VEGETABLE NUTRIENT COMPARISON

Beans are a valuable nutrient source ranking highest in comparison to other commonly consumed vegetables.[4]

- All vegetables do not supply an equal amount of nutrients per serving.
- **Table 3**, is an excerpt from a study that compared the nutrient value of 12 of the most commonly consumed vegetables.
  - *This comparison allows for the identification of vegetables that provide key nutrients in the greatest amounts.*
- The ranking of 7 for beans indicates that, of 10 nutrient categories (protein, fiber, calcium, potassium, magnesium, vitamins A, C, and E, iron, and folate), beans are among the top 3 vegetables in 7 of the 10 categories.
- Beans have the highest amount of protein compared to other commonly consumed vegetables **(Figure 3)** and are also high in fiber, iron and folic acid, which is especially important for female athletes.

The complete table can be found in the May/June 2011 article of *Nutrition Today*[4]

TABLE 3. Nutrient Content of Commonly Consumed Vegetables

Vegetable (1/2 cup)[a]	Energy (kcal)	Protein (g)	Dietary Fiber (g)	Calcium (mg)	Potassium (mg)	Iron (mg)	Folate (µg)	No. of Nutrients Ranking Highest[b]
Beans, dry, cooked	110	7.6	6	42	442	2.63	80	7
Broccoli, cooked, from fresh	32	2.2	3	37	268	0.62	98	6
Sweet potato, baked, peel not eaten	89	2	3.3	3.3	471	0.69	6	6
Peas, green, cooked, from frozen	62	4.1	4.4	4.4	87	1.12	47	4
Tomatoes, cooked	20	0.9	1.2	37	226	1.16	10	3
Carrots, cooked, from frozen	27	0.4	2.4	2.4	139	0.39	8	2
White potato, baked, peel not eaten	58	1.24	1	1	226	1.16	6	0

Source: USDA Food and Nutrient Database for Dietary Studies, 3.0 Beltsville, MD: Agricultural Research Service, Food Surveys Research Group; 2008 http://www.ars.usda.gov/Services/docs.htm?docid=17032

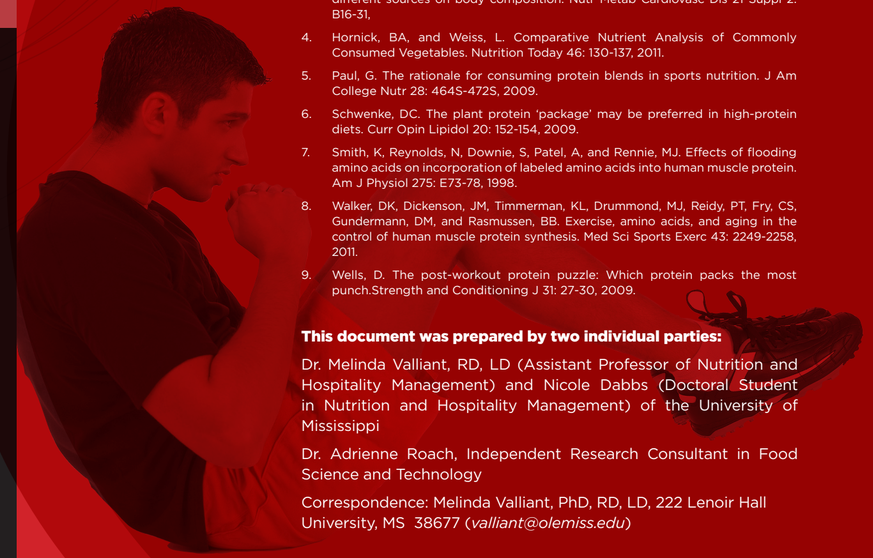
[a]Amounts are based on 1 serving of vegetables, equivalent to ½ cup of cooked vegetables (USDA Food Guide)

[b]Based on the highest amounts for each nutrient (protein, dietary fiber, calcium, potassium, magnesium, vitamin A, C, E, iron, and folate)

Meeting your athletes' protein needs:

THE TRAINING TABLE

- A 155 lb female basketball player needs 78 – 140 grams of protein a day preferably divided over 6 meals of 13 – 24 grams of protein per meal.
- 1 1/2 cups of canned black beans combined with one cup of brown rice and 1/2 cup broccoli will meet her protein needs for one meal and provide an excellent mix of amino acids and carbohydrates for muscle recovery and provide a percentage of her daily required intake for fiber (40%), iron (23%), and folic acid (34%).



