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Soy Protein in Feeding the Elderly

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ABSTRACT

Protein needs of the elderly may be moderately higher than those of younger adults when expressed as a percentage of total calories. Most experts recommend an intake of ca. 0.8 g protein/kg/day or ca. 12-15% of the total calories. Soya protein appears to be as good as animal protein in meeting the amino acid and protein needs of adult humans when consumed in adequate quantities. Attention must be given to the appropriate heat treatment and processing of soybeans to inactivate non-nutritional factors. The mineral and vitamin content of the diet should be monitored, because some of these nutrients may be altered or removed in the preparation of soya protein fractions or isolates for use in food products. Further research is needed to fully identify the nutritional requirements of the elderly, especially as affected by disease, trauma and drugs. In addition, nutrient interaction and bioavailability should be studied in foods which are processed by new techniques.

INTRODUCTION

Aging is a normal physiologic process which continues from birth to death. Typically, those in the U.S. population over 65 years of age are categorized as elderly. As the average life expectancy increases, the elderly constitute an ever increasing proportion of the total population. It is estimated that the elderly currently account for ca. 15% of the U.S. population, and this is projected to increase to ca. 20% by the year 2000.

The health and nutritional status of the elderly are of special concern. The elderly comprise a disproportionate share of hospital admissions; ca. 25% of the elderly in the U.S. are admitted to hospitals each year. The elderly also make more visits to their doctors than do younger persons, and about one in every 20 are in institutions for long-term care. These and other factors are important considerations in assessing the nutritional status and the utility of various foods and nutrient sources in the care of the elderly population.

FOOD INTAKE AND NUTRITIONAL STATUS OF THE ELDERLY

Food intake and nutritional status of the elderly are affected by a number of factors which are associated with aging. As aging progresses, normal physiologic changes occur. Functional renal capacity declines, muscle tone and strength decrease, basic metabolic rate and cardiac index decline and physical activity is commonly reduced. The elderly may tire more easily, get less exercise and therefore have lower caloric needs than younger persons.

Reduction in gastric secretions may affect dietary iron and vitamin B_{12} requirements, because stomach acid enhances iron absorption and the intrinsic factor secreted by the stomach is needed for B_{12} absorption. However, the absolute daily requirements for protein, vitamins and minerals are not significantly affected by age. The primary implication of these physiologic changes is that the elderly may need a diet which, except for energy, is comparatively rich in nutrients.

A decrease in glucose tolerance is a common metabolic change in the elderly. Although this can be overcome in many cases by reduction in body weight, this is often difficult to achieve and maintain, particularly in affluent societies. Excessive caloric intake is probably a less significant factor in developing countries.

Physical factors such as weakness, arthritis and other impairments may adversely affect the ability of the elderly to shop, cook, clean house and perform other routine activities. The elderly frequently suffer from the loss of teeth or poorly fitting dentures which can lead to poor food selection and a decreased nutrient intake. Decreased sensory perception may be manifested by an impaired taste acuity associated with poor zinc status and by a decreased sense of smell which results in a lack of interest in food.

Gastrointestinal diseases including diverticulosis, gallbladder disease and cancer become more common and these may affect both the types of foods consumed and the level of nutrient intake.

A common psychological finding among the elderly is depression. This may lead to anorexia and a lack of interest in preparing food. The unavailability of familiar or preferred foods, or a very limited time for eating meals in the institutionalized setting may decrease nutrient intake.

The financial strain of living on a fixed income is a social problem which can markedly affect the nutritional status of the elderly, because the food budget is frequently the easiest to cut. Living alone, lack of interest in food preparation and eating in the absence of social contacts can also lead to reduced food intake. In modern society, alcohol may have a significant effect on food intake and nutritional status. While it is often advised as an appetite stimulant for the elderly, care must be taken to guard against overindulgence, as alcohol can have both direct and indirect adverse effects on nutritional status.

PROTEIN IN NUTRITION OF THE ELDERLY

Strictly speaking, dietary protein requirements are an indirect expression of the need for essential amino acids and nonessential amino acid nitrogen, which are utilized for synthesis of skeletal and visceral proteins, enzymes, hormones, and other compounds and tissues.

