FORTIFICATION IN A GENERAL PROGRAM FOR BETTER NUTRITION

LYDIA J. ROBERTS, PH.D.[1]

WHAT is the significance of fortification in a general program for better nutrition? To answer this question satisfactorily would require more accurate knowledge than we now possess of the present dietary habits and the nutritional status of the people of the country. From the evidence which is available, however, it seems impossible to escape the conclusion that the diets of our people at their best have no great margin of safety, and that a significantly large proportion of them, especially in the lowest income groups, are deficient in one or more of the dietary essentials. This is strikingly illustrated in the study recently reported by Stiebeling and Phipard of 4,000 families in various sections of the United States (1). Outstanding among the deficiencies, in the judgment of the writer, are those of calcium and vitamin B_1, and in the southern states also the pellagra preventive factor, or factors. Iron, vitamins C and D, and other fractions of the B complex are also questionable and in none of the constituents is there any generous margin of safety. I shall present some evidence for calcium, and vitamin B_1, and for the marginal nature of the diet as a whole.

CALCIUM

The best index of the calcium intake is found in the consumption of milk, for this is the only liberal source of this constituent in the American diet. Although there has been a steady increase in the per capita consumption of milk during the past few decades it is still far from adequate. This is borne out by a study made in 1934, through the cooperation of the United States Department of Agriculture and twelve national women's organizations, of the milk

[1] From the Department of Home Economics, The University of Chicago.

consumption of 28,966 families in fifty-nine cities in all sections of the country (2). The average milk consumed by these families was 2.44 quarts per person per week, or less than three-fourths of a pint per day. Moreover, 459 families had no milk at all and two-thirds of the families had less than two quarts per person per week, or less than 0.6 pint per day. As might be expected, the per capita consumption was lower in the southern states, in families with the largest number of children, and in the lower income groups. This study is typical of many others which show that the consumption of milk by thousands of families comes nowhere near an adequate standard for building and maintaining strong bodies.

We are beginning, moreover, to accumulate some rather clear-cut evidence of widespread calcium deficiencies, even in adults. A recent editorial in the *Journal of the American Medical Association* (3) calls attention to the fact that generalized osteoporosis is common in adults, especially after fifty years of age. Orthopedic physicians report that many adult patients show extreme demineralization of the skeleton as revealed by roentgenogram, and they believe this to be the unrecognized cause of many of the ills and deformities of the elderly, such as the general loss of vigor, pathologic fractures of the vertebrae, extreme bowing of the spine which is often sufficient to shorten the stature materially, and a variety of other ailments. They believe this demineralization can be explained by a prolonged negative calcium balance over a period of years, due to the lack of calcium in the diet, or to insufficient vitamin D to favor its utilization. Ghormley (4) has shown that in many such cases improvement can be effected by a calcium high diet or a calcium salt with vitamin D. There seems, then, little doubt that the diets of a considerable number of our population are suboptimal for calcium and possibly also for vitamin D.

EVIDENCE FOR VITAMIN B_1

What evidence do we have for our belief that there is a shortage of vitamin B_1 in the American diet? First of all, we may cite the

difficulty encountered when one sets out to plan a diet which meets the standards for vitamin B_1 which have been proposed. Estimates of the B_1 requirement range from 200 to 600 international units. It is possible by the inclusion of liberal amounts of protective foods to bring the B_1 up to the minimum standards, but difficult, if not impossible, to reach the optimal ones and still include the quantities of white bread, sweets, and other refined foods to which people are accustomed. It is significant to note how the modern diet differs in this respect from that consumed by the average American one hundred years ago. Joliffe (5) has made an interesting analysis of this problem. He points out that not only has the consumption of cereals decreased during the last century but modern methods of milling have greatly reduced the content of B_1. In 1840 cereals furnished 32 per cent of the calories in the diet; they now constitute but 24 to 25 per cent. Whereas the process of milling one hundred years ago recovered from 85 to 90 per cent of the grain as flour and this contained 75 per cent of the original B_1, modern methods utilize but 70 to 75 per cent of the grain and the resulting flour contains but 10 per cent of the B_1.

