Some Nutrition Problems in Central Africa

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Every medical practitioner is trained in the science of nutrition, especially in its application to the feeding of mothers and infants and the treatment and prevention of various diseases. The subject is fundamentally the same in Africa as anywhere else in the world, but it differs considerably in detail from that in Europe, where many practitioners in the Federation were trained. These differences are encountered to some extent in European practice, but on a greater scale in non-European practice.

EUROPEAN NUTRITION

European immigrants to a tropical country, in its early stages of development, are mainly young men who retain their childhood tastes and feeding habits as far as circumstances permit, but have to adapt themselves rapidly to their new environment, often without the aid of their women-folk. Men are seldom experienced in cookery, and the women who accompany them or follow them to their new homes are provided with male Native servants who do not understand their language and have no idea of European cuisine or household fittings, and are confronted by many strange foods and, in the high veld, by water which boils at a lower temperature than 100° C. and so upsets their accustomed calculations, even for the boiling of an egg. It is difficult under such circumstances to maintain European standards to perfection, so inevitably the local traditional cookery of Europe has been replaced to a large extent by an African modification which is in some cases as good as or better than its prototype, but often worse. The tendency in recent years for mothers with young children to be employed outside their homes has undoubtedly worsened the position in urban centres so that more and more reliance is placed on unsupervised, half-trained or untrained native servants and on canned, processed and ready cooked foods at a greatly enhanced price. The worst feature perhaps is that neither the taste for good food nor the way to prepare it is being taught to the growing generation. Enthusiastic caterers who serve a good table in their hotels or restaurants tend to become disillusioned by their customers' lack of appreciation.

Close investigation of their patients' food consumption, particularly that of European children, will often horrify a medical practitioner interested in dietetics. In such cases financial hardship is by no means the only cause. Often the patients or their parents are in very good circumstances and spend two or three times as much on food as they need to secure a reasonable intake of protective constituents. In such cases the cause is ignorance due to the absence of any education or guidance in dietetics. Such ignorance is shared by rich and poor alike, whether they are intelligent and well-educated or the reverse. It is augmented by the growth of industrialism with its preference for luxuries to essentials. The only remedy is education, and it is the family doctor who should administer this education rather than the quacks, psychopaths and advertisers of patent foods and medicines, all of whom seem to be well entrenched at present.

European foods in the Federation differ from those in Europe in certain important respects. The staple food, bread, is made from wheat imported from overseas, at present Australia. This is a fairly soft wheat containing less protein than the Canadian wheat imported into Britain. The flour of 80 per cent. extraction is not enriched with calcium as it is in Britain (to the extent of 700 mg. Ca per lb.), therefore the intake of Ca is bound to be lower unless it is counteracted by a greater consumption of milk (700 mg. Ca per pint) or cheese (264 mg. Ca per oz.) or calcium gluconate, because milk and cheese eclipse all other sources of calcium in the European diet. The solubility of lime in water is so low that water cannot be considered as a source of calcium unless this is present in suspension sufficient to make the water turbid.

Fresh vegetables and fruits should be available in greater quantity and variety than in Europe, but poor marketing and storage facilities render the supply precarious and unnecessarily expensive for those who are dependent on these facilities. In carotene and Vitamin C value fresh local vegetables and fruits are at least as good as and, in many cases, much better than those produced in Europe. Tropical and sub-tropical fruits, including citrus, are generally much better sources of Vitamin C than the deciduous fruits of Europe (with the exception of blackcurrant).

As the main sources of calcium and riboflavin in the European's diet, milk and cheese are now available in adequate quantities and reasonable prices in Southern Rhodesia. The proposed increase in butter production will put a large quantity of skim milk on the market. As the skim milk contains practically all the proteins, calcium and riboflavin of the milk, its value for the feeding of children and pregnant and nursing mothers needs no emphasis.

Other sources of animal protein are generally cheaper and in greater abundance than in Europe, e.g., beef, offal, pork, poultry, eggs and game. Mutton and fish are somewhat dearer than in Britain and of lower quality, but nevertheless these are cheaper and more nutritious than many canned foods. Offal or the cheaper cuts of meat receive less and less attention as the housewife loses touch with her home and the highly technical art of homecraft which has preserved her species from extinction for thousands of years. Recent evidence before the Cost of Living Commission suggests that the average Rhodesian housewife is ignorant of the various cuts of meat and their purpose and therefore pays more for unsuitable cuts. Homecraft education seems now to be as necessary for the European as for the African.

Iodine deficiency should be a smaller problem among Europeans than among Africans because European foods come from so many different parts of the world that any iodine deficiency in the local soil has relatively little effect on iodine intake. Moreover the stockfeeds given to European-owned farm animals usually have iodine added to them; therefore the produce from such animals should be a source of iodine and the manure should add iodine to the local soil. However, such sources of iodine are precarious, whereas the deficiency in various soils throughout the country is as real as in many other parts of the world. Therefore iodised salt is indicated as a safeguard, if not a necessity, and, in any case, a slightly superfluous intake of iodine is better than too little, except perhaps in isolated cases.

