1.Coenzyme: A substance that enhances the action of an enzyme. (An enzyme is a protein that functions as a catalyst to mediate and speed a chemical reaction).

Coenzymes are small molecules. They cannot by themselves catalyze a reaction but they can help enzymes to do so. In technical terms, coenzymes are organic nonprotein molecules that bind with the protein molecule (apoenzyme) to form the active enzyme (holoenzyme).

A number of the water-soluble vitamins such as vitamins B1, B2 and B6 serve as coenzymes.

1b.Differences between fat soluble and water soluble vitamins.

Water-Soluble Vitamins

Water-soluble vitamins are those that are dissolved in water and readily absorbed into tissues for immediate use. Because they are not stored in the body, they need to be replenished regularly in our diet. Any excess of water-soluble vitamins is quickly excreted in urine and will rarely accumulate to toxic levels. With that being said, certain types of water-soluble vitamin, such as vitamin C, can cause diarrhea if taken in excess.

The water-soluble vitamins include the B-complex group and vitamin C, each of which offers the following health benefits:

Vitamin B1 (thiamine) helps to release energy from foods and is important in maintaining nervous system function.

Vitamin B2 (riboflavin) helps promotes good vision and healthy skin and is also important in converting the amino acid tryptophan into niacin.

Vitamin B3 (niacin) aids in digestion, metabolism, and normal enzyme function as well as promoting healthy skin and nerves.

Vitamin B6 (pyridoxine) aids in protein metabolism and the production of red blood cell, insulin, and hemoglobin.

Folate (folic acid) also aids in protein metabolism and red blood cell formation and may reduce the risk of neural tube birth defects.

Fat-Soluble Vitamins

Fat-soluble vitamins are dissolved in fats. They are absorbed by fat globules that travel through the small intestines and distributed through the body in the bloodstream. Unlike water-soluble vitamins, excess fat-soluble vitamins are stored in the liver and fatty (adipose) tissues for future use They are found most abundantly in high-fat foods and are better absorbed if eaten with fat.Because fat-soluble vitamins are not readily excreted, they can accumulate to toxic levels if taken in excess. Where a well-balanced diet can't cause toxicity, overdosing on fat-soluble vitamin supplements can.

There are four types of fat-soluble vitamin, each of which offers different benefits:

Vitamin A is integral to bone formation, tooth formation, and vision. It contributes to immune and cellular function while keeping the intestines working properly.

Vitamin D aids in the development of teeth and bone by encouraging the absorption and metabolism of phosphorous and calcium.

Vitamin E is an antioxidant that helps fight infection and keeps red blood cells healthy.

C.Niacin

Niacin is a coenzyme, like thiamine and riboflavin, that is responsible for energy release from carbohydrates. A niacin deficiency can lead to pellagra, a disabling disease with symptoms that may be characterized by four “Ds”: depression, diarrhea, delirium and dementia.

Niacin is found in fortified breads and cereals. Protein foods, such as eggs, fish, meat, dairy milk and poultry, are naturally rich in niacin. They are also plentiful in the amino acid tryptophan, which can be synthesized into niacin by the liver. Chicken breast, ground beef, halibut, tuna and turkey are particularly good sources of tryptophan. In the vegetable kingdom, asparagus, baked potatoes and cantaloupe have significant amounts of tryptophan.

Niacin has been used to lower LDL cholesterol and raise HDL cholesterol when administered as a drug under medical guidance. In heavy doses, niacin has been known to cause a “niacin flush” due to the capillaries increasing in size. This condition can lead to fatigue and even liver damage. Caution should be used if one is taking niacin or B-complex supplements.

Sources of niacin: eggs, fish, legumes, meats nuts, peanuts, poultry, pork

Roles in body: coenzyme, digestive and nervous system functions, healthy skin

Deficiency: appetite loss, confusion, fatigue, flaky skin, indigestion, pellagra

Toxicity: cramping, flushing, headaches, irregular heartbeat, irritated ulcers, liver dysfunction

Cooking Foods with Niacin

Niacin is one of the more stable water-soluble vitamins and is minimally at risk for destruction by air, heat or light.

