in building and maintaining lean muscle mass.

#### Start with High-Quality Protein

Although some may still talk of BV (biological value), NPU (net protein utilization) or even PER (protein efficiency ratio), the **accepted way** to evaluate the quality of protein today is to use the FAO/WHO recommended Protein Digestibility-Corrected Amino Acid Score (PDCAAS)<sup>1</sup>. This method is based on actual human amino acid requirements and has been adopted as the basis for protein labeling of foods and supplements by the United States Food and Drug Administration (FDA).

Supro® soy protein is the only plant protein to achieve the highest possible PDCAAS score of 1.00 demonstrating that it is equivalent in protein quality to dairy and egg proteins (Table 1)<sup>2</sup>.

#### Why Protein Digestibility-Corrected Amino Acid Score?

The FDA supports the PDCAAS method because it is the only method that takes into account human amino acid requirements, as well as protein digestibility.

The PDCAAS method specifically benchmarks a protein against the essential amino acid requirements of the 2-5 year old child. Among all age groups, the 2-5 year old child represents the group with the highest requirements for essential amino acids on a body weight basis. Using this method, Supro® soy protein meets or exceeds the essential amino acid requirements of children and adults alike<sup>3,9</sup> and hence carries the maximum possible score of 1.00.

**Table 1: Protein Digestibility-Corrected Amino Acid Scores of Select Food Proteins<sup>2</sup>**

Protein Source	PDCAAS
Isolated Soy Protein *	1.00
Casein	1.00
Egg White	1.00
Skim Milk Powder	1.00
Whey Protein	1.00
Beef Protein	0.92
Pea Flour	0.69
Kidney Beans (canned)	0.68
Pinto Beans (canned)	0.63
Whole Wheat	0.40
Wheat Gluten	0.25
* Supro® brand soy protein	

It is clear that soy protein is a high-quality protein, equivalent to other commonly used protein sources such as casein, egg white and whey and is superior in protein quality to beef protein making it an ideal choice for performance nutrition products.

**Arginine and Glutamine – High-Performance Amino Acids**

It is well documented that certain amino acids play a pivotal role in muscle synthesis and recovery. In terms of performance nutrition, the central role of arginine cannot be understated. Not only is this amino acid a precursor to creatine phosphate (one of the most valuable energy sources for muscle cells)<sup>10,11</sup>, it also stimulates the release of anabolic (growth) hormones critical for muscle formation; helps transport, store and excrete nitrogen; and boosts immune function<sup>12</sup>. So vital is arginine during periods of exercise that many nutrition and exercise practitioners consider it to be a “conditionally-essential amino acid” during exercise-induced stress<sup>13</sup>.

*Supro® soy protein contains more than two and a half times the arginine of whey protein and twice that of casein. In fact, Supro® soy protein contains more arginine than most other recognized protein sources<sup>14</sup>.*

The benefits of glutamine are equally impressive. Glutamine has a number of critically important functions that support athletic performance and recovery – two of its major roles include the maintenance of cellular hydration as well as buffering the impact of lactic acid, which inevitably builds up during exercise<sup>15</sup>. Glutamine also plays a role in protein synthesis and improves immune function<sup>12,16</sup>. Given these important functions, glutamine (like arginine) is considered to be a “conditionally-essential amino acid”.

*Supro® soy protein contains more glutamine than protein sources like whey, egg and casein<sup>14</sup>.*

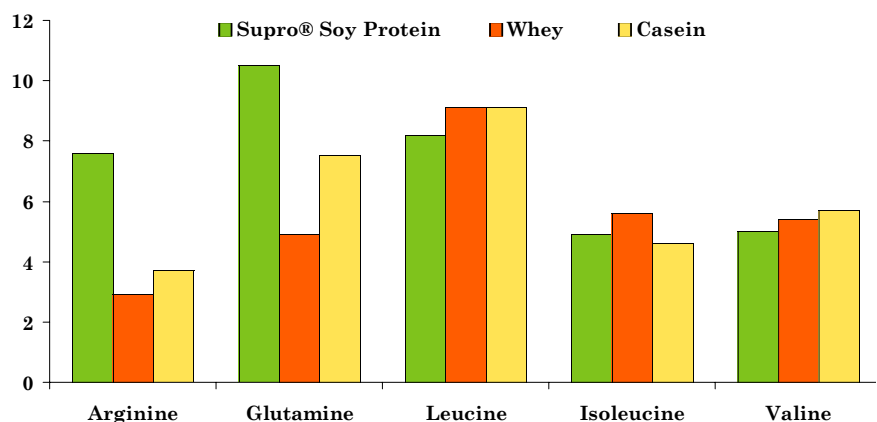
**Branched-Chain Amino Acids – Energy to Burn!**