REFERENCES:

1. de Souza, RJ, Swain, JF, Appel, LJ, and Sacks, FM. Alternatives for macronutrient intake and chronic disease: a comparison of the OmniHeart diets with popular diets and with dietary recommendations. Am J Clin Nutr 88: 1-11, 2008.
2. Fujita, S, Dreyer, HC, Drummond, MJ, Glynn, EL, Cadenas, JG, Yoshizawa, F, Volpi, E, and Rasmussen, BB. Nutrient signalling in the regulation of human muscle protein synthesis. J Physiol 582: 813-823, 2007.
3. Gilbert, JA, Bendsen, NT, Tremblay, A, and Astrup, A. Effect of proteins from different sources on body composition. Nutr Metab Cardiovasc Dis 21 Suppl 2: B16-31,
4. Hornick, BA, and Weiss, L. Comparative Nutrient Analysis of Commonly Consumed Vegetables. Nutrition Today 46: 130-137, 2011.
5. Paul, G. The rationale for consuming protein blends in sports nutrition. J Am College Nutr 28: 464S-472S, 2009.
6. Schwenke, DC. The plant protein 'package' may be preferred in high-protein diets. Curr Opin Lipidol 20: 152-154, 2009.
7. Smith, K, Reynolds, N, Downie, S, Patel, A, and Rennie, MJ. Effects of flooding amino acids on incorporation of labeled amino acids into human muscle protein. Am J Physiol 275: E73-78, 1998.
8. Walker, DK, Dickenson, JM, Timmerman, KL, Drummond, MJ, Reidy, PT, Fry, CS, Gundermann, DM, and Rasmussen, BB. Exercise, amino acids, and aging in the control of human muscle protein synthesis. Med Sci Sports Exerc 43: 2249-2258, 2011.
9. Wells, D. The post-workout protein puzzle: Which protein packs the most punch.Strength and Conditioning J 31: 27-30, 2009.

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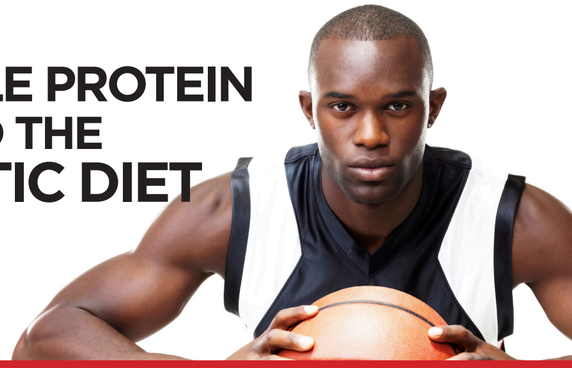
VEGETABLE PROTEIN AND THE ATHLETIC DIET



THE PLANT PROTEIN PACKAGE

Vegetable sources of protein are rich in complementary nutrients that support a healthy diet[6] **(Table 1)**. Such as:

- *Dietary fiber*
- *Minerals*
- *Vitamins*
- *Antioxidants*

Athletes wishing to reduce their fat and cholesterol consumption, may choose to decrease animal protein and increase the consumption of vegetable protein[6]. However, vegetable proteins are usually deficient in one or more essential amino acids.

Combining vegetables with complementary protein sources can provide an essential amino acid supply that is equivalent, and in some cases greater than, that provided by animal protein alone[3].

