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THE PROTEIN PROBLEM OF CHINA[1]

By Dr. WILLIAM H. ADOLPH

CORNELL UNIVERSITY; UNTIL RECENTLY PROFESSOR OF BIOCHEMISTRY, YENCHING UNIVERSITY, PEKING

PROTEIN INTAKE

THE protein problem of China implicates the nutrition problem of China as a whole. Our experience in the Far East leads us to believe that in normal times the question of sufficient calories usually takes care of itself. That is to say, in a closed area or in a large agricultural country undisturbed by much industry, when the population pressure is in equilibrium with the food supply, it would appear that people live or die, depending upon whether the supply of calories is sufficient or not. This is one reason incidentally why the problem of nutrition in China is such a fascinating one for the food economist; the equilibrium is such a simple straightforward equilibrium with very few side reactions. But aside from calories the question of protein is probably the first qualitative factor of importance. Our first set of data published about twenty years ago indicates a protein intake of approximately 80 grams per capita per day,[2] which figure subsequent studies have confirmed as an average statement of the protein intake.

THE RURAL DIET IS VEGETARIAN

A further accounting shows that about 95 per cent. of this average protein intake is derived from vegetable sources, while 5 per cent. is animal protein. One should hasten to explain that these figures are for the Chinese rural diet, which accounts for some 85 to 90 per cent. of the total population of the country. Please keep in mind that those who live in the more sophisticated centers, including those citizens of China whom we meet on the college campuses of this country, are accustomed to a dietary which approximates in character and variety that of the Occident.

[1] Paper presented at a Symposium on the Biological Value of Proteins, at the Cleveland Meeting of the American Chemical Society, April 6, 1944.

[2] W. H. Adolph, *Jour. Home Econ.*, 17: 1, 1925.

They represent, however, but a small percentage of the total population. Taking the country as a whole, therefore, with its 400,000,000 of population, and keeping in mind particularly the large agricultural areas of the interior we have here a very close approximation to a real vegetarian diet on a large scale!

Now, if the average protein intake is reckoned at 80 grams per day and the average body weight of the Chinese at 55 kilograms, it would seem that the standard protein requirement of one gram per kilo has been met. However, when the coefficient of digestibility of the protein, as it is actually encountered in the diet, is considered, it is evident that the real intake is much lower. Moreover, when the biological value of the protein is considered, it is readily understood that the average Chinese diet may be really deficient in protein.

Coefficient of Digestibility

The coefficient of digestibility for animal protein is usually taken as about 92. The figures which we have determined for protein in the typical Oriental vegetarian diet range from 55 to 80, with an average of about 65. In dietary studies involving protein intake on vegetarian diets, this low digestibility is not usually taken into account. There is the possibility of a general roughage effect due to the great bulk of the food. It has not been possible to distinguish clearly between what is strictly a roughage effect, *i.e.*, a reduced digestibility due mainly to the large bulk of the diet, and that due to an intrinsically low digestibility of the protein material. There is no question whatever that the vegetarian diet may be extremely bulky, but our experience, primarily with laboratory animals, leads us to suspect that bulk itself does not greatly interfere with digestibility. In metabolism experiments using diets consisting of sweet potatoes and cereals, we have found fecal nitrogen as high as 3 or 4 grams per day. Some of this may represent metabolic nitrogen, of course, but in any event it represents an equivalent somewhere in the balance sheet of say 20 to 25 grams of protein daily.

One of the problems in the Far East involving the coefficient of digestibility is in the use of polished rice. The digestibility of rice is increased with the degree of polishing. But it becomes necessary to balance carefully the advantages which may result from increased polishing against the accompanying losses in vitamins. And this calculation involves the welfare of the rice-eating fraction of the population, say 300,000,000 people. It is clear that the factor of digestibility must not be overlooked.

Biological Value

The biological values of most of the cereal and vegetable proteins used in the Orient have been determined by standard methods. Milk and egg proteins which do not figure largely in the Oriental dietaries have high biological values, say 88 to 94, when determined by Mitchell's method, while the proteins that do figure conspicuously in the Oriental dietaries show values which lie usually between 50 and 75. Proteins which do not interest the Occident have been of considerable interest to us in China, the protein of celery cabbage and the protein of sweet potato, for example, which have biological values of 76 and 72 respectively,[3] and these two together in many rural dietaries may comprise a very considerable fraction of the protein intake.

