PROTEIN NEEDS FOR ATHLETES

Bill Campbell, Ph.D, CSCS, FISSN
Overview

- Applied Protein Study
- Protein Basics
- Protein Quality – which type of protein is best?
- How much protein do athletes need?
- Protein Supplements

Other Important Considerations
  - Protein Timing
  - Leucine Content
“Postexercise protein supplementation improves health and muscle soreness during basic military training in marine recruits.”

Study was not conducted in athletes, but it does mimic the training demands that athletes experience during certain parts of their seasons.

Applied Protein Research Study

Study Design

387 U.S. Marine Recruits

Recruits were randomly assigned to ingest food supplements immediately after exercise during a 54-day basic training period

Supplements ingested were:
- Placebo: (0 g carbohydrate, 0 grams protein, 0 g fat)
- Control: (8 g carbohydrate, 0 grams protein, 3 g fat)
- Protein: (8 g carbohydrate, 10 grams protein, 3 g fat)

Results

No differences between the groups in body composition
However, the protein group lost more fat mass and retained the greatest amount of lean mass over the 54 days

Compared with placebo and control groups, the protein-supplemented group experienced:
- 33% fewer total medical visits
- 28% fewer visits due to bacterial/viral infections
- 37% fewer visits due to muscle/joint problems
- 83% fewer visits due to heat exhaustion
Perceived muscle soreness was measured on days 34 and 54 immediately after and 24-hours after:
- 6 mile full-gear hike (day 34)
- Maximum #s of pull-ups & sit-ups as well as a 3 mile run (day 54).

The protein group significantly improved muscle soreness scores in comparison with the control and placebo groups.
Unlike carbohydrates and fats, proteins/amino acids contain nitrogen.

Proteins are comprised of approximately 20 different amino acids.

<table>
<thead>
<tr>
<th>Essential Amino Acids</th>
<th>Nonessential Amino Acids</th>
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</thead>
<tbody>
<tr>
<td>Histidine</td>
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</tr>
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<tr>
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<td>Asparagine</td>
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<tr>
<td>Lysine</td>
<td>Aspartic Acid</td>
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<tr>
<td>Methionine</td>
<td>Cysteine</td>
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<tr>
<td>Phenylalanine</td>
<td>Glutamic Acid</td>
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<tr>
<td>Threonine</td>
<td>Glutamine</td>
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<tr>
<td>Tryptophan</td>
<td>Glycine</td>
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<td>Valine</td>
<td>Proline</td>
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<tr>
<td></td>
<td>Serine</td>
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<td></td>
<td>Tyrosine</td>
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</table>
What makes one protein different from another protein?

The sequence and the composition of the amino acids that comprise a given protein is what makes one type of protein different from another type of protein.

In particular, it is the composition of amino acids in a protein that determines if it is a high quality protein and one which athletes should ingest.
## Protein Basics

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# Protein Basics – Complete vs. Incomplete Proteins

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</tr>
<tr>
<td>Tryptophan</td>
</tr>
<tr>
<td>Valine</td>
</tr>
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These 9 essential amino acids must be obtained in the diet because the body is unable to synthesize these amino acids.

Dietary protein is classified as either *complete* or *incomplete* depending on whether or not the protein contains adequate amounts of the eight essential amino acids.
Protein Quality

Your athletes need to focus on ingesting high quality proteins.

What does this mean?
Protein Quality

Animal sources of protein (meat, fish, poultry, milk, cheese, and eggs) contain all essential amino acids and are, therefore, considered complete (high quality) sources of protein.

On the other hand, vegetable proteins (grains, legumes, nuts, seeds, and other vegetables) are incomplete proteins (low quality) because they are missing, or do not have enough of the essential amino acids.
Protein Quality

Trick for vegetarian athletes

If 2 separate, incomplete proteins are combined and their amino acid assortments complement each other, the essential amino acids missing from one are supplied by the other.

