A Short Review of Some Recent Work in Nutrition

With Special Reference to South Africa.

HARDING LE RICHE.

In view of the present interest in the nutrition of the people in South Africa, as is shown by the commencement of a Union Nutrition Survey (mostly anthropometric) and the Pretoria Survey (Somatometric and Home Budget study), it has been thought desirable to write a short review on some recent work in connection with the food aspects of nutrition.

As far as analyses of foodstuffs are concerned we are still largely dependent on published tables of overseas work (Sherman, 1928, McCance and Shipp, 1933, Schall, 1935, etc.). Analyses of certain South African foodstuffs have been done by Stammers and Segal, a short list of analyses has been published by Fox and a number of analyses have been done at the Onderstepoort Veterinary Laboratories and at the Division of Chemistry, Department of Agriculture, Pretoria. It is pleasant to know that a fairly large scale analysis of animal foodstuffs will be commenced at Onderstepoort during 1938 (private communication from Dr. A. I. Malan). Dr. van Zyl, of the Division of Chemistry, will have under his direction a food analysis project which will be carried out by Dr. Otto and his associates at the Government Chemical Laboratories, Johannesburg. We will, therefore, probably have a fairly complete list of analyses of South African foodstuffs within a few years.

1. *Total Calorie Allowance.* In a discussion of diet scales one usually starts with a consideration of the total calorie allowance per day for various individuals. We will not discuss the pros and cons of the various scales as laid down by Voit, Atwater, Chittenden and others, but will use the standards as laid down by the League of Nations' Mixed Committee on Nutrition (1936). The scale lays down 2,400 utilisable calories per day for basal requirements for adolescents and adults. By using a sliding scale based on the "Man Unit" the quantitative requirements for children and women of various ages are worked out. Then there is added a certain number of calories for each hour of work done. For "Moderate Work" one adds 100 calories per hour, for light work, 75 calories per hour. For adolescent boys, for instance, the total daily requirements would be 3,400 utilisable calories, *i.e.*, actual fuel value of food as eaten, not raw food as purchased. It is usually considered that 10 per cent. of the caloric value of food is lost by cooking. Therefore, one would consider that healthy active adolescent boys would need 3,800 calories per day (as purchased) and girls about 3,400 calories as purchased. A fact perhaps not fully enough realised in this country is that growing adolescents need much more food than their parents, especially if they are normal active children. Friend (1935) gives cases where active boys (at St. Paul's Hostel and Beresford Court) who do manual work all day, consume, on the average, 4445.3 to 4718.4 calories per day. These values are from scales in force during the period January to June, 1934.

2. *The Protein Requirements.* There have been many arguments about the amounts of protein required by people. Chittenden, van Noorden (1931) and others are in favour of a low protein quota, while Voit, Lusk, McCollum (1922), etc., are in favour of a liberal protein allowance. Modern work inclines one to be in favour of a high protein allowance. Again we follow the League's recommendations in setting a standard *i.e.*, 2.5 grams of protein per kilogram body weight. For an individual weighing 40 kilogrammes the allowance would be 100 grams. The Commission recommends that the protein should come from a variety of sources, and that it is desirable that during growth a large portion of the protein should be from animal sources. Friend (1935) recommends that at least half of the protein should be from first class animal sources. One would suggest that in general, diet scales should be calculated to contain 120 grams of total protein per day per individual. This protein allowance might be considered high, but it has been shown by modern nutritional studies that diets may just sustain life, or that they may be the optimum diets contributing to the greatest health and growth under a certain hereditary constitution. And our aim is to attain to the optimum standard of health.

In relation to the high versus the low protein question, the work of Orr and Gilks (1931) on the predominantly protein-eating Masai and the carbohydrate consuming Kikuyu is extremely interesting.

One is not justified in ascribing the superior size and strength of the Masai solely to their superior diet, as hereditary factors are probably also important, but the evidence given suggests that their nutrition has a great deal to do with their physical superiority.

