RETENTION, RESTORATION, AND FORTIFICATION OF VITAMINS IN FOODSTUFFS

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I VENTURE to use a wide title. Also, to make it clear that the views to be presented are interpretation of personal experience, conviction, and policy, since the food industries have never gone on record. What follows is believed to be rational *nutritionally* and practicable *technically,* in objective and procedure.

At the outset, qualifications must be stated. The requirements of the vitamins are not accurately known for different ages and body weights in the two sexes. The vitamin contents of different foods vary with type, variety, selection, state of maturity, season, technique of harvesting, conservation, processing, and shelf-life. Thus, some of the wide variations in reported analyses are derived from original materials, others are due to differences in behavior of test animals, while still others proceed from technique of testing.

It is therefore necessary to speak of ranges of vitamin contents rather than of points. At the same time, it is natural to have a leaning toward larger intake, that is toward adequate protection; and this is apparently justified by the experience that within reasonable limits, so far as we are aware, over-dosage of vitamins is impossible in foodstuffs, perhaps with the exception of vitamin D. As the intake of vitamin rises and falls, storage within the body rises and falls, and elimination rises and falls; under these circumstances, fear of intoxication is scarcely to be entertained, except in drug-use of vitamin concentrates. This view is supported by our knowledge of metabolic actions of vitamins. Optimal intake of vitamins by a people ought to be sought by popular choice in enlarged natural intake.

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I venture to suggest that a useful division, in respect of content of vitamins in foods, may be made under headings of *retention, restoration,* and *fortification.* By *retention* is meant such technique as brings to the dining table the native content of vitamin possessed by the food. Perhaps the best illustration is vitamin C, where it has become possible to have raw fruits and vegetables and canned fruits and vegetables contain at the moment of ingestion the content of vitamin C originally possessed. With many foodstuffs, some loss in vitamins occurs in processing or cooking. With certain foods, retention is technically easy; with others difficult. Still more important, with certain foods retention of vitamins is commercially easy and in conformity with consumers' tastes and specifications; with other foods, retention is commercially difficult or not in conformity with consumers' tastes and specifications.

It is not technically easy to retain vitamin B_1 in stable milled products of grains and in raw sugar. Furthermore, the taste of the public is against whole-grain meal and raw sugar, on grounds of color and other attributes. More important is the circumstance that whole-grain meal and raw sugar are prone to decomposition, and therefore do not lend themselves to distribution in a wide country with a large population. Any one who desires whole-wheat flour or raw sugar can obtain them on the market, at a price reflecting risk of processing and distribution; but the records of milling and of sugar refining show how small is the number of persons wishing to do so. We therefore have the established fact, both here and abroad (as is shown in the public reaction against compulsory high-extraction flour in Germany and Italy), that the taste of the public demands refinement in flour and in sugar.

Refinement in flour and in sugar carries with it heavy loss of vitamin B and of minerals. Here, where retention fails, restoration, *protective restoration* if you please, ought to find application. In other words, it ought to become commercially expedient, as it is already technically practicable, to restore to white flour the vitamin

B_1 (and B_2 if desired) removed in the act of milling. It is entirely practicable to take a properly pulverized synthetic vitamin B_1 and add it to flour, intimately mixed, to restore the B_1 to the whole-grain level, which may be taken as top limit of 70 international units per ounce. It is merely a question of price; but this is at the moment entirely beyond practical application. The manufacture of synthetic B_1 has scarcely begun, and simplification of the process will doubtless result in pronounced reduction in cost. In short, *protective restoration* with synthetic vitamin B_1 is feasible in milled products technically, but at present impracticable on grounds of price. Similarly, it is practicable in the technical sense to add synthetic vitamin B_1 to ready-to-eat cereal products, such as breakfast food, crackers, biscuit, etc.

Concentrates of natural vitamin B_1 may be prepared with a minimum of color, odor, and flavor, which presumably could be used in ready-to-eat grain products; but I have not seen such preparations that could be added to flour. An indirect method of restoration of vitamin B_1 provides a new yeast, which is so rich in vitamin as to yield a bread approaching whole-wheat bread in this respect, of course at a considerable increase in cost of yeast per loaf.

