# Protein Supply for Human Nutrition

**Protein malnutrition, frequently rated as the No. 1 health problem in underdeveloped areas, is being attacked on several fronts**

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ADVANCES IN FOOD TECHNOLOGY, education, and economic status have finally permitted the abundance and high quality of food in the United States practically to eliminate the standard deficiency diseases. Having reached this basic goal, however, does not imply that everyone has an ideal diet. The degrees of deficiency that characterize such diseases as pellegra, rickets, scurvy, and kwashiorkor are severe, and of long duration. Less severe deficiencies and imbalances such as characterize the anemias, dental caries, retarded growth, excessive fatigue, and fatty livers still persist. The most obvious and apparently the most serious form of malnutrition in this part of the world is associated with eating too much, in terms of total calories.

Even with the resources that we have had in this country, it will be noted that the last major deficiency diseases to be overcome were associated with a low intake of high quality protein foods. Pellagra, riboflavin deficiency, and the anemias associated with sprue were the latest to yield. The cereal food enrichment program made a valuable contribution to the gains, and further advances resulted from improved education of low income groups, combined with a general rise in the quality of our food and in standards of living. A result was more uniform and increased consumption of milk, meat, fish, and eggs in the areas where severe deficiencies had been prevalent.

As a source of calories, however, these animal protein foods are often more costly. Hence, as the population density increases in areas where earning power is low, the economic pressure is toward reliance on foods obtained directly from plants. This trend may not involve a disaster, but it does imply a greater risk of protein malnutrition.

Severe forms of protein malnutrition such as kwashiorkor and pellagra generally reflect amino acid imbalances more than low intakes of total protein. This situation permits several approaches to the problem. The first, and generally the preferred, attack is based on increasing the consumption of animal protein foods. In practice, this usually means increasing local production, wider distribution to low income groups, and sustained education to reach the entire population. Adequate importation of milk, meat, fish, and eggs into areas characterized by protein malnutrition is not always possible, and this is especially true for countries whose economic resources are limited.

A second major approach is through the use of legumes, cereals, and other plant sources of proteins selected to furnish the desired balance of available amino acids, even when no one or two of the products would be adequate. This gives the chemist an opportunity to work effectively with agriculturists, food processors, educators, and the medical profession.

A third approach is by adding synthetic amino acids in sufficient quantity to bring low-cost acceptable products to an approximately ideal content and balance, as measured in extensive tests with animals and human subjects. This approach is attractive and challenging to the chemical industry, but its extension to the human food supply is likely to be slow.

Current emphasis upon health impairment by excessive intake of calories can easily lead us into the trap of forgetting that only within the past 15 years have we escaped from a national background in which nutritional deficiencies were persistent and widespread. Technically, we have always been in a position to produce enough protective foods to prevent deficiency diseases in the United States. But poor education, low economic levels, occasional instances of alcoholism, a lack of basic information, limited transportation, and less efficient food supplies than we have today permitted severe deficiency conditions to continue through the centuries.

These Guatemalan brothers recovered from kwashiorkor in a test of food prepared from corn, cottonseed, sesame, kukui, and yeast

Food supplementation test group in Guatemala where Nevin S. Scrimshaw and associates are studying the benefits of increased intake of nonfat milk solids

If the United States continues to advance economically and culturally, so that research, education, and food distribution can continue, we are not likely to encounter widespread health impairment as a result of protein deficiency within the next several decades or centuries. To be sure, the food industry must continue to be alert to the protein quality and total balance of all nutrients in our food supply. To do less would be unfair to the public and to industry. In this area of research and education, however, we should be careful to recognize the protein contribution that can be derived directly from plants, including bread and other cereal foods such as oats, rice, corn, rye, and macaroni. These foods, together with legumes, nuts, and vegetables, have important cultural and economic advantages when they furnish about one half of the protein intake. They share with the animal-source foods, leafy vegetables, and fruits in furnishing an abundance of all the energy, vitamins, and minerals essential for normal human health.