The Branched-Chain Amino Acids (BCAA’s) are known to provide energy once the short-term muscle glycogen stores are expended – that’s usually at about the 20-minute mark during intense exercise<sup>17,18</sup>.

Not only are the BCAA’s (leucine, isoleucine and valine) taken by the muscles and oxidized at a greater rate during exercise, they also become a metabolic source of much needed glucose critical for on-going performance. The body’s capacity to remove nitrogen from the BCAA’s to form alanine which is, in turn, converted to glucose by the liver, demonstrates the pivotal role the BCAA’s play during intense exercise. In addition, research suggests a role for the BCAA’s in reducing central nervous system fatigue and immune system enhancement<sup>19-21</sup>.

Figure 1 compares the arginine, glutamine and BCAA contents of Supro® soy protein, whey and casein.

**Figure 1: Branched Chain Amino Acids Arginine and Glutamine Contents of Select Proteins (g/100g protein)<sup>1,14</sup>**



**The Case for Blending Proteins - The Emerging Concept of “Time-Released Protein”**

Scientific evidence is rapidly changing the way nutrition and exercise scientists now think about protein ingestion and its impact on muscle protein synthesis. Today, the concept of fast, intermediate and slow-release proteins is emerging.

The concept of “**Time-Released Protein**” (i.e. combining different sources of proteins that release their amino acids at different rates) is an emerging opportunity in the marketplace. Research points to the potential benefits associated with “**a continuous flow of amino acids into the bloodstream**”

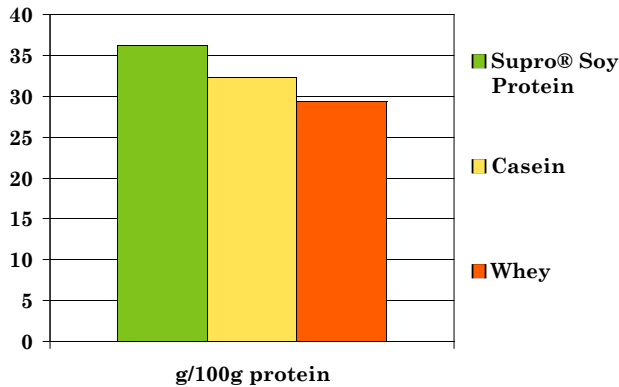
post ingestion, directly relating to the varying rates of digestion that different proteins display. The parallels with carbohydrate metabolism and the release of glucose are unmistakable as are the opportunities for manufacturers. The time-release concept and the potential for blending proteins for maximum performance is discussed in more detail further in the document.

## Targeting the “Critical Cluster”

The Critical Cluster refers to the presence of the high-performance amino acids (arginine and glutamine) in combination with the energy providing Branched-Chain Amino Acids (BCAA's) (leucine, isoleucine and valine) within a single protein source.

Figure 2 demonstrates how Supro® soy protein delivers higher total levels of the “Critical Cluster” of amino acids versus other common high-quality protein sources.

**Figure 2: Total “Critical Cluster” Arginine, Glutamine and the BCAA's (g/100g protein)<sup>1, 14</sup>**



## The Case for Blending Protein – Optimal Amino Acid Mix

Providing athletes with an optimal mix of amino acids – particularly those proven vital during performance is a real opportunity for marketers. By blending Supro® soy protein, with its superior arginine and glutamine levels, with whey protein, a significant contributor of BCAA's, the total cluster of critical amino acids known to be central to athletic performance can be maximized.

## Soy Protein's Natural Bioactives – Unique Antioxidant Performers

Antioxidants are agents, either consumed in the diet or made by the body, which work against molecular damage due to oxidant reactions caused by free radicals. Free radical production is high during exercise and the resultant oxidant stress appears to contribute to muscle damage and fatigue which may then limit exercise training and therefore act as a brake on the development of lean muscle mass<sup>22</sup>.

