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The Butter-Margarine Controversy[1]

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THE QUESTION WHICH VITALLY INTERESTS all of us is whether we need to feel undue alarm from a health standpoint at the present-day scarcity in butter. In other words, need we be necessarily distressed not only for our adult population but especially for our growing children if the butter shortage continues over a prolonged period?

We have become much more conscious as to what good nutrition involves since the war began. The Food and Nutrition Board of the National Research Council has published a chart of recommended dietary allowances which have been generally accepted as the most authoritative information to date. In their table, they have separated the requirements not only according to age and sex but also according to the extent of activity. In addition, this committee has suggested certain minimal dietary requirements necessary during pregnancy and also during the period of lactation. In the opinion of the Board, there was already adequate experimental evidence to indicate the probable daily requirement of calories, protein, and such inorganic ions as calcium, iron, copper, and iodine. It was also possible to formulate recommendations for the daily quantities of the fat-soluble vitamins, A and D, needed, as well as for two members of the B complex, namely, thiamin (B_1) and riboflavin (B_2 or G). Figures for the amount of vitamin C required were also included. While it was recognized that other inorganic salts and a number of vitamins listed as members of the B complex are also essential in an adequate diet, it was considered that our present information is inadequate to hazard a guess as to the amount required. While it is generally recognized by students of nutrition that, at best, the quantities of nutrients postulated by the Food and Nutrition Board of the National Research Council are tentative, this table has served as a most useful yardstick in the formulation of diets of high quality.

The question of importance in the topic under discussion is whether the fats play a specific role *per se* in this nutritional picture; if they do, one must ascertain whether such a function is reserved for butter and animal fats or whether it is shared generally by the vegetable fats and oils as well. The vegetable oils and fats (including the hydrogenated ones) are practically identical in physical and chemical properties with the animal ones. Can the body cells reject one and require the other?

Fats are the best vehicles for dissolving the fat-soluble vitamins, A, D, E, and K. From that standpoint, one might regard the fats as an essential foodstuff since they afford a simple medium to assure the absorption of these required vitamins.

Fat is also the most concentrated form of energy. To obtain the energy to produce the 2,500 calories which the person of average stature expends daily, it is necessary to oxidize ingested foods or, in their absence, body tissue. As large a proportion as 85 to 90 per cent of this total energy may originate from the metabolism of either carbohydrate or fat (or, as is generally the case, of a mixture of these foodstuffs). The quantity of fat to supply all the necessary heat would be 240 grams, since fat has an energy value of 9.3 calories per gram; were carbohydrate to serve as the sole source of this 90 per cent of the daily caloric requirement, about 550 grams would be used, as this foodstuff has a heat value of only 4.1 calories per gram. Moreover, since carbohydrate is usually present in foods along with considerable quantities of water while the fatty foods may be largely free from water, the discrepancies between the weight of food required to satisfy the caloric needs of the animal far exceed the 2.3 to 1 ratio of the caloric values of fat to carbohydrate.

It is believed that certain types of fats which are normally components of such structural parts as cell membranes cannot be manufactured in the animal body. The only source for this material, which appears to be an unsaturated fat, trilinolein, is in the food. Fats must be considered essential to the extent that they are necessary to furnish an adequate amount

[1] A lecture given before the Men's Faculty Club of the University of Southern California on 23 May 1945.

of this constituent. Corn oil is especially rich in trilinolein while butter may be largely devoid of it. We, of course, manufacture the usual type of adipose tissue without the necessity of the fat being supplied in the diet. An excess of fatty tissue is generally a reflection of a fondness for carbohydrates, since we can readily transform the latter foodstuff into fat.

An examination of the dietary habits of animals gives us definite evidence that milk fat is not required after infancy. Wild animals have continued a normal existence over centuries without milk or butterfat after weaning. Except for the cat, dog, and pig, the same is also true for domestic animals. As far as the human is concerned, the widespread use of butter and milk in the diet of the adult, made possible by the domestication of the cow, goat, horse, or camel, has come late in the history of the human race. Man has attained his physical and mental stature largely without milk fat after weaning. In fact, within our present era, certain Indian tribes have been known to live satisfactorily after the nursing period on diets which are completely devoid of milk or butterfat.