Some day we may reach a stage where it will be physiologically and economically advantageous to use synthetic amino acids or synthetic peptides and proteins as major supplements to the available food supply, but such a period does not seem to be close at hand. We shall need much more information than we now have before most nutrition scientists would be willing to endorse the practice. In animal foods, there is substantial and encouraging progress in this direction already and the trend is likely to continue. Methionine is well established. Lysine is fairly promising except for cost, and still others are on the horizon. Preliminary estimates of total sales in 1955 indicated about two million pounds at a value of about $4 million.

A similar situation exists with respect to such foods as cultured algae, yeasts (beyond their use in breads), fungi, plankton, and bacteria. Their utilization in animal foods has reached important levels already and probably will grow steadily as technology and nutrition research advance, but their introduction into human food supplies as major items to compete with roast beef, milk, cheese, salmon steaks, eggs, and bread is not likely to follow rapidly in the immediate future.

The risks associated with long-term effects of imbalances, the use of racemates instead of natural isomers, and the effects of marked differences from proteins in the time sequence of absorption from the intestinal tract have not been explored adequately in human nutrition. The evidence from experiments with animals, as reported by C. A. Elvehjem and other careful investigators, shows that risks to health in this respect cannot be taken lightly by either the chemical industry or the food industry.

In areas where the quality of protein intake is handicapped by inadequate consumption of animal protein, the imbalances are quite varied. Low intakes of methionine, tryptophan, lysine, isoleucine, and threonine are often at fault, and excess intakes of leucine and glycine can cause injury when the intakes of isoleucine and tryptophan are low. Among other recent papers in this field are those by R. R. Williams and D. M. Hegsted, *et al.* with special reference to the problems of cost and practical outlook for the future. W. B. Bradley and others have pointed out the economic and nutritional advantages furnished by modern breads that contain nonfat milk solids.

### *Synthetic Amino Acids Too Costly for Wide Use*

Human populations with widespread protein malnutrition cannot afford to use products so expensive as the presently available synthetic amino acids. Their economic situation makes it necessary to seek answers primarily by producing and consuming increased quantities of animal protein foods and by supplementing these products with plant protein foods that have reliable nutritive value. In both of these directions, progress can be made rapidly. There is no doubt of the great need for giving strong support to measures of this kind, pending further progress in the chemical industry and in human nutrition research.

In 1955 the U. S. reached a per capita protein consumption of 98 grams per day, of which two-thirds was from animal sources. This is a favorable picture when one considers that the liberal Recommended Dietary Allowances of the National Research Council suggest 55 to 100 grams per day for adults, of which 50% should be from animal sources.

In many parts of the world the picture is very different from ours—it is grim indeed where protein malnutrition is regarded as a dominant factor in causing sickness and death. Standard practice for millions of people is still based upon weaning youngsters onto a diet consisting almost entirely of foods high in starch, such as rice, corn, millet, or cassava, supplemented by variable intakes of a legume such as beans or peas. Tragically, these combinations often do not meet the human infant's requirement. The result in large areas of Central and South America, the Near East, Africa, the Far East, and India, is a rapid onset of malnutrition after weaning, with resultant stunting of growth, injury to the glandular organs, disturbances of the central nervous system, a high incidence of intestinal infections and diarrhea, and a high death rate among children 1 to 4 years old. In its severe form, the disease is gen-

This family in Brazil lives primitively, but its members are maintained in a good state of nutrition by use of local foods supplemented by nonfat milk powder

erally called kwashiorkor, or in Latin America, syndrome pluricarencial infantile. Although the major deficiency in this characteristic disease is a lack of good quality protein, concurrent deficiencies of vitamin A and riboflavin are common, and deficient intakes of calcium, vitamin C, iron, and fats are not uncommon. The degree to which other deficiencies are involved varies from section to section and can be estimated on the basis of dietary studies and clinical surveys. The death rate, stunting of growth, anemias, edema (swelling), fatty livers, pancreatic injury, atrophy of the intestines, and general impairment of health within the preschool age group, makes the problem of education and direct assistance extremely difficult.