In many parts of the Federation the summer months are hot enough to reduce calorie output and intake and to raise the output of sweat and the intake of water. If the latter is consumed in the form of alcoholic or sweetened beverages, the calorie intake is raised; this point should never be overlooked in obese patients who declare they "eat practically nothing." The same applies to the greater consumption of ice cream and sundaes in hot weather. Beef steak and kidney pudding, roast beef and Yorkshire pudding or fried bacon and eggs are all admittedly endowed with calories on a grand scale, so may not constitute the ideal hot weather diet. Nevertheless these foods are far less likely to give rise to obesity and malnutrition than alcoholic and sweetened beverages, ice cream, cakes and sweets, which require no healthy appetite for their consumption and confer no other nutrient than calories in significant quantity.

Among the most suitable articles of diet for providing a low proportion of calories to a high proportion of protein, minerals and vitamins is a soup or broth containing meat, sliced vegetables, legumes and skim milk which constitutes by itself a complete meal. Otherwise the sheet anchor of hot weather diets is probably a salad with lean meat, fish, eggs or cheese. The amount of vegetable oil required to make a tasty salad dressing is seldom enough for its use to be forbidden; indeed, such restrictions may result in a distaste for salads. Milk, skim milk or cheese is as essential for children and mothers in hot weather as in cold. Sugar, sweets and fats should, of course, be reduced to a minimum, but the Vitamin A value of butter and margarine should not be overlooked.

African Nutrition

In Native practice, the first essential to grasp is that the staple food (maize, sorghum, millets, rice, cassava or, in urban districts, white wheaten bread) supplies about 80 per cent. of the calories as compared with about 30 per cent. (by bread) for the average Europeans. This severely restricts the dietitian's scope in adjusting faulty diets and, since the cause is a low income, the remedy must not be costly. The staple food is not only the main source of calories, as it also supplies the bulk of the proteins, minerals and vitamins.

As his income rises the Native's diet does not necessarily improve. His taste and ignorance unfortunately lead him to consume white bread, sugar, sweetened mineral water, tea and patent foods of no greater nutritive value than, but three or four times the price of, the foods consumed by his poorer brethren. This additional expense and that of smart clothes, a bicycle, a plough, a Scotch cart, more cattle and, perhaps, an additional wife and more children, leave nothing over for improving his diet and that of his various families who, in the long run, probably suffer more than they gain from their father's affluence. Indeed, kwashiorkor is associated with just such circumstances which are the inevitable accompaniments of the introduction to industrialisation of an ignorant population. These circumstances involve an almost complete break with the traditional way of life, in particular with the traditional food habits. Without any authoritative guidance, ignorant people with low incomes naturally take to new foods which appeal to their taste, satisfy their appetites and are apparently cheap. Such a diet is invariably of adequate or high calorie value, but deficient in proteins, minerals and vitamins —similar to that of an average European school child permitted to choose his own food. An individual's taste for good food is not congenital, but acquired through education in childhood. On the other hand, the traditional food habits of a population are the outcome of trial and error over long periods of time, so they usually conform, at least to some extent, with the principles of dietetics. A study of Table I will show that the main sources of certain nutrients in the Africans' traditional diet are certainly not lacking in profusion, even though they are more precarious than those of the European.

If the traditional African diet is considered in detail, it is qualitatively a sound one under certain conditions. For instance, the staple food must provide an adequate quantity of protein of high biological value, either alone or if supplemented by other proteins. Cassava flour is notoriously deficient in this respect, as it contains only 1.5 per cent. of protein, so inevitably fails to support growth or health unless it is well supplemented by other proteins.

The comparative protein values of the common staple foods in Africa and elsewhere are shown in Table II.

Since growth and nitrogen equilibrium depend on the nature of the protein intake as much as on its quantity, it is obviously essential to ascertain the nature of the protein intake when nitrogen equilibrium appears to be disturbed, for instance, in kwashiorkor. The composition of many of the proteins can be ascertained from published works, but the busy clinician is hampered by the fact that such publications usually refer to specific proteins, not to foods as they are consumed. Therefore much laborious calculation is required. Food composition tables of the future will probably supply the necessary data, but in the meanwhile Table III has been prepared as an aid to the rapid calculation of the intake of the ten essential amino acids and cystine from certain common foods. Since these foods are also the main sources of some of the B group of vitamins, these values have been added to the list as far as they can be ascertained.

For ready calculation the figures in Table III have been estimated on the approximate average daily consumption in round figures. Thus 700 g. of maize, rice or wheat provide between 2,300 and 2,500 calories as a staple food, whereas 70 g. of oats is the normal amount required to make a pint of oatmeal or rolled oats porridge. Fifty g. ($1\frac{3}{4}$ oz.) of dried legumes or leaves or 100 g. ($3\frac{1}{2}$ oz.) of meat or fish represent approximate average intakes (when such foods are available). Fifty g. is about the weight of the edible part of a 2-oz. egg; 200 g. of dried skim milk is the recommended daily diet for the early treatment of a child suffering from kwashiorkor and weighing 10 kg. (22 lbs.); 1,000 g. of human milk (just over a quart) is sufficient for a healthy infant weighing about 3 kg. (6.6 lbs.), and the figures of 1,000 g. of whole cow's milk are shown for comparison; 10 g. of yeast is about the highest dose which most patients can tolerate.