The increased consumption of sugar is another factor that has helped to reduce the B_1 intake. The per capita consumption of sugar which in 1821 was about eight pounds per year has risen to well over one hundred pounds at the present time. (Some estimates give 119 pounds.) This furnishes about 18 per cent of the total calories, in contrast to 1.3 per cent in 1821. For a 3,000 calorie diet this amounts to 540 calories from a food totally devoid of any other dietary essentials. Joliffe points out that these two foods—cereals and sugar—comprise about 50 per cent of the diet. Thus a 50 per cent fraction of the calories which in the diet of 1840 provided 600 international units of B_1 has been replaced by one furnishing but 50 international units. The modern diet is, therefore, poorer in B_1 by 500 to 550 units. Baker, Wright, and Drummond (6) have shown similar changes in the English diet. From calculations of

actual dietaries they find that the charity diets of 1838 provided 1,000 to 1,200 international units of B_1, while those of the well-to-do Englishman today contain about 450 international units and those of the lower income groups only about 290 international units.

Offsetting the loss of B_1 from cereals, of course, has been the increase in the consumption of milk, fruits, and vegetables, but as Joliffe has shown, it would require very large quantities of these to make up for the 500 or more international units lost from the cereal source. It is true, of course, that the B_1 provided by these earlier diets may be in excess of that actually required. This we shall not know until the requirements for optimal nutrition have been eventually determined. But it is, in any case, significant that our diets today are very poor in B_1 as compared with those of our forbears.

Evidence is fast accumulating, moreover, that shows that B_1 deficiency is more common in this country than has been generally assumed. Strauss (7), Joliffe (5), and others have presented an impressive amount of evidence to show that beriberi in characteristic form is endemic in many parts of the United States, but that its presence is concealed by its diagnosis under many different names. It is their conviction that various forms of polyneuritis which are common among women during gestation, in persons with chronic gastro-intestinal disorders, in diabetes, in hyperthyroidism, and in alcoholism, and many other conditions, are all true beriberi caused by a relative lack of B_1 in the diet. They have shown that the calorie/vitamin ratio of the diets in such cases is below the 2.7 which Cowgill considers the level below which beriberi appears, and that the increase in vitamin B_1 with no other change in their diet will effect a cure. Spies (8) states that a B_1 deficiency is also almost invariably present in cases of pellagra, since the nervous manifestations do not clear up on treatment with nicotinic acid alone but do respond to thiamin therapy.

It seems obvious, then, that a true B_1 deficiency exists in a significant but unknown degree. When a deficiency disease is endemic,

moreover, a much larger proportion of the people are probably on the borderline or below and would be shown to be deficient if adequate methods of diagnosing subclinical cases were available.

NATURE OF THE AMERICAN DIET

Time does not permit the presentation of evidence of possible deficiencies in other dietary factors. It is pertinent, however, to call attention to the marginal nature of the American diet as a whole. Some indication of this is afforded by a comparison of three types of diets, as given in Table 1. One consists solely of natural food stuffs; that is, every item in the diet contributes its original quota of minerals and vitamins. One termed the "Good American" contains the amounts of the protective foods—milk, eggs, fruits, vegetables, meat, potatoes, and whole-grain cereals—commonly included by nutritionists in their rule-of-thumb formula to insure adequacy; the rest of the diet is made up from cereals, sugars, fats, and bread which supply little but calories and some protein. The third, termed

Table 1. Foods included in three types of diet.

Natural Foods			"Good American" Diet			"Poor American" Diet		
Food	Amt.	Cal.	Food	Amt.	Cal.	Food	Amt.	Cal.
Milk	1 qt.	672	Milk	1 pt.	336	Milk	1 c.	168
Egg	5/7	50	Egg	1	75	Egg	¼	20
Potato	3 sr.	400	Potato	1 sr.	150	Potato	1 sr.	150
Beans	⅓ sr.	50	Meat	1 sr.	150	Meat	2 sr.	300
Cabbage	4 sr.	75	Orange	1	70	Orange	¼ sr.	20
Apples	2	150	Apple	1	80	Apple	1 sm.	50
Whole Cereal		1,000	St. Beans	1 sr.	25	Lettuce	1 sr.	10
Molasses		200	Lettuce	1 sr.	15			
Fat	Butter / Other	400	Whole Cereal	1 sr.	100			
Sub-Total					1,001			718
			White Cereal		1,000	White Cereal		1,100
			Sugar		500	Sugar		700
			Fat	Butter / Other	500	Fat	Butter / Other	500
Total		2,997			3,001			3,018

