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DIETARY PROTEIN AND THE ROLE OF SOY

Protein Requirements and Exercise

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DIETARY PROTEIN AND THE ROLE OF SOY

By Rajavel Elango MSc, PhD

"Protein" as a name is derived from the Greek word *"proteios"* which means of the first rank or position, and of primary importance.[1] The word was originally coined in 1838 and was chosen to represent the fundamental nature of protein's role in human nutrition. However, the nutritional importance of protein is also because of its constituent amino acids. The 20 α-amino acids that are part of mammalian body protein are classified based on their nutritional importance into indispensable (essential) amino acids, conditionally indispensable (essential) amino acids and the dispensable (nonessential) amino acids. Thus, both protein quantity and quality are important to ensure the provision of all amino acids in the right balance to sustain normal bodily functions.

Protein Requirement

Dietary protein is an essential component of a healthy diet to support both growth and maintenance during stages of development, and maintenance alone during all other life stages.[2] Hence, the current definition of protein requirement is: ". . . the lowest level of dietary protein intake that will balance the losses of nitrogen from the body, and thus maintain the body protein mass, in persons at energy balance with modest levels of physical activity, plus, in children or in pregnant or lactating women, the needs associated with the deposition of tissues or secretion of milk at rates consistent with good health."[3]

Protein intake recommendations for North Americans are provided via the Dietary Reference Intakes (DRIs) as the Estimated Average Requirements (EARs) and Recommended Dietary Allowances (RDAs).[2] The EAR is the average daily nutrient intake amount estimated to meet the requirement of half the healthy individuals in a particular life stage and gender group. The RDA is an estimate of the minimum daily average dietary intake amount that meets the nutrient requirements of nearly all (97–98%) healthy individuals in a particular life stage and gender group.[2] The DRI estimates are a minimum requirement and do not represent a "ceiling" or maximum recommendation. In addition, the protein RDAs are based on direct evidence only for young adults.[2] For all other life stages, the values are based on factorial (mathematical) calculations from the young adult estimates.

Current Protein Intake Recommendations

Recommendations for young adults are set at 0.66 g/kg/d and 0.8 g/kg/d as the EAR and RDA, respectively (**Table 1**). These values are based on a comprehensive meta-analysis of available nitrogen balance studies conducted by Rand et al.[4] The nitrogen balance method has been the traditional method to determine protein requirements. Nitrogen balance identifies the protein requirement in healthy adults as the "continuing intake of dietary protein that is sufficient to achieve body nitrogen equilibrium (zero balance) in an initially healthy person of acceptable body composition at energy balance and under conditions of moderate physical activity and as determined after a brief period of adjustment to a change in test protein intake."[4]

Rand and colleagues acknowledged that there are several shortcomings of the nitrogen balance method. The drawbacks of this method have been covered in detail.[2,3] Briefly, the balance method measures a very small difference in whole body nitrogen intake and excretion, and tends to overestimate nitrogen intake and underestimate nitrogen excretion. The net result is an overtly positive balance which could lead to an underestimation of the requirement.[5]

Positive balances are observed in most adult studies, although it is biologically impossible for such balances to be sustained. Balance studies also require relatively long periods of test diet adaptation (7–10 days) because equilibration of the large (and slow changing) body urea pool requires at least 5–7 days after a change in test protein intake. The invasive nature of the nitrogen balance method makes it unethical to study most other vulnerable life stages. Clearly better non-invasive methodology that would allow direct data-driven determination of human protein requirements is needed.

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Human Protein Requirements Determined by Novel Method

The indicator amino acid oxidation (IAAO) method is a minimally-invasive technique that uses stable isotopes to determine amino acid requirements;[5,6] making it an attractive alternative for better assessing protein and essential amino acid needs in different populations.[7] The method is based on the physiological principle that excess amino acids cannot be stored; and therefore must be partitioned between incorporation into protein or oxidation. Thus, when one indispensable amino acid is deficient for protein synthesis, all other amino acids including an indicator amino acid (another indispensable amino acid, usually L-1-^{13}C-phenylalanine) are in excess and therefore will be oxidized (**Fig. 1**).[7]

With increasing intake of the limiting amino acid, oxidation of the indicator amino acid will decrease due to its increasing incorporation into protein (**Fig. 1**). Once the requirement is met for the limiting amino acid/protein, there will be no further change in the oxidation of the indicator amino acid with increasing intake of the test amino acid. The inflection point where the oxidation of the indicator amino acid stops decreasing and reaches a plateau is referred to as the "breakpoint" (**Fig. 1**). The breakpoint, identified with the use of two-phase linear regression analysis, indicates the EAR of the limiting (test) amino acid/protein.[5,7] This method is well-suited for studying protein requirements across the life cycle and in at-risk populations because IAAO requires only oral isotope provision, collection of breath samples and a single study day adaptation.[5]