We come back now to the question as to how effectively oleomargarine can do the job of butter. The term "oleomargarine" dates back to the time when oleostearine and oleo oil, by-products of the meat packing industry, were its principal ingredient. But still legally any margarine, regardless of the nature of the fat it contains, must be labeled "oleomargarine."

In the beginning, the margarines were maligned as inferior fats which were indigestible. However, investigators in the Office of Home Economics of the U. S. Department of Agriculture for some time previous to and during World War I had been comparing on human subjects the digestibility of various well-known animal and vegetable fats as well as many which were so unusual from a commercial standpoint that they were curiosities. With a very few exceptions, the coefficient of digestibility was invariably found to be approximately 95. This means simply that 95 of every 100 grams are absorbed from the gastrointestinal tract during the course of digestion and are therefore utilizable. In this group were all the common cooking oils as cottonseed, corn, peanut, and olive oils as well as butter and lard. The only exceptions to this relatively complete digestibility were noted with beef and mutton tallow and deer fat as well as several other natural or artificial fats having a melting point considerably higher than body temperature. Studies on several different oleomargarines by these same government scientists demonstrated equally high digestibilities for the oleomargarines as for butter. It is an interesting commentary that although these experiments were completed in 1917, the publication of the results was not made in one of the series of scientific government bulletins where the reports of the tests on the other fats had been published but in the *Boston Medical and Surgical Journal* in 1925 after the principal author had severed his connection with the government bureau. Today, no one questions the high digestibility of margarine.

Another earlier objection, political rather than nutritional, brought up against margarine was that it was made from foreign fats which were brought in to compete with the products of American farms. This may have been partially true when coconut oil was the basic fat used in margarine production; certainly, it can no longer be raised as an objection now that cottonseed, peanut, and soybean oils or animal fats which are almost entirely domestic products are practically exclusively used for the present-day margarine manufacture.

A third argument for the superiority of butter over margarine was advanced in 1913, when it was found that the former was a good source of vitamin A. Since it was soon determined that this vitamin, so essential for growth and for life, was absent in most vegetable oils, there would then appear to be some justification for the preference of butter to margarine on nutritional grounds. However, as soon as colorless vitamin A concentrates were available (there was a law against use of yellow-colored oils even when they contained the same natural provitamin A as butter, *i.e.* β-carotene), it became the practice to add sufficient of the vitamin A concentrate to margarine so that the concentration of vitamin A would be equal to that of an average butter. The amount of vitamin A to be used for the enrichment of margarine was originally set at 7,500 U.S.P. units per pound but later raised to 9,000 U.S.P. per pound, which was considered the average quantity in butter, although different butters may vary from 2,500 to 20,000 units per pound. Unfortunately, there is no way for the housewife by inspection of its label or of the butter itself to ascertain how much vitamin A is present. Although high concentrations of vitamin A usually run parallel to increasing yellow color in the natural product, this is not always the case. In fact, butter samples having the highest concentrations of vitamin A ever reported, produced by feeding massive doses of this vitamin to the cow, were found by the author to be practically colorless. But even if the depth of color were invariably a satisfactory index of the richness of butter in vitamin A, this criterion would be valueless as far as market butter is concerned. Artificial colors, which have no nutritive value whatsoever, are usually added to bring

the product to the desired hue. Butter is the only food exempt from the requirement of the pure food laws which makes mandatory the declaration of artificial color on the label of foods. No statement is required on the label or elsewhere that an artificial color has been added.