Increasingly, antioxidants are being considered vital for optimum athletic performance and recovery. Soy protein contains a number of naturally occurring bioactive compounds considered to have important antioxidant potential. Several nutrition studies, including human clinical research using soy protein with its bioactives, indicate that some of these compounds may to exert direct antioxidant protection while others may enhance the body's natural antioxidant mechanisms<sup>23</sup>. Nutrition scientists and exercise scientists are interested in soy's antioxidant capabilities and its potential to offset free radical actions that contribute to fatigue, muscle injury and soreness along with other disease processes<sup>24-28</sup>.

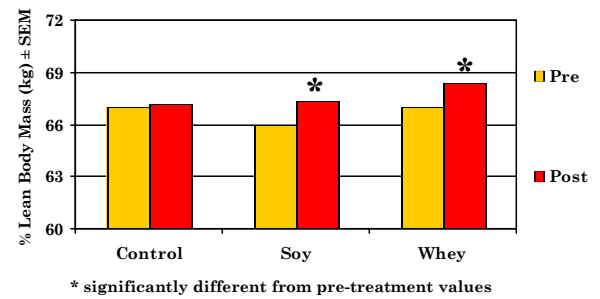
## Improved Antioxidant Status and Lean Muscle Mass Gains

Rossi, et. al.<sup>29</sup>, studied the impact of soy protein consumption versus whey protein on total antioxidant status of 20 subjects who were healthy, athletic college-aged males. In this study, subjects consumed either 40 grams of Supro® soy protein with its naturally occurring bioactives or 40 grams of whey protein daily for a period of three weeks. Consumption of either the soy or whey protein was followed by a strenuous exercise program. Researchers reported that the group that consumed soy protein exhibited an **increase in total antioxidant status and reduced levels of myloperoxidase, an enzyme that is an indicator of oxidant stress.**

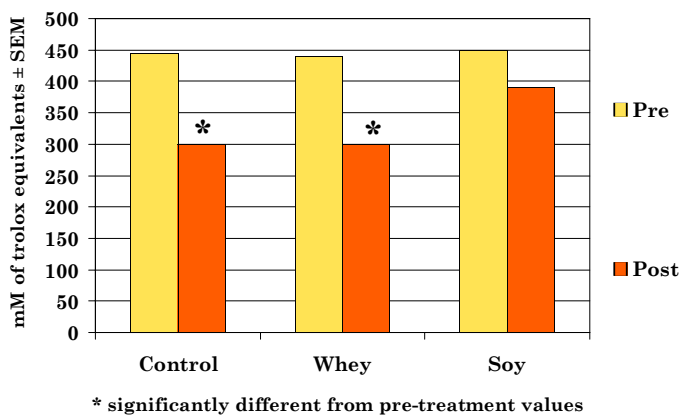
Brown, et. al.<sup>22</sup> examined the effect of soy protein and whey protein consumption, accompanied by a strenuous exercise program, on both lean body mass and antioxidant status. Healthy, college-aged males recruited for this study were given daily servings of micronutrient-fortified protein bars containing soy or whey protein (33g protein per day) for nine weeks. Nine subjects were in each treatment group. A control group, also consisting of nine subjects, did the training but did not consume either type of protein bar.

The researchers reported that exercise training plus the soy or whey treatments each produced a statistically significant increase in lean body mass versus the training program only group (control; Figure 3). Between the soy and whey groups, there was no statistical difference in the change in lean body mass. However, plasma radical scavenging capacities (total antioxidant status) fell in the whey group as well as the training alone groups. The total antioxidant status of the soy group was not significantly impacted (Figure 4). The researchers concluded that **both soy and whey protein bars promoted exercise training-induced lean body mass gain, but the soy protein bar had the added benefit of preserving two important aspects of antioxidant function.**

**Figure 3: Percentage Lean Body Mass Changes Pre vs. Post Treatment<sup>22</sup>**



**Figure 4: Plasma Antioxidant Status of Subjects Pre vs. Post Exercise<sup>22</sup>**



The capacity of soy protein to deliver antioxidant protection in tandem with increasing lean muscle mass, presents athletes with a potent and highly beneficial combination that has been proven in recent studies<sup>22,29</sup>. In particular, soy protein increases total antioxidant status relative to whey protein during an exercise program thereby limiting the potential for muscle damage and fatigue.