- *A popular combination are beans and rice (grains). (Beans are low in sulphur containing amino acids and grains are high).*

TABLE 1. Food Source: Animal vs. Plant

		Animal		Plant	
		Red Meat	Poultry & Seafood	Legumes (beans and peas)	Other Vegetables (Broccoli, carrots, green leafy)
Pros	Protein	H	H	M	L
	Fiber	L	L	H	M
	B-vitamins	L	L	M	H
	Minerals (Iron)	H	L	M	L
Cons	Fats	H	M	L	L
	Cholesterol	H	M	None	None

(H) High, (M) Moderate, and (L) Low

Table 1 highlights the macro- and micro- constituents of animal and plant protein that support or negate a healthy diet.

- *Legumes such as beans and peas are listed in a separate column to other vegetables because of their increased nutritional benefit in comparison to other vegetable categories.*

AMINO ACID COMPOSITION AND MUSCLE PROTEIN SYNTHESIS

Specific focus has been given to 5 amino acids for their critical role in the body during sports performance: The branched chain amino acids 1) leucine, 2) isoleucine, and 3) valine as well as glutamic acid and arginine [5].

Branched Chain Amino Acids (BCAA): BCAA's are oxidized by muscle cells during exercise to provide energy once glycogen stores are expended [5].

- Leucine: Of all the essential amino acids, leucine, has received considerable attention due to its potential ability to independently stimulate muscle protein synthesis [8].

Glutamic acid and **Arginine** are conditionally essential amino acids – they are rate limiting for protein synthesis under certain conditions [5].

- *Glutamic acid:* Glutamic acid is precursor to glutamine which can enhance post-work out glycogen restoration [9]. Glutamine ingestion is accompanied by an increase in growth hormone release, which is of particular interest to strength athletes [5].
- *Arginine:* Stimulus for growth hormone release when consumed with other amino acids [5].

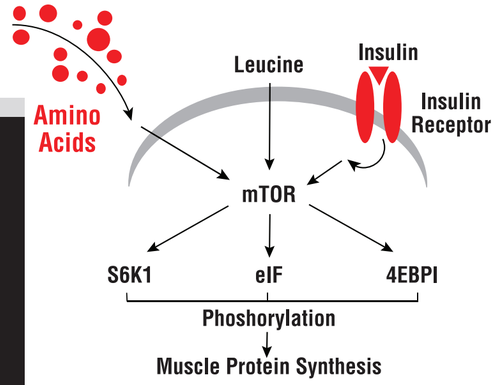


FIGURE 2: Muscle Protein Synthesis:

Simplified overview of mTOR (mammalian target of rapamycin) activation by insulin and amino acids. mTOR is a protein kinase that regulates a number of mechanisms including protein synthesis. It is proposed that leucine, a brached chain amino acid, can enter the cell through a "leucine-specific" pathway and independently initiate protein synthesis through activation of mTOR.[8]

Beans as a vegetable protein source contain a relatively high amount of branched chain amino acids, glutamic acid, and arginine (Figures 4 & 5) in comparison to other vegetable protein sources.

Beans can contribute to protein synthesis for muscle recovery in athletes desiring to increase their vegetable intake while maintaining adequate nutrition.

GENERAL PROTEIN NEEDS IN THE ATHLETIC DIET

TABLE 2. General Protein Recommendations Based on Activity

Level of Activity	Recommended Daily Protein Intake
Sedentary Adult	0.4 g/lb
Active Adult	0.4 - 0.5 g/lb
Endurance Athlete	0.5 - 0.6 g/lb
Ultraendurance Athlete	0.5 - 0.9 g/lb
Strength Athlete	0.7 - 0.8 g/lb