The figures in Tables II and III take no account of the digestibility of the various proteins which have been assessed by Atwater in a mixed diet to be:—

Animal foods	97%
Cereals	85%
Dried legumes	78%
Vegetables	83%
Fruits	85%
Total food average mixed diet	92%

It should also be noted that Block's and Bollings'[1] suggested optimal requirements of each aminoacid differ vastly from the normal requirements suggested by Rose[2] and Stare *et al.*[3] The normal or minimum requirements for infants and children are not yet known, but presumably the aminoacid composition of human milk gives some indication of these. The relationship between breast feeding, calorie and protein requirements will be discussed later under the heading of kwashiorkor.

The most notable feature of the figures in Table III is that 700 g. of any of the listed cereals provide adequate aminoacids as recommended by Stare *et al.*, except for the lysine in whole maize.

Note.—Tables referred to in this article appear on pages 68, 69, 70 and 71.

The figures in Table V demonstrate how a diet, of which 77 per cent. of the calories are provided by whole maize, can provide optimal quantities of all the listed aminoacids and an adequate intake of some of the B vitamins. Incidentally this diet also provides an adequate intake of calcium, iron and about 4,000 international units of carotene. Some fresh vegetables or fruit or Native beer would convert this into a well-balanced diet of adequate calorie value for moderate labour.

Whole maize and soyabean are not normal constituents of the African traditional diet, but unfortunately no figures could be obtained of the aminoacid composition of their traditional African equivalents (refined maize meal (about 70 per cent. extraction) and cowpeas), which might have altered the picture considerably, as in the composition of whole wheat and white flour. However, it appears possible to provide a nutritive diet even when the staple food is maize, without incurring much cost or alteration in the traditional diet. The low protein values of the starchy roots and fruits (except potato and yam) render greater supplementation necessary. In the case of cassava (the staple food of a large part of tropical Africa), the necessary supplement would be about 9 oz. of boneless meat or fish, 4 oz. of soya bean or 7 oz. of groundnuts or dried leaves daily. Therefore it seems clear that those parts of Africa where maize, millets, sorghum, wheat or brown rice constitute the staple food have a much easier problem to solve with regard to protein shortage than those parts where cassava, sweet potatoes or bananas are staple foods. Since protein malnutrition is generally believed to be the main etiological factor in kwashiorkor, it is appropriate to discuss this disease at this stage.

Kwashiorkor

Kwashiorkor is believed to have been described as early as 1906 in Germany under the name of "mehlnahrschaden," since when it has been described under 37 other names [4] in every continent except Australia and New Zealand. Its existence in a meat-exporting country like Australia would naturally be surprising; nevertheless kwashiorkor has been reported in Uruguay, another meat-exporting country, under the name of "Distrofia farinacea." This almost world-wide distribution leaves no reason to suspect any specific article of diet, such as maize, as the etiological factor. On the other hand, if the common etiological factor is protein malnutrition, the incidence might be expected to vary inversely with the proportion of protein in the diet. *Alia para,* it should be highest where cassava is the staple food and lowest where hard wheat, rye, oats, bulrush millet, barley or sorghum is the staple food. Reliable figures of incidence are unfortunately not available, but there is undoubtedly a high incidence among cassava eaters. On the other hand, the incidence of kwashiorkor in Dakar, French West Africa, where fermented bulrush millet, sorghum and rice are staple foods, is stated by Raoult [5] to be high, whereas the incidence in the adjacent Gambia appears to be very low,[6] although the staple foods are much the same; a well-marked "hungry season" occurs annually, and medical practitioners with considerable experience of the disease reside in or visit the territory.

A recent departmental enquiry in Southern Rhodesia elicited reports of the incidence of kwashiorkor in Salisbury Hospital (average six cases a month, with no seasonal difference), Umtali Hospital (70 cases with eight deaths in 1952; 67 cases with 22 deaths in 1953; and 57 cases with 13 deaths from January to August, 1954; main incidence from December to April), Gatooma Hospital (172 cases during the period 1st April, 1953, to 31st March, 1954; highest figures of admissions in June, July and October), Gwelo Hospital (average of two cases a month, with no seasonal difference), Umvuma Clinic (8 to 12 cases a month from January to May, but only one or two cases a month the rest of the year), Belingwe, Shabani and Lundi Clinics (about 15 cases a year, with highest incidence August, September and October), Fort Victoria (five cases a month, with incidence highest at beginning of summer). On account of the centralised control of the staple foods throughout the Colony by the Southern Rhodesian Grain Marketing Board, it seems unlikely that any material local difference occurs, but Dr. J. Montgomery, of Umtali, suggests that the seasonal incidence there may be related to the fact that food given to Native children in this age group is commonly maize porridge only, made from stored grain. Later in the year fresh maize is available and the diet is also supplemented by various vegetables and fruits.

These anomalies in incidence suggest that the nature of the staple food has less bearing on the etiology than the precise manner in which children are fed throughout the year. An investigation of this question among primitive women requires prolonged and painstaking enquiry by an intelligent and highly trained female nutritionist able to discriminate between important and valueless evidence. Unfortunately no such appointment has been made in Southern Rhodesia, although there appears to be an almost ideal field here for the investigation of this enigmatic and mortal disease.

