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SESSION II: NUTRITIONAL AND CHEMICAL STUDIES

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DIETARY PROTEIN QUALITY IN MALNOURISHED INFANTS: SOY PROTEINS

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In the development of foods for the prevention of malnutrition, we often lose sight of the fact that there are two fairly distinct goals to be met. Most widely recognized is the need for high-protein supplements to the poor diets of preschool children, school children, pregnant and lactating women, and other vulnerable groups. Although the quality of the protein in these foods is important, the relatively high concentration in which they can be presented, the fact that they are not meant to be the only food, and the relatively mature and efficient digestive systems of the individuals who are meant to consume them, allow considerable leeway in their formulation and evaluation. If the proteins in question have a score of 70 or better, if the PER in rats is in the vicinity of 2.0, if they can maintain adult humans in nitrogen balance, and if they will support "normal" growth in children, they are almost certain to prove satisfactory as supplements to the diets of vulnerable groups.

The second goal, and in our opinion the most important, is the need for complete foods which can replace human breast milk as the only food for the millions of infants who are weaned before 6 to 8 months of life. Despite many centuries of experience with cow's milk as such a substitute, we are still having to make modifications in this product to keep up with newer knowledge and make it adequate for nearly all infants. Success in the development of new and less expensive substitutes will not come easily. It is pertinent to the purpose of this meeting that the only other substitute which has met with wide success has been soy milk. Lest we think that this is simple, we must point out that in the soy milk available in this country wide differences in protein quality exist, and that even with the best we not infrequently encounter problems of adequacy in special circumstances.

The full-term human infant is born with a generous store of all known nutrients and can withstand deprivation for variable periods of time. Starvation can be survived for many days, even by the premature. Imbalanced

nutrition, however, is a very different problem. Inadequate provision of water in the face of a heavy solute load leads to dehydration and hyperosmolarity in a few days. Inadequate provisions of carbohydrate lead to hypoglycemia and ketosis, insufficient intakes of ascorbic acid result in impaired tyrosine metabolism, and shortage of pyridoxine in convulsions and impaired tryptophan metabolism. A low calcium phosphate ratio in the diet leads to poor calcium absorption and hypocalcemia, inadequate intakes of vitamins D and A can be tolerated for a few weeks. Recently, it has been demonstrated that a low intake of vitamin E, particularly if accompanied by a high one of polyunsaturated fatty acids, can lead in a very short time to serious difficulty. By contrast, however, poor intakes of iron and copper can be tolerated for many months by the full-term infant, though not as well by the premature.

In defining the adequacy of protein quality for the infant we must take into account a number of important variables. If we attempt to overcome deficiencies in quality by a more generous provision of protein, we immediately run into the problem of the solute load, at an age when the renal capacity is already being taxed by the higher protein requirement for rapid growth and by the much higher insensible water losses per unit of weight or surface area. When we reach 15 percent of protein calories, we have more than doubled the amount in human breast milk. In the digestion of protein by the adult or older child, the endogenous contribution of amino acids to the intestinal content is at least 50 percent of the total, making it possible to tolerate and utilize imbalanced dietary protein for relatively long periods of time. In the young infant, and notoriously so in the malnourished one, dietary amino acids represent a much higher proportion of the total, making their individual concentrations and the balance between them of much more critical importance. The rapid growth rate of the first year of life makes for important differences in the proportion of amino acids used for this purpose as against those required for maintenance, and accounts for at least some of the differences in amino acid requirements at different ages. The vulnerability of the infant to infection and the frequency of such insults results in frequent periods of depletion of "labile" proteins and requires that dietary protein be adequate for their prompt repletion. Finally, at least one amino acid, histidine, is essential for the infant but not for the adult.

With these considerations in mind, we have developed an approach to the evaluation of dietary protein quality which is possibly hypercritical but which has provided very suggestive information. In convalescent malnourished infants and children, we compare rates of weight gain, apparent nitrogen absorption and retention, and serum protein levels with those obtained with modified cow's milk at isocaloric, isonitrogenous levels. We then give the same product as the only source of protein for periods of 4 to 12 months, and if the results are satisfactory, we use it as the only source of protein in the initial treatment of malnourished infants and in the diet of very

young infants. The ability of dietary proteins to initiate recovery in kwashiorkor gives us a measure of their ability to replete labile proteins, and their ability to support nitrogen retention and growth in the marasmic or very young infant gives us a measure of their ability to support growth.

We have evaluated a variety of soy products in this fashion and have found important differences, which must in part be attributed to the effect of processing. Beginning with a well-known soy milk, which gives results very near to those of a modified cow's milk, we have studied a soy protein isolate, a full-fat soy flour, a corn-soy mixture enriched with methionine, a cottonseed-soy mixture, a cassava-soy mixture, a chick-pea-soy mixture, and most recently a soy milk made from a soy protein isolate.