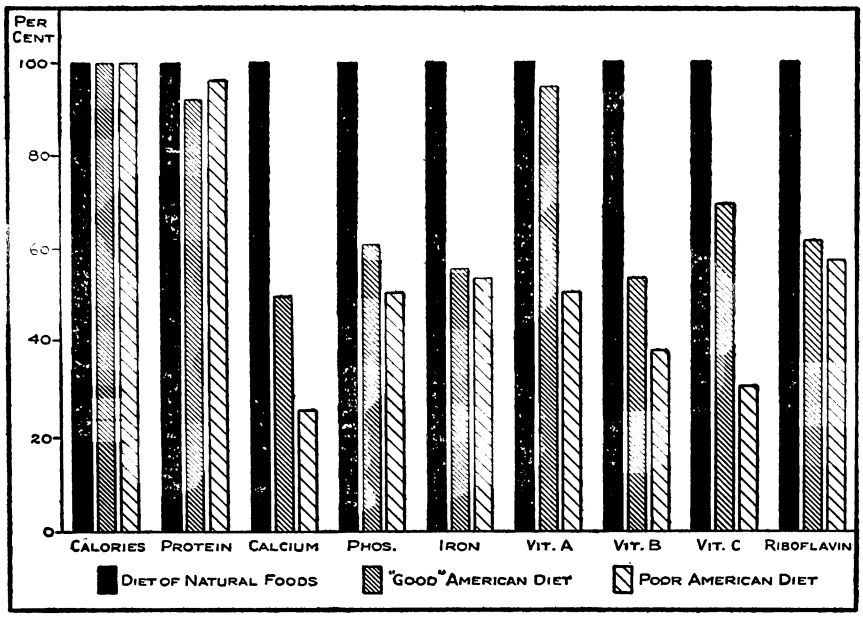

Fig. 1. Comparison of the nutritive value of three diets, natural foods, "good" American diet, and "poor" American diet.

the "Poor American," consists largely of meat, potatoes, sugar, white bread, and other refined cereal products with only meager amounts of the protective foods. The amounts indicated in the table are, of course, arbitrary ones but they serve adequately for purposes of comparison. The nutrients provided by these three diets are graphically compared in Figure 1. For each constituent the diet of natural foods is used as 100 per cent; the others are compared with it.

It is seen that even the so-called "Good American" diet falls a long way below the diet of natural food stuffs in many respects. This is explained by the fact that the protective foods constitute but 1,000 calories, or one-third of the total calories, and this fraction is depended upon to carry all the minerals and vitamins; the remaining two-thirds of the calories are derived from white bread and other refined cereal products, sugar, and fat, which are practically devoid of these constituents. It should be pointed out in this con-

nection that this food plan is not advocated by nutritionists as an ideal. It is merely set up as one way of assuring a minimum of adequacy in dietary essentials even while conceding to the popular demand for a diet containing a large proportion of refined foods. If this rule-of-thumb method is followed literally, moreover, the diet will usually meet at least the minimum dietary standards, but it has no generous margin of safety such as is afforded by the diet of natural foods.

Unfortunately, such evidence as is available indicates that relatively few people regularly have diets even quite as good as this. A considerable proportion of our population are subsisting on diets more like the one we have termed the "Poor American." As may be seen in the chart, this diet measures up to the one just discussed only in calories and protein, and is definitely below it—and consequently below even the minimum dietary standards—in most respects.

