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The Nutritive Value of Single Foods

(egg/meat/enriched cereals/rats/90-day test)

ROGER J. WILLIAMS, JAMES D. HEFFLEY, AND CHARLES W. BODE

Clayton Foundation Biochemical Institute and Department of Chemistry, The University of Texas at Austin, Austin, Texas 78712

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ABSTRACT **This is an extension of an earlier study in which we found that while commercial "enriched" bread alone would not support the life of weanling rats in a 90-day test, enrichment could be updated at low cost, with the result that rats consuming the improved bread alone lived during the test period and grew seven times as fast. Prominent nutritionists criticized this study on the basis that bread is not eaten alone and that other single foods are likewise deficient. It was stated: "the experiments you performed would have given the same or similar results if you had begun with milk, eggs, meat, or any other food".**

Skepticism regarding this statement led to experimental trials in which milk, meat, eggs, and several other foods, including breakfast cereals, were fed singly to groups of animals. Eggs proved to be a remarkably complete food, and milk exhibited about the same excellence until the iron deficiency became evident after about two months. "Enriched" breakfast foods and macaroni were highly deficient and could be improved greatly by supplementation.

As an outgrowth of this study, we are developing a method of biological testing which is incomparably better for evaluating foods than consulting food composition tables. On the basis of the tabulated data alone one might conclude that "enriched" puffed rice, for example, is only slightly inferior nutritionally to eggs. Our experiments have shown this assumption to be grossly in error.

Our total environment includes not only the air we breathe and the water we drink but also the food we consume. These external environmental factors derive their importance from the fact that they do not remain external; they are the materials which enter into the internal environments of our body cells and tissues.

We should have great concern for the *quality* of the internal environments in which our cells and tissues function because, as in the entire biological world, these environments can vary all the way from those which barely keep cells alive, up through hundreds of gradations to levels supporting something like optimal performance.

In a forthcoming well-documented book (1) a reasonable case has been made for the proposition that, aside from infections, the poor internal environments we commonly furnish our cells and tissues is the major cause of disease. There are roughly 40 nutritional items which act as a team (each one indispensable) in the environment of healthy cells. Ideally then, each mouthful of food should not only furnish fuel but also should contribute in a positive way to building up our frequently impoverished internal environments. This is important all through life, particularly so during the developmental stage.

With this perspective and background we recently tested the possibility that commercial "enriched" bread might be materially improved at small cost (2). Bread is an unusual food because it is a staple which often contributes each day a substantial part of the diet, particularly among those of low income.

To test this possible improvement, we fed 64 weanling rats of four different strains "enriched" bread alone for 90 days; for comparison, matched groups were fed a modified bread to which we had added small amounts of vitamins, minerals, and one amino acid, lysine. The materials added cost a fraction of a cent a loaf.

Without questioning the desirability of diversity in nutrition, or assuming that the nutritional needs of rats are the same as those of human beings, we came to the conclusion that commercial "enriched" bread can be greatly improved for all mammals, because in "enriched" bread the chain of nutrients is very incomplete. The experimental evidence supporting this conclusion is that the rats lived on the modified bread and grew on the average seven times as fast. On the "enriched" bread, as expected, the animals, on the average, failed to live throughout the test period.

These experiments were criticized mainly on the basis that bread is not eaten alone and should not be tested by itself. It was contended that other foods are also deficient, but when eaten in combination are satisfactory. It was stated: "The experiments you performed would have given the same or similar results if you had begun with milk, meat, eggs, or any other food".

Skepticism regarding this statement led us to carry out the experiments with single foods, which are described below. As a result of these experiments our work has turned in important and unexpected directions.

EXPERIMENTAL

Weanling Holtzman male rats in individual cages (12 in each group) were fed exclusively each of the following common human foods: (*1*) pasteurized vitamin D whole milk; (*2*) hamburger meat cooked 20 min at 350°F; (*3*) all-meat commercial, precooked frankfurters; (*4*) fresh eggs steamed 10 min in a shallow pan; (*5*) canned tuna fish; (*6*) commercially roasted peanuts; (*7*) shredded-wheat breakfast cereal; (*8*) wheat-flakes breakfast cereal (this was commercially "enriched" with thiamin, niacin, and iron); (*9*) puffed rice breakfast cereal (this was commercially "enriched" with thiamin, niacin, and iron); (*10*) macaroni, boiled 9 min (this was commercially enriched with thiamin, niacin, riboflavin, and iron).