Trowell[7] enumerates the constant features of severe kwashiorkor as follows:—

(1) A markedly subnormal weight unexplained by an infection or other disease.
(2) Profound mental apathy coupled with peevishness on being disturbed.
(3) The passage of loose stools containing undigested food.
(4) Considerable reduction in serum albumin (leading to oedema).
(5) Decreased serum alkaline phosphatase, cholesterinase and amylase, with a low blood urea and cholesterol.
(6) Typical pathological changes in the pancreas and liver.
(7) A moderate degree of anaemia.

Trowell also describes the variable features of severe kwashiorkor as—

(a) the degree of fatty infiltration of the liver and its enlargement;
(b) the degree or absence of oedema;
(c) the presence of subcutaneous fat;
(d) changes in the hair and skin;
(e) the presence of associated vitamin deficiencies; and
(f) infection which, especially in the tropics, may bedevil the fundamental nutritional picture and make extra demands on protein metabolism.

Trowell mentioned the difficulty in deciding what constitutes mild kwashiorkor, which usually shows itself in a child of one to four years of age who is markedly underweight and has soft dyspigmented hair and whose diet contains a low proportion of protein. He discusses the differential diagnosis of dyspigmented hair, including the possibility of a genetic factor among Africans. The latter possibility was experienced by Autret[8] during his survey with Brock of kwashiorkor in Africa when a light-haired Native designated his father's tribal home as "the very far north." Further enquiry elicited the information that the tribal home was Scotland. In such cases the hair is not lighter than the skin.

The main incidence of kwashiorkor is from one to four years, i.e., the late breast-feeding, weaning and post-weaning ages. Among the grounds for attributing the disease to protein malnutrition is the fact that the protein/calorie requirements are higher at this age than at any other, but the intake of protein by children where kwashiorkor is endemic is far below these requirements, although calorie intake is normal or high. The following tabulated data from Brock and Autret[9] illustrate this point very well:—

Daily requirements of the African child at the age of—	*12 months.*	*18 months.*	*2 years.*
calories	730	860	1,000
protein	20 g.	25 g.	30 g.
Daily production of mother's milk supplying—	1,000 g.	500 g.	0 g.
calories	630	315	0
protein	14 g.	7 g.	0 g.
Additional foods in the diet must supply—			
calories	100	545	1,000
protein	6 g.	18 g.	30 g.
Calories required from additional foods can be supplied by one of the following—			
millet	29.1 g.	158.6 g.	291 g.
maize	27.7 g.	151.0 g.	277 g.
plantain (fresh)	89.0 g.	485.0 g.	890 g.
cassava flour	29.5 g.	160.8 g.	295 g.
These amounts will provide vegetable protein in the following daily amounts—			
millet	2.9 g.	15.8 g.	29 g.
maize	2.6 g.	14.2 g.	26 g.
plantain (fresh)	1.0 g.	5.4 g.	10 g.
cassava flour	0.44 g.	2.4 g.	4.4 g.

An attempt has been made in Table VI to express this protein deficiency in terms of the essential aminoacids, showing the comparison between maize and oatmeal as supplements to human milk. It will be observed that the diet containing maize is deficient in total proteins and that both diets are deficient in methionine. If the figures for refined maize meal were available, the figures for total proteins, lysine and tryptophane would be much lower.[10] Brock and Autret [11] remark that the average diets in African countries whose food balance sheets have been published by F.A.O. show a very low daily intake of methionine, definitely below even the most modest estimate of needs. They also remark that, apart from the methionine, which is here the limiting factor for the utilisation of the proteins, the amounts of tryptophane and lysine are on the low side in relation to estimated requirements.

If the protein intake in childhood is markedly deficient in one or more of the essential aminoacids, it is of little more use in nitrogen metabolism than sea water in maintaining water balance. Therefore, in the investigation of kwashiorkor one is working in the dark if reliable figures are not available of African children's requirements of the essential aminoacids and the sources of these in their diets. Attempts have already been made to cure kwashiorkor with various essential aminoacids without success. The invariable presence of fatty infiltration of the liver naturally focussed attention on the sulphur-containing aminoacids methionine and cystine, and on choline, inositol and vitamin B12 which are associated with these aminoacids in the turnover of the liver phospholipids. None of these, nor protein hydrolysates, nor various combinations of the vitamins, have been successful in therapy, yet skim milk has been. Brock and Autret [12] suggest that the good results obtained by feeding patients with skimmed milk may be due partly to the fact that the milk does not require the intervention of pancreatic enzymes to be digested. Pantothenic acid deficiency has been suspected [13] as a possible cause of the skin and hair changes in kwashiorkor, although Bigwood [14] has suggested that an equally probable factor in etiology is sulphur deficiency, since the skin and hair demand for sulphur is greater than that of other tissues of the body and the diet of cassava eaters contains far less than is required.

Whatever may be the essential deficiency or deficiencies which give rise to kwashiorkor, there are usually multiple deficiencies in endemic areas. However, although these vary in different localities, there is one common deficiency in *child-feeding* in all localities, to wit, protein available to human metabolism. The failure of any kind of protein therapy in many severe cases of kwashiorkor is no argument against protein malnutrition as the etiological factor, because the same can be said of the therapy applied to fatal cases of malnutrition in the prison camps during World War II. Irreversible change in specialised tissue is a well known feature of severe malnutrition.

