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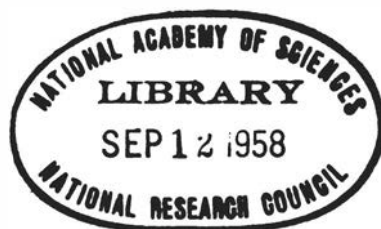
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CEREAL ENRICHMENT IN PERSPECTIVE, 1958

Prepared by

NRC. ~~THE~~ COMMITTEE ON CEREALS,
" Food and Nutrition Board
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CEREAL ENRICHMENT IN PERSPECTIVE, 1958

This publication follows other closely related documents published by the Food and Nutrition Board.¹ It covers pertinent literature from 1950 to the present and includes a brief review of the early history of enrichment. Its primary purpose is to analyze the present situation in order to foster interest in further promotion of enrichment of staple cereal foods.

In this publication an effort has been made to use the terms "enriched", "enrichment", etc., only in the strict legal sense of the Food and Drug Administration's standards applying solely to cereal

products with specified contents of thiamine, riboflavin, niacin, and iron. (See Webster's Collegiate Dictionary, 1950 *et seq.*) Addition of vitamin D to milk or A to oleomargarine is not "enrichment", technically speaking, but "fortification."

As the practice of such additions to foods extends to other countries, variations of formula are occurring without alteration of fundamental purpose. It is convenient to have an inclusive term to cover all such variations, and "enrichment" has sometimes been used in that broader sense, but the context will make the meaning clear.

REVIEW OF EARLY HISTORY OF ENRICHMENT

The Council on Foods of the American Medical Association issued a statement March 18, 1939² encouraging "the restorative addition of vitamins or minerals or other dietary essentials in such amounts as will raise the content of vitamins or minerals or other dietary essentials of general purpose foods to recognized high natural levels; with the provision that such additions are to be limited to vitamins or minerals or other dietary essentials for which a wider distribution is considered by the Council to be in the interest of public health."

In August, 1940 the Subcommittee on Medical Nutrition of the National Research Council issued the following statement³: "It is generally agreed that the diet of the civilian population is minimal in its provision of vitamin B₁, and in case of war the deleterious effect of an inadequate supply of vitamin B₁ is likely to manifest itself (unfavorably), especially in men doing heavy labor."

Following the discovery of the structure of vitamin B₁ (thiamine) by Williams *et al* and its economic production by Merck & Co., Inc. and later by Hoffmann-La Roche, Inc., many producers in the milling and baking industries became interested in improving the nutritional quality of their products. As early as 1939, 12,000,000 pounds of specialty bread per month was being manufactured with the addition of thiamine and vitamin B complex and non-fat dry milk, producing a very nutritious loaf. The flour hearings of 1940 and bread hearings of August 7, 1941 and April 1943 developed standards for flour and a basis for standards for bread as well. Levels of thiamine, riboflavin, niacin, iron, vitamin D, and calcium were proposed, based on the recommendations of Dr. E. M. Nelson of the Federal Food and Drug Administration and endorsed by other prominent nutritionists, Drs. Wilder, Sebrell, Jolliffe, and Williams, who testified at the hearings, November 14, 1940. The term "enriched"

¹ Facts About Enrichment of Flour and Bread, October 1944.

Enrichment of Flour and Bread. A History of the Movement. Bulletin of the National Research Council No. 110. November 1944.

Supplement to the Facts About Enrichment of Flour and Bread. March 1946.

Bread and Flour Enrichment 1946-47. February 1947.

Outlook for Bread and Flour Enrichment. A Review of Events during 1947-48. November 1948.

Flour and Bread Enrichment 1949-50. October 1950.

² J. Am. Med. Assoc. 113: 681 (1939).

³ Minutes of Meeting August 5, 1940.

was introduced in testimony concerning farina by Dr. Frank L. Gunderson during the flour hearings and quickly received support of government officials and of other witnesses. It was adopted by the Food and Drug Administration as the most satisfactory descriptive term. The flour enrichment standards were issued May 27, 1941⁴ and later amended⁵ to provide the regulations which are now in effect. A sound background based on the experience of medical men, biochemists, and nutritionists was thus provided both for temporary action by the War Food Board and for permanent measures of the Food and Drug Administration.

The bread and flour enrichment program was inaugurated by the National Nutrition

Conference for Defense, May 1941. By mid-1942 it was estimated that three-fourths of all white bread and family flour had been enriched voluntarily with thiamine, dry milk, niacin, and iron. The use of riboflavin, except as supplied by dry milk in much of the loaf bread, was not possible until October 1943, because of inadequate supplies.

The principle of restoration rather than that of fortification based on public health needs still has proponents. Neither view has prevailed fully and both are useful for clarification of thinking. The Food and Drug Administration, however, accepts only evidence of health needs as valid and legally defensible.

WAR FOOD MEASURES

The War Food Administration was temporarily made responsible for the handling of food emergencies created by World War II. This agency took prompt action to promote cereal enrichment. Under its authority a Food Distribution Order requiring the enrichment of all bread went into effect in January 1943. Flour enrichment was not made mandatory. War Food Order Number 1, issued April 25, 1944, put enrichment of bread on a more formal basis and made it conform more nearly to the Federal Security Agency's⁶ proposed definition of enriched bread published in August 1943⁶. When Food Distribution Order Number 1 was issued, there was no definition of enriched bread. However, according to proposals under discussion, enriched bread was to be made from enriched flour or to

have the equivalent ingredients added to the dough during its preparation for bread production. The Food and Drug Administration considered it unwise to issue temporary standards because War Food Standards were the responsibility of the War Food Administration. War Food Order Number 1 was repealed October 18, 1946, before the enriched bread standards were promulgated. Actually, however, by tacit agreement, the proposed standards of the Federal Security Agency were in general faithfully followed.

For a full discussion of this matter in the United States, see "Enrichment of Flour and Bread. A History of the Movement"⁷. The British experience with their corresponding problems is recounted in "Breads, White and Brown"⁸.

STATE LEGISLATION

Enrichment was promoted by various states, as well as by private enterprise.

South Carolina enacted the first enrichment law in 1942. A number of states passed

⁴ Federal Register 6: 2574-2582 (1941).

⁵ Federal Register 8: 9115-9116 (1943).

⁶ Federal Register 8: 10780-10788 (1943).

⁷ National Research Council Bulletin 110 (1944) pp. 19-20 and 53-55.

⁸ R. A. McCance and E. M. Widdowson. Pitman Publishing Co. London, 1956.

*The Food and Drug Administration operated within the Federal Security Agency, through which official pronouncements were made. The agency is now designated the Department of Health, Education, and Welfare.

enrichment legislation during the war years and immediately thereafter. In 1950, when the last report on the progress of enrichment was published⁹, 26 states, Hawaii, and Puerto Rico had passed flour and bread enrichment legislation patterned after the levels discussed in the Food and Drug Administration hearings. Kansas and Oklahoma passed enrichment legislation in 1947, Massachusetts and Rhode Island in 1948, and Colorado, Nebraska, and Ohio in 1949. New Mexico is the only state that has passed legislation on enrichment since 1950. Vigorous campaigns were waged in Minnesota and Michigan, but opposition developed and the legislation did not pass.