In cheap dietaries most of the proteins come from cereals and legumes. Due mainly to the fact that cereals and legumes contain a great deal of inert substance (cellulose), the co-efficient of digestive utilization of the protein is lower than that of the concentrated animal protein. This fact must not be forgotten in working out dietaries. A mixed cereal legume diet may provide all the amino acids needed for growth and maintenance and still be inferior to an animal protein diet of the same calculated calorific value. It must also be realized that vegetable proteins are of lower biological value than animal proteins, *i.e.*, more vegetable proteins are required to maintain nitrogen equilibrium than animal proteins, as animal proteins contain amino acids approximating the proportions needed by the human organism.

According to McCollum (1922) experimental studies on animals "all point to the conclusion that when the life history of the individual is considered, a generous protein ingestion, or one allowing a fair margin of safety over the lowest percentage which just suffices to induce maximal growth in the young, will serve to maintain optimal vigour for the longest possible period."

3. *The Fat Requirements.* There is as yet no unanimity as to the amount of fat needed per day. In view of the extreme importance of the fat-soluble vitamins, it is advisable to have a fairly liberal allowance of fat, which, according to Friend (1935), should make up 25 to 30 per cent. of the total daily calories. He says he would put the proportion of the animal fat at 90 per cent. of the total fat supply. Also, fat is a highly concentrated form of energy, giving 9.45 calories per gram, against 4.1 calories per gram for carbohydrate and 4.35 calories per gram for protein. This must be remembered in the feeding of adolescents, who may be undernourished due to their not being able to consume enough bulky carbohydrate foods for their needs.

Another function of fat seems to be its "sparing action on the antineuritic Vitamin B" (Evans and Lepkowsky, 1929). Whipple and Church (1936) have also shown that rats deprived of Vitamin B develop deficiency symptoms more rapidly if the diet were free from fat than if it contained 10 per cent. of lard.

Another argument in favour of retaining a reasonable fat requirement is that fat increases the satiety value of a food, *i.e.*, it increases the time spent by the food in the stomach. Meat, eggs, milk and also sugar increase the satiety value.

It should be realised, however, that the amount of fat should be lower in summer as it might cause digestive disturbances if ingested in excess during hot weather.

4. *The Carbohydrate Allowance.* There is usually an excess of carbohydrates in cheap dietaries, as cereals and legumes are generally cheap. Carbohydrate should not be given at the cost of sufficient protein and fat. It is usually a very bulky food, due to cellulose in most preparations. When highly milled, in order to remove most of the cellulose, there is also a removal of the germ which contains especially Vitamin B. The more a cereal is refined, the less is its protective power (*i.e.*, less vitamins and mineral salts are present).

As is stressed in the League Commission's Report, the increased use of the potato is recommended to replace part of the highly milled cereals, and sugar in the dietary as it contains extra Vitamin C and more readily available calcium and phosphorus than are present in cereals. Potatoes also yield more iron and B-Vitamins.

Mrs. Mellanby's well-known work on dental caries has shown that a high cereal diet is closely associated with dental caries.

Oranje, Noriskin and Osborn (1935) working on the Bantu find a higher incidence of caries among natives living on a "European" diet than those still comparatively primitive. Maughan Brown (1935) from an examination of 145,000 school children during the last fourteen years, decides that there seems to be evidence to support the view that a deficiency of calcium and phosphorus, separately or together, in the diet, is largely responsible for the development of bad teeth. The above opinions are indicative of the lack of agreement as to the exact aetiology of dental caries. But in general it may be stated that a good balanced diet, adequate in vitamins and minerals, prenatally and post-natally, would, more than anything else, ensure the development of good strong teeth.

5. *The Vitamin Requirements.* The latest Union Public Health Report (U.G. No. 52, 1937) mentions that international standard preparations of the following vitamins are now available: Vitamin A (*B* Carotene), Vitamin B, Vitamin C (l-ascorbic acid) and Vitamin D (Calciferol). "It is hoped that in the near future, an active control may be exercised over these products." And may one add that one hopes that the assay of South African foodstuffs for vitamins, on a fairly large scale basis, is not so far off. The provision of sufficient vitamins in the proper natural foodstuffs will obviate the necessity for pharmaceutical preparations of vitamins in highly concentrated, and perhaps dangerous, forms.

