

Human nutrition in the Use and Management Programme

By DAVID P. CUTHBERTSON, *Department of Pathological Biochemistry,
The University and Royal Infirmary of Glasgow*

Whereas the Human Adaptability Section (HA) is particularly interested in the study of human communities which appear to exist in a state of health on low intakes of essential nutrients and also of the relation of nutrition to physical and mental development, the Use and Management Section (UM) is particularly interested in quality and quantity of plant protein and in the exploitation of indigenous sources. It is also concerned with factors in foods which induce or condition deficiency or toxic states and thereby diminish their value, e.g. aflatoxin in ground-nuts. It is under an obligation to see that no important field of nutrition vital to the International Biological Programme (IBP) is missed. I shall mainly confine myself to those interests which have so far got under way, and will start with work initiated at the Tropical Products Institute (TPI).

Preparation of protein foods from fresh coconut kernels

The kernel of the coconut contains about 4.5% protein and about 40% oil, and the potential annual supply is over 200 000 tons protein. Most of this is at present used for animal feeding or as fertilizer. According to Dr P. C. Spensley of the TPI, whose project this is, coconut protein isolates have a net protein utilization factor of around 70 and there is every reason to suppose that such isolates should, in appearance and flavour, be more acceptable to man than are many other vegetable proteins.

Work planned at the TPI: (a) to select the most profitable method for extraction of high-quality oil and edible protein from the fresh kernels; (b) to explore methods of processing the extracted protein into convenient, acceptable and inexpensive foods.

Selection of process. This work which is just beginning at TPI's Process Development Laboratory at Langley will be carried out in collaboration with the Central American Institute of Investigation and Industrial Technology, Guatemala, and, it is hoped, with the Ceylon Institute of Scientific and Industrial Research, and with due attention to similar work at the Central Food Technology Research Institute at Mysore.

Treatment of protein fraction. In the course of the investigation appreciable quantities of aqueous solution of proteins will become available; work will be carried out on the preparation of high-protein foods from them, and on the determination of the yield, protein content, amino acid composition and eventually nutritional value of foods prepared by different techniques.

Sugars. If the protein is separated by precipitation the aqueous phase remaining will be examined to determine whether the sugars in it are likely to have sufficient value to repay the cost of further processing.

Fermentation methods with cassava to improve its nutritional value

Cassava (*Manihot utilissima*) has spread rapidly since its cultivation has a low labour requirement, and it has an accommodating and extended harvest, a high

starch and relatively low fibre content per unit dry matter, a potential energy production per acre ten times that of cereals, and a highly efficient usage of soil nutrients. However, because of its low and poor-quality protein content and lack of accessory food substances, its exclusive use as a staple crop leads to malnutrition. This deficiency must be compensated through suitable sources of good-quality protein, e.g. fish.

Current methods of processing in Africa and elsewhere (outside South America) are largely a development of methods used in South America for the better varieties. Present methods of processing to eliminate toxic and bitter compounds lead to the production of material lacking in protein and accessory food substances.

TPI is studying the development of fermentation methods for the enrichment of cassava products using the minimum processed root, with or without other raw materials, selected organisms and agents to assist and direct fermentation. The aim is a simple domestic or local industry process producing a product that is palatable and acceptable locally.

The work involves the selection of yeasts for their activities in splitting and metabolizing cyanogenetic glycoside, and for their potential for protein synthesis.

Selection of form of substrate. Not much progress has yet been made. Partial fermentation products of cassava tend to produce a sour dough less palatable than meals.

Other raw materials. Yeast or fungal protein has been shown to be unsatisfactory when it is the sole protein source: bean grits are suitable additives. Swedish work suggests that the addition of methionine is necessary to balance yeast or fungal proteins.

Choice of organisms/additives. The aim is to select a combination of organisms and additives which will give satisfactory growth under non-sterile conditions. Toxicity, product composition and acceptability will require testing.