In the states where enrichment legislation has not been enacted, bread and flour enrichment is voluntary with the baker and the miller. Fortunately, nearly all of the bread and flour is enriched in the states not having legislation. Nearly all the large producers of bread and family flour who

ship in interstate commerce produce only enriched products. A good many small bakeries and some small flour mills are prone to neglect it, but their total volume of production is a minor fraction of the entire output. It is estimated that 80 to 90 per cent of all white bread and white family flour produced is now enriched, although exact figures are not available.

Seventeen years have now passed during which great progress has been made in improving the staple food of the American people. Renewed efforts should be made to make enrichment of all white flour, bread, and rolls in the United States an accomplished fact. Weakness and criticism of one food product reflect on all others. All food industries should adopt policies that will reflect their interest in giving the consumer the benefit of scientific discoveries tending to promote better and more nutritious foods.

STANDARDS FOR ENRICHED BREAD

Proposals for standards of identity for enriched bread were published¹⁰ October 14, 1948, but the ensuing hearings were protracted for months and became highly controversial; as a result, standards were not issued until May 15, 1952, and became effective August 13, 1952¹¹. Following the publication of the proposed standards, a public hearing was held to discuss objections to items in the proposals. During the hearings, testimony covering every item entering into the various bread formulas under consideration was presented by representatives of the industries affected. Suitability of ingredients for food and their safety for human use had to be demonstrated. In certain cases, ingredients could be included in the standards solely because of their functional value. When the hear-

ings were concluded, the Hearing Officer and his staff prepared the standards on the basis of evidence given at the hearings, and published them. After 90 days they were legally in effect. (By later amendment of the Food and Drug Act, standards of identity are now issued more expeditiously. No hearings are held unless there is protest to the government proposals, and the hearings when held are limited to protested matters¹²).

There is no provision in Federal law requiring the enrichment of any cereal product, but there is authority given by Congress to establish standards of identity. There are "required" and "optional" ingredients for enriched products. Thiamine, riboflavin, niacin, and iron are required ingredients and all four must be included

⁹ Food and Nutrition Board, National Research Council. Flour and Bread Enrichment, 1949-50. October 1950.

¹⁰ Federal Register 13: 6024 (1948).

¹¹ Federal Register 17: 4453 and 4613 (1952).

¹² U. S. Code Annotated 21: 260-261 (1956).

if the product is labeled "enriched". Calcium and vitamin D are optional ingredients and may be included or omitted at the option of the producer. The wrapper and label declaration on "enriched" products informs the consumer of the amount of enriching ingredients which the product contains and the percentage of an individual's minimum daily requirements supplied by a given weight, e.g., 8 ounces, of the product.

The definition of enriched bread¹³ is such that the exclusive use of enriched flour in making it will fulfill the legal levels of enriching ingredients. Consistency between the definitions for enriched bread and enriched flour was deemed important for legal reasons. However, enriched bread is rarely actually made from enriched flour. The usual practice is to use wafers containing the vitamins and iron in preparing the dough in the bakery. It has been considered repeatedly that the use of enriched flour by all bakeries might simplify the process of enforcing enrichment, since there are only about 200 mills in the United States which make bakery flour, while there are nearly 19,000 bakeries requiring inspection. Enrichment of all flour would provide almost automatic enforcement in all bakeries, because nearly all bakery flour moves in interstate commerce and is subject to Federal inspection. However, bakery flour is also used for sweet goods, crackers, and other products for which no enrichment standard exists.

A few large bakeries have tried the use of enriched flour but the practice has not been maintained. The principal objection to its use has been the slightly higher cost. In view of the present lower costs of the enrichment ingredients, it is suggested that the bakers and millers again review ways and means of making more practical the inspection and standards control, thereby bringing about more general enrichment of bread and flour and assuring the nutritional benefits of enriched bread to the entire

public. No doubt one of the greatest weaknesses of the enrichment program is that the practice of enrichment is so frequently ignored or neglected by small neighborhood bakeries. Though the total volume of bread produced by such bakeries is small, the number of bakeries looms large in statistics of violations. This brings enrichment into discredit, especially in states where enrichment legislation is poorly enforced.

Despite these weaknesses, the generally splendid support of the enrichment program is exemplified by the fact that it was continued when millers lengthened the flour extraction to 80 per cent from April through August 1946 to conserve food during the postwar world shortage.

Enrichment wafers are compounded on the basis of supplying 100 pounds of flour with enrichment ingredients at levels to conform with the standards for enriched bread. The tablets contain thiamine, niacin, riboflavin, and iron. A one-pound loaf of enriched bread must contain:

	<i>Minimum</i>	<i>Maximum</i>
Thiamine	1.1 mg.	1.8 mg.
Niacin	10.0 mg.	15.0 mg.
Riboflavin	0.7 mg.	1.6 mg.
Iron	8.0 mg.	12.5 mg.

The label must contain a statement such as the following: "8 ounces of this bread supplies at least the following percentages of adult minimum daily requirements: thiamine 55%; riboflavin 30%; niacin 50%; iron 40%." The minimum daily requirements of 1 milligram of thiamine and 10 milligrams of iron for an adult, established by the Food and Drug Administration, have long been in effect. Recently a requirement of niacin has been established¹⁴ and that for riboflavin has been changed. The new levels are as follows:

	<i>Milligrams</i>
Riboflavin	
Infants	0.6
Children	0.9
Adults	1.2
Niacin	
Children under 6 years	5.0
Children 6 years or older	7.5
Adults	10.0

¹³ Federal Register 6: 2574-2582 (1941) and Federal Register 8: 9115-9116 (1943).

¹⁴ Federal Register 22: 3841 (1957).

Until the niacin requirement was officially stated, the only information regarding niacin that the label could carry was the num-

ber of milligrams provided, a practice in effect for many years.

OPTIONAL INGREDIENTS

Calcium and vitamin D are optional ingredients but, if added, must be declared on the label. If used, the levels prescribed per pound of enriched bread are as follows:

	<i>Minimum</i>	<i>Maximum</i>
Calcium	300 mg.	800 mg.
Vitamin D	150 USP units	750 USP units

In general, the optional ingredients have been little used in enriched flour or bread. In enriched self-rising flour, calcium is a required ingredient. It appears as monobasic calcium phosphate which, together with sodium bicarbonate, constitutes the leavening agent in lieu of added baking powder. This form of flour is very popular in the South and is generally enriched, but Vitamin D is not included as an optional ingredient.

In 1951-52 a number of large bread-manufacturing companies began adding vitamin D to bread at levels which supplied 92 per cent of the daily requirements in 8 ounces of bread. This amount was designed to insure the proper utilization of the calcium supplied by the bread. Perhaps this move by bakers was dictated in some degree by a desire for a new advertising point. The position of the Food and Nutrition Board has been not to encourage the addition of vitamin D to bread.

