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1. **Biological value** (**BV**) is a measure of the proportion of absorbed [protein](https://en.wikipedia.org/wiki/Protein) from a food which becomes incorporated into the proteins of the organism's body. It captures how readily the digested protein can be used in [protein synthesis](https://en.wikipedia.org/wiki/Protein_biosynthesis) in the [cells](https://en.wikipedia.org/wiki/Cell_%28biology%29) of the organism. Proteins are the major source of [nitrogen](https://en.wikipedia.org/wiki/Nitrogen) in food. BV assumes protein is the only source of nitrogen and measures the proportion of this nitrogen absorbed by the body which is then excreted. The remainder must have been incorporated into the proteins of the organisms body. A [ratio](https://en.wikipedia.org/wiki/Ratio) of nitrogen incorporated into the body over nitrogen absorbed gives a measure of protein "usability" – the BV.

Unlike some measures of protein usability, biological value does not take into account how readily the protein can be [digested](https://en.wikipedia.org/wiki/Digestion) and absorbed (largely by the [small intestine](https://en.wikipedia.org/wiki/Small_intestine)). This is reflected in the experimental methods used to determine BV.

BV uses two similar scales:

1. The true percentage utilization (usually shown with a percent symbol).
2. The percentage utilization relative to a readily utilizable protein source, often [egg](https://en.wikipedia.org/wiki/Egg_%28food%29) (usually shown as unitless).

These two values will be similar but not identical.

The BV of a food varies greatly, and depends on a wide variety of factors. In particular the BV value of a food varies depending on its preparation and the recent diet of the organism. This makes reliable determination of BV difficult and of limited use — fasting prior to testing is universally required in order to ascertain reliable figures.

BV is commonly used in nutrition science in many [mammalian organisms](https://en.wikipedia.org/wiki/Mammals), and is a relevant measure in humans. It is a popular guideline in [bodybuilding](https://en.wikipedia.org/wiki/Bodybuilding) in protein choice.

1. **i. BODY PROTEIN METABOLISM**

Assessing protein quality with respect to its efficiency in supporting body protein metabolism should include consideration of the capacity of the diet to provide substrate needs for protein synthesis and any other biosynthetic pathways, ie, a suitable source of nitrogen and IAA (lysine, threonine, valine, isoleucine, leucine, methionine, phenylalanine, tryptophan, and histidine). However, to this assessment method should be added provision of sufficient signal amino acids, (eg, leucine), required for those regulatory steps whereby metabolism is optimized and anabolism is stimulated. It is arguable that current methods used for assessing protein quality have only evaluated substrate needs rather than any provision of regulatory amino acids. Evaluation of protein quality with the PDCAAS approach measures the protein's metabolic effectiveness at a dietary intake that meets minimum requirements. By this measure, protein requirements are low compared with most nutritionally complete habitual diets. Indeed, applying an adaptive metabolic demand model of protein homeostasis protein requirements may be even lower after complete adaptation to the extent that a dietary recommendation based on the true minimum intake for nitrogen equilibrium would become of questionable nutritional significance. Furthermore, in the context of an adaptive model and the higher habitual protein intakes in subjects consuming the currently recommended healthy diet, it has been suggested that the assessment of protein quality by amino acid scoring becomes problematic, with the metabolic demand for amino acids reflecting a complex adaptive response to varying intakes of protein and amino acids .This means that as protein intake increases, for example toward the upper half of the current acceptable macronutrient density range, both the metabolic demands for amino acids and the consequent fate of the dietary amino acids will become increasingly difficult to predict in terms of generating a single reference amino acid pattern against which to judge protein quality, especially across the entire life span and in all physiologic conditions. For example, leucine regulation of muscle protein synthesis via the mammalian target of rapamycin signal cascade requires increases in intracellular leucine concentration, which also increases amino acid oxidation. The PDCAAS approach argues that increased amino acid oxidation reflects inefficient use of amino acids, but this ignores any transient signaling influence of specific amino acids before their oxidation. Thus, within the context of potential benefits associated with higher protein intakes, it is important to consider to what extent the quality of the protein (eg, amino acid profile) influences its anabolic signaling.

## Ii.DIETARY PROTEIN AND AMINO ACID BIOAVAILABILITY

A second important issue in quality evaluation relates to the bioavailability or digestibility of a protein or the capacity to provide metabolically available nitrogen and amino acid to tissues and organs. The food matrix in which a protein is consumed can have significant impact on the bioavailability of amino acid for metabolic needs. Digestive losses and structural changes of amino acids are caused by numerous antinutritional factors in foods. These issues have been addressed with particular attention to animal compared with plant proteins.