g/lb = grams per kilogram of body weight

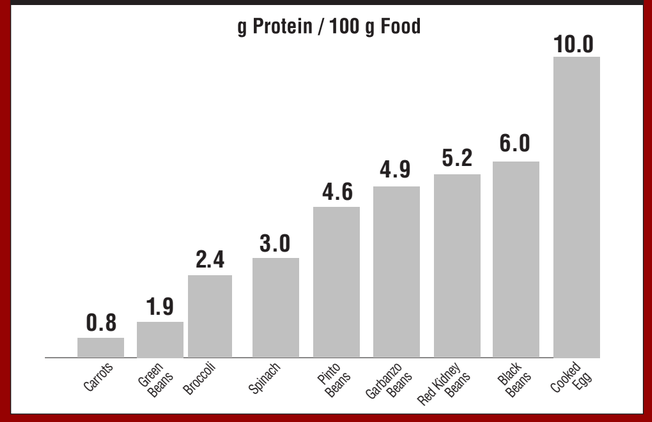
Daily protein requirements of endurance and resistance trained athletes can be meet through diet alone, without the use of protein supplements, given than sound nutrition and energy intake is sufficient to maintain body weight. [9]

- Athletes subject their muscles to intense levels of damage and stress during and after rigorous training.
- Because this process is a necessary component of strength and muscle development, it is imperative that athletes consume an ample amount of quality protein **(Table 2)** to facilitate protein synthesis and ensure a positive nitrogen balance [2,5].
- Consuming an adequate amount of quality protein after training promotes the accumulation of skeletal muscle protein, leading to repair and growth of muscle tissue[7].

VEGETABLE PROTEIN COMPARISON

Beans have the highest amount of protein compared to other commonly consumed vegetables **(Figure 3).**

FIGURE 3. Vegetable Protein Comparison



The amino acid profile of eggs is ideal as they are rich in both branched chained amino acids and glutamic acid (7) and thus, used for comparison purposes. All data used in Figures 3, 4, and 5 was obtained from USDA Food and Nutrient Database for Dietary Studies, 3.0 Beltsville, MD: Agricultural Research Service, Food Surveys Research Group. Methods of food preparation - Vegetables: carrots, green beans, broccoli, and spinach (cooked, boiled, drained, w/o salt); Canned beans: pinto, garbanzo, red kidney, and black (canned solids and liquids); Egg (whole, cooked, scrambled).

SELECTED AMINO ACID COMPOSITION OF CANNED BEANS

Beans contain a relatively high amount of amino acids recognized as being essential to skeletal muscle protein synthesis **(Figures 4 & 5).**

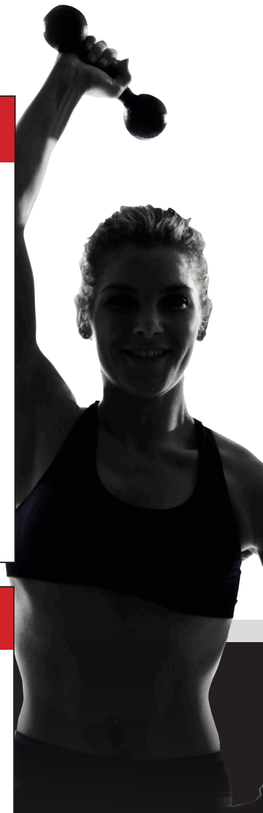


FIGURE 4. Amino Acid Comparison: Branched Chain Amino Acids

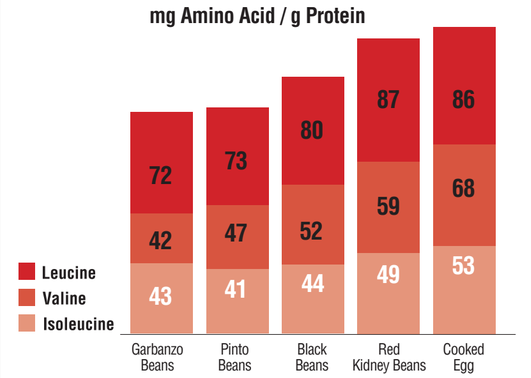


FIGURE 5. Amino Acid Composition: Glutamic Acid and Arginine