Actually, approval of the optional ingredients in enriched flour and bread in 1941 by the Committee on Food and Nutrition, predecessor of the present Board, was predicated on some legal complications concerning the use of the term "enriched" which

had already risen at that time. Prior to inauguration of the systematic cereal enrichment program, farina "enriched" with vitamin D had been sold by the Quaker Oats Co., which later took exception to the cereal enrichment formula proposed by the Food and Drug Administration and took the matter to court. The company won in the lower court but the decision was eventually reversed by the Supreme Court as recounted in "Enrichment of Flour and Bread. A History of the Movement."¹⁵ In the hope that it would be of assistance in resolving these issues then in contest, the Food and Drug Administration then favored the inclusion of vitamin D as an optional ingredient. Calcium was added as a second optional ingredient on the ground that vitamin D plays a large role in the utilization of calcium.

Further evidence bearing on the scientific merit of these inclusions has since accumulated. A review of data indicates that the average calcium content of enriched bread in the United States is approximately 400 milligrams per pound¹⁶. Inasmuch as the recommended daily allowance of the Food and Nutrition Board calls for 800 milligrams for the average man, the amount supplied by bread can make a substantial contribution to the body's requirements. Bread and other grain products were second only to dairy products as a source of calcium in the average diet of families in 1955. Grain products accounted for 16 per cent of the calcium, compared with 64 per cent from dairy products¹⁷.

¹⁵ National Research Council Bulletin 110, (1944). p. 17.

¹⁶ U. S. Dept. of Agriculture. The calcium content of commercial white bread. Tech. Bull. 1055 (1952). p. 5.

K. Kulp, O. C. Golosinec, C. W. Shank, and W. B. Bradley. J. Am. Dietet. Assoc. 32: 331 (1956).

¹⁷ U. S. Dept. of Agriculture. Dietary Levels of Households in the U. S. Household Food Consumption Survey 1955, Rept. No. 6. p. 24.

The utilization of the calcium in white bread has been found to be very good^{18 19}. Most of the calcium in American bread is derived from the added milk used in making bread, the calcium salts—usually phosphates and sulphates of dough conditioners—and antimycotics such as calcium pro-

pionate. Mollsgaard *et al*²⁰, Denmark, carried out some extensive experiments on phytates in brown bread. By extending the time of fermentation, the phytates were broken down, thus preventing some of the deleterious effects of whole wheat bread on calcium utilization.

MILK IN BREAD

Non-fat dry milk has long been an important constituent of bread. It is generally used in amounts of approximately 4 per cent in standardized enriched white bread. In 1950 the Committee on Cereals sponsored a study to determine the value of various methods in use for evaluating the quality of non-fat dry milk for baking purposes. Much of the skim milk powder produced is unsuitable for bakery use and no accepted test of quality from this standpoint exists. In the manufacture of non-fat dry milk, it should be heated at 165° F. for 30 minutes or the equivalent before drying; otherwise it has a strong softening action on doughs which makes them difficult to handle with modern machinery.

The Harland-Ashworth Test for undenatured whey proteins remaining in the non-fat dry milk has been widely used to determine baking quality. In the collaborative study conducted by Bradley *et al*²¹, twelve laboratories ranked six samples of non-fat dry milk rather consistently on the basis of this test. However, the absolute differences of the results among laboratories precluded its use as a basis for specifications. Subsequently the Harland-Ashworth Test was standardized by workers at the University of Minnesota and rechecked in a collaborative study conducted by the American Dry Milk Institute²². It now appears suitable for specification purposes.

PROTEINS IN BREAD

Wheat proteins have been extensively studied, but there is very little information on the nutritive value of protein in bread made from 72 per cent extraction flour. The chief source of protein in bread is the wheat protein. Second in importance is the protein of non-fat dry milk solids added in breadmaking, and third, the protein of the yeast used in breadmaking.

It has been possible to improve the protein supply of the American people by additions of non-fat dry milk solids to bread. The amounts added generally range from

3 to 5 per cent. This addition supplies a number of important amino acids, such as lysine, valine, and methionine, which with the amino acids supplied by yeast greatly improve the flour proteins. Comparison of the pattern of man's amino acid requirements according to Rose with the pattern of the amino acid content of average enriched bread, using tryptophan as unity, reveals that bread protein is only slightly deficient in lysine and even less deficient in methionine to meet man's requirements²³.

¹⁸ C. Hoffman. Reproduction of animals on an exclusive diet of bread. *Ind. Eng. Chem.* **15**: 1225 (1923).

¹⁹ W. Hale. The role of bread in nutrition. *Ind. Eng. Chem.* **15**: 1221 (1923).

²⁰ H. Mollsgaard, K. Lorenzen, I. G. Hansen, and P. E. Christensen. *Biochem J.* **40**: 589 (1946).

²¹ W. B. Bradley, C. N. Frey, W. F. Geddes, and R. Jenness. A collaborative study of methods for evaluating the quality of non-fat milk solids for use in breadmaking. *Transactions, American Association of Cereal Chemists* **11** (3): 217 (1953).

²² S. Kuramoto, R. P. Choi, S. T. Coulter, and R. Jenness. Standardization of Harland-Ashworth Test for whey protein nitrogen (in preparation).

²³ F. N. Hepburn, E. W. Lewis, and C. A. Elvehjem. Amino acid content of wheat flour and bread. *Cereal Chemistr* **24**: 312 (1957).

WHOLE WHEAT VS. ENRICHED WHITE FLOUR AND BREAD

A comparison of the nutritive value of whole wheat flour with that of enriched flour is of interest but somewhat academic in relation to the enrichment program. Although whole wheat flour is sold side by side with white flour, the American public buys over 90 per cent of the total as white in preference to the brown. The same is true for white and brown bread. Moreover, most of the brown bread is made with white flour with a modest admixture of whole wheat. Actually, 97 per cent of the wheat milled for both family and bakery use goes on the market in the form of white flour. Obviously, improvement of the major product consumed is of greater importance to public health.

A study involving protein and vitamin utilization when various types of bread made from whole wheat, 70 per cent white flour, 85 per cent meal, and 70 per cent white flour enriched were employed was recently reported by Widdowson and McCance²⁴. Bread supplied 70 to 75 per cent of total calories. The subjects were 100 underfed German children in Wuppertal and 150 in Duisberg, 5 to 15 years of age, living in orphanages. At the outset they weighed 9 per cent less than American children of similar age and were 5 per cent shorter in stature. The children were separated into groups at meal time and each group given a different type of bread. The children had about 80 milliliters of milk

and 8 grams of animal protein per day.

The children in all groups began to improve at an equal rate. Their heights and weights went up faster than those of American children of comparable age. Previous undernourishment was responsible for the rapid gains when adequate food was supplied. At the end of a year there was still no difference among the groups, but the growth and increase in weight had slowed slightly. No difference had been demonstrated among the nutritional values of the various breads.

During the progress of the experiments, chemical analyses were made of the diets for thiamine, riboflavin, nicotinic acid, and iron. These showed that, owing to the large amount of vegetables present in the diet, the children, even those eating the unenriched flour, were getting as much of the B vitamins as they required. This flour, incidentally, carried almost 0.5 milligram thiamine per 1,000 calories, i.e. much more than was in American 70 per cent extraction flour. Thus it was clear that no nutritional deficiencies would be likely to occur among the different groups. The consumption of 8 to 11 grams of animal protein and the vegetable proteins supplied sufficient supplementation to the wheat protein to make it very effective. These experiments show that bread requires only modest supplementation with other foods to produce good nutrition.