In this and other connexions a search for good sources of lysine, methionine and threonine may ultimately be needed to bring up the qualitative deficiencies of this and other plant products. Such biomodification studies have been applied by TPI to yams, cocoyams and other crops of the *Coleus* species. Yams alone provide 20 000 000 tons per annum of food in the tropics.

Leaf protein

Mr N. W. Pirie's work at Rothamsted has shown that protein can be satisfactorily extracted from leaves on a technological scale, and research elsewhere has shown that its nutritional value is greater than that of most plant proteins and as good as many animal proteins, though Dr Gopalan of Hyderabad maintains that recovery from plasma protein depletion is not so rapid as with animal proteins. However, it is not intended that leaf protein be the sole source of protein in the diet; suitable complements will be necessary. In countries accustomed to a predominantly vegetarian diet presentation, if suitably managed, has produced no difficulties; elsewhere serious difficulties arise. Leaf protein—equivalent to one-fifth of the total protein—in mixtures with groundnut butter or dried skim milk is acceptable by infants and

the mothers feeding them. Leaf protein can readily be incorporated in vegetable stews and other dishes for older children. The amount of leaf being eaten in any event per day is such that neither the green colour nor the slight flavour of leaf is noticeable. It seems essential to effect dietary changes by stages and to remember that leaf protein is one constituent of a foodstuff and not a foodstuff in its own right. If the élite can be shown to use and enjoy such products then little difficulty is encountered.

Although in some temperate zone plant species the total extracted protein is unexpectedly small, we note that Mr Pirie can get 60% from most and 75% from some twenty to thirty species which are amenable to field cultivation and from which extraction is satisfactory. It would appear that an agronomic system can be achieved which gives two to three times as much extracted protein annually per acre as can be got in any other way. The yield of extracted protein from lucerne is already 1.5 to 1.6 tons per hectare per year and is likely to reach 3 tons. Protein from lucerne contains less methionine than most leaf proteins but when supplemented gives a protein efficiency ratio of 2.3 (soya protein 2.4).

During Phase 2 of IBP, equipment for extracting protein from crops should be set up in several overseas countries (e.g. India, New Guinea, Central or South America). The so-called 'village unit' extracts protein from 300–500 lb lots of leaf in the course of 1–1½ h and seems the most suitable initially. The cost is about £360 with electric drive.

Protein quality of oil and other seeds

Dr A. A. Woodham of the Rowett Research Institute is engaged in a collaborative study of different strains of groundnuts of all the principal varieties grown. He is attempting to discover the inherent factors responsible for the variable quality of the protein concentrate (some may contain more conarachin, the superior protein of the nut, than others), the trypsin inhibitors and their liability to inactivation, and to find if these are genetically determined. This will be extended to other oilseeds. Initial studies on the techniques of isolation of protein fractions have been made and on the amino acid composition of such fractions where the variability has been achieved by heat treatment. Dr Woodham is also collaborating with Dr G. D. H. Bell of the Plant Breeding Institute in particular as to the feasibility of changing the proportion of protein in barley. There is a suggestion that low-protein samples have a superior amino acid content to high-protein samples. A concentrate having an amino acid composition superior to that of fish meal has been obtained from barley by use of salt solutions, which remove preferentially the lysine and the proteins containing the sulphur amino acids. He is also working with the Nigerian Grain Legume Gene Bank. Depending on the outcome of the work already in progress, the question of large-scale protein extraction from the groundnuts and barley may arise.

Groundnut butter is being given to infants as a protein supplement and found acceptable.

By 1960, TPI investigations had progressed to a stage where it appeared that

groundnut cake would be one of the better supplementary protein sources. However, another line of research that was developing within the Tropical Products Institute led to the discovery of the now well-known fungal metabolite, aflatoxin, as a contaminant of some groundnut products. It was shown subsequently that such contamination is a consequence of poor harvesting, handling and storage conditions and that it is not a necessary hazard of groundnut utilization. Nevertheless, the Institute's findings, together with those of other laboratories, argue for some caution in the use of groundnut in human and animal diets. There is a suggestion that the high incidence of primary carcinoma of the liver and other liver disease in certain populations may be related to fungal contamination of food. Approaches include dietary surveys under field conditions and the elimination of aflatoxin from foods by preventative and other procedures. Among the latter are possibilities for microbial and fungal metabolism of the aflatoxin series to non-toxic products in fermented foods.