The adult RDA for niacin is 14 to 16 milligrams of niacin equivalents (NE) daily.

2.Protein quality describes characteristics of a protein in relation to its ability to achieve defined metabolic actions. Traditionally, this has been discussed solely in the context of a food protein's ability to provide specific patterns of amino acids to satisfy the demands for synthesis of protein and other specific metabolites. As understanding of protein's actions expands beyond its role in maintaining body protein mass and satisfying metabolic demands for biosynthetic pathways, it is clear that the concept of protein quality must expand to incorporate these newly emerging actions of protein.

Which protein characteristics are important for which processes or functions? In the context of a brief review of the strengths and weaknesses of current methods for assessing protein quality, this paper will explore particular characteristics of the protein consumed that could impact optimal health and would need to be considered in an expanded protein quality concept. Clearly, for this newly emerging area, our main objective will be to define research questions for future exploration.

DEFINING PROTEIN QUALITY

It is a long-accepted paradigm that protein quality is an important aspect of any consideration of human protein needs, as evidenced by extensive efforts to measure quality and standardize those measurements. For this reason, in the present context of optimal protein intakes, discussion of “what sort” is equally relevant as the question of “how much.”

There are 2 important aspects of protein quality: 1) the characteristics of the protein and the food matrix in which it is consumed, and 2) the demands of the individual consuming the food, as influenced by age, health status, physiologic status, and energy balance. Multiple factors influence protein quality, and these issues have been debated extensively for decades. In light of increasingly diverse functions of protein in human health, the appropriate endpoints by which the “how much” question is investigated become equally important for the assessment of protein quality. With respect to dietary protein's ability to satisfy metabolic demands in relation to maintaining muscle and bone, significant data have emerged to suggest that protein's role in health may be based on factors that are not captured by current protein quality estimates.

The current aim of protein quality evaluation is to determine the ability of a protein to meet maintenance needs plus special needs for growth, pregnancy, or lactation: “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 pregnant/lactating women, the needs associated with the deposition of tissues or the secretion of milk at rates consistent with good health.”(4)

Current protein quality methods assess animal growth (protein efficiency ratio) or, in humans, nitrogen balance, where both digestibility and the suitability of the amino acid pattern of absorbed amino acids (biological value) determines net protein utilization. The practical difficulties and poor sensitivity of the nitrogen balance method has led to the adoption of the protein digestibility-corrected amino acid score (PDCAAS) approach.

The PDCAAS, which was introduced by the Food and Agriculture Organization of the World Health Organization (FAO/WHO) in 1991 (5), is the current internationally approved method for protein quality assessment (4). Briefly, PDCAAS is based on the combination of an age-related amino acid reference pattern that is representative of human requirements plus estimates of the digestibility of the protein. The amount of potentially limiting amino acids in the test protein is compared with their respective content in the appropriate reference pattern, identifying the single most limiting amino acid that determines the amino acid score. The current consensus is that meeting the minimum requirements for lysine, methionine, and tryptophan, the most limiting amino acids in poor quality proteins, determines the amino acid score and will lead to a plateau of nitrogen retention (4). At the plateau of nitrogen balance, any further increase in plasma amino acids would stimulate increased oxidation and elimination of the excess amino acids, implying that protein quality above requirements does not matter. This score is assumed to predict biological value, or the anticipated ability of the absorbed test protein to fulfill human amino acid requirements. The score is then corrected for digestibility giving the PDCAAS value, which is assumed to predict net protein utilization.

Inherent in PDCAAS or nitrogen balance is that provision of substrate for protein synthesis and other pathways is limited by available (digested and absorbed) indispensable amino acids. Thus, protein utilization is predicted from expected digestibility and the amino acid composition of the protein. These 2 characteristics of the protein determine the ability of a dietary protein to meet minimum human amino acid requirements for nitrogen balance and, hence, its nutritional quality.