However, several years ago reports were published in the *Journal of Dairy Science* of work carried on in the University of Wisconsin indicating that butter *per se* possesses a certain growth-promoting influence (independent of the vitamin A effect) which could not be demonstrated in various vegetable oils. Weanling rats when given diets of whole milk grew faster during the first three weeks than other rats which received skimmed milk into which vegetable fats were homogenized. The differences were largely eliminated by the end of the six-week period. It was suggested that this effect of butter was to be ascribed to certain long chain saturated fatty acids present in the butterfat which were not contained in the vegetable oils. This was taken as the long-awaited "proof" that butter possesses some inherent characteristic not shared by vegetable fats which make its use in animal nutrition preferable. Although these preliminary experiments were not convincing from a scientific standpoint, the results were heralded far and wide by the dairy interests. It was not long before many of our intelligent citizens were wondering if butter should not be a "must" in the diet.

Extensive experiments were undertaken several years ago under the direction of the author at the University of Southern California to amplify the studies started at the Madison laboratories. These experiments were planned to avoid several criticisms of the earlier work which obviously would favor the butter animals. In the first place, the weanling rats were so distributed into the groups receiving the various diets that the average weights were identical in the various groups at the start. In the Wisconsin tests, the rats which were given the butter diet weighed 31 per cent more at the start of the experiment than those which were fed the cottonseed and soybean diets. Since the weight at weaning is a good index of the subsequent rate of growth, such low-weight groups could hardly have been expected to have grown as well even if afforded a superior diet to the butter rats. A second difficulty of the Wisconsin group was avoided by using dried skimmed milk powder mixed with the various fats instead of the liquid skimmed milk. In this way the diet remained homogeneous and a separation of fat from the liquid milk did not occur. The results of our tests showed that corn, cottonseed, olive, peanut, and soybean oils as well as a commercial margarine were all equally efficacious in promoting growth, as was butterfat on diets of mineralized skimmed milk powder which were fortified with the fat-soluble vitamins. No differences in rate of growth were noted after 3, 6, and 12 weeks. That the growth was similar for the rats on the different diets was further confirmed by the finding that the growth of their bones (tibia) at 3 and 6 weeks measured by X-ray photographs was identical. The diets were all shown to be equally well utilized, as demonstrated by the fact that the same amounts were required to cause equivalent growth. Moreover, the composition of the body tissues of rats sacrificed after receiving the different diets for 12 weeks was also shown to be similar. This would indicate that all fats were equally efficient in producing real growth and that the gain in weight in no case was only the result of an undue deposition of fat.

The Southern California experiments reported above also demonstrated the important part flavor may play in the diet. It was found that when rats were given a choice, they would usually prefer the butter-containing diet to the one having the vegetable oil. It was found that this preference is related to the so-called "butter flavor" normally present in butter, and it can as readily be induced by pure diacetyl or by commercial butter flavor as by butter itself. The quantities necessary to induce this preference are very small, only 4 parts per million being required. In fact, rats prefer a level of 4 to 8 parts per million and 8 to 16 parts per million. Possibly some of the better growth reported earlier on rats receiving butter may be because the animals are induced to eat more of such food. The flavor is a pleasing one which they have learned to prefer during the period of nursing. As far as can be determined, however, diacetyl plays no essential role in nutrition, and it can be manufactured by the normal male as well as by the lactating female.

In further experiments it was reported that the vegetable oils were equally satisfactory components of the diet as butter in furnishing adequate nutrition for normal pregnancy and for lactation. The index as to the efficiency of lactation can be deduced from the proportion of baby rats which survive as well as by the weight of the rats when they are weaned at the age of 21 days. In a large number of tests on the various vegetable fats, margarine, and butter, there was no evidence of superiority in any dietary group. In fact, in all cases the diets were equally effective in allowing normal pregnancy and successful lactation.

Recently some additional evidence has been adduced on the claim of the Wisconsin investigators that butterfat is especially required by the very young rats. They stated that prematurely weaned rats required butterfat to a greater extent than animals weaned at the normal time. Moreover, if animals were weaned

at a later than normal period, no superiority in the butter diet could be noted. However, Zialciti and Mitchell, of the University of Illinois, were able to raise successfully rats fed on artificial mixtures by the use of medicine droppers starting within seven days after birth. When such animals were given mixtures containing corn oil, the subsequent growth was as satisfactory as for those which were fed on a mixture containing butter as the fat. We have reported similar results on a large series of rats weaned at 14 days instead of the usual 21-day period which received diets containing a butter or margarine or corn, cottonseed, peanut, or soybean oils.