CORN PRODUCTS ENRICHMENT

In the southern part of the United States, corn meal and corn grits are staple foods for large segments of the population. In Alabama, Georgia, Mississippi, North Carolina, and South Carolina, all degerminated corn meal and grits sold are required by law to be enriched to the same levels as flour. In South Carolina and Alabama, the enrichment of both degerminated and

whole corn meal is mandatory. Some custom grinding is exempt from this requirement, but the amount becomes less and less with the passage of time as the small mills give way to larger ones. In other southern states, voluntary enrichment of whole corn meal is practiced to varying degrees, depending on the effectiveness of the educational programs of state agencies.

²⁴ R. A. McCance and E. M. Widdowson. Studies on the nutritive value of bread and on the effect of variations in the extraction rate of flour on the growth of under-nourished children. Med. Res. Council. London, Spec. Rept. Ser. No. 287 (1954).

The corn meal and grits brought into the South from the midwestern corn belt is all of the degerminated variety and is almost entirely enriched. The proportion of corn products for human consumption in the South which originates in the Midwest to that which is produced and milled in the South varies considerably from year to year according to the yield from southern fields as influenced by rainfall and other climatic conditions. The tendency is for the southern crops to be used as long as they last and for the import from the Midwest to supply the balance. In an average year the corn of western origin used for human feeding in the South approximately equals that grown in the southern states. Hence, roughly half the corn for human use enters the market in an enriched state from the Midwest. An additional amount, not readily ascertainable with precision, is enriched at southern mills.

A survey of the extent of corn meal enrichment was made in the summer of 1957 through the cooperation of the Agricultural Extension Services or State Health Departments of 12 southern states. Spot checks were made in retail stores in different areas of each state as to the kind of corn meal sold and the extent to which each was enriched. The results showed that the percentages of corn meal sold which was enriched were:

	<i>Per Cent</i>		<i>Per Cent</i>
Alabama	95	North Carolina	74
Florida	31	South Carolina	100
Georgia	87	Tennessee	81
Kentucky	60	Texas	97
Louisiana	64	Virginia	26
Mississippi	78	West Virginia	55

A report was not obtained from Arkansas; otherwise the entire South where corn is an important human food was covered. Obviously the intensiveness of the survey

varied from state to state and the figures are probably not strictly comparable with one another. Nevertheless, the results are most encouraging in that they indicate that a high percentage of enrichment has been achieved in areas where corn consumption is highest. Recurrence of endemic pellagra is difficult to imagine if these practices are maintained at present levels. It is important that an educational program on the merits of corn meal enrichment be continued.

Corn grits were not included in the survey, but nearly all of this product is made by larger mills and nearly all is enriched. During the past decade the smaller mills have discontinued producing corn grits because more labor and equipment are required to produce grits than corn meal. The larger mills usually enrich and market good-appearing, clean grits in consumer-size packages which the homemaker prefers because washing before cooking is unnecessary. Quick-cooking grits, a rather recent innovation of the larger mills, has hastened the trend to eliminate washing. In 1946 many small mills produced a quality of grits that homemakers washed before cooking. For this reason, the Food and Drug Administration promulgated a standard for grits enrichment which included rinse resistance to protect those consumers who washed grits before cooking. In August 1957, a spot survey among 11 southern states revealed that 92 per cent of the homemakers no longer wash grits. The need for rinse resistance has therefore been eliminated by changes in milling and merchandising. The time may be appropriate for a change in the Federal standards for enriched grits by elimination of the requirement for rinse resistance. This would cut the cost of enrichment approximately in half. Further information on the program for the enrichment of corn meal and grits may be found in an article by Lease²⁶.

²⁶ E. J. Lease. Corn meal enrichment. *J. Am. Dietet. Assoc.* 29: 866 (1953).

MACARONI PRODUCTS ENRICHMENT

The enrichment of macaroni, spaghetti, and other alimentary pastes has been provided for by the issuance of standards²⁶. Since the customary Italian method of cooking most of these products in an excess of water leads to substantial loss of the nutrients, the minimum prescribed levels per pound are higher than those for flour: thiamine 4 milligrams, riboflavin 1.7 milligrams, niacin 27 milligrams, and iron 13 milligrams. A segment of the alimentary paste industry requested the issuance of standards and has been zealous in behalf of enrichment

standards and practice; another segment, perhaps of about equal size with respect to volume production, has been rather indifferent in the matter. Hence about half the total production is systematically enriched and half is not at the present time.

New York State has given some consideration to compulsory enrichment of alimentary pastes for the benefit of its relatively large population of Italian extraction. However, no legislative action has been taken by New York or any other state.

RICE ENRICHMENT

In Asia

In Asia, through the enterprise of Hoffmann-LaRoche, Inc., the first process for making a premix for rice improvement was devised in Manila, P. I., and later operated there and in Bangkok, Singapore, and Osaka. Rice grains heavily impregnated with thiamine, niacin, and iron were coated with an alcoholic solution including zein, abietic acid, talc, and fatty acids. The coating served the purpose of preventing loss of vitamins during the washing of rice prior to cooking. The premix was designed to be mixed at the rice mill with 199 times its own weight of ordinary white rice; the mixture provided the same levels of thiamine, niacin, and iron as does enriched flour in the United States. A requirement was that not less than 85 per cent of the nutrients be retained after a prescribed washing in cold water. Several years later a second process for making rice premix was devised and placed in commercial production by Merck & Company. This process employed the use of zein and confectioners shellac to achieve a premix having qualities similar to the one already in use. Both processes compete for the market. In all the Philip-

pine endeavors²⁷, fortification to U. S. levels with thiamine, niacin, and iron has been practiced, riboflavin being omitted. Nevertheless, the Filipinos have continuously and officially referred to the product as "enriched" rather than "fortified", the connotation of the former term being preferred for popular appeal.

During the Bataan Experiment, 1947 to 1950²⁸, enrichment was subsidized, but as attempts were made in 1950 and 1951 to extend the practice to larger populations in the rice-producing provinces of northern Luzon the retail price of rice had to be advanced about 1 per cent to cover the cost of enrichment. Local ordinances forbade the sale of unenriched white rice but these were poorly enforced. This was also true of a national law adopted in August 1952 under the leadership of Dr. Juan Salcedo, who had conducted the Bataan Experiment. There has never been substantial protest by consumers of the advance in retail prices. Rice millers have, however, protested, and this opposition has become well organized since about 1953.

The most obvious reason for this opposition is that the non-complying miller has a

²⁶ Federal Register 11: 7520 (1946).

²⁷ J. Salcedo *et al.* Artificial enrichment of white rice as a solution to endemic beriberi. Report of field trials in Bataan. *J. Nutrition* 42: 501 (1950).

