18/MHS06/024

Med Lab Sci

BCH 204

Q1. What do you understand by the term Biological value of protein

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_(biology)) 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 organism’s 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.

The biological value of a protein extends beyond its amino-acid composition and digestibility, and can be influenced by additional factors in a tissue-specific manner. In healthy individuals, the slow appearance of dietary amino acids in the portal vein and subsequently in the systemic circulation in response to bolus protein ingestion improves nitrogen retention and decreases urea production. This is promoted by slow absorption when only protein is ingested (e.g. casein). When a full meal is ingested, whey achieves slightly better nitrogen retention than soy or casein, which is very likely achieved by its high content of essential amino acids (especially leucine). Elderly people exhibit ‘anabolic resistance' implying that more protein is required to reach maximal rates of muscle protein synthesis compared to young individuals. Protein utilization in inflammatory or traumatic conditions increases substantially in the splanchnic tissues containing most of the immune system, and in wounds and growing tissues. This happens especially in the elderly, which often suffer from chronic inflammatory activity due to disease, physical inactivity and/or the aging process itself. Consequently, the proportion of protein absorbed in the gut and utilized for muscle protein synthesis decreases in these situations. This compromises dietary-protein-induced stimulation of muscle protein synthesis and ultimately results in increased requirements of protein (∼1.2 g/kg body weight/day) to limit gradual muscle loss with age. To optimally preserve muscle mass, physical exercise is required. Exercise has both direct effects on muscle mass and health, and indirect effects by increasing the utilization of dietary protein (especially whey) to enhance rates of muscle protein synthesis.

Q2. Methods of assessment of protein quality.

**Protein efficiency ratio (PER)**

Protein efficiency ratio (PER) is based on the weight gain of a test subject divided by its intake of a particular food [protein](https://en.wikipedia.org/wiki/Protein) during the test period. From 1919 until very recently, the PER had been a widely used method for evaluating the quality of protein in food.

The food industry in Canada currently uses the PER as the standard for evaluating the protein quality of foods.[[1]](https://en.wikipedia.org/wiki/Protein_efficiency_ratio#cite_note-1) The official method for determining the protein efficiency ratio is from Health Canada's Health Protection Branch Method FO-1, October 15, 1981

The U.S. [Food and Drug Administration](https://en.wikipedia.org/wiki/Food_and_Drug_Administration) now uses the [Protein Digestibility Corrected Amino Acid Score](https://en.wikipedia.org/wiki/Protein_Digestibility_Corrected_Amino_Acid_Score) (PDCAAS) as the basis for the percent of the U.S. [recommended daily allowance](https://en.wikipedia.org/wiki/Recommended_daily_allowance) (USRDA) for protein shown on food labels. However, the PER is still used in certain FDA regulations. The US FDA official methods to calculate the PER are as stated in the Official Methods of Analysis of AOAC International, 16th ed. (1995) Section 45.3.05, AOAC Official Method 982.30 Protein Efficiency Ratio Calculation Method; and Official Methods of Analysis of AOAC International, 18th ed. (2005)

**The net protein utilization**

The net protein utilization, or NPU, is the ratio of amino acid mass converted to proteins to the mass of amino acids supplied. This figure is somewhat affected by the salvage of essential amino acids within the body, but is profoundly affected by the level of limiting amino acids within a foodstuff

Like Biological Value, NPU estimates nitrogen retention but in this case by determining the difference between the body nitrogen content of animals fed no protein and those fed a test protein. This value divided by the amount of protein consumed is the NPU which is defined as the "percentage of the dietary protein retained". Miller (12) proposed a procedure which involved replicate groups of 4 weanling rats housed in group cages which were fed either the "protein-free" or the "test" diet for 10 days. These conditions were chosen empirically and the particular merits of these conditions remain to be demonstrated. Since in young animals there is a high correlation between body nitrogen and body water content (13-16), the substitution of body water measurements for body nitrogen measurements has been widely used. Indeed, measurement of body water may be more accurate than

**Critique**

Critique As has been stated, the use of estimates of protein quality to calculate the amount of protein needed to meet requirements when different diets are consumed requires that the estimate of quality vary in some known fashion, preferably in linear fashion, from zero to 100% utilization. Actually, when Block and Mitchell (17) first proposed the use of Amino Acid Scores (Fig. 1), they found that Biological Value did not follow the predicted relationship with Amino Acid Score. Rather, the regression line relating BV and Amino Acid Score indicated that proteins completely lacking an essential amino acid and which would therefore have an Amino Acid Score of zero would apparently yield a BV of approximately 25% This would mean that the requirement could be met with such proteins if they were fed at a level providing four times the estimated minimal protein requirement. This presumably cannot be true since it would imply that the protein needs could be met without a supply of all of the essential amino acids.