For comparison the following items were fed (*11*) shredded

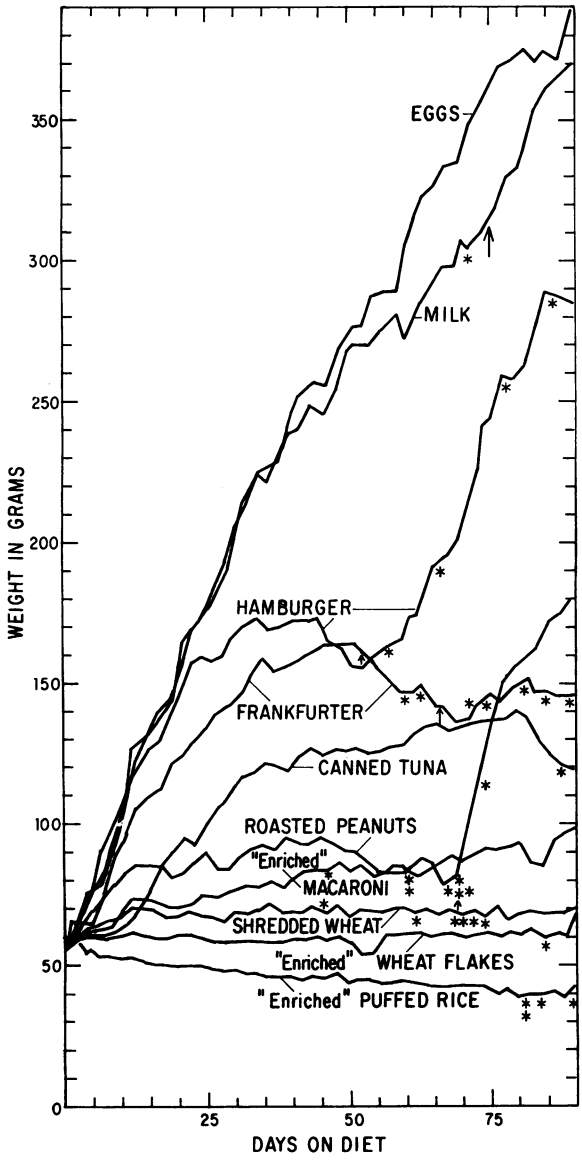

FIG. 1.

Note *Asterisks* indicate animal deaths. *Arrows* indicate diet supplementation.

wheat, supplemented*; (*12*) "enriched" wheat-flakes, supplemented*; (*13*) "enriched" puffed-rice, supplemented*; (*14*) "enriched" macroni, supplemented*.

The milk-fed rats were kept in plastic cages with aluminum bottoms and had no access to other metals. The fish-fed rats were started for about 2 weeks on sardines, but they ate sparingly so the diet was changed to tuna.

As indicated in Fig. 1, eggs alone proved to be an exceptionally good food for the young rats during the test period. Milk alone showed up nearly as well, except that after about 2 months the deficiency of iron (and copper) began to be exhibited and an iron–copper supplement was given. Hamburger meat, frankfurters, and tuna fish showed up well for 40–50 days. The first two were supplemented, when the animals lost weight, with "Nutrins"†, a commercial food supplement (vitamins and minerals), at the rate of two ampules per pound (454 g) of diet. None of the other human foods—including those designated "enriched"—at any time showed promise of sustaining growth even remotely approaching "normal".

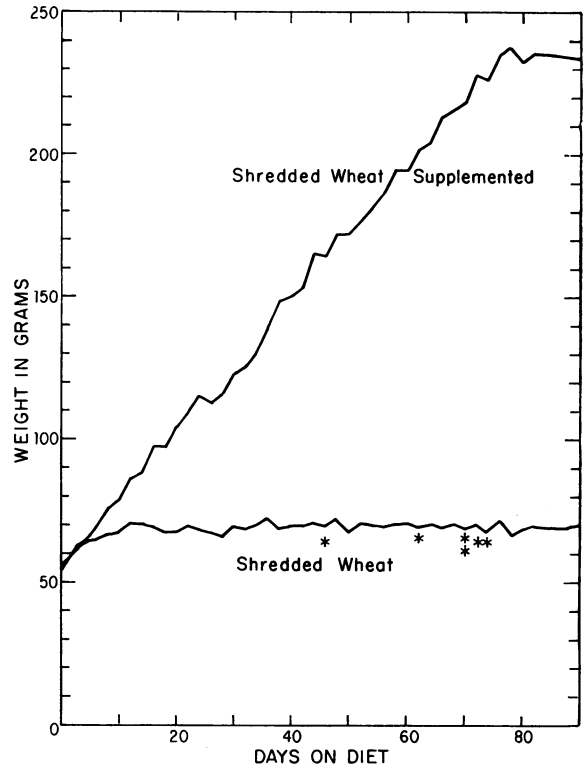

FIG. 2.