²⁸ Better health through better rice. Williams-Waterman Fund, Research Corporation. New York, 1952.

competitive cost advantage of 1 per cent over the complying one. If everyone complied there would be no problem, but even a small number of noncompliers can undermine general compliance. A second basic reason is that, under a law which has been in effect for decades, rice millers, in common with all manufacturers, are supposed to pay a tax of 2 per cent annually on the value of their output. Since there are over 8000 rice millers in the Philippines, of whom at least 7000 are very small operators who keep no books, the law has never been enforced in the rice trade on more than 10 per cent of the output. Under-reporting of output has been universal and customary. If, however, the government supervises the distribution of premix it can readily calculate thereby the amount of tax actually due. This now appears to be the heart of the problem, though it was overlooked for several years. The present outlook is uncertain.

There is excellent public support for rice enrichment, and well organized protests in its favor have been made by about 50 leading civic, scientific, professional, labor, and women's organizations. It has been proposed in new legislation that rebate of a substantial fraction of the rice milling tax be made upon presentation by the miller of receipts for purchase of premix. There are now two strong commercial firms selling premix under government supervision. The way to success seems quite clear if a strong administration will throw its support to the new legislative proposal. As matters stand, little enforcement is now in effect except in the city of Manila, where the Director of Health has insisted that his own inspectors keep the markets under surveillance. Elsewhere only 5 to 10 per cent of the rice has been enriched at best, and this has declined in recent months.

In view of this history in a country where beriberi ranks second only to tuber-

culosis as a cause of death, it is obvious that effective cereal enrichment cannot be practiced except with skillful and dedicated government support. There is no hope for it via commercial competition in underdeveloped countries. The excellent support the milling and baking industries have given to bread and flour enrichment in the United States is impossible in most countries.

Rice enrichment is being initiated among the Chinese Nationalist Troops²⁹ in Formosa. This is regarded as a measure to provide for higher military fitness and not for general civilian adoption in the immediate future, although the latter would be advantageous³⁰. The principal obstacle to civilian use lies in the prevalent methods of cooking rice. One of these involves large volumes of cooking water which is usually discarded, with heavy consequent losses of vitamins if the rice were enriched. Another method involves quiescent steaming of the rice, which, with the types of premixes presently used, leads to heavy yellow staining by riboflavin of the grains of rice which lie adjacent to each premix grain. This renders more obvious the need for a premix having rinse resistance and containing riboflavin that will not cause spots. This offers a real challenge to the premix manufacturing technician, but some optimistic views are presently entertained.

In the application of enrichment for the troops, these difficulties can be overcome by supervision in the military kitchens. The formula prescribed for the troops in Formosa requires the following quantities of nutrients per kilo of rice:

	Mg.
Thiamine	2
Riboflavin	6
Niacin	30
Iron	20

The higher level of riboflavin prescribed is due to the prominence of riboflavin deficiency among the soldiers as well as

²⁹ C. F. Consolazio *et al.* Nutrition studies in the Far East II. Biochemical findings before and after enrichment of rice with vitamins. *Metabolism* 5: 219 (1956).

³⁰ N. Jolliffe and Ta-Cheng Tung. Nutrition status of the civilian population of Formosa. *Metabolism* 5: 309 (1956)

among civilians³¹. At present the needs of the troops are being cared for by the use of special enrichment wafers which are added to each lot of rice as it is about to be cooked. Premix plants are, however, in process of erection, and it is the intention to enrich in the future by mixing the premix with the rice in proper proportions.

In Korea, enrichment of rice for troops proved unnecessary because all the rice they use is undermilled³². Either undermilling or enrichment should be provided for the Korean civilian population.

In the United States

The average national per capita consumption of rice in the United States is too small to be significant with reference to the incidence of nutritional diseases in the entire population. However, southern Louisiana, the coastal regions of South Carolina and Georgia, and some sections of New York City are exceptional areas where rice consumption rises to 50 to 100 pounds per capita per year. Elsewhere in the nation, one finds isolated families who consume rice as one of their main staple foods. Puerto Rico (see page 14) and Hawaii are areas under the American flag where rice consumption is even greater.

South Carolina has taken the lead in rice enrichment in the United States by enacting a law that took effect July 1, 1956 prohibiting the sale of ordinary white rice. The law permits two types of enrichment. Packaged rice, which is clean and ready for use, must be labeled conspicuously, "To Retain Vitamins Do Not Rinse Before or Drain After Cooking", and may be enriched with non-rinse-resistant ingredients. Rice sold in bulk must be enriched by means which will give rinse resistance to the enrichment ingredients and must be conspicuously labeled "Do Not Drain After Cooking".

The nutritional improvement of rice in the United States to this date has not

usually included riboflavin. The South Carolina law declares riboflavin an optional ingredient. The Food and Drug Administration has used the word "enriched" in a very definite sense, and standards of identity for enriched bread, corn meal, grits, and other products include four constituents. The use of the word in connection with products that do not carry all four of the nutrients prescribed in the standards of identity for bread is not considered advisable. In view of the widespread use of rice in certain parts of the United States, the Committee on Cereals of the Food and Nutrition Board believed that action by the Food and Drug Administration to establish standards for nutritionally improved rice was desirable.

The following resolution was adopted by the Food and Nutrition Board at its meeting on October 27, 1956.

"The Food and Nutrition Board recognizes that certain segments of the population of the United States consume substantial quantities of milled rice, and that the nutritional improvement of rice would substantially better the nutrient intakes of these people. The Board has endorsed this general principle in May 1949 and May 1952, and hereby reaffirms its position regarding the desirability of nutritional improvement of milled rice, and further requests the Food and Drug Administration to consider the early establishment of definitions of identity for nutritionally improved rice."

Such action was taken by the Food and Drug Administration by publishing a proposal³³ which permits enrichment without rinse protection provided the label bears a conspicuous warning against washing before cooking. Riboflavin was proposed as a required ingredient.

Methods for enriching rice by non-rinse-resistant means have not been subjected to extensive commercial trial as yet. It has

³¹ Herbert Pollack. Nutrition studies in the Far East I. The problem and outline of the test protocol. *Metabolism* 5: 203 (1956)

³² Interdepartmental Committee on Nutrition for National Defense. Korea: Nutrition survey of the Armed Forces. April 1957.

³³ Federal Register 21: 10412 (1956)

been proposed that this be done by merely adding a powdered premix to the rice. Experience has shown that a powdered premix adheres to the surface of the rice grains surprisingly well under mechanical shaking as in transport of rice. However, maintenance of proper distribution of the premix in packaged rice must be fully assured by commercial experience.

All protests filed with the Food and Drug Administration on the standards for enriched rice proposed in December 1956³⁴ and revised in August 1957³⁴ have been reviewed and an order was issued³⁵ which took effect February 27, 1958, with certain corrections of wording and staying the effectiveness of the riboflavin requirement.

It remains to be seen how extensively and effectively rice enrichment will be carried out throughout the United States under these provisions.

Federal Standards for Enriched Rice, Effective February 27, 1958

	<i>Amounts per pound</i>	
	<i>Minimum</i>	<i>Maximum</i>
Thiamine	2.0 mg.	4.0 mg.
Niacin (or niacinamide)	16.0 mg.	32.0 mg.
Iron	13.0 mg.	26.0 mg.
Riboflavin*	1.2 mg.	2.4 mg.
Calcium (optional)	500.0 mg.	750.0 mg.
Vitamin D (optional)	250 USP	1000 USP
	units	units

* The requirement for riboflavin has been stayed. A public hearing will be held on the issue of whether the standard of identity shall include riboflavin as a required ingredient of enriched rice.

