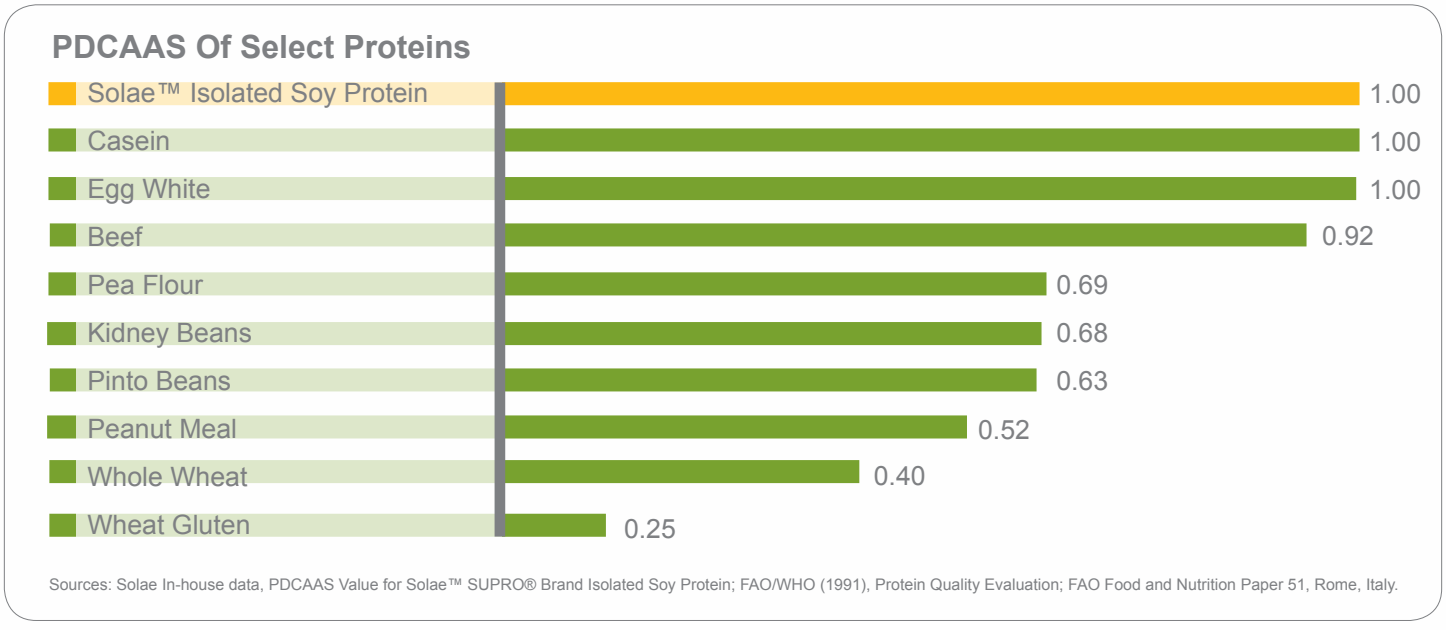
Solae™ Science Series

Soy Protein: A High Quality, Complete Protein

Soy protein is a high quality, complete plant protein that is comparable to high quality animal protein (e.g., beef, milk, eggs). As a primary source of protein, soy can help children and adults adequately meet their protein needs. Soy protein is unique in that it is the only complete source of vegetable protein widely available. Protein could be considered the most important macronutrient for humans[1,2]. The roles of protein in the human body are numerous. Among other things, proteins function as enzymes and hormones, as transporters and receptors, and as part of the structural integrity of most organs in the body[2]. Amino acids serve as precursors for nucleic acids, hormones, vitamins and other important molecules[3]. With so many important roles in all aspects of bodily functioning, it is essential that humans consume enough high-quality protein each day to meet the body's demands.

Comparability of Different Proteins

The PDCAAS values for Solae™ isolated soy protein and other common proteins are presented below. These data show that soy protein achieves the maximum PDCAAS value of 1.00 and is deemed a nutritionally complete protein.



Sources: Solae In-house data, PDCAAS Value for Solae™ SUPRO® Brand Isolated Soy Protein; FAO/WHO (1991), Protein Quality Evaluation; FAO Food and Nutrition Paper 51, Rome, Italy.

PDCAAS methodology takes into consideration three important parameters:

1) the food protein's essential amino acid profile,
2) corrected for its digestibility
3) its ability to supply the FAO/WHO's amino acid, and requirements for 2-5 year olds[4].

For humans, amino acid requirement values have been used to develop reference amino acid patterns for the purpose of evaluating the quality of food proteins or their capacity to efficiently meet both the nitrogen and indispensable amino acid requirements of an individual. Protein quality is a measure of protein bioavailability, and its evaluation is a means of determining the capacity of food proteins and diets to satisfy the metabolic demands of amino acids and nitrogen.