Table 1. Protein Requirements Determined in Humans vs. Recommendations across the Life Cycle

	DRI[1] (2005) g/kg/day	IAAO[2] g/kg/day	% kcal
Young Adult Men			
EAR[3]	0.66	0.93	~10%
RDA[4]	0.80	1.2	~13%
Children (6–10 y)			
EAR	0.76	1.3	~9%
RDA	0.95	1.55	~10%
Pregnant Women (~16 week gestation)			
EAR	0.88	1.22	~13%
RDA	1.1	1.66	~18%
Pregnant Women (~36 week gestation)			
EAR	0.88	1.52	~17%
RDA	1.1	1.77	~20%
Elderly Women (>65 y)			
EAR	0.66	0.96	~13%
RDA	0.80	1.29	~15%
Elderly Women (80+ y)			
EAR	0.66	0.85	~10 %
RDA	0.80	1.15	~13 %

[1]Dietary Reference Intakes; [2]Indicator Amino Acid Oxidation derived requirement estimates; [3]Estimated Average Requirement; [4]Recommended Dietary Allowance

Using the IAAO method described above, we have determined the protein requirements across the life cycle (**Table 1**), beginning with young adult men,[8] 6–10 year old children,[9] pregnant women during early (~16 week) gestation and late (~36 week) gestation,[10] elderly women (>65 years old)[11] and men (>65 years old),[12] and in octogenarian (80+ year old) women.[13] Our estimates are 30–70% higher than the current recommendations. While on a body weight (g/kg) basis the IAAO determined requirements are higher, when expressed as a percent of energy, the IAAO estimates range from 10–20% across different life stages, thus, are well aligned with the acceptable macronutrient distribution range (AMDR) for energy from protein. Conversely, the current DRIs for all life stages call for a protein intake of only 7–10% of energy and therefore are not practical.

Soy: A High Quality Protein

Beyond the amount of protein, the type of protein is an important consideration, and is currently extensively being discussed by the Food and Agriculture Organization (FAO).[14,15,16] Protein quality is defined as the capacity of food sources to provide individual amino acids in sufficient quantity to the body. In general, animal sources are considered of higher quality, since they contain all essential amino acids at higher concentrations on a mg/g protein basis.

Soy and other plant sources, such as legumes and pulses, are considered good quality protein sources. But in general, plant proteins are low in one or more essential amino acids; for example, cereals are low in lysine and pulses/legumes are low in methionine. Furthermore, plant protein sources are also affected by cooking and processing methods and by the presence of anti-nutritional factors.[17]

However, plant-based diets,[18] primarily based on pulses/legumes,[19] are being encouraged as a sustainable diet choice by the FAO[20] and the Institute of Medicine (IOM).[21] Sustainable diets have a low environmental impact and contribute to food and nutrition security and a healthy life for present and future generations. To provide dietary guidelines that include plant-based recommendations for environmental sustainability,[22] we need a better understanding of the role of individual foods to support protein synthesis *in vivo*—particularly of plant dietary protein sources. Toward this objective we have embarked on a recent set of studies using our novel IAAO method to test the protein quality of food sources.[22]

In vivo protein quality is primarily determined by two factors—digestibility, followed by bioavailability of amino acids for protein synthesis. We have determined that methionine is ~87% and 72% bioavailable from casein and soy protein isolate, respectively.[23] We also reported that lysine from cooked white rice is highly bioavailable (97%);[24] however, dry heat

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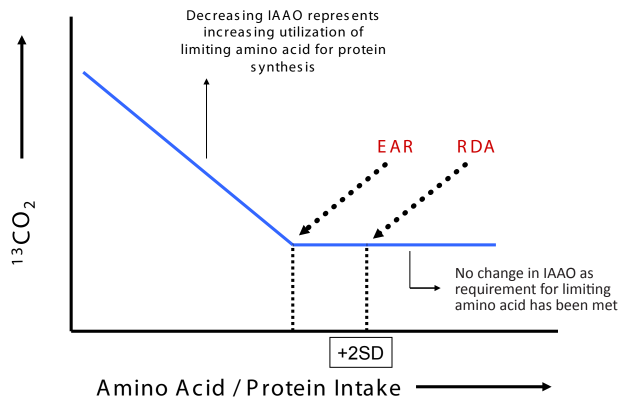
(browning of rice) reduced lysine bioavailability to 70%. Recently we showed in adult men that tryptophan bioavailability from cooked cornmeal is 80%, though lysine bioavailability from corn is 71%.[25]

A key point is that the IAAO method measures both digestibility and bioavailability of amino acids because it is based on an end-point carbon oxidation measure and therefore accounts for all losses of dietary amino acids during digestion, absorption, and cellular metabolism. Our results have the potential to be applied in designing plant-based diets for vulnerable populations, such as young children, to meet individual limiting essential amino acids.