The etiology of scurvy and beri-beri was ascertained not by therapeutic experiments, but by the effect of certain foods in preventing these diseases. The most obvious shortage for child-feeding in areas where kwashiorkor occurs is milk. The inhabitants in such areas attempt to remedy this shortage by delayed weaning, but the production of human milk for a child of 12 months or more is usually insufficient for its needs, so the calorie requirements are met by foods which provide insufficient protein and insufficient quantities of certain essential aminoacids to utilise even the little protein in the diet, apart from insufficient vitamins of the B complex and other essential nutritive factors which so confuse the clinical picture.

These facts together with the established therapeutic value of skim milk suggest that an important means of prevention lies in the provision of an adequate milk supply, or a good substitute, in the endemic areas, together with measures to ensure that it is consumed by all children during the susceptible ages. Wakefield [15] has suggested that the introduction of milch goats on a large scale would go a long way towards solving this problem among the poorer sections of the population, especially in Africa, where lush pasture is seldom enough to support cows, but bushes and shrubs are adequate for goats. Satisfactory substitutes for cow's milk can be made from either soybeans or groundnuts.[16] It is known that African women in their kraals in Southern Rhodesia prepare such substitutes, but the dietetic investigation of cases of kwashiorkor in Salisbury Hospital has not yet revealed a case where such a substitute was used, so it is by no means a general practice. On the other hand, investigation has revealed the use of much advertised patent foods containing a large proportion of carbohydrate. This is an example of the break from tradition caused by industrialisation.

Although it is as difficult to define the symptoms of sub-clinical kwashiorkor as those of pellagra or scurvy, it seems practically certain that the clinical disease is really a breakdown arising from stress added to a sub-clinical state of marginal ill-health in the same way that paralysis is a complication of non-paralytic poliomyelitis. The stress factor in kwashiorkor appears in most cases to be an attack of enteritis before the onset of typical symptoms, but whether this is the immediate cause of the breakdown or its first effect is not yet clear.

PELLAGRA

This is probably the commonest dietetic deficiency disease among the maize-eating populations of the Federation. The reasons why maize is more commonly associated with pellagra than any other staple food are several. Firstly, a maize-eating population is inclined to obtain 70 per cent. or more of its calorie intake from maize, therefore any defects in its nutritive composition are magnified as compared with populations on a mixed staple diet, such as rice, sorghum and millets. Nevertheless it should be noted that at least half of the crops produced by Africans in Southern Rhodesia consist of sorghum and millets [17] and that these grains and some locally grown rice are consumed in the Native areas on apparently as large a scale as maize. However, in the European area maize consumption eclipses that of the other cereals. Therefore, *alia para*, pellagra should be more prevalent in the European area, but there are no data to decide this question. The greater consumption of meat in the European area appears to be compensated by a lower consumption of legumes,[18] dried leaves, fungi, ants, game and caterpillars, all of which have considerable anti-pellagra value.

The protein, zein, accounts for about half of the total protein in the whole maize grain and for about half that in the endosperm (the part reserved by refined milling for human consumption). In the germ (which contains one-fifth of the total protein of the grain, but is discarded in refined milling), zein is present only in small amount, the chief protein in this organ being glutelin. Zein is an imperfect protein devoid of lysine and containing only a trace of tryptophane. However, the amount of glutelin in the endosperm and germ tends to correct the deficiencies of zein *provided that the whole maize is consumed*.[19]

Refined milling of maize therefore reduces both the protein and aminoacid value considerably, in addition to removing a large proportion of the B vitamins and minerals (see Table IV). Furthermore, maize contains some substance which is antagonistic to niacin and increases its requirements.[20] Intestinal synthesis of the vitamin from tryptophane is discouraged by sucrose [21] which is more and more being consumed by Africans. Niacin in maize is to a large extent in the form of a precursor united with some protein-like substance. In this form the niacin is apparently not available to the body until treated with strong acid or weak alkali. It is possible. therefore, that the treatment of maize with lime water in the preparation of Mexican tortillas, by increasing the availability of the niacin the maize diet, may help to explain the low incidence of pellagra among tortilla-eating populations.[22] Another feature of tortilla preparation, which is common to some parts of Africa, is the pre-soaking of the maize grains which transfers a good deal of the niacin from the outer aleurone layer (its main locality) to the inner endosperm. Moreover, tortillas are made from the whole maize grain.

In Southern Rhodesia the steps to improve maize for human consumption have been:—

(1) The provision of whole-meal maize, milled to 24-mesh, to Government employees. No complaint has been received nor any trouble experienced over many years. This is not the statutory "straight-run" meal, which is 16-mesh and therefore too coarse for human consumption.

(2) The preparation of tortillas on an experimental scale.

(3) Fortification of maize-meal with calcium. niacin and riboflavin. This measure is about to be implemented. This is an incomplete mixture to improve the meal, but the addition of fish flour, soya meal, skim milk powder or yeast would so alter the cost and constitution of the meal that it would not be likely to secure much support at present as a general measure.

SOME OTHER DIETETIC PECULIARITIES OF AFRICANS

The only sources of vitamin A in the Southern Rhodesia Natives' diet are green or yellow vegetables or fruits, because the Native seldom or never consumes butter, cheese, whole-cream milk, eggs, liver or fatty fish: the white maize he eats contains no carotene, and red palm oil is not available as it is further north.