For protein mixtures in a meal, the score is calculated from the amino acid pattern of the digested protein mixture. Because available protein in food will be first limited by digestibility, which cannot exceed 100%, PDCAAS cannot exceed 100%. Thus, in calculating PDCAAS values, amino acid score values >100% are truncated. Whereas PDCAAS values of diets based on mixtures of proteins will reflect the complementation of proteins that might be deficient in one or more indispensable amino acids (IAA), this is also the foundation of one criticism of the PDCAAS approach for those with higher IAA levels. Specifically, the truncation of the PDCAAS value and the calculation of the amino acid score based on only the first limiting amino acid arguably underestimate the power of a high-quality protein to balance the IAA composition of inferior proteins (6).

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 (2, 7). 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 (8), 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 (9, 10). This means that as protein intake increases, for example toward the upper half of the current acceptable macronutrient density range (11), 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 (12). 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.

Although concern has always been expressed about the importance of dietary protein for the elderly, especially in the context of the age-related loss of skeletal muscle mass (sarcopenia), there has not been a firm consensus that the published evidence indicates any measurable age-related change in the minimum protein requirement (13) or the nitrogen-balance data which form the basis of the current PDCAAS reference pattern (4). However, emerging experimental evidence suggests that there is an age-related change in the regulatory influence of IAA on muscle protein synthesis that will reduce the effectiveness of dietary protein to maintain muscle mass (14, 15).

Muscle growth and maintenance occurs in response to a complex interplay of stimuli, including physical activity, hormonal signaling, and substrate supply. However, amino acids are a prerequisite for muscle protein synthesis, and a dietary supplement of IAA is a potent stimulus (16). There is, in fact, a dose-response relation between IAA concentrations in the blood and muscle protein synthesis (14, 15, 17, 18). In the elderly, there is, at the same time, decreased sensitivity and responsiveness of muscle protein synthesis to IAA (19, 20). Currently, human studies have not identified the mechanisms of these effects. Although intervention studies point to the need for a combination of both nutritional support and resistance exercise, the ideal amino acid pattern of the extra protein involved is unknown.

There is limited evidence to date on the relative influence of different protein sources on increasing muscle mass in human trials. Studies measuring the effects of meat-containing and lactoovovegetarian diets, coupled with resistance training protocols, on muscle mass have been mixed (21, 22), although methodology varied and the research is only beginning to emerge. According to Wilkinson et al (23), fluid skim milk promoted greater muscle protein accretion than a soy protein beverage when consumed after resistance exercise. Phillips et al (24) have suggested that any improved nitrogen retention observed with milk compared with soy consumption during a resistance training protocol may reflect differences in the amino acid profile during delivery to peripheral tissues. However, it is not known whether this is a function of different rates of digestion, peak postprandial amino acid flow through the splanchnic bed and consequent rates of amino acid oxidation and deamination (higher for soy than milk protein), or the different amino acid profiles of the 2 protein sources.

Although human evidence is beginning to emerge, there is abundant evidence from animal studies that sufficiently high doses of leucine may be particularly important in muscle protein synthesis through synergistic effects with insulin in signal transduction pathways and in the presence of adequate dietary energy. As proposed by Garlick (7), there are worthwhile research opportunities regarding the promising potential role for leucine in protein metabolism as well as the possibility of an intake threshold at which overstimulation by leucine could negatively impact glucose metabolism. A review of the leucine literature by Layman (25) estimated that stimulation of muscle protein synthesis would be optimized with 18 g IAA, including 2.5 g leucine, at each of 3 meals per day.

A clear research goal is to identify the optimal dietary amino acid pattern in terms of specific amino acids, the total IAA content (26), or perhaps even the conditionally indispensable amino acid (6) for determination of protein quality. Although leucine is abundant in a variety of protein sources, confirmation of the need for particularly high intakes of leucine at each meal, particularly within a calorie-restricted diet, could have implications for choosing a protein source.