To make an accurate approximation of the vitamin content of a certain diet scale is well-nigh impossible, as the vitamin content will vary according to many circumstances such as *e.g.*, exposure of animal to sunlight in the case of Vitamin D in milk, the amount of carotene in the diet of the cow (in relation to Vitamin A, etc.). So also will the amount of Vitamin B vary according to the extent of milling of the cereals, the amount of wheat germ present, or whether yeast was used or not in the preparation of the bread. Vitamin C is easily oxidisable in an alkaline medium, and knowing the culinary indignities vegetables are often subjected to, the amount of Vitamin C is often negligible in cooked vegetables. Cabbage and carrots could with advantage be eaten in the form of salads, their method of preparation retaining minerals and especially Vitamin C.

Vitamin A is one of the fat-soluble vitamins, and is especially high in fish liver, while strange to say, it is absent from lard. This vitamin has been called the "anti-infectivity" vitamin largely on account of the work of Mellanby and Green (1929) on puerperal sepsis. It would seem that this function has been overrated (Orenstein, 1932; Sutherland, 1934) as, according to Cramer (1930) animals kept on a Vitamin A deficient diet do not differ in immunological reactions from normal animals. What this vitamin does do however, is that it keeps the mucous membranes in a state of physiological activity, *i.e.*, it helps to keep out infective organisms. This view is also held by Harris (1933).

One must realise, however, that clear cut results, such as are found in the study of avitaminosis-A in animals, would not readily be found in human beings. In deficient human diets there are usually a large number of deficiencies—in animal experiments only one factor is measured at a time, the other dietary factors being the optimum.

Dr. Helen Mackay (1934, Sub-Ed. B.M.J.), having done a good deal of work on Vitamin A deficiency in England, suggests that, although severe Vitamin A deficiency is rare in Europe, a slight degree of deficiency is present among poorer children in England, leading to eye changes (xerophthalmia and nyctalopia). Such a state would also exist among poor Europeans and Natives in South Africa especially in times of drought and depression. Staz (1937), testing mine natives for night blindness finds that the mine diets are probably as adequate in Vitamin A as the diet of a group of American Rural School Children and also that in a certain American hospital.

In relation to Vitamin D deficiency the classical experiments of the two Mellanbys have shown that a lack of fat soluble Vitamin D is very closely associated with an abnormal growth of bone. The absence of Vitamin D is an important factor in the causation of rickets and dental caries. Fortunately for people having a Vitamin D deficiency, in South Africa with its strong ultra-violet radiation (Osborn, 1932), the skin contains ergosterol which, when irradiated, has all the properties of Vitamin D. It is interesting to note that at present a very important "Sunlight Survey" is being carried out by Fraulein Reimerschmidt of the Institute of Physical Therapy, University of Jena, in co-operation with the Union Department of Public Health, the cost of the investigation being generously borne by Dr. Hans Merensky.

Rickets is very rare among Europeans in South Africa (Brown, 1935), although it does occur in urban natives on a deficient diet. Dental caries is not any less frequent in South Africa among Europeans than in England. Consequently, on the basis of this fact alone, there is something more in the etiology of caries than avitamimosis-D.

Vitamin C and the B-vitamin group are known as the water-soluble vitamins. As is well known, lack of Vitamin C results in the appearance of scurvy, *i.e.*, weakness, small haemorrhages under the skin, haemorrhages from the gums, periosteal haemorrhage and liability to infection. Fish and Harris (1933) have shown that Vitamin C deficiency may be a factor in the production of dental caries. From this aspect alone, the provision of sufficient amounts of this vitamin is essential in all dietaries.

Gothlin, quoted by Harris (1934), stated that probably 18% of children treated by him in country schools in Sweden are subscorbutic.

We have no definite information on this point in South Africa. Murray (1932) says that School Medical Officers have found sub-acute scurvy in children, during drought in South Africa. Work has been done by Fox, Levy, Delf and others in connection with Vitamin C deficiency in the diet of mine natives. Bernstein and Weiner (1937) have found that mine natives have very low stocks of ascorbic acid compared with Europeans. This bio-chemical work confirms the findings of various medical men among the natives who have noted the liability of the Bantu to scurvy.