In Figs. 2, 3, 4, and 5 are shown the growth curves of animals fed shredded wheat and the "enriched" commercial foods, in comparison with the same foods modified by the same supplementation used in our previous "enriched" bread experiment. It was noted that the supplementation, which was originally designed for "enriched" *wheat* bread, improved other wheat products, but did not dramatically improve the puffed rice. A modified supplementation also failed to show much improvement, and after the 83rd day these animals were shifted to an exclusive egg diet, with the results recorded in Fig. 4.

DISCUSSION

It is clear that wide ranges of internal environments have been provided the weanling rats in our experiments, and it seemed obvious from casual inspection of the animals that brain and body development have been grossly affected. Some rats gained in stature during this crucial developmental period so that they became splendid specimens, weighing over a pound each, while others were so stunted that they weighed less after 90 days than when they were weaned. The internal

* The supplementation in each case was the same as that used in the earlier bread experiment, namely: "To each pound (454 g) of "enriched" flour was added: pyridoxine, 2 mg; pantothenate, 4.5 mg; cobalamine, 2.2 μg; vitamin A, 2160 U; vitamin E, 20 mg; folic acid, 0.5 mg; L-lysine, 0.5 g; calcium, 300 mg; phosphate, 713 mg; magnesium (oxide), 150 mg; manganese (sulfate), 20 mg; copper (sulfate), 4 mg".

† General Nutrition Corp., 418 Wood Street, Pittsburgh, Pa. 15222.

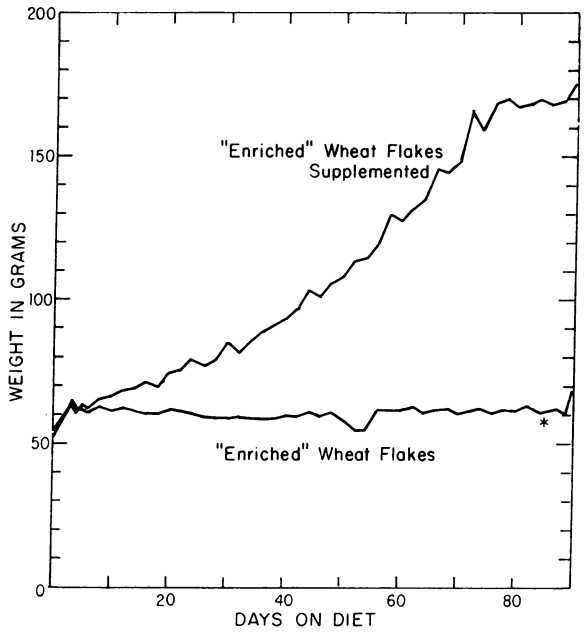

FIG. 3.

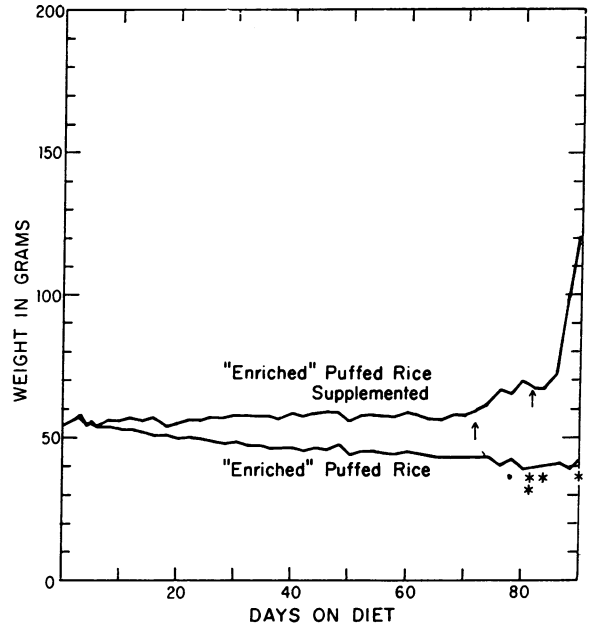

FIG. 4.

environments of the cells and tissues of the rice-fed rats, for example, were exceedingly poor, and the supplementation designed for wheat did not improve it markedly. However, when these rats were given the egg diet the internal environmental situation changed and they grew rapidly. Each staple food which is initially deficient, as shown in this test, must be supplemented in a distinctive and appropriate way if its all-roundedness is to be materially improved.

Four substantial conclusions arise from the consideration of these experimental results. First, individual staple articles of diet differ markedly in their food value when tested alone. Milk and eggs, for example, do not belong in the same category with "enriched" bread in this regard, because they contain something approaching a balanced nutritional chain. Eggs proved to be an extraordinarily good food for young rats and appeared to exhibit no deficiencies whatever. Milk, except for the well known deficiency of iron and copper (which is not manifest early), belongs in the same category. Hamburgers, frankfurters, and canned tuna, while not in the same class with eggs, supported early growth much better than the other foods tested.