In the case of vitamin B_2, the problem is somewhat different. If we attempt restoration with natural vitamin B_2 and prepare, let us say, extracts of yeast or of rice polishings, we shall secure both B_1 and B_2 in variable proportions. Personally I have never seen such extracts adapted for use with flour, or even for ready-to-serve cereal products—though this is merely a question of refinement of concentration and purification. Concentrated extracts of B_2 are to be obtained from milk-whey and also from special yeasts, again with problem of purification and concentration. Synthetic riboflavin is available but is very expensive. To what extent, however, in the protective restoration of highly milled flour, we should attempt to restore B_2 as well as B_1, is not clear from the literature.

When we come to *retention of vitamin A* and *D,* the situation is

more complex. We have here, in the first place, two kinds of retention, indirect or direct, to use the terms in a special sense. The first is potential protective retention, that is, retention of potential original content. By this I mean the higher content of vitamin A which can be given to milk (and of course to butter) and to the yolk of eggs by a diet rich in A or provitamin. We have wide variation between the vitamin A content of milk in summer and winter, if traditional methods of feeding are allowed, since most of the provitamin of grasses is lost in the usual curing of hay. It is possible (as shown in Northern Europe with the use of the Virtanen method) to have the vitamin A content of milk maintained throughout the year by appropriate feeding. Therefore, it is technically possible, wherever practicable, to maintain a high level of vitamin A content of milk through indirect retention, through diet selected to assure high A content. Direct retention of A in dairy products is also entirely practicable, in the technical sense, because there is no reason, in the proper processing of milk and butter and cheese, why vitamin A should be destroyed.

Restoration of vitamin A in milk (or butter), to top natural level, is practicable technically, though not easy because of the necessity of removal of flavor and odor of the fish-liver oil concentrate added to milk. Just as it is possible to raise the vitamin A content of milk by a diet rich in provitamin, so it is possible to add concentrated vitamin A from fish-liver oil and thus produce a protective restoration. The problem is one of price, odor, and flavor. Whether it is desirable to restore vitamin A only to butter, or also to milk, is a question which will need to be explored, though no principles of nutrition are involved.

Protective restoration of vitamin D is evidently a limited field. We are justified in the assumption that in the human being, during the summer in this latitude, there is a high rate of activation of sterols and a consequent high level of storage, which declines to a point approaching or touching deficiency during the winter. Ap-

parently this doesn't hold true in milch cows, since direct experiments with sunshine and ultra-violet light do not indicate a significant increase in formation of activated ergosterol. Apparently, under the most favorable circumstance, the natural vitamin D content of cow's milk doesn't exceed 50 international units per quart; but we are not certain to what extent this depends upon lack of ergosterol or cholesterol or inability of the ultra-violet light to penetrate. Possibly the sunlight activates secreted sterols, which are later resorbed. To feed milch cows a fortified ration is a highly specialized procedure. In any event, to undertake a restoration of vitamin D in the milk supply to the highest natural level would not be sufficient to compensate for the low incidence of ultra-violet light in winter. Here *restoration* must be supplemented by *fortification,* unless children are to rely on fish-liver oils. It is possible to feed laying hens in such a way as to produce a high vitamin D content of the yolk of the egg, but this is hardly capable of nation-wide introduction and acceptance. Also, it is possible to restore vitamin D by direct radiation of milk.

It does not seem possible to enter into any discussion of the subject of restoration of nicotinic acid and vitamin E, since so little is known of requirements or deficiency.

The diet of the majority of families, even in a country with a high standard of living (like the United States) is determined more by purchasing power than by consumers' choice or knowledge of nutrition. In an impressive manner, increase in family income is accompanied by enlarged use of protective foodstuffs and lowered use of staples. Therefore, any effort on the part of processors to improve the diet through retention and restoration, must seek to accomplish this without significant increase in cost.

Coming now to the subject of *fortification,* it seems desirable to define this as *supplementary addition, in excess of natural limits.* To add, let us say, 60 international units of synthetic vitamin B_1 to flour could be called restoration; but to add 120 would certainly

need to be called fortification. It would seem to be the natural point of view to try to be satisfied with restoration whenever possible and to proceed to fortification only under unusual or extreme circumstances. Following this view, it may fairly be stated that restoration of vitamin B_1 and B_2 in cereal products is all that need be undertaken; fortification in our country seems unnecessary. In the same sense, it may be urged that restoration of vitamin A is all that is needed, since ample intake is assured if the nation's milk supply contained the highest natural level. But in the case of vitamin D, this does not hold for all regions.

