

THE COMPARATIVE NUTRITIONAL VALUE OF WHITE  
AND WHOLE WHEAT FLOUR.\*

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For a number of years, nutrition investigators have been establishing a series of facts that should revolutionize our dietary habits to a greater extent than is as yet apparent. The existence of accessory food factors is no longer a matter of theory, but of accepted fact. Although vitamins await chemical isolation, we know that their inclusion in the diet of experimental animals produces a normality of growth such as cannot be obtained by any purified synthetic diet composed of carbohydrates, proteins, fats, and minerals in whatever variety of proportions. Yet in many instances we have failed to realize fully the advantage of natural foods over those which have undergone refining and vitamin-killing processes.

No other class of foods undergoes so great a change in the process of preparation as do the cereal grains. How large a part these hold in our daily diets is often not appreciated. Bread in its various forms, crackers, breakfast foods, rice, and other cereal foods, individually or collectively, form many of the dishes used in modern cookery. Since we eat so largely of cereals, our best source of the B-vitamin, we surely should suffer no deficiency of this factor, the lack of which results in stunted growth, loss of appetite, debility, and the specific disease, beri-beri. But, alas modern fashion has decreed that our bread must be fine and white in texture, that our rice must be highly polished, that our breakfast foods must be refined and easily cooked. For centuries, dark bread was considered a sign of poverty, food only for the peasantry; in oriental countries, unpolished rice is consumed only by the poorest of the natives; whole grain cereals, containing the entire kernel including the seed germ, have been considered food fit only for animals, not for civilized man. Yet the peasants maintain a degree of health unknown to their wealthier lords living upon refined foods; the poor oriental, who must of necessity mill his rice by hand, never suffers from beri-beri, an affliction of those who live upon the polished rice from commercial mills; and the animal

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fed a whole grain ration attains a rapid growth and healthy vigor unexperienced by others fed a more artificial diet.

Our modern processes of milling wheat, our most commonly used cereal, eliminate the germ and most of the superficial layers of the kernel. Almost 30 per cent. of the original grain is omitted from "patent flour," and the deplorable fact is that this discarded 30 per cent. contains practically all the vitamin element and about 75 per cent. of the mineral constituent of the cereal.

In order to demonstrate the result of thus impoverishing our cereals, the following experiment was conducted in our nutrition laboratory at the University of Oregon Medical School. Three litters of white mice were used, containing 28 animals. One-half of each litter was given a chemically adequate and balanced diet containing "best patent unbleached flour" as their only source of starch, and of vitamin B. The other half of each litter was given the same basal diet, the "patent flour" being replaced with a whole wheat flour containing the entire kernel. It is impossible to obtain in the market a standard 100 per cent. whole wheat bread, as most bakers, even in making so-called "whole wheat bread," do not incorporate a high or even a constant percentage of whole wheat flour. Many bakers use a commercial graham flour which is a combination of bran and shorts and other by-products from the white-flour mills. Hence in our diets, we used the ground whole wheat and the bolted white flour instead of commercial brands.

Seventy-three and a half grams of dry white flour and the same amount of the whole wheat flour were carefully weighed and each stirred into sufficient boiling water to make a thick mush. The cooking was continued for one hour in double boilers. To each of these portions were added 18 grams of purified casein, six grams of butter (for the A-vitamin), and 2.5 grams of salt mixture (McCollum No. 185). This gave us a diet of constant composition, adequate in protein, fat, carbohydrate, minerals and vitamin A, and one in which the only variable factor was the B-vitamin.

The average weight curves of each of the two groups (Fig. 1) strikingly illustrate the effect that milling of cereals has upon growth. After four weeks of the experiment and previous to any deaths, the gain per individual on the white flour diet was 2.5 grams or .625 grams per week. During the same period, the average gain per individual on the whole wheat diet was 9.8 grams or

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2.45 grams per week. In other words, the mice on whole wheat flour gained almost as much in one week as did the mice on white flour in four weeks. The whole wheat flour was four times as efficient in promoting growth as white flour.

The amounts of food consumed by the two groups was, however, unequal. At the beginning the same weight of food mixture

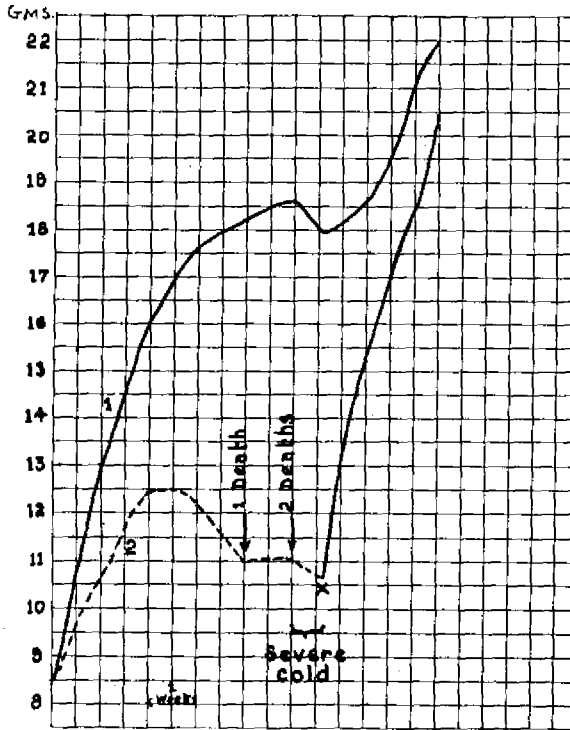


FIG. 1. Comparative growth curves of white mice on whole wheat flour and white flour. Curve 1. Average weight of 14 individuals, 73.5 per cent. of whose ration consisted of whole wheat flour. Curve 2. Average weight of 14 individuals, 73.5 per cent. of whose ration consisted of patent unbleached white flour. At "x" the cereal was changed to whole wheat flour and the average was taken for the 11 remaining individuals.

was offered to each group. Those on whole wheat consumed an average of 200 grams per day, but those on white flour ate scarcely 100 grams. This loss of appetite is a marked symptom of vitamin B deficiency whenever found. Allowing for the difference in the relative amounts of food actually consumed by the two groups, the

whole wheat cereal is still twice as efficient as the white flour. When the white flour group was changed to whole wheat, their appetites improved with the first meal, so that they ate the entire 200 gram portion. They attacked the whole wheat food ravenously, although the white flour ration was still in their cage.