**Biological Value (BV)**

Biological value, as defined by Thomas (4) and Mitchell (5,6) has long been considered the method of choice for estimating the nutritive value of proteins. It has been defined as the "percentage of absorbed nitrogen retained in the body" and a complete evaluation of the dietary protein includes measurement of the Biological Value and the Digestibility. These values are obtained by measuring the fecal and urinary nitrogen when the test protein is fed and correcting for the amounts excreted when a nitrogen-free diet is fed. True digestibility is defined as the percentage of food nitrogen absorbed from the gut

**The net protein utilization**

The net protein utilization, or NPU, is the ratio of [amino acid](https://en.wikipedia.org/wiki/Amino_acid) mass converted to [proteins](https://en.wikipedia.org/wiki/Protein) to the mass of amino acids supplied. This figure is somewhat affected by the salvage of [essential amino acids](https://en.wikipedia.org/wiki/Essential_amino_acid) within the body, but is profoundly affected by the level of [limiting amino acids](https://en.wikipedia.org/wiki/Essential_amino_acid) within a foodstuff.

It is used as a measure of "protein quality" for human nutritional purposes.[[1]](https://en.wikipedia.org/wiki/Net_protein_utilization#cite_note-1)

As a value, NPU can range from 0 to 1 (or 100), with a value of 1 (or 100) indicating 100% utilization of dietary nitrogen as protein and a value of 0 an indication that none of the nitrogen supplied was converted to protein.

Certain foodstuffs, such as [eggs](https://en.wikipedia.org/wiki/Egg_(food)) or [milk](https://en.wikipedia.org/wiki/Milk), rate as 1 on an NPU chart.

Experimentally, this value can be determined by determining [dietary](https://en.wikipedia.org/wiki/Diet_(nutrition)) protein intake and then measuring [nitrogen](https://en.wikipedia.org/wiki/Nitrogen) [excretion](https://en.wikipedia.org/wiki/Excretion). One formula for NPU is

NPU = ((0.16 × (24 hour protein intake in grams)) - ((24 hour urinary [urea](https://en.wikipedia.org/wiki/Urea) nitrogen) + 2) - (0.1 × ([ideal body weight](https://en.wikipedia.org/wiki/Ideal_body_weight) in kilograms))) / (0.16 × (24 hour protein intake in grams))

The [Protein Digestibility Corrected Amino Acid Score](https://en.wikipedia.org/wiki/PDCAAS) is a more modern rating for determining protein quality. Best assessment of quality of protein is by digestible indispensable amino acid score which is superior to PDCAAS

**Amino acid score**

Amino acid score, in combination with [protein digestibility](https://en.wikipedia.org/wiki/Protein_digestibility), is the method used to determine if a [protein is complete](https://en.wikipedia.org/wiki/Complete_protein). [PDCAAS](https://en.wikipedia.org/wiki/PDCAAS) and [DIAAS](https://en.wikipedia.org/wiki/DIAAS) are the two major protein standards which determine the completeness of proteins by their unique composition of [essential amino acids](https://en.wikipedia.org/wiki/Essential_amino_acid)

Block and Mitchell (17) originally proposed that since all amino acids must be present at the site of protein synthesis in adequate amounts if protein synthesis is to proceed, a comparable deficit of any amino acid would limit protein synthesis to the same degree. Thus, they suggested that if the composition of an "ideal protein" was known, i.e., a protein which contained every essential amino acid in sufficient amounts to meet requirements without any excess, then it should be possible to compute the nutritive value of a protein by calculating the deficit of each essential amino acid in the test protein from the amount in the "ideal protein". The "most limiting amino acid", the one in greatest deficit, would presumably determine the nutritive value

{\displaystyle PER\,={\frac {Gain\ in\ body\ mass(g)}{Protein\ intake(g)}}}