Supplementary Value: Mixed Cereal Proteins

It is of interest to discover that in the rural, cereal-consuming areas of north China, in spite of the tendency toward simple and rather monotonous diets, the cereals consumed, whether as cooked cereal or in the form of a bread, are usually not single cereals, but are mixed cereals. The mixtures, moreover, follow definite proportions, which differ in different areas, but proportions which have been fixed apparently over many centuries. We have determined the biological values of these cereal mixtures and have invariably found the biological values much higher than those of single cereals.[4] It would appear that in each area, within the limits of the agricultural conditions prevailing in that area, a formula has been worked out which provides a protein mixture of high biological value, if not of maximum value. This may be another case of blind experimentation, examples of which are wide-spread throughout Asia. The rural peoples are generally prepared with a ready response when questioned regarding the relative nutritive value of the food items used in that area. They may state that this food "stays with you" or that food "furnishes muscular vigor." One of our pastimes has been that of checking up these rural opinions and finding that they often correspond closely to estimates of nutritive value made in the laboratory.

Now on the practical side we are very much interested in another type of supplementary protein. Wan and Lee[5] found that the best vegetarian diet that they could devise for laboratory animals had a biological value of 74. By the simple device of adding a small per cent. of dried beef to the diet the biological value was increased to over 80. The implications involved in this are self-evident.

Celery Cabbage Protein

Of the vegetable proteins, the nutritionists in China are suggesting the larger use of the leaf vegetable

[3] H. C. Kao, W. H. Adolph and H. C. Liu, *Chinese Jour. Physiol.*, 9: 141, 1935.

[4] W. H. Adolph and F. W. Cheng, *Chinese Jour. Physiol.*, 9: 245, 1935.

[5] S. Wan and W. Y. Lee, *Chinese Jour. Physiol.*, 5: 157, 1931.

proteins, with particular attention directed toward the well-known celery cabbage. It has been proposed that leaf vegetables be used to replace some of the cereal which now constitutes 88 per cent. of the rural dietary. Animal experiments[6] followed by experiments with human subjects have indicated that this is possible. And of course this has the advantage not only of increasing the amount of good protein in the diet but also that of calcium and other important accessories. When added to a basal cereal diet it made little difference whether the celery cabbage was fed in fresh or in dried form. In these experiments maximum growth was obtained when the celery cabbage constituted on a dry basis 20 per cent. of the mixture. At the same time the celery cabbage-cereal mixed protein showed a slightly higher biological value. A large-scale dairy industry would be economically impossible in China at present, but it is believed that the farm economy could effect such an adjustment as this, involving slightly more green vegetable and slightly less cereal with satisfactory results and without seriously disturbing the economic *status quo*.

Animal Protein vs. Vegetable Protein

In the laboratory of the Peking Union Medical College, Dr. Hsien Wu[7] over a period of 10 or 15 years has conducted experiments on the subject of vegetarian *vs.* omnivorous diet, using laboratory rats. He has shown in the first place that an omnivorous diet, *i.e.*, one consisting of both animal and vegetable food materials, is superior to the best vegetarian diet that they have been able to devise. A very large number of simple vegetarian diets were tried, and vegetarian combinations in every shape and form. The superiority of the omnivorous diet has been measured in terms of growth, of reproduction, performance of work. They show that the superiority of the omnivorous diet is largely due to the superiority of the animal protein over the vegetable protein, although of course the vegetarian diet also tends to be deficient in other factors as well.

Protein in the War Economy

A war economy inevitably leads to the use of more vegetable food, with a corresponding decrease in the amount of animal products consumed. This urge is accompanied by the statement that more people can be fed by such an arrangement. This is probably a step in the right direction as a temporary war measure, and with enriched cereals and other enriched vegetable products much large-scale relief may be possible, but our observations in the Far East lead us to interpose a note of caution. Such an arrangement must be carefully controlled and carried out with a thorough understanding of the implications involved in the vegetarian diet. Do we know, for example, how far the change from the omnivorous diet to the vegetarian can be carried with impunity? Many of our blessings in health and vigor are, nutritionally speaking, related to animal protein. Our experiences in the internment camps emphasized again that attempts to change too radically the dietary pattern of a group of Occidentals was usually not attended with success. America desires to share and to be of assistance to the other peoples of the world, and at the same time desires to maintain the efficiency of the American worker in the war effort. The question may be raised as to how far we should undertake to change a dietary pattern which so far has served us well in the war effort.

Nutritional Edema

It is difficult to point specifically to certain factors in the physical make-up of the peoples of rural China as due to protein deficiencies. Cases of nutritional edema, however, are not unusual. When such cases are fed a diet containing a liberal amount of animal protein, the serum protein is usually promptly restored to the normal level. Ling[8] reports a group of 24 famine subjects so treated and the edema was cured in about two months. In general, the item of poor protein is only one of the factors that enters into the clinical picture in nutritional edema, but it is probably the important one.