The unique presence of the bioactives in soy protein also delivers important health benefits that go beyond those linked to athletic performance. A comprehensive review of the impact of soy protein with its naturally occurring bioactives has shown that it significantly reduces total serum cholesterol, LDL cholesterol and triglyceride levels while also increasing beneficial HDL cholesterol levels.

Soy protein's proven antioxidant properties provide marketers with a unique opportunity to meaningfully differentiate their products and offer consumers all important recovery benefits.

### Soy Protein Promotes Lean Muscle Mass

The widespread perception that soy protein cannot match whey protein when it comes to lean muscle mass development is a myth!

***Soy Protein matches the ability of whey protein to increase lean muscle mass.***

This finding has been observed in a number of recent studies that have directly measured the muscle-building potential of whey (dairy) protein versus soy protein using either protein bars<sup>22</sup> (Figure 3), protein drinks<sup>31</sup> or protein shakes<sup>32</sup>, during a resistance-training program.

All three studies showed that **both soy protein and whey contributed to lean muscle gain with a resistance training exercise program but the level of lean muscle growth did not differ between the protein sources.**

In fact, in one of the studies **soy protein had the added advantage of preserving two different aspects of antioxidant function – a benefit not observed in the whey treatment group<sup>22</sup>** (Figure 4).

The ability of soy protein to match other protein sources like whey or beef protein in terms of muscle mass gains is not restricted to research with younger individuals. Increasingly the aging population use exercise to retain physical

### The Case for Blending Protein - Scientifically Proven Lean Muscle Growth

Even though independent scientific investigation now shows that soy and whey are equivalent when it comes to muscle growth during resistance training, marketers may be best positioned to offer a blended soy and whey protein product.

This approach capitalizes on the consumer perception of whey protein as effective for lean muscle growth but takes into account the new findings that soy protein is equivalent to whey protein in this regard.

capabilities, improve quality of life and delay reductions in muscle mass and strength traditionally associated with the aging process.

A recent intervention study with older men demonstrated that soy protein (as part of a lactoovovegetarian diet) matched a beef protein-containing diet in terms of improving maximal dynamic strength of all the muscle groups trained and increasing muscle mass<sup>33</sup>. Body composition, resting energy expenditure, and measures of lean body mass did not differ significantly between groups or change over time.

### **Soy Protein Builds Lean Mass, Retains Healthy Hormones**

Another misperception regarding soy protein is the mistaken belief that consuming soy protein negatively impacts male hormones. Research now proves that this is not the case.

Rubin, et. al.<sup>32</sup> showed no difference between whey and soy protein in regard to lean muscle growth during a resistance exercise program and also investigated changes to testosterone, estradiol, testosterone/estradiol ratio, or sex hormone binding globulin. The researchers concluded;

*There were no differences between individuals consuming soy protein or whey protein with regard to testosterone, estradiol, testosterone/estradiol ratio, or sex hormone binding globulin.*

### **Time-Released Protein**

Until now little attention had been paid to the kinetics of protein digestion and how this may impact amino acid metabolism and deposition within the body. Studies now reveal that the speed of absorption of amino acids varies according to type of dietary protein ingested and that this may impact postprandial protein synthesis, breakdown and deposition<sup>35</sup>.

Research shows that whey protein produces a dramatic but short rise in plasma amino acids while casein has a more prolonged effect probably due to a slower rate of gastric emptying<sup>35</sup>. Investigations into the postprandial kinetics of soy protein compared to casein-based milk proteins indicate a more intermediate effect in terms of its release of amino acids with maximum release of amino acids from soy protein taking place 2.5 hours after ingestion while the milk proteins peaked at 3.9 hours<sup>36</sup>.

The significance of the research into the kinetics of protein digestion, amino acid release and subsequent metabolism has the potential to fundamentally reshape the way in which protein is consumed in regard to athletic performance.

### **Soy Protein Slows Energy Release**

The presence of protein can have a profound impact on the rate at which glucose (energy) is released into the body. Scientists often measure this impact in terms of Glycemic Index (GI).