The Food and Agriculture Organization (FAO) and the World Health Organization (WHO) Joint Expert Consultation's Protein Quality Evaluation Report[4] recommended the protein digestibility-corrected amino acid score (PDCAAS), which is a simple, scientific and rational procedure for assessing protein quality. The United States Institute of Medicine (IOM) in its 2005 discussion of Daily Reference Intakes (DRIs) reaffirmed the use of PDCAAS for evaluating the relative nutritional quality of different protein sources[3]. Additionally, the US Food and Drug Administration (US FDA) adopted the use of PDCAAS for the protein quality evaluation of foods in 1993.

The PDCAAS methodology takes into consideration three important parameters: 1) the food protein's essential amino acid profile, 2) corrected for its digestibility and 3) its ability to supply the FAO/WHO's amino acid requirements for 2-5 year olds[4]. Although there are relatively small differences in amino acid requirements for age-sex groups beyond infancy, the 2-5 year old requirement is used because it is the most demanding pattern of any age group excluding that of infant requirements. For a given protein, the essential amino acid that is present in the relatively lowest quantity when compared to the standard is used for calculation of the final PDCAAS value. The highest possible score using the PDCAAS method is 1.00[4].

The digestibility of protein is defined as the proportion of ingested protein that is absorbed. True digestibility of protein corrects for endogenous fecal nitrogen (measured as nitrogen loss that occurs on a protein-free diet) and is expressed as a true digestibility percent. The true digestibility of Solae isolated soy proteins is 97% (internal data), and comparable to other high quality proteins such as milk, meat and eggs that range between 94-97%[5]. Other plant proteins are of lower digestibility.

The use of Protein Efficiency Ratio (PER) to assess protein quality, although still used by some, measures the ability of a protein to support growth in young growing rats. It over-estimates the value of some animal proteins and underestimates the value of some vegetable proteins for human growth[4, 6]. On the other hand, PDCAAS considers the full contribution of vegetable proteins to the diet. Additionally, vegetable proteins such as high quality soy protein have economic and sustainability advantages when compared to animal proteins.

Table 1: Suggested Indispensable Amino Acid Requirements Published by the WHO/FAO[5] and the U.S. IOM[3] Expressed as Milligrams per Gram Protein

Amino Acid	WHO/FAO Suggested Requirements			U.S. IOM	
	1 - 2 yrs	3 - 10 yrs	Adults	1 - 3 yrs	Adults
Histidine	18	16	15	18	17
Isoleucine	31	31	30	25	23
Leucine	63	61	59	55	52
Lysine	52	48	45	51	47
Methionine + Cysteine	26	24	22	25	23
Phenylalanine + Tyrosine	46	41	38	47	41
Threonine	27	25	23	27	24
Tryptophan	7.4	6.6	6.0	7	6
Valine	42	40	39	32	29

Meeting Human Protein Requirements

Soy protein meets the essential amino acid requirements of children and adults. National and international organizations [3-5,7] and individual researchers[8] have published protein and amino acid requirement recommendations. These recommendations are used to assess whether a protein source is nutritionally complete based on its amino acid composition. The most recent estimations of the indispensable amino acid requirements for various age groups were published by the WHO/FAO[5]. Values for children and adults were published by the U.S. IOM[3] as part of the DRIs for protein and amino acids. These values are presented above. Isolated soy proteins commercially available from Solae meet the published estimated indispensable amino acid requirements for children and adults. Selected age groups are presented in Table 1.

Soy is a nutritionally complete protein with PDCAAS=1.00 and comparable to milk, eggs and meat.

Isolated soy protein has been shown to maintain nitrogen balance when fed as the sole protein source at minimum recommended intake levels. The nutritional characteristics of soy protein in human nutrition have been reviewed[9-11]. Soy protein was once widely regarded as nutritionally inferior to animal protein. The sulfur-containing amino acid methionine is the first limiting amino acid in soy protein, and animal bioassays such as the rat-based PER suggest that the biological value of soy protein is only 62-92% compared to that of casein. However, animal assays underestimate biological value because rats have a higher methionine requirement than humans[9] so these techniques cannot be used to accurately estimate the quality of soy protein for humans. Unequivocal data generated during the past 25 years have shown that soy is a nutritionally complete protein based on its indispensable amino acid spectrum.

Numerous nitrogen balance studies[12-18] have demonstrated that unmodified soy protein, when fed in nutritionally appropriate amounts to human subjects, is comparable in quality to that of beef, milk and other animal proteins. These nitrogen balance studies provide clear, consistent evidence that isolated soy protein (including Solae™ SUPRO® brand isolated soy protein) is a complete protein that can meet protein requirements. These data further provide direct, definitive evidence that isolated soy protein is nutritionally comparable to high quality animal proteins when fed in nutritionally appropriate amounts.

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