METHODS OF IMPROVING THE DIET

It is readily apparent that the American diet needs improving. How can this be accomplished? There can be no question that the ideal solution would be to bring about the needed improvement by increasing the use of the protective foods, and by returning to some extent at least to a greater use of some of the less-highly milled cereal products and other refined foods. Programs of popular education should, moreover, be directed toward this end. Desirable as this end is, however, it can be accomplished only by a long and vigorous program of popular education, and we are faced with the immediate need to do something to better the nutritional status of our people. The line of least resistance, therefore, might be to add to certain basic foods which are consumed in largest amounts by the mass of the people the dietary essentials that have been shown to be most lacking in the usual diet, so that no matter what they eat, they would "willy-nilly" have an automatic source of the dietary essentials. This method has already been used with iodized salt and

with vitamin D milk, and the advisability of extending this plan to other foods is being seriously considered.

If this procedure is to be used, then highly refined products, especially flours, would seemingly head the list of foods to be fortified. I have presented evidence, for example, that our diets are submarginal in vitamin B_1. The suggestion has been made that some potent source of B_1, such as a highly potent yeast or crystalline thiamin be added to all flour and milled cereals so that every cereal product that people ate—bread, macaroni, pastries—would automatically contain it. Would this be in the interests of better nutrition? In my judgment, it probably would, *if* it could be done at no additional cost to the consumer—for the lower income groups are the ones that most need to have it provided in this way—and *if* all advertising for the resulting product could be properly controlled. Similarly the addition of yeast or of nicotinic acid, as well as B_1—and possibly also riboflavin—to the cornmeal and flour used in the sections of the country where pellagra is endemic might be an advantage to the general health, providing the entire fortification program could be under medical direction so that it would be properly safeguarded.

The chief danger I see in such fortification procedure is that it might tend to give a false sense of confidence that all the deficiencies of refined cereals have been overcome. It must be remembered that cereals have lost far more than just thiamin or any other single vitamin in the process of milling and that some of these other factors may be equally important in human nutrition. Figure 2 has been prepared to illustrate this point. It shows the nutrients provided by 750 calories of cereal—the amount statistics indicate to be the present average per capita consumption—when used as whole-meal flour, and as white flour. The solid bar in each pair represents the amount of the nutrient in the whole-meal expressed as 100 per cent; the hatched bar indicates the relative amount in the white flour. It is seen that the amount of protein is essentially the same in the two types of flour but that in all other materials the white flour

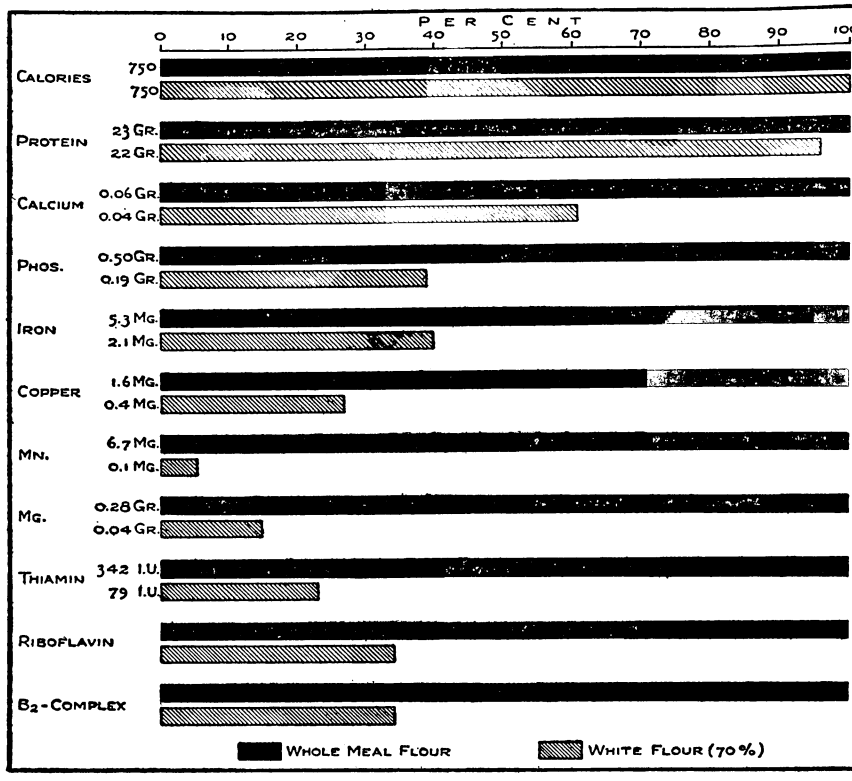

Fig. 2. Dietary essentials furnished by 750 calories of cereal when eaten as whole meal flour and as white flour.