Apparently, if we are to recommend the addition of vitamin D to foodstuffs, in order not to rely on fish-liver oils, restoration is not sufficient and fortification will need to be considered. On the assumption that such fortification lies naturally in dairy products (since vitamin D is fat-soluble), this would imply the addition of vitamin D to milk. Such addition has already been accepted by the American Medical Association, applicable to milk, up to the present not applicable to butter. The amount that would be added in fortification under such circumstances would represent the amount of vitamin D known to be sufficient during the winter for the protection of children against rickets; the figure at present employed by the American Medical Association, 400 international units to the quart, is certainly adequate for this purpose. This may be added in the form of natural vitamin concentrates, as synthetic vitamin D, or may be contributed by intensive direct irradiation.

There is at present considerable cross-action, if we might so term it—that is, tendency to incorporate B_1 and B_2 into fatty foods and to add vitamins A and D to cereal foods. I cannot repress the personal conviction that this now popular tendency is temporary, and in the long-term view it will be found better to confine restoration and fortification to foods in which vitamins naturally occur. This would mean for the present, until further information is available, that vitamins B_1 and B_2 be added to cereal foods from which they

have been removed and that vitamins A and D be added to dairy products.

We must bear in mind that attempts to introduce vitamins in foodstuffs up to the optimal requirement run counter to the desire of physicians to prescribe these vitamins in cases of deficiency, and to the wish of pharmacists and grocers to sell preparations of vitamins, in capsules or tablets, for self-medication. If we review the history of the practice of medicine, we may perhaps feel driven to the expectation that in the next few years the public will stress self-medication, with vitamins purchased in concentrated form and sold in drug stores, and perhaps in groceries, on a scale in excess of use of these vitamins in restoration and fortification of foodstuffs. Whatever may be the function of students of nutrition in safeguarding the interest of the public in the practice of medicine, it ought at least to be our endeavor to safeguard the interest of the public within the food field. It is in this sense that I suggest the separation of *retention, restoration,* and *fortification,* as actors to play successive stages, in the hope that under such rational procedure the administration of vitamins may be used as much as possible in foodstuffs and least in the drug field, where inevitably self-medication will supersede prescription by physicians. We should *first* seek *retention* of native vitamins, *then restoration* when advantageous, *then fortification* when warranted, leaving medication to the last, applicable to regions and groups where ingestion of vitamins as food components encounters exceptional difficulties. In the history of the dietary use of iodine we find some confirmation of this view. If one were to adopt an ultra-modern point of view, one might perhaps regard foodstuffs merely as carriers of protein, fat, and carbohydrate, and endeavor to supply the accessories, including vitamins and minerals, more or less synthetically in tablets. Most of us, however, are not yet prepared to turn the diet over to chemists and pharmacists, or to undertake the dieting of our race as we ration experimental animals. We must separate *prevention* from *treat-*

ment of vitamin-deficiency diseases. Clear-cut clinical deficiencies usually respond best to concentrates in capsule or tablet, though hypodermic medication in heroic doses is often called for. But prevention of deficiency through adequate intake of vitamins should be sought in the food supply, in which vitamins have been retained, restored, or appropriately fortified.

At the same time, it is to be recognized that if synthetic production of vitamins proceeds to the point of very low costs, these may be lower than the costs of natural vitamins, under circumstances of prevalent methods of distribution of foodstuffs. It has become fashionable in scientific circles to predict the factory synthesis of protein, carbohydrate, and fat, in replacement of animals and crops. Certainly the synthesis of vitamins is far closer than is the synthesis of protein, carbohydrate, and fat. Eventually, therefore, it is conceivable that sometime in the future vitamins may be obtainable for mass nutrition cheaper by synthesis than from natural sources. Until that moment arrives, however, it will be wise to continue to seek and develop reliance on natural vitamins, in natural foodstuffs, appropriately modified by retention, restoration, and fortification.