Foods derived directly from the tissues of plants and animals are likely to contribute constructively to the internal environment of the cells and tissues of the animals that consume them, whereas those processed foods which are largely derived from the energy storehouses of plants and animals cannot do so. Nature does not distribute the essential nutrients in a haphazard fashion. All living cells carry an assortment, but energy storehouses do not. The egg of a fowl provides in a single package all the nutrients needed to build a young fowl, and it is not surprising that the same nutrients provide a good environment for the tissues of growing rats. This observation should not be construed to mean that long-term heavy consumption of eggs by human beings has been proved desirable.

Diversity in nutrition is recommended, but it must be done in such a way that the sum total of the diet yields everything needed. An assortment of foods which are largely stripped of everything except energy-yielding constituents will not suffice.

If guarding our internal environments is important, then these observations are valuable. Only if we take the position that cells and tissues thrive equally well in good and poor environments can we ignore the quality of the foods we eat. No food should be avoided or condemned because it is not a complete food. If it helps round out a complete environment, it is valuable.

The second conclusion is that many cereal products, including those called "enriched", are like "enriched" bread in that they can be vastly improved at small cost.

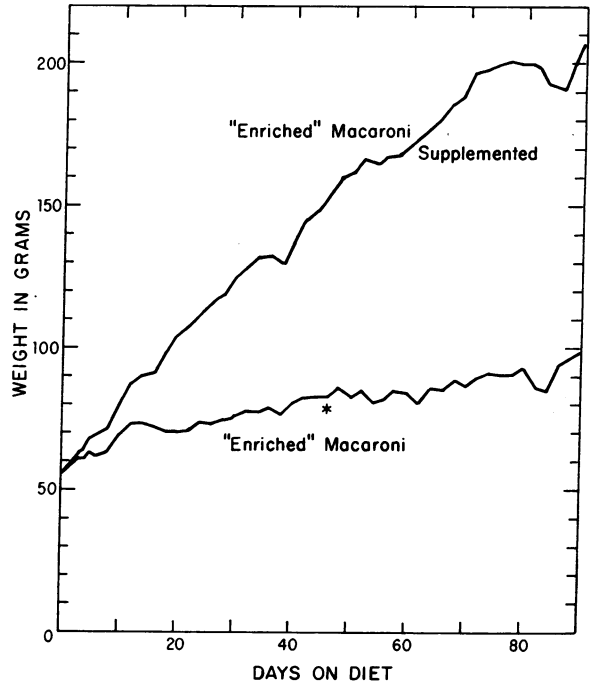

FIG. 5.

Thirdly, we conclude that the usual tables giving the composition of foods are wholly inadequate to yield the kind of information that can be obtained by biological testing. These tables at best include only a sampling of the nutrients. Important items like magnesium, trace minerals, vitamin B_6, folic acid, pantothenic acid, and vitamin B_{12} are commonly left out. If one is concerned mainly with thiamin, niacin, riboflavin, and iron, "enriched" bread, for example, appears excellent, but biological testing, which involves the interplay of the team of needed nutrients, shows "enriched" bread to be not only deficient but readily subject to improvement.

The fourth and most important conclusion we draw is that by biological testing similar to that described, we are in a position to answer many questions which have been unanswered up to the present. How does food "A" compare nutritionally with the same food: (*1*) without additives, (*2*) grown under different conditions, (*3*) derived from a closely related species, (*4*) processed in a different way, (*5*) preserved in a different manner? Food "A" may be any vegetable, cereal, meat, or food of any kind, and in each case minor or major differences will be easily detectable.

The fact that rats (or other small animals) grow rapidly and may have relatively high protein and other requirements makes the biological tests sensitive and far more valuable than if the small animals were insensitive to nutritional changes.

The unity in the biological world is far-reaching and the potential scope of such biological testing as we have done is great. Many questions can be answered and the results applied to the betterment of human internal environments.

In connection with this investigation we are fortunate in two respects. The senior author has been concerned directly or indirectly most of his professional life with cellular nutrition. This gives him a unique perspective. We are also fortunate in that our work is supported by the Clayton Foundation for Research, and we may carry out investigations on topics we believe are in the public interest.

1. Williams, Roger J., *Nutrition Against Disease: Environmental Prevention* (Pitman Publishing Corp., New York, N.Y., and London, in press).
2. Williams, Roger J., "Should the Science-Based Food Industry be Expected to Advance?", paper presented to Nat. Acad. Sci. USA, Oct. 21, 1970, to be published as a chapter in *Orthomolecular Psychiatry*, ed. David R. Hawkins and Linus Pauling (W. H. Freeman and Co., San Francisco, Calif., in press).