Reclamation of Nitrogen

Now there is still another angle to the protein problem—the reclamation of nitrogen; and this is a phase to which less attention is given in America. Rural China for centuries has returned to the soil large amounts of the protein wastage from the human metabolic process. In the case of the solid portion of night soil, practically all is collected, but the process of drying, composting or preparing for actual use on the farm is inefficient and not more than 50 per cent. of the nitrogen gets back into the soil.[9] In the case of the liquid portion of night soil somewhat less of the nitrogen than this, about 10 per cent. in north China, 35 per cent. in south China is actually returned to the soil. The studies in composting and use of night soil are among the most important scientific investigations now in progress in China. These studies neglect the esthetics of sewage disposal, but they do represent an attempt to increase the efficiency of the nitrogen conservation process. For rural China we

[6] P. C. Hsu and W. H. Adolph, *Chinese Jour. Physiol.*, 15, 275, 1940.

[7] S. Wan and H. Wu, *Chinese Jour. Physiol.*, 9: 119, 1935.

[8] S. M. Ling, *Chinese Jour. Physiol.*, 5: 1, 1931.

[9] S. D. Wilson and Y. Wang, *Peking Nat. Hist. Bul.*, 13: 269, 1939.

have been using the figure 450 grams as the amount of nitrogen excreted per capita per year. This is an important figure in all calculations. We are omitting mention of one type of nitrogen reclamation cycle in which the soil and agricultural crops are by-passed and excreted nitrogen is used directly for conversion into animal tissues without being converted first into agricultural product!

Food Relief and Rehabilitation

One of the questions of immediate importance is the problem of food relief. The war in China, which has been under way now for seven years, has badly disturbed the delicately balanced factors of food supply and demand. Not only have 10 million people or more migrated from occupied China into free China, but the army of several more million tends to be fed from the area in which it is stationed. The army itself continues to suffer from a deficient ration. The need as far as it is a need for calories can be met by simply sending in more cereals and organizing transport which will bring these additional calories to the point where they are to be used. But for a long-term relief program something more adequate must be done and there is a growing conviction that it will be desirable to concentrate on proteins. This is not an easy problem. It is only partly economic. A concerted research program is necessary. We will need to know more about some of the less common foods. China has made some use of the soybean, but only to a limited extent. Why?

From one angle a beginning has been made by the agronomists. By crop selection a millet has been produced which contains over 14 per cent. of protein instead of the usual 9 per cent.; this would represent a possible out-and-out increase of 50 per cent. in the gross protein production. If the need is for a better quality of protein, is the only answer to be found in a meat industry or in a dairy industry? The war and the present cooperative undertakings in China offer an unusual opportunity for a first step in solving these problems. Nutritionists in the Far East have for too long a time concerned themselves merely with the problem of *enough* food. It is appropriate that they now approach the problem of the *right kind* of food.

Summary

(1) The protein intake of China is approximately 80 grams per capita per day, 5 per cent. of which is animal protein. (2) The lower digestibility of the protein in vegetarian diets causes the effective protein intake to be much less than is indicated by this figure. (3) Attempts in the laboratory to devise an adequate diet using foods from vegetarian sources only have not met with marked success. (4) The use of mixed cereals in the diet has provided protein of higher biological value; this habit may reflect the attempt on the part of the rural peoples to work out a more effective protein intake. (5) It is suggested that in China some of the cereal protein in the dietary intake be replaced by more leaf vegetable protein. (6) The question is raised as to how far it is feasible in the war economy to replace animal protein by vegetable protein. (7) In long-term plans for food relief in the Far East it is urged that an emphasis be placed on the protein factor.

OBITUARY

ARCHIE SCOTT WOODS

THE untimely death of Archie Scott Woods in an automobile accident near San Diego, Calif., on April 20, 1944, is mourned by men of medicine and by the institutions which they serve. Through his association with the John and Mary R. Markle Foundation he was well known to them and had become not only a friend but a sympathetic and eager helper in their efforts to advance medicine in this country. It was in connection with problems in tropical medicine in the Armed Forces in which lately he had become greatly interested that he had journeyed to the West Coast and there met his death. He should be numbered among the casualties of war.

Archie Woods' career was an unpredictable achievement, its starting point a fortunate circumstance. Born in London, Ontario, Canada, in 1895, and spending his early life in eastern Pennsylvania, he had not, through his parents or family connections, any association with medicine. He graduated from Lafayette College in 1916 with a degree in mechanical engineering and worked for a time for Wood, Dodson and Company, coal operators in Bethlehem, Pa. He later was with E. B. Smith and Company, investment bankers in Philadelphia. In 1925 he went to New York City to be secretary to John Markle, anthracite coal operator and philanthropist. With the formation of the John and Mary R. Markle Foundation in 1927, Archie Woods became its vice-president, treasurer and director. The decision having been reached to devote the funds of the foundation largely to research in medicine, he was entrusted by his board of directors with the responsibility wisely to distribute them.

Thrust into a field of activity of which previously he completely lacked both knowledge and experience, he became an ardent student of medicine and at the