More recently, the Wisconsin scientists have stated that growth of young rats was as satisfactory when oleomargarines were incorporated in the diets as when butter was the fat, provided that the basal carbohydrate in the diet was starch, dextrin, sucrose, glucose, or mixtures of them. Only when lactose was the sole carbohydrate was there some indication of less satisfactory growth on the nonbutter tests. It should be mentioned that the lactose content in these tests was higher than in whole milk powder. When lactose is present in the proportion found in whole milk, the weight of evidence is that all vegetable fats have a nutritive value similar to butter if fortified with the fat-soluble vitamins.

Another crucial test for the adequacy of a diet is its ability to support growth and reproduction over a number of generations. Dr. H. C. Sherman, of Columbia University, has maintained a colony of rats for 50 generations on a diet consisting of one-third whole milk powder, two-thirds whole ground wheat, and a little salt supplemented with small amounts of lettuce and lean meat once a week. Such a diet must therefore be considered as entirely adequate for the rat. In the May 1945 issue of the *Journal of Nutrition,* there is a progress report of the author detailing experiments where rats had already been maintained over ten generations on a diet identical with Sherman's except that skimmed milk powder was used in place of the whole milk powder and an amount of margarine fat was added corresponding to the normal content of butterfat in the whole milk powder. These tenth-generation animals were in much better physical condition than the first-generation rats. In fact, at the present time the experiment has progressed to the thirteenth generation and the rats have continued to be in excellent condition.

It is a moot question how far tests on rats can be applied to humans. Certainly many of the dietary deficiency diseases found in the human subject have their counterpart in the rat. The rat, like the human, is omnivorous. The anatomy of the gastrointestinal tract is similar. To accomplish a study over ten generations in the human would require 300 years compared with five years in the rat. From the analogies between rat and man, it is not too much to expect that a diet which is nutritionally satisfactory for the rat would also be beneficial for man and vice versa. Conclusions on the nutritional value of diets for humans based on rat experiments would seem to be entirely justified as far as fats are concerned.

Even had it been shown that milk fat were a requirement for animals or for man, one would expect that the milk fat from any one species of animal would meet the requirements best for that particular species. It is well known that there is a wide difference in the composition of the milk of different species and also that this variability in composition also obtains with the fat. Hilditch and Meara in the conclusion of a paper where the composition of fat from human and cow's milk has been compared state the following:

> Human milk fat, in regard to its component acids, has more resemblance to a typical margarine fat-blend than to butterfat.

The experiments that I have just outlined reaffirm that fact that vitamin-fortified margarine and butter have a substantially equivalent nutritional value. They are supported by the conclusions of an entirely unprejudiced group, the Committee on Public Health Relations of the New York Academy of Medicine, who recommend in their report of 1 February 1943 as follows:

> In order that the health of the population may not be impaired by the adoption of a diet insufficient in fats and fat soluble vitamins, the Committee recommends that the manufacture, distribution, and consumption of oleomargarine be encouraged and suggest specifically:
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> (1) That the regulations set by the Federal Security Administrator in 1941 be amended to make it mandatory that all oleomargarines be fortified with vitamin A at a uniform level of 9,000 United States Pharmacopoeia Units per pound of finished product;
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> (2) That the War Production Board be requested to allow the use of fats and oils for the manufacture of oleomargarine in such quantities as would offset the necessary withdrawal of butter from civilian use;
>
> (3) That federal and state laws which restrict the manufacture and distribution of oleomargarine be suspended for the duration of the butter crisis;
>
> (4) That wide publicity, both lay and professional, be given the fact that oleomargarine, fortified by vitamin A, is nutritionally equal to butter; and
>
> (5) That this matter be brought to the attention of the President of the United States, the Secretary of Agriculture of the United States and his Technical Assistant on Civilian Requirements, and the Commissioner of Agriculture and Markets of New York State.