ENRICHMENT IN OTHER COUNTRIES

While the responsibilities of the Food and Nutrition Board are limited to the United States, the indirect interest of its members as well as that of American millers extends throughout the world. Hence a brief account of the extension of food enrichment to other lands is in order.

Cereal Enrichment in Latin America

Cereal enrichment in Latin America is in general handicapped by some of the same factors as in Asia, namely, the lack of data on incidence of deficiency diseases, indifference of governments to public health problems unless they are politically weighted, and shortage of dollars with which to buy vitamins.

In addition to these, there are many complexities arising from the fact that the staple cereal is sometimes wheat, sometimes rice, sometimes corn, or even some other starchy product such as cassava. In some areas all these products are found side by side in the markets, each preferred by some element of the population. In general, Latin Americans do not use cereals in the same high proportions as do rice-eating Asians.

Nevertheless, the total consumption of refined cereals, i.e., white flour, white rice, and cassava, represents a substantial part of the total diet. The situation is made more critical by a rather large consumption of corn which by nature is low in niacin and tryptophan. A tremendous nutritional advantage, much greater than that achieved in the United States, would therefore result from appropriate enrichment.

The Indian populations of Central America and the Pacific and Andean areas largely use corn as their staple grain. Corn is, however, produced mainly in small patches and processed in the home. There is a minimal industrial production of corn, hence factory-type enrichment does not apply. Home enrichment is out of the question.

There is a relative absence of pellagra in Guatemala and Mexico in spite of a very high corn consumption. Until the scientific basis for this situation is understood, sound advice cannot be given regarding improvement of the nutritional quality of the grain supply for these countries. A limited amount of tortilla flour is being factory produced on the outskirts of Mexico City and enrichment of this is contemplated. Perhaps this

³⁴ Federal Register 22: 6887, 6993 (1957)

³⁵ Federal Register 23: 1170 (1958)

practice will be extended for the benefit of city dwellers in the future.

White flour in the form of bread and white rice as the boiled grain are commonly used by Spanish-speaking Latin Americans. In general, white bread is used more widely than white rice. In Chile and in northern Brazil, little rice is consumed. In the lowlands of Colombia and of Ecuador and in the southern part of Sao Paulo, Brazil, rice outranks white bread in importance.

The statistics of production versus import of both these products are extremely variable from country to country. Ecuador and Honduras, for example, produce a surplus of rice; all other Latin American countries import at least a portion of their supply. Most Latin American countries produce some wheat, sometimes at fabulous costs—as in upland Colombia. Some additional supplies are imported, partly as wheat to be milled locally, partly as flour for immediate sale to homes and bakeries.

Because of these complexities, any proposed cereal enrichment laws must take into account enforcement both in local mills and at ports of entry. Often there are also conflicts of interest between local producers and importers. There are problems enough to deal with when only a single cereal is concerned and when it is all of domestic origin, as in the Philippines. One can imagine the difficulties when both rice and wheat are involved and when part of each is imported, some in rough form, some in finished form. This is often the situation in the Latin American scene.

For Latin America it is simpler to enrich flour than rice. Enrichment of flour is less expensive because protection against washing loss is not necessary. Since all North American millers enrich their flour, the Latin American buyer can get it simply by ordering it wherever flour importation is economically in order. In contrast to the flour millers, the North American rice millers have been persistently reluctant to enrich; the Latin American buyer must

demand enriched rice. A genuine popular demand for enriched rice in Latin America may ultimately prevail, but at present the Latin American buyer must have strong convictions and be prepared to fight for them.

In view of the current situation, there is no immediate prospect of general rice enrichment in any Latin American country. However, with respect to white flour the prospect is much better. Chile, which consumes mainly wheat, long since took the lead in this under the guidance of Chilean statesmen and public health workers. Legislation following U. S. standards took effect January 1, 1954 and, according to latest information, is proceeding quite successfully—this in spite of dollar shortage problems under which Chile suffers.

Enrichment of both domestic and imported flour is required by law in San Salvador, and similar legislation is under active consideration in Guatemala, Honduras, Nicaragua, Costa Rica, and Panama. The law proposed in Panama also covers rice. Flour legislation has been discussed in Mexico, Ecuador, Colombia, and Peru, but at present action seems remote. In Venezuela, all flour is imported from the United States. There is no dollar shortage and the government has lush reserves of oil royalties. Flour and rice enrichment have both been discussed for three or four years without definite action.

In Brazil, the State of Sao Paulo has long been eager for flour enrichment and has an interest in rice enrichment as well. Dollar shortage problems and want of sympathy on the part of the National Government at Rio de Janeiro have delayed effective decision.

The idea of enrichment of rice and flour has been planted widely throughout Latin America and may grow to major proportions in future years.

Rice Improvement in Puerto Rico

On the insistence of a shrewd and civic-minded governor and supported by the work of Dr. Lydia Roberts, the Puerto Rico

legislature adopted compulsory rice fortification in May 1951. Many United States rice millers protested, but Puerto Rico enforced the law without the slightest difficulty³⁶. U. S. standards for enriched cereals are followed except that riboflavin is omitted.

All Puerto Ricans have been getting fortified rice for the past five years. The result was accomplished so quietly that most Puerto Ricans are not even aware that their health is protected by a different form of rice. Since the per capita consumption is about 140 pounds of rice per year, the vitamin and iron contribution from fortification is substantial. However, Puerto Rico's problem was quite simple because all the rice used is imported. Furthermore, all the rice imported by Puerto Rico comes from the United States and passes in interstate commerce and is therefore subject to the jurisdiction of the United States Food and Drug Administration. Falsely labeled rice is subject to seizure enroute. Hence routine inspection at the ports of entry is all that is required of Puerto Rican authorities.

Enrichment in Cuba

Great efforts have been made during the last eight years by the Fundación de Investigaciones Médicas, Havana, to educate the people to demand enriched rice. Much of this educational endeavor has been futile because it has not been possible to maintain even token quantities of enriched rice continuously on the Cuban market. One cannot effectively teach people to use a given product unless they can buy it in a nearby market.

Compulsory enrichment laws for flour and rice have been framed and even passed by the legislative body, but the presidential signature approving the measures was not obtained. Cubans eat on an average 80 pounds of white flour and 120 pounds of white rice per year. With so much refined cereal in the Cuban diet, enrichment is imperative.

Food Enrichment in Europe

In France, food enrichment is substantially prohibited by the restriction of the sale of fortified foods to pharmacies. Switzerland, Holland, Belgium, Italy, and some others permit the addition of vitamins to foods at levels approved by the governments. Claims for beneficial effects must have prior approval of local health authorities. Actual practice of food fortification under these circumstances is negligible except perhaps as a token of further reconsideration.

Germany has no compulsory food fortification. Most margarine is fortified, but only negligible amounts of flour are enriched. The sale of vitaminized foods is permitted by regulation dating from 1942, but the practice is limited except with respect to margarine.