Conclusion

Protein nutrition plays a critically important role in overall health. Therefore, it is important to ensure that recommendations for dietary protein intakes match human demands. However, current protein recommendations may not be adequate to meet *in vivo* demands—especially in different life stages. On the other hand, protein-rich animal sources are environmentally demanding to produce, and plant-based proteins such as soy are considered sustainable. To ensure all amino acids are provided to meet body demands, consume a variety of plant-based protein sources each day.

Figure 1. Indicator Amino Acid Oxidation (IAAO) Concept



EAR, estimated average requirement
RDA, recommended dietary allowance
SD, standard deviation

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PROTEIN REQUIREMENTS AND EXERCISE

By Mark Messina, PhD, MS

There is general agreement that individuals engaged in strength and endurance exercise training require more dietary protein than the generally healthy population. As noted by Paddon-Jones, the RDA (0.8 g/kg bodyweight) "was never designed to provide prescriptive guidance for populations with extraordinary demands, be they clinical or athletic."[1] Just how much dietary protein is needed by exercisers is a matter of some debate, and (not surprisingly) will depend upon the type and intensity of the exercise. But in general, recommendations range from 1.2 to 2.0 g/kg,[2-4] although a recent meta-analysis on protein supplementation involving resistance exercise trainees reported an upper 95% confidence interval of 2.2 g/kg/day.[5]

While these recommendations are considerably higher than the RDA, they are compatible with guidelines from the Institute of Medicine to consume a diet that ranges in protein content of between 10 and 35% of calories. The upper end of that range represents a daily protein intake of 175 g for a person consuming 2,000 calories per day, which for a 160-pound person is about 2.4 g/kg body weight. Furthermore, according to NHANES data, the average American male consumes about 99 g of protein per day (about 1.4 g/kg body weight for a 160 pound person).[6] Thus, it is not difficult to consume the amount of protein needed by exercisers—especially when considering that caloric needs will increase as a result of exercise.

Over the years concerns have arisen about the potentially harmful effects of high-protein diets. One concern frequently mentioned is the adverse effect of protein intake on renal function. However, a very recently published meta-analysis of the clinical data found that high protein intakes do not adversely influence kidney function or glomerular filtration rate in healthy adults.[7]

In addition to total protein intake, questions have arisen about the impact of the timing of protein ingestion on performance, especially gains in strength and lean body mass in response to resistance exercise training. The anabolic window refers to the time period after resistance exercise during which dietary protein maximally stimulates muscle protein synthesis. A commonly held belief is that the anabolic window lasts for about 2 hours. However, more recent research refutes this belief and downplays the importance of timing.[5,8] Enhanced protein synthesis following exercise may last for as long as 24 hours.

Another factor potentially influencing muscle mass is dietary protein distribution; that is, the distribution of protein intake throughout the day. Americans tend to consume most of their protein at dinner and via after-dinner snacking.[9] However, evidence suggests that for optimal benefit, protein intake should be evenly distributed throughout the day. To this point, Schoenfeld and Aragon,[10] propose that to maximize anabolism, one should consume protein at a target intake of 0.4 g/kg/meal across a minimum of 4 meals in order to reach a minimum of 1.6 g/kg/day. Using the upper daily intake of 2.2 g/kg/day reported in the literature and spreading intake over the same 4 meals would necessitate a maximum of 0.55 g/kg/meal. These recommendations mimic those made earlier by Paddon-Jones and Rasmussen[11] to consume 25–30 g protein per meal.

Finally, there is the question of the influence of protein type on gains in muscle mass and strength. Because of its high leucine concentration and perhaps also because it is so quickly digested, whey protein is generally considered to be the optimal protein source for building muscle.[12] Certainly, acute studies that measure muscle protein synthesis over a 4-hour period support this conclusion.[13,14]

However, a recent systematic review concluded that over a period of many weeks, protein source plays a minor (if any) role in determining gains in lean body tissue and strength in response to resistance exercise training.[5] This point was recently confirmed by a meta-analysis that included 9 clinical trials that compared the effect of soy protein supplementation with whey protein supplementation and supplementation with other animal proteins on gains in strength and lean body mass in response to resistance exercise training programs lasting between 6 and 36 weeks.[15] This analysis found no difference in gains between soy protein and whey and soy protein and the other animal proteins. Despite this finding, more work needs to be done to determine whether these findings apply to extremely highly-trained individuals. Still, overall, the evidence indicates that protein amount is more important than protein source.