This practice of combining two incomplete protein sources to derive the needed essential amino acids is referred to as protein combining (and the proteins are said to be complementary proteins).
Measures of Protein Quality

There are several methods of determining the quality of various proteins:

- Biological Value (BV)
- Net Protein Utilization (NPU)
- Protein Efficiency Ratio (PER)
- Protein Digestibility Corrected Amino Acid Score (PDCAAS)

Protein quality ultimately depends on the amino acid profile of the protein; hence, complete protein sources that contain greater amounts of essential amino acids generally have higher protein quality (regardless of the classification system utilized to rank various proteins).
# Measures of Protein Quality

## Protein Quality Comparison Chart

<table>
<thead>
<tr>
<th>Protein Type</th>
<th>Protein Digestibility Corrected Amino Acid Score (PDCAAS)</th>
<th>Amino Acid Score</th>
<th>Protein Efficiency Ratio (PER)</th>
<th>Biological Value (BV)</th>
<th>Protein Digestibility % (PD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Whey Protein</td>
<td>1.00</td>
<td>1.14</td>
<td>3.2</td>
<td>100</td>
<td>99</td>
</tr>
<tr>
<td>Whole Egg</td>
<td>1.00</td>
<td>1.21</td>
<td>3.8</td>
<td>88-100</td>
<td>98</td>
</tr>
<tr>
<td>Casein</td>
<td>1.00</td>
<td>1.00</td>
<td>2.5</td>
<td>80</td>
<td>99</td>
</tr>
<tr>
<td>Soy Protein Concentrate</td>
<td>1.00</td>
<td>.99</td>
<td>2.2</td>
<td>74</td>
<td>95</td>
</tr>
<tr>
<td>Beef Protein</td>
<td>0.92</td>
<td>.94</td>
<td>2.9</td>
<td>80</td>
<td>98</td>
</tr>
<tr>
<td>Wheat Gluten</td>
<td>0.25</td>
<td>.47</td>
<td>NA</td>
<td>54</td>
<td>91</td>
</tr>
</tbody>
</table>

**Source:**
Measures of Protein Quality - Summary

- High quality sources of protein:
  - Meat
  - Fish
  - Poultry
  - Milk
  - Eggs
  - Cheese
Overview

- Applied Protein Study
- Protein Basics
- Protein Quality – which type of protein is best?
- How much protein do Athletes Need?
- Protein Supplements

Other Important Considerations
  - Leucine Content
  - Protein Timing
How much protein do athletes need?

Currently, the RDA for protein in healthy adults is 0.8 g/kg body weight per day.

This recommendation is estimated to be sufficient to meet the needs of nearly all (97.5%) healthy men and women age 19 years and older.

Read this past sentence carefully – then ask yourself what it does not address!
How much protein do athletes need?

This amount of protein intake may be appropriate for nonathletes, but it is likely not sufficient to:

- Offset the oxidation of protein/amino acids during exercise training (approximately 1–5% of the total energy cost of exercise)
- Provide substrate for lean tissue accretion
- Repair exercise induced muscle damage
How much protein do athletes need?

Other factors that need to be considered when determining an optimal amount of dietary protein for training athletes include:

- Protein quality
- Energy intake
- Carbohydrate intake
- Mode and intensity of exercise
- Timing of protein intake
How much protein do athletes need?

Some of the leading research organizations serving athletes have published recommendations that exceed the 0.8 g/kg/day threshold:

- ACSM\(^1\) = 1.2 to 1.7 g/kg of body weight
- NSCA\(^2\) = 1.5 to 2.0 g/kg of body weight
- ISSN\(^3\) = 1.4 to 2.0 g/kg of body weight


How much protein do athletes need?

Practical Advice:
- Eat a gram of protein for every pound of bodyweight.
- This comes out to 2.2 grams of protein per kg of bodyweight.
How much protein do athletes need?

- Research studies indicating a need for protein intakes above 0.8 g/kg of bodyweight in physically active individuals:
Protein Supplements

- It is recommended that athletes obtain their protein requirements through whole foods.

- However, many athletes choose to obtain a portion of their protein intake from supplements such as:
  - protein powders
  - meal replacement drinks
  - high protein energy bars

- Reasons for supplementing the diet with protein supplements include:
  - Convenience and simplicity
  - Protein supplements also have other benefits such as a longer shelf life than whole food sources
  - More cost effective in many cases
Protein Supplements

The most popular types of protein supplements are:

- Whey protein (milk protein)*
- Casein protein (milk protein)*
- Soy protein*
- Egg protein
Whey Protein

- Currently the most popular source of protein used in nutritional supplements marketed to athletes
- A fast digesting protein
- Whey is one of the two major protein groups of bovine milk (accounting for 20% of the milk)
- Provides high levels of the essential and branched chain amino acids
- BV of 104 and a PDCAAS of 1.0
- Increases muscle protein synthesis at a greater rate than other types of proteins
  - Possesses ‘anabolic’ properties, likely due to its high leucine content
Protein Supplements