The Vitamin B complex appears to be much more complex than was thought at first. But as far as human beings are concerned, two components seem to be of the greatest importance, namely, Vitamin B_1 (anti-neuritic, anti-beri-beri) which is thermolabile and present in alcoholic extracts of yeast, and the so-called "anti-pellagra" factor, Vitamin B_1, which is thermostable and absent from alcoholic extracts of yeast. This vitamin complex is found in the germ of cereals and pulses, etc. For this reason the use of wholemeal bread is advocated in poor communities where there is no great variety of foodstuffs from which this vitamin may be obtained. There is reason to believe that the Vitamin B complex has a specific stimulatory effect on the digestive tract, enabling effective digestion and absorption of food to take place. Cluver (1929) points out that pellagra is rare among Europeans in South Africa, only six cases having been reported at the time of writing. That the incidence among the Bantu, who are predominantly maize-eating, with very little other food, is higher, is to be expected, but even then it is of relatively infrequent occurrence.

What has been written above on the subject of vitamins is not intended to be an exhaustive review—it only tries to give a general picture of developments in this fascinating field.

6. *Mineral Requirements.* The mineral requirements of the animal body are not of very great importance. Sherman points out that the ordinary diets of Europeans and Americans, at least among dwellers in cities and towns, are probably more often deficient in calcium than any other mineral salt. This is without doubt also true of the dietaries of the poorer Europeans, and almost all the natives and Europeans in South Africa. Fox and Osborn (1936) point out that there is cause for alarm in the case of calcium consumption in poor urban groups in South Africa, for more than half of them never see milk. And milk is considered by Sir John Orr to provide 2/3 of the dietary calcium. The importance of phosphorus, iron and iodine must not be forgotten. "Nutritional" anaemias, especially in pregnant and lactating women, is not at all rare. In the Lang Kloof area in the Cape Province it is quite a common occurrence to find enlarged thyroids due to iodine deficiency.

THE REQUIREMENTS OF THE BODY FOR MINERAL SALTS (McKILLOP, 1936)

	Calcium Gramme.	Phosphorus Gramme.	Iron Mg.	Iodine.
Pregnant Women	2·0	1·5	10	Amounts needed in considerable excess of Adult figure.
Lactating Women ..	2·0	1·5	10	
Child	1·0-1·5	1·5	10	
Adolescent ..	1·0-1·5	1·5	10	
Adult ..	0·5	0·75	5·10	0·000014 gram.

The table gives the approximate amounts of Ca, P, Fe and I needed by people per day.

The importance of Calcium, Phosphorus, Iron, Sodium, Potassium and Iodine needs no stressing at present, because these minerals are discussed fully in all text-books on physiology. But it would be interesting to see what is known about the minerals occurring in very small quantities in the human body. Iodine, for instance, (Sheldon, 1934) is found in the tuber cinereum, while bromine is found in the pituitary, especially in the anterior lobe. Blood bromine is lowered to almost half the normal figure in manic-depressive psychoses. It has now been well established that fluorine, in excess of 1.5 parts per million of drinking water, causes mottled teeth. Its physiological function is an open question. Silicon has been demonstrated in the human eye, while lithium has also been found in human tissues. Rubidium has been found and seems to be associated with growth. Magnesium is an essential mineral. Animals deprived of it develop marked vasodilation and tetany, and show signs of renal damage. Copper is essential for the formation of haemoglobin. Zinc is also apparently essential for life. As knowledge increases, the importance of even the most minute constituents of the body becomes evident.

Conclusion. It must be realised that "economy" in food has only one set of consequences —decreased efficiency, increased disease and

concomitant increase in palliative medical attention, and last but not least, as a consequence of malnutrition, there is a tremendous intensification of human misery.