Scandinavian Food Enrichment Programs

The Scandinavian countries have welcomed the food fortification principle. Denmark leads in this, requiring fortification of all white flour in a manner resembling that prevailing in the United States. Niacin is not required, but calcium is. Riboflavin levels are about twice as high as those in the United States. Denmark also requires the fortification of margarine with 20 I. U. of vitamin A and 0.5 I. U. of vitamin D per gram, levels similar to those in the United States.

In Sweden, neither flour nor margarine fortification is required by law. However, it is followed voluntarily in the major part of the production of flour and of substantially all the margarine. Vitamins A and D are added to margarine. Norway requires a similar fortification of margarine, but flour enrichment is little practiced.

British Policy on Nutritional Improvement of Staple Foods

Great Britain has been the scene of extensive debate on the principle of food fortification. As early as July 1940³⁷ the British Government decided to fortify all flour and

³⁶ Lydia J. Roberts. Enriched rice for Puerto Rico. *Rice Journal* 54(8):9 (1951)

³⁷ T. Moran and J. C. Drummond. *Nature* 146: 117 (1940)

bread with thiamine but never actually carried it out for the major part of the production. Because of war conditions, British thiamine production was delayed and has not yet risen to substantial levels. Incidents in Parliament gave rise to the suspicion that vitamin manufacturers were destined to reap inordinate profits. Nutritional leaders favored the milling of long extraction flour, a practice disliked by the millers and therefore unsuccessful until it was made compulsory in April 1943. The addition of 7 ounces of calcium carbonate per 280-pound sack of 80 to 85 per cent extraction flour was required. The production and use of this type of flour was maintained by government subsidy until September 29, 1956.

Since August 1953 white flours have been permitted, but for such flours an addition of 1.65 milligrams of iron, 0.24 milligram of thiamine, and 1.60 milligrams of nicotinic acid per 100 grams of flour, as well as 14 ounces of calcium carbonate per 280-pound sack, is required by law. Such flours do not enjoy government subsidy and sell at a higher price. As a consequence, they represent only a small volume in comparison with the long extraction "National Flour". Since 1954, fortification of all margarine with vitamins A and D is required.

The early decision of British food authorities to encourage long extraction flour seems to have been justified by the threatened submarine blockade. Great Britain needed to maintain substantial food stocks in its island fortress, and the cereal could be shipped and stored more economically as grain. Grist was needed for the existing British mills to aid in conserving foreign exchange. The mill byproducts were needed as cattle feed. Furthermore, the people, with their backs to the wall, could be persuaded to lay aside their preference for white flour as a means of saving their country. The continuation of this policy in the postwar period may also have been justifiable as an economic measure to conserve foreign exchange.

Since the war closed, there has been

agitation by the milling and baking industries of Great Britain for abandonment of the subsidy on the national long extraction flour and encouragement of artificial enrichment in its place. As a result of the Cohen Report³⁸, this action was taken on September 29, 1956. The levels of enrichment have not been changed, and it is reported that enrichment has been widely adopted in commercial practice.

Enrichment in Canada

After the commencement of the enrichment program in the United States, Canadian millers and bakers realized the opportunity it provided for making flour and bread reliable sources of the B vitamins and thereby perhaps helping to arrest the downward trend of bread consumption. At a conference of millers, bakers, nutritionists, and government officials, called in July 1941 to discuss a program of flour and bread improvement, the Department of Pensions and National Health expressed strong opposition to fortification of flour and favored the production of long extraction flours. Subsequently, the Department of Pensions and National Health issued an order giving specifications for two kinds of high vitamin flour, namely "Vitamin B Flour" to contain not less than 550 I.U. of thiamine per pound, and "Vitamin B White Flour" to contain not less than 400 I.U. per pound. The order made it an act of adulteration to add synthetic thiamine to flour and prohibited the use of the term "vitamin" in labeling or describing any flour or bread other than the two types of "Canada Approved". These flours were introduced on a voluntary basis. The Vitamin B White Flour (Canada Approved), representing from 77 to 80 per cent of the wheat kernel, was inferior to standard grades in baking quality, and sales of the flour were insignificant apart from government purchases. In an attempt to provide a flour of higher and more uniform baking quality, the specifications for the "Vitamin B White Flour" were amended in 1943 to provide a minimum thiamine con-

³⁸ Report of the Panel on Composition and Nutritive Value of Flour, presented to Parliament May 1956. Sir Henry Cohen, Chairman, London, H. M. Stationery Office Omd. 9757.

tent of 340 I.U. per pound and a maximum ash limit of 0.595 per cent. The adoption of these new standards did not materially increase its acceptance. The quantities of enriching ingredients per pound are:

	<i>Minimum</i>	<i>Maximum</i>
	mg.	mg.
Thiamine	2.0	2.5
Riboflavin	1.2	1.5
Niacin	16.0	20.0
Iron	13.0	16.5
Calcium (from bone meal)	500.0	650.0

In 1944 enrichment of all flour imported into Newfoundland was made compulsory by the Government of Newfoundland. When Newfoundland entered confederation with Canada in 1949, it was agreed that compulsory enrichment of flour would continue in Newfoundland, although enrichment was illegal under the Food and Drug Act of Canada. In 1953 the Food and Drug Act was modified to permit flour enrichment in any part of Canada.

PUBLIC HEALTH BENEFITS OF ENRICHMENT

The Newfoundland Report

Having reviewed the history of enrichment, its factual basis and the means whereby it has been introduced, it remains to evaluate the success achieved in terms of public health and what remains to be done. Experience in Newfoundland still affords the most tangible evidence of the effect of enrichment on public health.

The Newfoundland Survey³⁹ showed broad aspects of improvement in public health following enrichment of all bread and flour for four years. Total mortality fell from 12.1 to 10.5 per 1000 population, and infant mortality fell from 102 to 61 per 1000 births. Deaths from tuberculosis dropped 25 per cent. Although other factors also contributed to the improvement in health, there was a selective decrease in those signs of malnutrition which enrichment of bread and flour would be likely to correct. In spite of educational efforts to correct ascorbic acid deficiency by increasing the amount of vitamin C in the diet, the incidence of ascorbic acid deficiency had not improved.

Fortification of margarine with vitamin A and enrichment of flour with thiamine,

riboflavin, niacin, iron, and calcium were introduced in Newfoundland in 1944. By 1948 the signs of malnutrition had become less prevalent, and much of the apathy and listlessness which characterized the population in 1944 was no longer evident. There were also favorable changes in mortality statistics.

In view of the results reported by Moore, and the studies on Newfoundland reported by Wilder *et al*⁴⁰, one is led to the view that the Newfoundland diet must have had deficiencies which were definitely corrected by the addition of thiamine, riboflavin, niacin, and iron.

Benefits in the United States

A 1943 publication of the Food and Nutrition Board⁴¹ contained the statement that "all the evidence from numerous surveys over the past ten years to the present among persons of all ages in many localities is without exception in complete agreement that inadequate diets were widespread in the nation." This view was based on findings in clinics of the nation and confirmed by dietary surveys made during the decade 1930-1940. The purpose of this review is

³⁹ W. R. Aykroyd, N. Jolliffe, O. H. Lowry, P. E. Moore, W. H. Sebrell, R. E. Shank, F. F. Tisdall, R. M. Wilder, and P. C. Zamecnik. Medical resurvey of nutrition in Newfoundland, 1948. *Can. Med. Assoc. J.* **60**: 1 (1949)

Grace A. Goldsmith, W. J. Darby, Ruth C. Steincamp, Anne S. Beam, and Ellen McDevitt. Resurvey of nutritional status in Norris Point, Newfoundland. *J. Nutritio* **40**: 41 (1950)

⁴⁰ R. M. Wilder. Recent nutrition survey in Newfoundland; significance of the findings. Presented at the Conference on Nutrition in Newfoundland, sponsored by The Nutrition Foundation, Inc., April 4, 1949.