One bag (200 lbs.) of finger millet is required to make from 75 to 80 gallons of Native beer. The total cost of production, including labour, is about 7d. a gallon containing 1 to 1.5 g. Ca, .96 mg. vitamin B1, 1.76 mg. riboflavin, 12 mg. niacin, 38.4 mg. vitamin C and, possibly, other B vitamins too. Therefore prohibition or limitation of this beverage can be disastrous unless alternative sources of these nutrients are provided.

The sources of calcium in the African traditional dietary are more abundant than those in the European dietary. Since the wild and cultivated green vegetables in the reserves are mainly dark, with a higher calcium content than the lighter green vegetables popular among Europeans, vegetables are relatively more important sources of calcium to the Native than to the European. The small fish which are consumed whole by Nyasaland Natives comprise an important source of calcium. Finger millet, which is a staple food of the Bemba tribe in Northern Rhodesia and is consumed to some extent throughout the Federation, either in porridge or Native beer, contains some 350 mg. of calcium per 100 g. A figure fairly near this has been confirmed in Southern Rhodesia by local analysis. These and other important sources of calcium are largely abandoned during residence in the European urban areas, and this possibly accounts to some extent for the dental caries which arises when the Native tries to adapt himself to European conditions.

The intake of cyanocobalamin (vitamin B12) apparently depends on the intake of foods from animal sources and should, therefore, in many areas, be little or negligible. However, Gelfand [23] has declared that the incidence of macrocytic anaemia among Africans in Southern Rhodesia is very low. This suggests either that consumption of animal foods must be greater than all the evidence suggests (particularly the incidence of severe kwashiorkor) or that there are unsuspected sources of the vitamin, such as foods which have been acted on by moulds (e.g., Native beer), as suggested by Dean.[24]

The iron intake of Africans from maize alone appears to be sufficient for ordinary purposes and that in a well-balanced African diet is superfluous. The use of iron pots for cooking raises the intake beyond that assessed purely on food consumption. Nevertheless, the anaemia-producing diseases, malaria, bilharzia, syphilis and hookworm and heavy infestation with ectoparasites, such as bedbugs, doubtless raise the African's requirements of iron, and it has been suggested by Edington [25] that the anaemic African probably absorbs abnormal quantities of iron.

Iodine deficiency is well known in many parts of Southern Rhodesia, including the African schools in and around Salisbury. The consumption of species of brassica leaves in some of the affected areas may aggravate the condition by rendering the little iodine in the local foods unavailable by fixation. The remedy is of course the iodisation of all salt for human consumption. The salt and foods sold for animals are usually iodised by the manufacturers, but these foods are not purchased in the Native Reserves to any extent.

Summary and Conclusions

Some of the salient circumstances affecting the nutrition of Europeans and Africans in Central Africa, more particularly in Southern Rhodesia, have been described and discussed.

The nutrition of Europeans is adversely affected by circumstances arising from early colonisation and industrial expansion. Education by the medical profession should correct the existing ignorance of dietetics and wise expenditure.

The nutrition of the African population is bad and this is not improved by industrial expansion. The remedy lies largely in sound planning of the food and agriculture policy as indicated by the results of scientific investigation, not by public demand. In addition, the education of African women in practical dietetics and mothercraft is essential.

The field for scientific investigation is vast but little explored; nevertheless the little we already know indicates that the direct cost of food and the indirect cost of dietetic deficiencies would show a substantial reduction for the relatively small expense of scientific investigation and application of appropriate measures.

Table I.—Main Sources of Certain Nutrients in European and African Diets in Central Africa.

EUROPEAN

Calories	*Proteins*	*Fats*	*Calcium*	*Vitamin A*	*Vitamin B1*	*Riboflavin*	*Niacin*	*Vitamin C*
Staple food (20%-40%) Fats and Oils, Starchy Vegetables, Sugar, Meat, Fish, Dairy produce.	Staple food (20%-40%) Meat, Fish, Eggs, Milk, Cheese, Legumes.	Butter, Margarine, Vegetable oil, Cooking fat, Meat (especially pork and bacon), Fatty fish, Eggs, Cream.	Milk, Cheese, Legumes.	Dairy Produce, Margarine, Eggs, Offal, Fatty fish, Green and Yellow vegetables and fruits.	Staple food, Offal, Legumes.	Milk, Cheese, Legumes. Offal, Staple food.	Meat, Offal, Fish, Eggs, Milk, Cheese, Legumes.	Vegetables and Fruits.

AFRICAN (TRADITIONAL DIET)

Calories	*Proteins*	*Fats*	*Calcium*	*Vitamin A*	*Vitamin B1*	*Riboflavin*	*Niacin*	*Vitamin C*
Staple food (70%-90%) Starchy vegetables, Groundnuts, Beans and peas, Meat.	Staple food (70%-90%) Groundnuts, Beans and peas, Leaves, Ants, Caterpillars, Meat, Fish, Game, Rodents.	Groundnuts, Meat, Staple food.	Finger millet, Beans and peas, Green vegetables, Fish bones, Native beer (made from finger millet), Ash of burnt grass (used for cooking).	Green and Yellow vegetables and fruits.	Staple food, Groundnuts, Beans and peas, Native beer.	Staple food, Groundnuts, Beans and peas, Native beer, Edible fungi.	Staple food, Groundnuts, Beans and peas, Native beer, Meat, Fish, Edible fungi.	Native beer, Vegetables, Fruits.