Both men and women experience a decline in the total amount of lean body mass with aging, based on measurement of lean body mass using whole body potassium analyses (1). There is also a decline in creatinine excretion with aging which relates to a decrease in lean body mass (2). Results of postmortem studies (3) show that a major portion of this loss appears to be from skeletal muscle. In the newborn, e.g., muscle accounts for ca. 25% of the total body weight. In the young adult, that percentage increases to ca. 45% and declines to ca. 27% in people who are over 70 years of age. By comparison, the visceral proteins, such as liver, are relatively stable compared to the skeletal muscle mass.

Uauy et al. (4) interpret results of their studies to indicate selective loss of lean body mass in the form of skeletal muscle with very efficient preservation of visceral proteins in the elderly compared to young men. Conversely, Zanni et al. (2) suggested that elderly men in their studies appeared to retain lean body mass of uniform composition. Overall, there is about a 3-5% decrease in basal metabolic rate (2) each decade after 30 and a decrease in the rate of muscle protein breakdown as aging progresses (5). In addition, elderly persons may produce more urea and appear to be less efficient at conserving nitrogen than younger individuals (5). Results of balance studies to determine protein requirements of the aged are contradictory. Estimated quantities of dietary protein needed to bring the elderly into nitrogen balance have been reported to be higher (6-8), lower (9), or equivalent (2,10,11) to that for young adults. The protein requirements of older people have recently been studied by three groups of investigators again with consensus. Uauy et al. (6) found that 0.8 g of whole egg protein/kg of body weight was needed in the diet of the elderly to achieve nitrogen equilibrium. This is a level twice that predicted by the factorial method and greater than the level of 0.57 g/kg recommended by the FAO/WHO report (12). In view of the lower energy requirements of the elderly, these authors recommend a diet providing 12-14% protein calories as suitable for the elderly. This is somewhat higher than the amount recommended in 1974 by the Food and Nutrition Board of the National Academy of Sciences, National Research Council (13), but similar to the 1980 recommendations (14).

Two other recent reports (2,15) show that the same amount of dietary protein/kg of body weight will bring both young and aged into protein equilibrium. The Food and Nutrition Board of the National Research Council (14) concludes that it is prudent to ensure that the elderly receive 12% or more of their energy intake in the form of protein, especially because they are more likely to have episodes of chronic diseases and stress resulting in depletion of body proteins. This is based on the general recognition that energy intake/kg of body weight falls progressively with age whereas the amount of protein/kg of body weight needed for nitrogen equilibrium is not reduced and, in fact, may increase slightly.

All of this implies that the diet of the elderly should be one of high quality, i.e., it should be relatively rich in protein, vitamins, and minerals/unit of energy and should be in forms which are easily consumed, digested, absorbed and metabolized. The recommendation that total protein intake of the elderly be maintained at approximately the same level as in earlier years may be difficult to achieve in practice, however. Limited financial resources are probably the major deterrent to adequate nutrient intake among the elderly. In addition, a loss of teeth or poorly fitting dentures may present problems in chewing protein-containing foods. It has been documented that the intake of high-protein foods is decreased in later years. Women over 70 years have been found to ingest only half as many calories from meat, fish and poultry as do women between 30 and 39 years of age (16).

SOYA PROTEIN IN FEEDING THE ELDERLY

The soybean must be considered an important source of dietary protein for the elderly because of its wide availability, low cost, high nutritional value and ease of incorporation into foods. While there is relatively little scientific data available on the protein and amino acid requirements of the elderly, there is even less information on the utilization and metabolism of soya protein in this age group. Perhaps the best we can do at this point is to extrapolate the body of scientific knowledge on the similarity of total protein requirements for elderly and young adults and then examine the available data on soya protein quality for adult humans.

The majority of studies for determining the nutritional value of soya protein in adult humans has been based on measurements of nitrogen balance. Additionally, biochemical parameters such as serum protein and amino acid levels, hemoglobin, blood urea nitrogen, and urinary creatinine excretion have been included.

Utilization of textured vegetable protein (TVP) prepared from defatted soya flour was compared with a methionine-supplemented TVP or ground beef in adult subjects at an intake of ca. 0.4 g protein/kg/day (17). Mean nitrogen balances were -0.3 g/day for beef and -0.7 g/day for TVP.

Utilization of TVP was improved to -0.45 g/day with methionine supplementation, a value which was not significantly different from that for beef. When total protein intake was increased to ca. 0.7 g/kg/day, nitrogen balances were very similar with all three dietary protein sources.