Other differences were likewise noted. While, without exception, the mice on the whole wheat retained throughout the experiment their soft, pure white fur, by the end of the first week, those on white flour had fur of distinctly yellowish appearance, matted into coarse greasy clumps. (Fig. 2.) The general indication was that of a dysfunction of the glands of the skin. The mice on the whole wheat diet were at all times happy, contented, and normally active. Those on white flour became very restless, trying in every

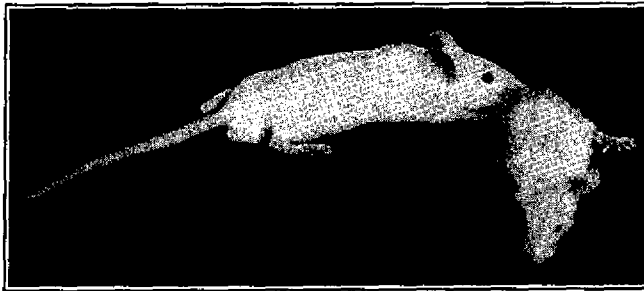


FIG. 2. Photograph showing the relative size and hair condition of mice on white and whole wheat flour. The mouse in the foreground was for 5 weeks on a diet containing 73.5 per cent. of white flour; the mouse in the background was during the same period on a diet containing 73.5 per cent. of whole wheat flour.

possible way to get out of their prison. It was almost pitiful to see them cling to a hand placed in the cage or try to jump out when the cover was removed.

During the fifth week of the experiment, three mice on the white flour died very suddenly. Several were dragging their hind portions, unmistakably typical of polyneuritis. In an attempt to save these animals, and to demonstrate that their ill health was a matter of diet and not due to some other factor, whole wheat flour was substituted for the white flour of their previous diet. The paralytic condition cleared up within a day; the condition of the fur returned to normal, the nervousness disappeared, and a marked increase in weight resulted, as shown in the graph.

The resistance of the white flour group was markedly lowered

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in respect to temperature changes. During the sixth week of the experiment our city experienced a bit of real winter. After the first cold night, while the mice on whole wheat flour were as lively and active as ever, several of the ones on white flour were stiff in the bottom of the cage and all were huddled together, shivering. They recovered, however, when placed near a radiator. This warm corner was reserved for both groups during the rest of the cold spell in order to forestall any further serious consequences. Both groups, as shown in the graph, suffered a loss in weight at this time.

Not only is whole wheat of advantage from a health point of view, but likewise from an economic standpoint. The white flour mice ate one-half as much as the other group and gained only one-fourth as much. In order to make a gain commensurate with that of the latter, the former would have had to consume twice the amount of food, if such a thing were possible. When one considers that the cost of the white flour was 5.5 cents per pound, and that of the whole wheat flour was 7.4 cents per pound, the economic value of the whole wheat is readily apparent. Since the mice received the same value from one-half pound of whole grain cereal as from a whole pound of white flour, the actual cost was 5.5 cents for white flour and 3.7 cents for the whole wheat. For one gram gain in weight on the whole wheat diet, the total cost of food was 2.7 cents; for one gram gain on the white flour ration, the cost was 4.9 cents. The use of white flour in a diet is therefore 80 per cent. more expensive than whole wheat. (Fig. 3.)

FIGURE 3. *Superiority of Whole Wheat Flour.*

Flour	Market cost per lb. cts.	Actual cost per lb. cts.	Cost per unit gain in weight cts.
White .....	5.5	5.5	4.9
Whole wheat .....	7.4	3.7	2.7

Hence white flour is 80% more expensive than whole wheat.

SUMMARY.

1. White mice on a properly balanced diet containing whole wheat flour increased in weight four times as rapidly as did their

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brothers on a chemically identical diet in which the whole wheat was replaced by white flour.

2. Whole wheat improves the appetite so that the mice receiving it consumed twice the food eaten by those on white flour.

3. The gain in weight per unit of food consumed was doubled by using the whole wheat.

4. From the standpoint of health and life, whole wheat is incomparably superior. The mice on it were healthy, happy and contented. Many of those on white flour developed paralysis and three died.

5. Those on whole wheat had much greater resistance to cold weather.

6. The fur of the white flour group became clumped and abnormally oily.

7. When the white flour mice were given the whole wheat diet, they rapidly regained weight, their fur became normal, and they seemed contented, thus furnishing positive, as well as negative, proof of the superiority of whole wheat.

8. The dietary difference between white and whole wheat flours is largely a difference in vitamin B. Modern milling removes this necessary food factor.

9. This experiment demonstrated that the cost of food per gram of weight gained was 4.9 cents on a diet containing white flour and 3.7 cents on one containing whole wheat. For nutritional purposes, whole wheat flour is worth nearly twice as much as white flour.

The presentation of facts such as these to parents and teachers wins their support to scientific feeding and will lead, we trust, to healthier and happier future generations.

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