⁴¹ National Research Council Bulletin 109. Inadequate diets and nutritional deficiencies in the United States. Washington, 1943.

to summarize the evidence as to how far those conditions have been remedied by the enrichment program and other factors.

For example, a study by the late Dr. Philip C. Jeans and his associates⁴² shows the contribution of cereal enrichment to the diets of some 400 pregnant women of low income in Iowa. In each of the five groups into which subjects were classified, cereals provided the major part of the daily thiamine intake and the mean intake for each group was ample. The report states: "In Iowa, practically all cereal foods and flours are enriched; therefore, the intakes of thiamine, iron, and riboflavin were all far higher than would be possible with unenriched white flour products. Bread alone supplied from 15 to 31 per cent of the thiamine; from 40 to 50 per cent was provided by cereal foods. White flour products predominated heavily in the diets; therefore, had the bread and flour been unenriched the thiamine intake would have been cut by 30 to 40 per cent and many women would have been close to actual deficiency." The conclusion of the authors is typical of the value which nutritionists have placed on the enrichment program: "The fact that the bread is enriched has certainly aided the majority of women re-

ported in this study from having even greater deficiencies in iron, thiamine, and riboflavin. The usefulness of the enrichment program is obvious. It appears that, in addition to the present program, enrichment of bread with a greater amount of non-fat dry milk solids also would improve the nutrition of these women and their families by automatically increasing their intake of calcium and animal protein."

From the clinics serving the poorer elements of the population comes evidence that B vitamin deficiencies in the United States have largely disappeared since 1942. This evidence is confirmed by Jolliffe⁴³, Bean, Vilter, and Blankenhorn⁴⁴, the Army Medical Nutrition Laboratory⁴⁵, and by Darby, Goldsmith, Sebrell, Spies, Wilder, and others by personal communication.

The observations of the Medical Nutrition Laboratory are perhaps particularly significant. That study dealt with alcoholic derelicts of the streets of Chicago who were in no position to benefit from increased employment such as would be influential in improving the diets of other low income groups. Jolliffe has also called attention to the fact that there has been no corresponding decrease in the incidence of scorbutic symptoms observed in these clinics.

DIETARY TRENDS IN RELATION TO ENRICHMENT

Dietary trends in the United States are periodically reviewed by the Department of Agriculture⁴⁶. The latest (1955) of these reviews shows new trends and habits in buying and eating foods. One-fifth of the meals are now eaten outside the home. Ready-processed foods represent a large

proportion of the purchased foods. There is thus a continuing responsibility for the purchaser to keep in mind the nutritional balance of the foods served in the home.

A nation-wide study of diets of urban families in 1948⁴⁷ showed that these families purchased about a quarter of a pound

⁴² P. C. Jeans, M. B. Smith, and Genevieve Stearns. Dietary habits of pregnant women of low income in a rural state. *J. Am. Dietet. Assoc.* **28**: 27 (1952)

⁴³ N. Jolliffe. Conference on corn enrichment. Clemson College, Clemson, S. C., 1947.

⁴⁴ W. B. Bean, R. W. Vilter, and M. A. Blankenhorn. *J. Am. Med. Assoc.* **140**: 872 (1949)

⁴⁵ Army Medical Nutrition Laboratory. Report No. 71 (1950)

⁴⁶ Nutritive value of the per capita food supply, 1909-1945. Institute of Home Economics, U.S. Dept. Agriculture, Washington, 1946.

⁴⁷ 1948 food consumption surveys. Institute of Home Economics. U.S. Dept. Agriculture, Washington, 1951.

Household food consumption surveys 1955. Reports No. 1-No. 10. Institute of Home Economics, U.S. Dept. Agriculture, Washington, 1956.

⁴⁸ Nutritive content of city diets. Special Report No. 2. U.S. Dept. Agriculture, October 1950.

(5 slices) of bread per individual per day, of which 86 per cent was white enriched. This amount of enriched bread contributed about 315 calories, 9.6 grams protein, 3.6 grams fat, 90 milligrams calcium, 2 milligrams iron, 0.28 milligram thiamine, 0.18 milligram riboflavin, and 3.5 milligrams niacin. The effect of the flour and bread enrichment on the nutritive value of the family diets is shown below for the entire sample and for two income classes. The contribution is significant and is largest where most needed—among the low income groups.

*Annual Income Addition to Diet Due to Enrichment
Class (per cent)*

	<i>Iron</i>	<i>Thiamine</i>	<i>Riboflavin</i>	<i>Niacin</i>
All classes	12	16	3	13
\$1000 to \$2000	14	20	5	15
\$5000 to \$7500	10	13	2	9

Bread and flour, according to Phipard⁴⁸, constitute a larger share of the diets of low income groups. At 17.2 cents per pound, 5 cents invested in bread purchased the following proportions of the NRC adult daily allowances: thiamine, 20 per cent; iron, 19 per cent; niacin, 17.5 per cent; riboflavin, 12 per cent; and calcium, 13 per cent. If the bread had not been enriched, the thiamine, iron, niacin, and riboflavin contributed would have been insignificant.

The summaries based on the survey of

food consumption of households in the United States in 1955⁴⁹ point out that there has been an increase in protein and niacin consumption but a slight decrease in ascorbic acid, due to a shift in emphasis on fruits and vegetables. Other nutrients show no great change compared with the results shown in the survey of 1948. There is a high level of food consumption in the United States, but efficient distribution has not been achieved. The enrichment of staple foods such as flour, bread, rice, and corn is a positive step toward wider distribution and consequently a broader base for consumption of nutrients essential to good nutrition.

Long-range trends since 1909-13 are illustrated in charts 1⁵⁰ and 2⁵¹. Particularly noteworthy is the downward trend of consumption of cereal products as shown in chart 2. Maintenance of per capita intake of the enrichment nutrients, particularly thiamine, in spite of this decline is strikingly illustrated in charts 3⁵² and 4⁵⁰.

The enrichment program has evidently accomplished much that is constructive and beneficial to public health. However, this summary shows the need for continued education to inform people as to how to obtain good diets and how important it is to bring their food habits in line with the principles of good nutrition.

⁴⁸ Bread facts for consumer education. U.S. Dept. Agriculture AIB 142, November 1955.

⁴⁹ Food consumption of households in the United States. U.S. Dept. Agriculture. Household food consumption survey, 1955. Report No. 3.

⁵⁰ Faith Clark. Family spending for food. *Cereal Science Today* 1: 155 (1956)

⁵¹ Agricultural Research Service. Neg. 58 (4)-5543, 1958.

⁵² Agricultural Research Service. Neg. 58 (4)-5542, 1958.