Table II.—The Protein Value of Some Staple Foods Providing 2,500 Calories.*

(The Medical Research Council's recommended average minimum intakes for tropical countries are 2,500 calories and 60 grams of protein daily.)

Cereals	*Amount (as purchased) providing 2,500 calories*	*Protein*
	Grammes	Grammes
Hard wheat flour, wholemeal	753	104
Hard wheat flour, under 80% extraction	687	87
Soft wheat flour, wholemeal	751	79
Soft wheat flour, under 80% extraction	685	59
Rye, wholemeal	784	86
Oatmeal or rolled oats, 45% extraction	649	84
Bulrush millet (Pennisetum), 90% extraction	718	84
Barley, wholemeal	753	83
Sorghum (kaffircorn meal), 90% extraction	729	74
Maize, wholemeal	702	67
Maize meal, 85% extraction	689	58
Rice, brown (only hulls removed)	700	53
Rice, white, milled, 65% extraction	694	46
Finger millet (Eleusine coracana), 90% extraction	753	49
Starchy Roots and Fruits		
Potato (Solanum tuberosum)	3,570	61
Yam (Dioscorea spp.)	2,778	58
Taro (Colocasia spp.)	2,907	44
Tanier (Xanthosoma spp.)	2,294	39
Sweet potato (Ipomoea batatas)	2,577	28
Banana or plantain (Musa spp.)	3,521	28
Cassava, fresh (Manihot spp.)	2,294	21
Cassava flour (Manihot spp.)	740	11

* Values calculated from F.A.O. Food Composition Tables for international use, Washington, 1949.

Table III—Aminoacids and Some B Vitamins in Certain Foods (Edible Portion).

Food	Arginine (g.)	Histidine (g.)	Isoleucine (g.)	Leucine (g.)	Lysine (g.)	Methionine (g.)	Cystine (g.)	Phenylalanine (g.)	Threonine (g.)	Tryptophane (g.)	Valine (g.)	Total Proteins (g.)	Vitamin B1 (m.g.)	Riboflavin (m.g.)	Niacin (m.g.)	Choline (m.g.)	Vitamin B12 (micro-g.)
700 g. whole maize	3.2	1.5	2.7	15.0	1.3	2.4	1.0	3.3	2.5	0.5	3.3	66.5	3.2	0.8	14.0	346	0
700 g. white rice	3.6	0.8	2.7	4.5	1.6	1.7	0.7	3.9	2.1	0.7	3.2	46.9	0.6	0.2	11.2	685	0
700 g. whole wheat	3.8	1.9	3.3	6.2	2.5	2.3	1.6	5.2	3.0	1.1	4.1	85.4	2.9	0.7	32.2	*	0
700 g. white flour	3.6	2.0	4.1	8.4	1.7	2.8	1.7	5.1	2.5	0.7	4.6	82.0	2.2	0.5	11.9	426	0
70 g. rolled oats	0.6	0.2	0.6	0.8	0.3	0.2	0.2	0.7	0.4	0.1	0.6	9.1	0.4	0.1	0.6	*	0
50 g. soya bean	1.5	0.5	1.0	1.4	1.2	0.4	0.4	1.2	0.8	0.2	0.9	19.0	0.5	0.2	1.1	196	0
50 g. groundnuts	1.5	0.3	0.4	1.0	0.4	0.2	0.2	0.8	0.2	0.1	1.2	12.8	0.4	0.1	8.0	77	0
50 g. peas	1.0	0.1	0.5	0.7	0.6	0.1	0.1	0.5	0.4	0.1	0.4	11.1	0.4	0.1	1.2	*	0
50 g. dried leaves	0.8	0.3	0.7	1.3	0.7	0.3	0.2	0.5	0.5	0.2	0.7	12.0	*	*	*	*	0
50 g. whole egg	0.4	0.1	0.5	0.6	0.4	0.3	0.1	0.4	0.3	0.9	0.5	6.2	0.1	0.1	0.2	*	*
200 g. dried skim milk	3.1	1.8	6.0	8.0	5.3	2.4	0.7	4.0	3.2	1.1	6.0	72.0	0.7	3.6	2.0	345	22
1,000 g. human milk	0.6	0.4	1.0	1.3	1.0	0.3	0.5	0.8	0.6	0.3	1.2	14.0	*	*	*	*	*
1,000 g. cow's milk	1.4	0.8	2.7	3.6	2.4	1.1	0.3	1.8	1.5	0.5	2.7	33.0	0.3	1.6	1.0	135	10
100 g. liver	1.1	0.5	1.0	1.4	1.1	0.5	0.2	1.0	0.8	0.2	1.1	17.0	0.3	2.5	15.0	561	105
100 g. lean beef	1.5	0.6	1.2	1.5	1.6	0.6	0.3	1.0	0.9	0.3	1.1	19.6	0.1	0.2	4.1	94	6
100 g. fish	1.4	0.4	1.1	1.3	1.1	0.6	0.2	0.9	1.0	0.2	1.1	18.8	0.1	0.2	2.5	79	7
10 g. yeast	0.2	0.1	0.3	0.4	0.4	0.1	0.1	0.2	0.3	0.1	0.3	5.0	1.6	0.4	3.5	*	*
Optimal average.																	
Daily intake (Block and Bolling)[1]	3.5	2.0	3.3	9.1	5.2	3.8		4.4	3.5	1.1	3.8	60	1.5	1.8	12.0	*	*
												Medical Research Council's Minimum Average Requirements.					
Normal requirements.																	
According to Rose[2]	*	*	1.4	2.2	1.6	2.2	*	2.2	1.0	0.5	1.6						
According to Stare *et al.*[3]	1.8	0.5	1.3	3.6	1.4	1.4	*	1.4	1.2	0.4	1.3						

