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BIOLOGICAL VALUE OF PROTEINS

The biological value of a protein has traditionally been defined on the basis of its amino-acid content in relation to human requirements and the suitability for digestion, absorption and incorporation into body proteins. The role of energy in the meal, amounts and amino acid composition of protein, meal distribution over the day and effects of physical activity are important factors determining protein requirements. Moreover, the biological end point and potential tissue of interest (e.g. whole-body protein vs. muscle protein) should be considered when evaluating the biological value or 'quality' of a protein for a given population.

A general recommendation is to include 0.8 g of protein per kilogram of body weight in adults per day in the diet, although recent reevaluation of protein requirements with stable isotopes (as compared to the nitrogen balance methodology) suggests that this recommendation is an underestimate. Requirements in absolute numbers/weight/day have generally been defined without taking the different factors that may influence these requirements into account. Athletes, elderly and critically ill individuals may require 1.5–2 g/kg ideal body weight/day.

Ultimately, dietary protein is essential for optimal health and well-being given its integral role in lean tissue remodeling and immune surveillance. Therefore, not only the absolute amount but also the quality of protein and the presence of other (macro)nutrients in the meal should be considered when determining the optimal nutrition for a variety of life conditions.

One of the problems of proteins is that their actual absorption and incorporation into body proteins has been claimed to be subject to error because it cannot be excluded that amino nitrogen is lost in the stools or metabolized by the bacterial flora. The high absorption rate and content of essential amino acids of whey make it especially suitable for the elderly population who typically present with an 'anabolic resistance' to dietary protein, which may be mediated partly by a greater splanchnic protein turnover that is necessary in host response, and partly by hormones and cytokines steering the inflammatory response.

THE VARIOUS METHODS OF ASSESSMENT OF PROTEIN QUALITY

It has long been known that proteins differ greatly in their nutritive value. This can be demonstrated grossly by any number of methods such as comparison of rates of growth, nitrogen retention, or other measures of physiological performance of animals or human subjects consuming diets containing approximately equal amounts of different proteins.

1. **BIOLOGICAL VALUE:** Biological Value (BV) Biological value, as defined by Thomas and Mitchell as the percentage of absorbed nitrogen retained in the body. It has long been considered the method of choice for estimating the nutritive value of proteins, 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.

   BIOLOGICAL VALUE:

   $BV = I-(F-F_O)-(U-U_O) \times 100 / I-(F-F_O)$

   Where

   I = Nitrogen intake of test protein

   F = Fecal nitrogen

   Fo = Fecal nitrogen on nitrogen-free diet (Metabolic N)

   U = Urinary nitrogen

   Uo = Urinary nitrogen on nitrogen-free diet (Endogenous N)

   DIGESTIBILITY

   $I-(F-F_O) \times 100 / I$

   Where

   I = Nitrogen intake of test protein

   F = Fecal nitrogen

   Fo = Fecal nitrogen on nitrogen-free diet (Metabolic N)

2. PROTEIN EFFICIENCY RATIO

The protein efficiency ratio (PER) has been the method most widely used because of its simplicity. Osborne, Mendel and Ferry observed that young rats fed certain proteins gained little weight and ate little protein whereas those which were fed better quality proteins gained more weight and consumed more protein. In an attempt to compensate for the difference in food intake, they calculated the gain in weight per gram of protein eaten and this has been called PER.

3. **NET PROTEIN RATIO (NPR):** A major criticism of the PER has been that it does not take into account the protein required for maintenance since only gain in weight is used in the calculation. Bender and Doell suggested that this criticism could be avoided by the inclusion in each test of a group of animals fed a protein-free diet. Net Protein Ratio (NPR) was then calculated as the overall difference in gain (gain in weight of the test group plus loss in weight of the protein-free group) divided by the protein eaten. It is apparent that if body composition is constant, this procedure is identical to NPU except that it is expressed in arbitrary units which are less useful than the percentage of protein utilized. The weaknesses are, of course, identical with those discussed under NPU.

4. **RELATIVE NUTRITION VALUE (RNV):** Hegsted et al. proposed a slope-ratio assay using rats in which the slope of the regression line relating body protein (or body water) of a standard protein (egg protein or lactalbumin) assumed to have maximal nutritive value was compared to that of the test protein. The tacit assumption made in the measurement of NPU or BV that these values are independent of the level of protein fed is thus tested in this procedure. As in the calculation of NPU and BV the original assumption was made that the regression line should bisect the Y axis at the point defined by the group fed the protein-free diet. In young growing rats where maintenance requirements are relatively small compared to the growth requirements, this method is probably the most logically defensible of the assays available as an estimate of the protein quality for growth.

5. **NITROGEN BALANCE INDEX :** Allison and Anderson showed, as has been discussed above, that Biological Value is the slope of the regression line relating nitrogen balance and nitrogen intake and suggested that this might have certain advantages in practice over the usual method of determining biological value. The concept of this index is rather similar to Relative Nutritive Value discussed above. Since it is becoming increasingly clear that nitrogen retention is not linearly related to nitrogen intake in the region of intake below maintenance, the validity of this index requires confirmation.