Moreover, a similar conclusion has been reached by

the Food and Nutrition Board of the National Research Council in their Reprint and Circular Series, No. 118, released in August 1943, where it is stated:

(1) Margarine fortified with vitamin A in accordance with Food and Drug regulations supplies an important amount of this nutrient as well as of much needed fat. A previous recommendation of the Food and Nutrition Board that all margarine be fortified is reaffirmed. Because of the high proportion of margarine now fortified, mandatory requirement of fortification for all margarine for table use seems unnecessary at present, though it may become desirable if the situation changes in such a manner as to reduce importantly the proportion now fortified.

(2) The present available scientific evidence indicates that when fortified margarine is used in place of butter as a source of fat in a mixed diet, no nutritional differences can be observed. Although important differences can be demonstrated between different fats in special experimental diets, these differences are unimportant when a customary mixed diet is used. The above statement can only be made in respect to fortified margarine and it should be emphasized that all margarine should be fortified.

(3) It is obvious that the present excise and license taxes imposed by both Federal and State governments on margarine interfere with the distribution and utilization of certain of our fat resources, but the implications of these taxes are so extensive and complex that no recommendation with respect to them can be made in this report.

Finally, it should be stated that the nutritional value of milk is not confined to the fat; it possesses proteins of excellent quality and it is an excellent source of certain inorganic salts needed in the diet, such as calcium and phosphorus. Milk is an especially adequate source of riboflavin. We can scarcely view with concern the increasing use of margarine in the diet if that means that larger amounts of whole milk become available at a reasonable cost for human consumption.

Developing Food Acceptance Research[1]

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At the present time there appears to be in process of development a science which treats of foods and the consumer of foods as a *relationship* in which the producer or processor of foods (for industrial survival) and the consumer of foods (for human survival) share an equal interest.

During World War II, now just ended, each item of the ration had been carefully produced and prepared according to quality specifications, and each item had been tested to contain and retain through long periods of storage its quota of vitamins, minerals, protein, and calories. But when the soldier-consumer refused to accept some of these ration items, and when these items began to accumulate in the storage dumps in various theaters of the war, a new problem in supply, theretofore unrecognized, was raised to a major issue. To determine the causes of nonacceptance followed as an official directive.

Parallel with the refusals by the soldier-consumer, populations under economic stress, or belabored with a poor soil, or lost in the forest fringe or in marginal environments, or seduced into overspecialization, reveal similar conflicts over acceptance and nonacceptance of foods.

The reasons for this parallel will appear with further development of the subject. Needless to say, both the Army population under stress and the civilian population isolated from the normal balance of supplies—even though it may be living in the midst of a prosperous society—have much in common.

But why had not the subject of food acceptance become an issue before? In order to answer this question and in order to uncover causes, as a step toward instituting prevention, let us go back a few decades.

Not long ago, even in the time of our grandfathers, there was little need for concern over the nonacceptability of the harvest. Each family was largely self-sufficient. Out of the family garden the *seed* for the coming year—and only the best—was selected. That *best* of the harvest was judged at the family table by means of a sizable panel of children and parents, aunts and grandparents, a panel representing all ages and both sexes.

Locally adaptable varieties of sweet corn, apples, squash, peas, beans, bred on the spot for acceptability, were also prepared and cooked in home style. Home cooking meant recipes devised out of the ingredients at hand, upon which the family panel had also placed its stamp of approval. These home recipes had sometimes passed through the judgment of generations of

[1] Research in food acceptance was formally introduced into the Army's food supply program when, in November 1944, a Food Acceptance Research Branch was set up in the Subsistence Research and Development Laboratory, under Col. Rohland A. Isker, Commanding Officer. Food acceptance research has since been included as a section of the food research program of the Military Planning Division, OQMG.

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