The aminoacid composition has been calculated from Block's and Mitchell's figures (Nut. Abst. & Rev., 16.2.1946), except in the case of white flour, fish and four of the leaf aminoacids, which were calculated from Block's and Bolling's figures.[1] The nitrogen factors used were those in Table III of the Food Composition Tables of F.A.O. (Washington, 1949), which, together with Food Composition Tables—Minerals and Vitamins (F.A.O. Rome, 1954)—were used as far as possible to calculate protein and vitamin figures.

* Figures not available.

Table IV—One Pound White Maize Meal.

	Calories	Protein (g.)	Fat (g.)	Calcium (mg.)	Iron (mg.)	B.1 (mg.)	Riboflavin (mg.)	Niacin (mg.)
96% extraction ("straight-run")	1,633	43.0	19.0	91	17.3	1.14	0.54	5.4
85% extraction ("roller meal")	1.631	41.7	13.5	73	13.2	0.27	0.14	2.7
Proposed additions on fortification	0	0	0	560	0	0	0.88	13.2

(Values from Fox, F. W., and Goldberg, L. "South African Food Tables," S.A.I.M.R., Johannesburg (1944).

Table V—African Diet Containing 77 per cent. of Maize.

	Calories	Arginine (g.)	Histidine (g.)	Isoleucine (g.)	Leucine (g.)	Lysine (g.)	Methionine (g.)	Cystine (g.)	Phenylalanine (g.)	Threonine (g.)	Tryptophane (g.)	Valine (g.)	Vitamin B1 (m.g.)	Riboflavin (m.g.)	Niacin (m.g.)	Choline (m.g.)	Vitamin B12 (micro-g.)
700 g. whole maize	2,492	3.2	1.5	2.7	15.0	1.3	2.4	1.0	3.3	2.5	0.5	3.3	3.2	0.8	14.0	346	0
50 g. groundnuts	273	1.5	0.3	0.4	1.0	0.4	0.2	0.2	0.8	0.2	0.1	1.2	0.4	0.1	8.0	77	0
50 g. soya beans	168	1.5	0.5	1.0	1.4	1.2	0.4	0.4	1.2	0.8	0.2	0.9	0.5	0.2	1.1	196	0
50 g. dried leaves	132	0.8	0.3	0.7	1.3	0.7	0.3	0.2	0.5	0.5	0.2	0.7	*	*	*	*	*
100 g. lean beef	174	1.5	0.6	1.2	1.5	1.6	0.6	0.3	1.0	0.9	0.3	1.1	0.1	0.2	4.1	94	6
Total	3,239	8.5	3.2	6.0	20.2	5.2	3.9	2.1	6.8	4.9	1.3	7.2	4.2	1.3	27.2	713	6
Optimal intake (according to Block and Bolling)	—	3.5	2.0	3.3	9.1	5.2	3.8		4.4	3.5	1.1	3.8	1.5	1.8	12.0	*	*

(Methionine and Cystine combined: 3.8. Vitamin B1, Riboflavin and Niacin figures: Medical Research Council's minimum requirements.)

* Figures not available.

Table VI—Aminoacid Composition of 860 Calories Diet for African Child of 18 Months (Quantities expressed in grammes).

	Arginine	Histidine	Isoleucine	Leucine	Lysine	Methionine	Phenylalanine	Threonine	Tryptophane	Valine	Total Proteins
(a) Human milk supplemented by whole maize meal.											
500 g. human milk	.30	.20	.50	.65	.50	.15	.40	.30	.15	.60	7
157.5 g. whole maize meal	.72	.34	.61	3.38	.29	.54	.74	.56	.11	.74	15
Total	1.02	.54	1.11	4.03	.79	.69	1.14	.86	.26	1.34	22
*Requirements	.9	.25	.65	1.8	.7	.7	.7	.6	.2	.65	25
(b) Human milk supplemented by rolled oats.											
500 g. human milk	.30	.20	.50	.65	.50	.15	.40	.30	.15	.60	7
141.6 g. rolled oats	1.21	.40	1.21	1.62	.61	.40	1.42	.81	.20	1.21	18.4
Total	1.51	.60	1.71	2.27	1.11	.55	1.82	1.11	.35	1.81	25.4
*Requirements	.9	.25	.65	1.8	.7	.7	.7	.6	.2	.65	25

* The requirements of aminoacids have arbitrarily been selected as half those recommended by Stare *et al.* since the real requirements for a child on 25 g. protein daily have not yet been ascertained. The requirements of protein are those recommended by the League of Nations and the United States National Research Council.

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