Several studies indicated that methionine supplementation improves the nutritional value of soya protein for humans, particularly when fed as the sole source of protein and at relatively low intakes. Zezulka and Calloway (18) assessed the minimal amount of soya protein with and without methionine required to meet amino acid needs in adult men consuming a diet supplying an adequate level of total nitrogen. Results indicated that methionine supplementation of the soya protein at a level to bring total daily sulfur amino acid intake up to a level of 900 mg/day improved the utilization of soya protein isolate at low intakes (3 g nitrogen/day from soya protein). When soya protein intake was increased to provide 6.5 g nitrogen/day (ca. 0.6 g/kg/day for a 70-kg man), the soya protein product given as the sole source of dietary protein and without methionine supplementation appeared capable of meeting the amino acid requirements of adult subjects. However, methionine supplementation improved utilization of the product even at this level of intake, suggesting that essential amino acid requirements could be met with a lower total amount of dietary protein from methionine-supplemented soya. These workers also demonstrated (19) that N-acetyl-L-methionine and sodium sulfate could be substituted for methionine as a supplement for soya protein. This is of interest as a possible means of circumventing the high cost of methionine and possible off-flavors in foods caused by methionine degradation.

Scrimshaw and Young have summarized an extensive series of studies on the utilization of soya protein in adult human subjects (20). The results indicate that selected soya products approach or equal foods of animal origin and are capable of meeting the essential amino acid and protein needs of human adults. Well processed soya protein isolate products fully replaced beef without reducing dietary nitrogen utilization when total protein intakes approximated the current dietary allowances. Methionine supplementation at low to moderate levels improved soya protein utilization when protein intake was inadequate, but these authors reported a decreased nitrogen utilization in response to methionine supplementation at 1.6% of total protein, a level which only slightly exceeded the amount calculated to bring the total sulfur amino acid concentration up to that suggested by the 1973 FAO/WHO provisional scoring pattern. They concluded that, under conditions of normal use in adults, methionine supplementation of good quality soya proteins is probably unnecessary.

Other factors must also be considered in evaluating soya or any other protein in the diet of the elderly subject. For example, the bioavailability of amino acids as affected by protein source, processing, or interaction with other components of the diet should be kept in mind.

Lysine may become the first limiting amino acid if soya protein has undergone excessive heat treatment in the presence of reducing sugars which may enhance the Malliard or "nonenzymatic browning" reaction. Generally, the effect of the browning reaction or amino acid oxidation on protein quality is of relatively little significance in a mixed U.S. diet for adults because protein intake generally exceeds the Recommended Dietary Allowances. Furthermore, heat treatment is critically important to maximize the nutritional value of soya protein (21).

Perhaps as important as the amino acid level and balance in soya protein is the effect of various non-nutritive factors in the soybean. The scientific literature describes several components of soybeans which may adversely affect nutrient utilization or nutritional status (22). Phytic acid has been shown to interact with many trace minerals and the phosphorus of soya protein is not well utilized. The effect of phytate on trace mineral availability is related, at least in part, to the total level of major and trace minerals in the diet as well as the processing of the soybean prior to incorporation into the foods.

Soybean trypsin inhibitor may decrease the digestibility of soya protein in some species but this proteinaceous material is denatured by adequate blanching or toasting (23) The phytohemagglutinins present in raw soybeans depress growth in laboratory animals, but these, like soybean trypsin inhibitor, are inactivated by heat treatment. The goitrogenic factor of soya protein can be overcome by the addition of iodine to the diet but is also denatured by proper heat treatment. With heat treatment and processing variables properly controlled, the nutritive value of raw soybean flour can be increased to be approximately equal to that of meat or milk. Heat treatment is essential for good protein utilization (21). The importance of these factors in the nutritive value of soya protein has been reviewed by Rackis (22).

A very high protein intake may increase urinary calcium excretion (23). This is at least theoretically important in the elderly because calcium intake is frequently marginal in this group. From a practical standpoint, however, the elderly are not likely to consume diets which contain large amounts of protein.

Soya protein is especially useful in preparing foods or diets for individuals who cannot digest lactose, the carbohydrate of milk. Lactose intolerance is relatively common among adults of many ethnic groups, as well as in patients with various gastrointestinal conditions or undergoing radiation or chemotherapy.