John Brock and his associates in South Africa have shown that a mixture of pure amino acids, including the eight shown by W. C. Rose to be essential in human nutrition, initiates a cure of kwashiorkor. As a public health measure, this approach is still impractical. Complete restoration of health would not occur without furnishing all of the nutrients that are required in a balanced diet. In practical terms, this means working toward diets that include—in addition to cereals—green leafy foods, fruits, legumes selected on the basis of their available amino acids, and animal protein foods in so far as they can be made available.

Physicians agree that kwashiorkor, if it has not progressed too far, is usually cured in a practical sense by an adequate intake of skim milk, meat, fish, or eggs. These foods also furnish minerals and a generous source of vitamins in the B complex, in addition to calories and flavor. Low-cost fruits and vegetables are grown in nearly all major tropical areas, and could furnish a generous source of vitamins A and C in addition to minerals, sugars, and proteins. Their adequate use depends, however, on education—and lack of nutrition education is almost as serious in many of the areas as a lack of working capital or fertile land. It is common practice to distribute vitamin A capsules with nonfat milk powder in the medical clinics, but a satisfactory way to furnish stabilized vitamins A and D in the nonfat milk powder apparently has not been developed. The problem merits careful study.

In India where vegetarianism (except for milk acceptance) is a common practice, research on the plant proteins has been relatively active, as it has more recently in Central America, Africa, and elsewhere. This kind of study merits world-wide coordinated support. Sesame seed and cottonseed, for example, contain protein of good quality and can be grown in most of the areas where deficiencies are severe. Cottonseed requires special processing, however, to remove gossypol. Some of the Indian legumes (grams) also show considerable promise as single or blended protein foods. Wheat, corn, rice, oats, beans, peanuts, peas, soybeans, and cocoanut presscake can make an important contribution toward complete protein sources if used properly with other foods. The rice and fish diets of the Orient are famous for their efficiency. In the countries where kwashiorkor still persists, the foods required for a good diet could be developed and introduced rapidly if supported by a modest amount of education, research, and working capital. The booster sources of protein should be selected with care, but the added quantities need not be large. There is a critical need for testing the potential low-cost foods that would prevent protein malnutrition. The tests should include sequential studies with experimental animals, normal and protein-deficient children (under careful observation), and finally representative population groups to assure performance in practice.

Very recently, the Rockefeller Foundation furnished a special fund to the National Research Council to accelerate research work on an international basis. United Nations agencies (UNICEF, FAO, and WHO) are working in cooperation with the above groups and with many private foundations and government groups in a world-wide attack on the central problem of protein malnutrition.

### *Needless Sacrifice*

The present needless sacrifice in human life and health literally includes millions of persons in the technologically less advanced portions of the world. During the weaning and postweaning period, the death rate in those areas often reaches the shocking range of 10 or more times higher than that in the United States and Western Europe. There is no adequate basis for appraisal of the injury inflicted on those who survive. Physical stunting is often equivalent to 2 or 3 years of growth, and there are further penalties evident in depressed tissue functions and altered structures. Progress is going to be slow and difficult in working toward nutritional goals such as we enjoy, but that is all the more reason for tackling the job. Increased milk, meat, fish, and poultry production is getting under way in many of the countries where little progress has been made for centuries, but the necessary educational support is barely beginning. Increased use of plant foods, trace elements for livestock, antibiotics, silage and nonprotein nitrogen feeding, vaccines, modern sanitation, and food engineering, all have an important part to play.

You ask, "Why has this condition persisted through decades and centuries?" A primary cause has been the failure to recognize until recently the nature and seriousness of the problem. This lag in defining the problem was especially true with respect to the feeding of small children. Equally critical was the need for trained personnel in each part of the world, to guide research and education in the basic and applied aspects of agriculture and human nutrition. Perhaps I should add that our best nutrition scientists from the United States, Canada, Europe, and other favored parts of the world are constantly adding to their own knowledge, too, as they work with local scientists in areas where protein malnutrition is still severe—frequently rated as "health problem number one." As the problems are solved, both they and we will be better neighbors.