is definitely poorer. In terms of the whole-meal flour it has lost one-third of its calcium, two-thirds of the iron, three-fourths of the copper and thiamin, and almost all of the manganese and magnesium. According to the data given by Copping (9), the loss of flavin and other B_2 factors is from 34 to 80 per cent. The decrease in calcium and phosphorus is probably less significant, but the loss of several milligrams of a well-utilized iron and the other minerals whose values in nutrition are just beginning to be appreciated, as well as other fractions of the B complex, may be a matter of importance.

While the supplementation of cereals with one or two vitamins then would help to remove some of the deficiencies in the American

diet, the fortified product will be far from the equivalent of the original cereal. If the plan is accepted, the exploitation of the product should be so safeguarded as not to give the impression that all the deficiencies of the cereal have been overcome. It would seem desirable indeed that other constituents which cereals are normally expected to contribute should also be added, or more properly, retained in the product by the process of milling.

If fortification is accepted as an automatic method of improving the diet, the safest procedure would appear to be along the line of fortification of natural carriers. Addition of iodine to salt, and the various B factors to cereals are of this nature. I would personally favor also the addition of vitamin A to all butter substitutes to at least the amounts found in a good grade of summer butter, so that the poor man's diet would contain a more liberal supply of this vitamin. Further than this I am not prepared to go at the present time.

To sum up, I believe that, if it could be properly safeguarded, a judicious use of fortification might be of decided benefit in a general program for better nutrition. If undertaken, leadership in the movement should be given by physicians and specialists in nutrition who should work out carefully considered policies as to the foods which should be fortified, the materials to be added, and the absolute and relative amounts to be used, and who should also direct the distribution and promulgation of the fortified products.

Whatever is done in the way of fortification, however, must always be regarded as merely a supplementary or "first-aid" measure. Our major emphasis should be directed toward the improvement of the diet along the lines already indicated as desirable. We must remember that the last word has not yet been spoken in respect to nutrition and that there may still be many essential dietary factors of which we are as yet unaware. We can not, therefore, trust solely to fortification, but must still put our major faith in a varied diet containing generous amounts of natural foods.

BIBLIOGRAPHY

1. Stiebeling, H. K. and Phipard, E. F.: Diets of Families of Employed Wage Earners and Clerical Workers in Cities. United States Department of Agriculture Circular, January, 1939, 507, p. 141.

2. How Much Milk? Consumer's Guide 3. May, 1936, No. 10, p. 3.

3. Senile Osteoporosis. Editorial. *Journal of the American Medical Association,* February 4, 1939, 112, No. 5, p. 434.

4. Ghormley, R. K.; Sutherland, C. G.; and Pollock, G. A.: Pathologic Fractures. *Journal of the American Medical Association,* December 25, 1937, 109, No. 26, p. 2111.

5. Joliffe, N.: A Clinical Evaluation of the Adequacy of Vitamin B_1 in the American Diet. International Clinics, 1938, 4, p. 47.

6. Baker, A. Z.; Wright, M. D.; and Drummond, J. C.: The Nutritive Value of Bread. *Journal of the Society of Chemical Industry,* 1937, 56, p. 191.

7. Strauss, M. B.: The Therapeutic Use of Vitamin B_1 in Polyneuritis and Cardiovascular Conditions. *Journal of the American Medical Association,* March 26, 1938, 110, No. 13, p. 953.

8. Personal communication.

9. Copping, A. M.: The Nutritive Value of Wheaten Flour and Bread. *Nutrition Abstracts and Reviews,* January, 1939, 8, No. 3, p. 555.