**Table 1: Approximate Essential Amino Acid Profile of Various Protein Sources**

<table>
<thead>
<tr>
<th>ESSENTIAL AMINO ACID</th>
<th>MILK PROTEIN ISOLATE</th>
<th>WHEY PROTEIN ISOLATE</th>
<th>WHEY PROTEIN HYDROL.</th>
<th>CASEIN</th>
<th>SOY PROTEIN ISOLATE</th>
<th>EGG PROTEIN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Isoleucine</td>
<td>4.4</td>
<td>6.1</td>
<td>5.5</td>
<td>4.7</td>
<td>4.9</td>
<td>5.7</td>
</tr>
<tr>
<td>Leucine</td>
<td>10.3</td>
<td>12.2</td>
<td>14.2</td>
<td>8.9</td>
<td>8.2</td>
<td>8.4</td>
</tr>
<tr>
<td>Lysine</td>
<td>8.1</td>
<td>10.2</td>
<td>10.2</td>
<td>7.6</td>
<td>6.3</td>
<td>6.8</td>
</tr>
<tr>
<td>Methionine</td>
<td>3.3</td>
<td>3.3</td>
<td>2.4</td>
<td>3.0</td>
<td>1.3</td>
<td>3.4</td>
</tr>
<tr>
<td>Phenylalanine</td>
<td>5.0</td>
<td>3.0</td>
<td>3.8</td>
<td>5.1</td>
<td>5.2</td>
<td>5.8</td>
</tr>
<tr>
<td>Threonine</td>
<td>4.5</td>
<td>6.8</td>
<td>5.5</td>
<td>4.4</td>
<td>3.8</td>
<td>4.6</td>
</tr>
<tr>
<td>Tryptophan</td>
<td>1.4</td>
<td>1.8</td>
<td>2.3</td>
<td>1.2</td>
<td>1.3</td>
<td>1.2</td>
</tr>
<tr>
<td>Valine</td>
<td>5.7</td>
<td>5.9</td>
<td>5.9</td>
<td>5.9</td>
<td>5.0</td>
<td>6.4</td>
</tr>
<tr>
<td><strong>Total BCAAs</strong></td>
<td><strong>20.4</strong></td>
<td><strong>24.2</strong></td>
<td><strong>25.6</strong></td>
<td><strong>19.5</strong></td>
<td><strong>18.1</strong></td>
<td><strong>20.4</strong></td>
</tr>
<tr>
<td><strong>Total EAAs</strong></td>
<td><strong>42.7</strong></td>
<td><strong>49.2</strong></td>
<td><strong>49.8</strong></td>
<td><strong>40.7</strong></td>
<td><strong>36.0</strong></td>
<td><strong>42.3</strong></td>
</tr>
</tbody>
</table>

Approximate concentration of essential and branched chain amino acids (EAA and BCAA, respectively) present within various forms of commercially available protein (g/100 g). Adapted from [27]. Casein is the average of reported values for Calcium Caseinate, Sodium Caseinate, and Potassium Caseinate; Whey Protein Isolate is the average of reported values for Ion-Exchange and Cross-Flow Microfiltrated Whey Protein Isolates. Hydrol. is hydrolysate.

Casein is the major component of protein found in bovine milk accounting for ~80% of the total protein content.

- A slow digesting protein
- BV of 77 and a PDCAAS of 1.0
- Possesses anti-catabolic properties
Protein Supplements

- Soy Protein
  - Soy is the most widely used vegetable protein source
  - BV of 77 and a PDCAAS of 1.0
  - Soy is an attractive alternative for those seeking non-animal sources of protein in their diet and those who are lactose intolerant
  - Soy protein is maligned by some (especially male bodybuilders) due to its isoflavone content.
    - Soy isoflavones have the ability to bind to estrogen receptors, mimicking the effects of estrogen in some tissues and antagonizing (blocking) the effects of estrogen in others
Figure 2 Resistance training-induced changes in lean mass in studies of patients receiving supplemental protein sources - soy, whey, or casein or an energy-matched carbohydrate drink.

Values are presented as the absolute exercise-induced mean gain (±SD) in lean mass. The studies included are those of Rankin et al. [59], Hartman et al. [31**], Cribb et al. [60,61], Candow et al. [58]. □, milk; ■, whey; □, casein; ▬, soy; ▢, CHO.