GI measures the blood glucose profile elicited by a standard amount of carbohydrate (usually 50 grams) from a test food consumed by a human subject. Over the next two to three hours, the blood of that subject is sampled and the glucose content measured and plotted on a graph. The results are then compared to that subject's glucose response to 50 grams of a reference carbohydrate – usually glucose.

Numerically, GI is calculated by measuring the area under the curve after consumption of a test food, divided by the area under the curve for the reference carbohydrate. The end result is essentially a GI value, which can be used as a tool for ranking carbohydrate foods via the speed and extent to which a particular food is likely to raise blood sugar levels. The quicker the carbohydrates in the food are broken down by the digestive system, the greater their impact on raising blood sugar levels, and the higher the GI value.

**GI values can be interpreted as follows:**

**High GI: Over 70**

**Medium GI: 56-69**

**Low GI: 55 or less**

### **The Case for Blending Protein - Continuous Release of Amino Acids**

The emergence of fast (whey), intermediate (soy) and slow (casein) release protein brings with it the opportunity for marketers to develop products that deliver a deliberate and prolonged supply of amino acids to the bloodstream.

The speed of protein digestion and amino acid absorption has a major effect on the ability of the body to build muscle mass. Products that are able to feed muscles a regular supply of amino acids via a combination of whey, soy and casein (rapid, intermediate and slow release) will be well placed to take advantage of this compelling and developing area of performance nutrition research.

High GI foods will release glucose rapidly into the blood stream, thus causing a more immediate spike in energy. Low GI foods provide a more sustained release of glucose (energy) into the bloodstream, thus are often favored by athletes involved in prolonged physical activity.

Many things can affect the GI of a food, including the presence of protein. The presence of protein will generally slow the release of carbohydrate into the blood stream and thus lower the GI of a food product. This will favor a more sustained, longer-term release of energy to the body. ***GI determinations on soy protein-containing foods and beverages confirm its impact on GI and ability to significantly lower GI.***

### **Supro® Soy Protein – A Competitive Edge**

The evidence supporting the role of Supro® soy protein in performance nutrition is compelling. Supro® soy protein is backed by a growing body of clinical evidence proving its value and effectiveness for the performance-oriented consumer.

Scientific research demonstrates that Supro® soy protein:

- ▶ Is a high-quality protein
- ▶ Supports the development of lean body mass
- ▶ Aids muscle recovery
- ▶ Provides energy for muscles during exercise
- ▶ Builds muscle strength in conjunction with an exercise program
- ▶ Reduces oxidative stress associated with exercise
- ▶ Maintains healthy hormone levels
- ▶ Sustains energy levels via its impact on glycemic index

The ability of Supro® soy protein to positively impact antioxidant status, reduce oxidative stress, thus aid in muscle recovery, is a benefit unique to soy protein. For athletes, this benefit means reduced muscle fatigue, reduced muscle soreness, and quicker muscle recovery, allowing for more effective and efficient workouts.

Market opportunities exist to take advantage of the current and developing science demonstrating Supro® soy protein's benefits for performance-minded consumers, via the development of products based exclusively on soy protein or blends of milk and soy proteins.

Blended products offer the opportunity to position the unique recovery and health benefits of soy protein as complementary to the benefits provided by milk proteins, namely whey protein. Opportunities also exist to position products on the complementary and unique amino acid profiles such products provide. Finally, products based on blends of milk and soy proteins, have the potential to take advantage of the fact that these proteins differ in how quickly they are digested and absorbed by the body, thus creating a "timed release" of amino acids to the blood stream and key muscle groups. This attribute of blended products represents an important benefit, particularly for those consumers interested in maximizing muscle gains through a combination of diet and exercise.

Supro® soy protein also offers health benefits beyond those specifically linked to performance nutrition. These benefits include its positive impact on cardiovascular health<sup>30</sup>, glucose metabolism<sup>37</sup>, bone health<sup>38,39</sup>, renal function<sup>40</sup>, and prostate health<sup>41-43</sup>. The ability to offer health benefits, along with other benefits important to performance-minded consumers, underscore the potential for Supro® soy protein in the dynamic, science-driven performance nutrition market.

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