AREAS OF NEEDED RESEARCH

While available data indicate that the absolute protein requirement of the elderly is very similar to that for young adults, there is a need for more information in several important areas. First, there is relatively little information on which to base nutrient intake standards for the elderly. Extensive data are needed on which to establish RDAs for this population group. Little is known about the impact of dietary amino acid intake on organ function in various disease states, and we need to define the optimal amino acid intake in the management of specific diseases, such as uremia and liver disease. In addition, we need more information about the effects of surgery, fractures, prolonged bed rest and other types of stress on protein requirements of elderly patients. Another area requiring intensive study is the impact of diet on drug metabolism and of drugs on nutrient utilization, because a high percentage of elderly people are on drugs for acute and chronic medical conditions.

We need to study further the validity and reliability of various parameters to index protein nutritional status. There is some information on serum albumin metabolism with advancing age, and this is particularly useful as the serum albumin is often used as a biochemical index of protein nutritional status.

In addition, research is needed to understand more about the effects of processing on the nutritional value of soya protein and foods containing soya protein. Further information is needed on nutrient bioavailability and nutrient interaction in new foods which will be developed in response to consumer demand and economic factors.

RECOMMENDATIONS

Nutrition is a key aspect of health in the aging process. Most experts recommend an intake of ca. 0.8 g protein/kg/day for the elderly, or ca. 12-15% of the total calories.

Soya protein appears to be as good as animal protein in meeting essential amino acid and total protein needs of adult humans when consumed in adequate quantities. Attention must be given to appropriate heat treatment and processing of soybeans. In addition, the mineral and vitamin content of the diet should be monitored, because some of these nutrients may have been altered or removed from the raw beans in processing.

Further research is needed to identify nutritional requirements of the elderly, especially as affected by disease, trauma and drugs. In addition, nutrient interaction and bioavailability should be studied in foods which are processed by new techniques.

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Progress and Future Needs for Research in Soya Protein Utilization and Nutrition

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ABSTRACT

Although soya protein was clearly recognized as an essential part of the diet in the Orient centuries ago, its acceptance in the western world has been slow and recent. Progress in utilization has revolved around solving problems of flavor, nutrition and functionality, and has resulted in commercial development of flours and grits, concentrates, isolates, textured products, cereal-soya blends and beef-soya blends. Among the latter two developments, cereal-soya blends established the principle of using soya to increase protein content and quality of cereal diets consumed in many countries, and beef-soya blends demonstrated the usefulness of soya in extending expensive meat supplies. Governmental actions such as approval of soya in school lunches and in military diets in the U.S. have also contributed to progress in utilizing soya protein in foods. Future research needed to increase food uses of soya protein includes: further improvement in flavor, greater versatility in functional properties, development of new foods rather than simulation of traditional items, and elaboration of adequate methods for determining soya proteins in regulated products. Highlights in soya protein nutrition research include: discovery of the need for moist heat treatment to develop maximal nutritive value; establishment of methionine as the first limiting amino acid; isolation and characterization of trypsin inhibitors; determination that trypsin inhibitor retards growth and causes pancreatic hypertrophy; discovery of negative feedback control of pancreatic enzyme secretion; and demonstration of apparent adequacy of soya proteins in meeting protein requirements of young children and adults. Further nutritional research is needed in the following areas: long-term studies with humans to determine protein quality as well as possible needs for fortification with vitamins and minerals; establishment of need or lack of need for supplementation with methionine; mechanism of action trypsin inhibitors when ingested from soya and other sources; and development of rapid methods for measuring protein quality.

INTRODUCTION

Food use of soybeans has a long and somewhat paradoxical history. The plant was probably domesticated in the eastern half of North China as long ago as the 11th century B.C. (1) and the seed was used as a foodstuff for centuries before written records were kept (2). Through experience rather than scientific experiments, the Oriental people learned that soybean protein was essential and could not, with safety, be omitted from their diet. By contrast, adoption of soybeans by the western world has been very recent. Soybeans did not become established as a commercial crop in the U.S. until the 1920s, and usage was considerably different than the traditional foods in the Orient. The industry that has developed produces two basic products: oil and defatted meal. The oil is used primarily for edible purposes, and the defatted meal is largely fed to poultry and livestock. Nutritional studies in the 1930s and 1940s demonstrated that when properly processed, soya meal is an excellent protein source for animal feeding. However, early attempts to use soya proteins for human feeding met