Other Important Considerations

Leucine content and Protein Timing
Protein Timing: New Research

What we know (research has demonstrated):
- Ingest high quality protein post-exercise (RE)
- Whey protein is the best choice/most anabolic

Questions that remain unanswered:
- How much protein should be ingested post-X?
- What should be ingested in the hours following resistance exercise?
Protein Timing: New Research

Protein Timing: New Research

Methods

- 24 resistance trained men engaged in 4 sets of 10 reps of leg extensions at an intensity of 80% 1RM.

- Subjects were randomized into one of three protein timing groups.

- Each group ingested 80 grams of whey protein isolate over the next 12 hours, but the timing was different between each of the three groups.
Protein Timing: New Research

Methods

- **Group 1:** ingested \textbf{10 grams of protein} eight times every \textbf{1.5 hours} (Pulse Strategy)

- **Group 2:** ingested \textbf{20 grams of protein} four times every \textbf{3 hours} (Intermediate Strategy)

- **Group 3:** ingested \textbf{40 grams of protein} immediately after the workout and then again \textbf{6 hours later} (Bolus Strategy)

Skeletal muscle biopsies were taken from the subjects’ legs and analyzed for markers of muscle protein synthesis (phosphorylation of p70S6K) at 1, 4, 6, 7, and 12 hours post-exercise.
Protein Timing: New Research

Results

- Pulse strategy did not elevate markers of protein synthesis at any time point.

- Intermediate strategy significantly increased markers of protein synthesis at the 1hr time point (~12 fold) and this effect was still evident at the 4hr time point (~8 fold).

- Bolus strategy significantly increased markers of protein synthesis at the 1hr time point (~20 fold) and 7hrs post-exercise (~12 fold).
Protein Timing: New Research

Applications:

- Ingest 40 grams immediately following resistance exercise.
- Ingest 40 grams of protein 6 hours post-exercise.

What amount of protein should be ingested at 3 hours post-exercise?

- Ingest 20 grams 3 hours post-exercise (MPS ~8-fold at hour 4)
- What if 40 grams were ingested 3-hours post-exercise?
# The Perfect “Planned” Day

<table>
<thead>
<tr>
<th>Time</th>
<th>Meal</th>
</tr>
</thead>
<tbody>
<tr>
<td>7am</td>
<td>Egg white omelet with spinach and cheddar cheese; oatmeal, skim milk</td>
</tr>
<tr>
<td>10am</td>
<td>Pre-workout shooter (protein and carbs)</td>
</tr>
<tr>
<td>12 noon</td>
<td>Post-workout beverage (protein and carbs)</td>
</tr>
<tr>
<td>3pm</td>
<td>4 oz turkey, 2 slices whole wheat bread, spinach salad w/ ¼ cup walnuts, low-fat dressing</td>
</tr>
<tr>
<td>6pm</td>
<td>6 oz grilled salmon, steamed broccoli, ½ cup of carrots, 1 apple</td>
</tr>
<tr>
<td>9pm</td>
<td>1 cup low fat cottage cheese , ½ cup berries, banana with natural peanut butter</td>
</tr>
<tr>
<td>Time</td>
<td>Meal</td>
</tr>
<tr>
<td>--------</td>
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</tr>
<tr>
<td>8am</td>
<td>High quality protein shake (multivitamin, fish oil supplements)</td>
</tr>
<tr>
<td>10:30am</td>
<td>3-4 eggs (egg beaters), whole wheat toast; oatmeal, skim milk</td>
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<tr>
<td>1pm</td>
<td>2 footlong turkey and ham subs (lettuce, onion, tomato), chicken breast salad</td>
</tr>
<tr>
<td>4pm</td>
<td>High quality protein shake, fruit with peanut butter</td>
</tr>
<tr>
<td>6pm</td>
<td>Grilled chicken breast sandwich, chargrilled chicken garden salad</td>
</tr>
<tr>
<td>8pm</td>
<td>Pre-performance shooter (protein and carbs)</td>
</tr>
<tr>
<td>11pm</td>
<td>Post-workout beverage (protein and carbs)</td>
</tr>
<tr>
<td>1am</td>
<td>Ribeye steak or sizzling chicken steak fajitas; steamed vegetables</td>
</tr>
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</table>
Questions?