Finally, there is speculative evidence to suggest that a blend of proteins may have subtle advantages over any single protein. For example, data from a 12-week trial by Reidy et al.[16] found that a blend of casein (50%), whey (25%), and soy protein (25%) enhanced overall whole body lean mass in young men undergoing resistance exercise training more than whey protein alone. Also, Mobley

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et al.[17] recently found that soy protein preferentially increased the size of type I (slow twitch) muscle fibers whereas whey protein supplementation preferentially increased the size of type II fibers (fast twitch).

In conclusion, exercise increases dietary protein requirements. With respect to gains in muscle mass and strength, data suggest protein type plays a much lesser role than protein amount. Although speculative, blends of proteins may have advantages over single proteins. For maximal benefit, dietary protein should be evenly distributed throughout the day.

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Putting Soy Protein On Your Plate

BONUS ARTICLE

Access this "Healthy Handout" at soyconnection.com/healthprofessionals/newsletter.

FDA AUTHORIZES QUALIFIED HEALTH CLAIM FOR OILS HIGH IN OLEIC ACID

By Lisa Kelly, MPH, RDN

In November, the Food and Drug Administration (FDA) authorized the use of a qualified health claim citing that oils high in oleic acid, such as high oleic soybean oil, may reduce the risk of coronary heart disease.[1]

The authorized health claim applies to edible oils containing at least 70 percent of oleic acid, a monounsaturated fat that provides the stability required for oils to perform in a variety of food applications. Food companies with existing products which meet FDA requirements can consider adding the health claim to labels of foods made with the ingredient (with inclusion of the proper disclaimers), and brands seeking to source heart-healthy ingredients for emerging products can test high oleic soybean oil in formulations. High oleic soybean oil oleic acid levels exceed 70 percent and can go as high as 75 percent, and the oil is lower in saturated fat compared to some other high-stability oils commonly used in food production.

High oleic soybean oil, approved for global use as of December 2017, offers food companies increased functionality, such as extended fry life, increased stability and a neutral flavor profile, making it ideal for frying, sautéing, baked goods and snack foods. It is a domestic crop, supporting U.S. farmers.

The announcement of the qualified health claim for oils high in oleic acid follows the FDA's August 2017 authorization of the use of a qualified health claim confirming conventional soybean oil's ability to reduce the risk of coronary heart disease.[2] Conventional and high oleic soybean oils have different fatty acid profiles.

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Putting Soy Protein on Your Plate

By Matt Jacobs, MA, RD, LD, NSCA-CPT

Protein is vital to the human body to function and grow adequately. Protein can be found in both animal and plant foods as well as supplemental powders and bars. Prioritizing and incorporating a variety of protein sources on your plate can ensure adequate vitamin, mineral, and fiber intake.

The building blocks of proteins are called amino acids. Of the 20 amino acids used to synthesize protein, the body needs to obtain 9 of these from the foods we eat. These 9 are appropriately named essential amino acids.

The quality of a protein food is determined by its digestibility and amino acid content. Animal proteins are typically higher quality than plant proteins, although this is not the case with soy protein. The quality of soy protein is similar to that of animal proteins.[1] Soy products also offer lower saturated fat content than their animal counterparts.

Add soy proteins to your plate with these options:

Breakfast	soy yogurt, whole grain cereal with soymilk, prepared frozen soy breakfast sandwich, tofu, soy sausage scramble
Lunch	tofu hotdogs or burgers, soy nut butter sandwich, soups, stews, or salads with edamame, tempeh
Dinner	soy pasta with marinara, soy “meat” alternative retail products
Snack	edamame, soynuts, soy yogurt, shake made with soy milk, soy protein powder

The current protein Recommended Dietary Allowance (RDA) for healthy adults is 0.8 g/kg body weight (bw)/day.[2] Special populations, such as athletes, may benefit from a protein intake above the current RDA, such as 1.2 to 2.0 g/kg bw/day.[3] Similarly, healthy aging adults may benefit from protein intake between 1.3 and 2.0 g/kg to prevent sarcopenia.[4] For example, a 170-pound adult would need to consume 62 g of protein per day at 0.8 g/kg, and 93 g at 1.2 g/kg.

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