The starving children of to-day are the inefficient dependent citizens of to-morrow. It is these children who will greatly swell the ranks of tuberculosis sanitoria and chronic sick hospitals. It is they who will be the recipients of the "semi-fit" pensions. Not that disease will ever disappear, but well-nourished people can readily resist infection when it comes.

In South Africa, people have at last been awakened to the ghastly fact that about half of our Europeans, and practically all of our coloured and native populations are living below the bread line. But mere awareness of this unpleasant phenomenon is not sufficient—purposive, constructive action is needed, not only from the State, but from every single citizen.

The question of health is always closer to the hearts of women than it is to the interests of men, for it is the women who have to look after sick children; they have to listen to the plaints of their hungry infants while their lords and masters ar playing golf or visiting the local pubs, or working, or loafing.

When Mrs. K. Malherbe, M.P., proposed her famous "Nutrition of the People" motion in Parliament at the beginning of last year, she not only focussed public attention on the subject, but she caused something of basic importance to be done about the question of physical status of the children for the first time in the history of South Africa. The Nutrition Survey is the concrete result of her proposal.

If the influence of one lady could accomplish for the health of the people what Mrs. Malherbe's motion has done, and will do, may we pray for the day when there will be a hundred and fifty ladies in Parliament.

Acknowledgements. This paper was written during the tenure of a Research Grant from the S.A. Council for Educational and Social Research for the Pretoria Nutrition Survey, and it gives me great pleasure to thank the Council for enabling me to carry out this work.

BIBLIOGRAPHY.

Bernstein, R. E. and Weiner, J. S. (1937). *S. Afr. J. Med. Sci.*, Vol. 2, No. 2, pp. 37-43.
Brown, H. M. (1935). *S. Afr. Med. J.*, Vol. 9, No. 23, pp. 819-824.
Cluver, E. H. (1929). *Brit. Med. J.*, Oct. 26th, pp. 751-754.
Cramer, W. (1930). *Lancet*, 1., 1153, May 24th.
Evans, H. M. and Lepkowsky, S. (1929). *J. Biol. Chem.*, Vol. 82, p. 269.
Friend, G. E. (1935). The Schoolboy: a Study of his Nutrition, Physical Development and Health. W. Heffer and Sons, Cambridge.
Harris, L. J. (1933). *Brit. Med. J.*, 2, 231, August 5th.
League of Nations (1936). The Problem of Nutrition. Vol. 2, Geneva.
McCance, R. A. and Shipp, H. L. (1933). *Brit. Counc. Med. Res. Counc. Spec. Rept. Ser.* No. 187.
McCollum, E. V. and Simmonds, N. (1922). The Newer Knowledge of Nutrition. 2nd Ed. Macmillan, New York.
McKillop, M. (1936). Food Values. G. Routledge and Sons, London.
Mellanby, E. and Green (1929). *Brit. Med. J.*, June 1st (quoted by Orenstein, 1932)
von Noorden, C. (1931). Alte und neuzeitliche Ernahrungsfragen. Verlag von Julius Springer, Berlin.
Oranje, P., Noriskin, J. N., and Osborn, T. W. B. (1935). *S. Afr. J. Med. Sci.*, Vol. 1, Nos. 1 and 2, pp. 57-62.
Orenstein, A. J. (1932). *S. Afr. Med. J.*, 12th Nov., p. 685.
Osborn, T. W. B. and Fox, F.W. (1937). Dietary Comment on Family Budgets. Blue Book U.G., 21, 1937.
Public Health, Union Dept. of, Annual Report for 1937. U.G., No. 52.
Sheldon, J. H. (1934). *Brit. Med. J.*, Jan. 13th, pp. 47-52.
Staz, L. (1937). *S. Afr. J. Med. Sci.*, Vol. 2, No. 4, pp. 143-150.
Sutherland, R. (1934). *Brit. Med. J.*, 1; 791-795.
Vitamin A Deficiency. Sub. Ed. *Brit. Med. J.* (1934) 1; 811, May 5th.
Whipple, D. V. and Church, C. F. (1935). *J. Biol. Chem.*, 109, *Proc.*, 98-99. *Nutr. Abs.*, 1935, 5, 2, No. 1413.