As mentioned previously, the PDCAAS value is calculated by first scoring the test protein against an appropriate reference amino acid pattern, then correcting for digestibility. The currently accepted method for assessing digestibility is based on measures of fecal nitrogen in a rat assay. Fecal measures in this assay appear to appropriately assess human nitrogen digestibility. It has been noted, however, that ileal measures may better assess amino acid digestibility. Both cost and time involved in measuring true ileal digestibility in human subjects are intensive, although other monogastric species, such as the pig, have been considered .It has also been noted that research is needed to assess the impact of kinetic differences between proteins in the intestinal lumen when measuring ileal digestibility. Sarwar and Schaafsma have argued that digestibility factors developed from the rat bioassay may not appropriately correct for the range of antinutrient effects in the food matrix, both naturally occurring and formed through processing methods. Although heat, oxidation, and other treatments are carried out for consumer protection and benefit, they can lead to formation of Maillard compounds, oxidized sulfur amino acid, D-amino acids, or cross-linked peptide chains, which limit amino acid bioavailability. The multiple antinutritional factors present in foods have led Sarwar and Schaafsma to also question the biological efficiency of complementation of low-quality with high-quality proteins. Also, as stated above, the truncation procedure and the restriction to only the first limiting amino acid are subject to criticism because these latter issues do not allow expression of the power of a high-quality protein to balance the IAA composition of inferior proteins . A high ileal digestibility of proteins is also relevant for reducing the amount of dietary nitrogen entering the colon. Protein fermentation by the intestinal flora may result in the formation of toxic compounds, including ammonia, dihydrogen sulfide, indoles, and phenols that could irritate the colonic epithelial cells and increase the risk of colon cancer

## iii.PROTEIN QUALITY IN RELATION TO ENERGY TURNOVER AND GLUCOSE HOMEOSTASIS

Dietary protein function is not usually considered in relation to energy status and glucose homeostasis. Although energy intake and expenditure, either above or below metabolic needs, influences protein utilization, the impact of protein quality in populations with varying levels of energy turnover has not been considered in the past. However, it is logical to question the influence of energy turnover on amino acid needs and the consequent reference amino acid pattern for assessing protein quality in any target population. Current evaluation of dietary protein utilization, especially in relation to its quality, assumes subjects are in energy balance, consuming nutritionally adequate diets, and engaging in moderate rates of physical activity . Departure from energy balance markedly changes protein utilization and has been suggested as an important factor in the lack of reproducibility of the nitrogen balance studies. In subjects who are otherwise in energy balance, the protein utilization effects of varying levels of physical activity are very poorly understood. In the context of the obesity epidemic, there is an important potential role for protein as a part of diets aiming to limit weight gain or help with weight loss. Several mechanisms have been proposed to explain the well-documented influence of dietary protein's role in body weight regulation, such as thermogenesis .improved body composition, improved glycemic control ,and, as discussed below, appetite regulation . These effects have been assumed to relate to the quantity of dietary protein and its relative proportion compared with the other macronutrients. However, there is evidence to suggest mechanisms that would have implications for protein quality assessment . Improved glycemic control is important in the context of management of type 2 diabetes and also in relation to body-weight regulation. Studies that have increased protein intakes at the expense of carbohydrates have shown that a diet with 30% of energy derived from protein, 20% from carbohydrate (with low biologically available glucose), and 50% from fat is effective in improving glycemic control in people with type 2 diabetes without an adverse effect on serum lipids or renal function . There are several potential mechanisms of these influences of protein which might be responsive to the protein structure or amino acid profile. One is the influence of variation in amino acid composition on the magnitude and duration of postprandial insulin secretion, an important but relatively unexplored question in this context. Another is gluconeogenesis rates in relation to both the pattern of amino acids as substrates as well as their influence as regulators of the metabolic pathway. Individual amino acids differ as substrates for gluconeogenesis, and the branched-chain amino acids have a unique role in providing amino groups for production of alanine (from pyruvate) and recycling of glucose carbon from skeletal muscle to liver for gluconeogenesis . The overall significance of protein or the amino acid pattern on glucose homeostasis through insulin secretion, de novo glucose production, or alanine recycling has not been investigated.

## iv.SATIETY INDUCTION

As indicated above, in the context of weight and energy-balance regulation, dietary protein is now known to play an important role in appetite regulation. Thus, the effect of protein on satiety becomes a potential endpoint for quality assessment. Given the complexity of the neuroendocrine and metabolic mechanisms of appetite regulation , it is difficult to predict how quality will modulate protein's influence within the satiety cascade given the likelihood of both pre- and postabsorptive signaling. Proteins that are more rapidly digested (fast proteins), such as whey, appear to have greater influence on satiety than casein (a slow protein), which clots in the stomach and induces a slower hyperaminoacidemia . In part, the difference in rate of digestion alters levels of the gut hormones glucagon-like peptide-1 and cholecystokinin . Hence, another feature of protein that influences its effectiveness (ie, “quality”) in terms of appetite regulation relates to its tertiary structure and consequent behavior in the gastrointestinal tract. Protein structure is a characteristic not currently addressed in quality evaluation. Another potential mechanism in satiety induction involves the presence of bioactive amino acid sequences, which may be absorbed and have metabolic effects that increase satiety . Casomorphins, casein-derived peptides, slow gastrointestinal motility via gastric opioid receptors which mediate lower postprandial plasma amino acid concentrations, thereby preventing the satiating effect of higher plasma amino acid levels. Caseinomacropeptide, a glycosylated peptide comprising 15% to 20% of whey products, stimulates cholycystokinin production, which leads to greater satiety . Finally, it is well known that proteins increase diet-induced thermogensis, and it has been shown that this effect is closely associated with satiation/satiety