Microbial food

Micro-organisms can be considered as an abundant and universal biological resource. It is reported that some 300 000 tons of microbial protein are being produced per annum. These organisms can produce edible protein, fat, or carbohydrate, and vitamins, from materials entirely inaccessible to human digestion and without the requirement of agriculturally useful land. Research on the production of microbial food is included in the IBP programme of several countries.

In Sweden Professor C. G. Hedén has given much thought to finding organisms which will metabolize methane into protein and to how the protein can be released and separated from undesirable parts of the cell. If oil were to be used production of microbial protein would seem unlimited.

Algal protein. Production units in Czechoslovakia have glass bottoms so that the spaces beneath them can be used as greenhouses for vegetable production in winter for the acreage involved is the crux of the problem, but production falls far short of the fishpond cultivation. Urea and alkali have been used in Japan in an attempt to separate the protein. Japanese work suggests that the digestibility of algal protein is not as low as hitherto considered.

Vegetable protein mixtures

Incaparina, vegetable-based 'frankfurters' and the Indian Multipurpose Food and many others have been used successfully.

Study of the biological aspects of food preservation and storage that could be used in developing areas, especially the tropics

Food preservation, and the prevention of crop losses by means of pesticides are already part of the programme of a great many institutes, and there is a good deal of discussion from time to time among members of the staffs of the Torrey Research Station, Tropical Products Institute, Lowestoft Marine Research Station, Food Manufacturers Research Association and the Meat Research Institute. The assumption underlying the discussions held so far seems to be that, for a generation at least,

simpler methods as distinct from 'modern' methods of preservation will be needed. Research is therefore needed to try to make 'traditional' methods such as drying, smoking, salting, and fermentation more trustworthy and effective. The programme also envisages work on fish flour and on use of antibiotics in food preservation, especially in regions with high ambient temperatures. In relation to the use of wild or semi-wild herbivores for meat production the main problem is that the source putrefies and becomes dangerous in something like 6 h if it is not cut up and cooled. There is a certain amount of evidence that injection of antibiotics could be useful in controlling this situation; one or two investigations under tropical conditions have been made, but none have paid attention to the behaviour of anaerobic bacteria which are the important ones in this situation.

Animal nutrition in the Use and Management Programme

By A. T. PHILLIPSON, *Department of Veterinary Clinical Studies,
University of Cambridge*

In discussing the International Biological Programme (IBP) and aspirations in relation to the nutrition of animals, I shall regard 'nutrition' in a broad way. The subject matter so far included in the IBP that can be considered as strictly nutritional in relation to animals is so far very small. Indeed, the kinds of problem with which IBP is concerned mean that nutrition is only a part of a problem that involves all its allied sciences.

It has been emphasized that all sections of IBP are to some extent concerned with food production. If the activities of IBP make a material contribution to the food problems of the world, it will undoubtedly have served a useful purpose. The Use and Management (UM) Programme as far as animal nutrition is concerned, has a strong emphasis on exploring various ways of increasing the world's supply of animal products. Fortunately, mankind's predatory habits do not always outweigh his interest in animals and the biological environment in which they live, so that it is clearly understood that exploitation of unusual and possible sources of animal protein can only be successful if a thorough study is made of the ecological situation in which animals live as well as the characters of individual species within a population. The preservation of wild animal communities on account of their intrinsic value for biological study is not, strictly speaking, part of the activity of section UM but of section CT (Conservation of Terrestrial Communities). Even so, section UM and section PT (Productivity of Terrestrial Communities) who have joined forces on a comparative study of wild and tame herbivores are acutely aware of the need to understand the existing balance between wild herbivores and their environment if they are to come to any conclusion on the possibilities of future exploitation.

It was to explore the need for information on these matters that a symposium was organized at Aberdeen and Cambridge in the autumn of 1965 under the auspices of