Future Considerations in Margarine Fortification[1]

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Abstract

The present and future nutritional rationale for margarine fortification is discussed. The trend to increase the polyunsaturated fat content of margarine coupled with the newer knowledge of vitamin E requirements suggest that vitamin E fortification of margarine be considered; a practice common in Europe. The composition of current margarine is reviewed with respect to PUFA and vitamin E. The vitamin A content, low cost, wide availability and high caloric value of margarine suggest a possible role in feeding the underprivileged. In this connection, the use of margarine as a carrier of lysine to improve the protein quality of cereal foods with which it is used is suggested.

Introduction

The philosophy of food fortification in the United States is changing as we learn more about specific dietary deficiencies and about the nutritional effects of both affluence and poverty. The nutritional rationale for margarine fortification should be reviewed periodically, both when new nutritional findings are made and when compositional changes occur. Awareness of the nutritional aspects of his product by the margarine manufacturer has resulted in the introduction of new polyunsaturated fatty acid (PUFA) formulations and of low fat margarine products. This flexibility in response to new nutritional findings is encouraging and fosters new thoughts for an expanding nutritional role for margarine in the diet.

The average American consumes approximately 10 lb of margarine/year or 12.4 g/day. The major nutritional contribution of margarine to the average consumer and to the individual who may consume as much as 100 g/day is shown in Table I. In addition, margarine supplies significant but variable amounts of vitamin E and PUFA. The trend to high PUFA margarines plus the now known relationship between PUFA and vitamin E, suggests that the role of margarine in vitamin E nutrition be evaluated.

Vitamin E

An increase in the vitamin E requirement with increased intake of PUFA has been well established both for adults (1) and infants (2). This relationship was considered by the Food and Nutrition Board of the National Research Council when establishing an adult Recommended Dietary Allowance of vitamin E of 30 IU/day (3). It appears that a minimum of 0.6 mg of α-tocopherol is required for each gram of PUFA in the diet (4). It is becoming increasingly evident, however, that extra external and internal stresses may increase our requirements for the antioxidant protection provided by vitamin E (5–7). Although requirements due to environmental stress will be difficult to estimate, this protective function of vitamin E is receiving increased attention in current research on vitamin E.

If we believe that a food should be self sufficient nutritionally, then margarine should contain a minimum of 0.6 mg of vitamin E/g of PUFA or alternately sufficient vitamin E so that a consumer who obtains most of his dietary fat from margarine simultaneously obtains adequate vitamin E for his daily needs. If the vitamin E adequacy of margarine is evaluated by the standard of 0.6 mg of α-tocopherol/g of PUFA, then of seven retail margarines which were assayed in 1966 (Table II), five were adequate and two were deficient. In 1969, seven retail soft-type margarine products were assayed (Table III). Three out of five soft margarines were satisfactory, one was marginal and one was deficient. The two imitation margarines (40% fat) were marginal or satisfactory in the E/PUFA ratio. Comparing the data in Table II and Table III, the seven bar margarine products had a mean E/PUFA ratio of 0.71 (range 0.33–0.95) compared with a mean for the soft margarines of 0.74 (range 0.39–1.5). It appears that the increased PUFA content of the soft margarines has been achieved by judicious partial hydrogenation and with vegetable oils, such as cottonseed, which have favorable E/PUFA ratios. The average E/PUFA ratios for unhydrogenated soybean, corn, safflower and cottonseed oils are 0.28, 0.36, 0.45 and 0.65, respectively.

The vitamin E contribution of margarine may be evaluated in another way. Based on the range shown in the 1966 and 1969 samples, the consumer of 12.5 g of margarine obtains 0.6–6.1 IU of vitamin E while the individual who may consume 100 g obtains 4.7–49 IU/day. The vitamin A fortification level of margarine is 300% of the RDA per pound of margarine. If the same rationale is applied to vitamin E, then margarine should contain 90 IU/lb. Half of the margarines assayed in 1966 and 1969 contained less than this level.

Whole cereal grains and vegetable oils are the richest source of vitamin E in the diet. Processing, however, particularly of the cereals, removes considerable vitamin E. White flour is very low in vitamin E (8) and a recent study of breakfast cereals by Herting and Drury (9) shows a drastic loss of vitamin E in processing. The burden of supplying vitamin E therefore falls primarily on fresh vegetable oils. Refined vegetable oils, although containing fair amounts of vitamin E, contain considerably less than the crude oil (10). The vitamin E intake provided by an average diet is, therefore, not over abundant. This was demonstrated by the work of Bunnell et al. (11) who showed that it would be difficult to achieve an RDA of vitamin E in the average diet. Losses of vitamin E due to the oxidative destruction of free tocopherol can also occur in cooking in vegetable oils and margarines. Fortification with vitamin E using the stable alpha-tocopheryl acetate form would, of course, overcome this type of loss.

A secondary point concerning fortification of margarine with both vitamin A and vitamin E is the fact that ingestion of vitamin E with vitamin A, increases the liver storage of vitamin A appreciably (12).

Special Purpose Margarine for the Underfed

Should specialized margarines be considered for distribution in USDA domestic food donations? The margarine quantities purchased in these programs have been variable but relatively small compared to lard, shortening and

TABLE I

Major Nutritional Contributions of Margarine

Nutritional contributions	Consumption per day	
	12.5 g	100 g
Fat,	10 g	80 g
% diet fat	7.5%	60%
Calories,	90	720
% of 2800 calorie diet	3.2%	25%
Vitamin A,	410 U	3280 U
% of MDR	10%	82%

[1] One of three papers being published from the Margarine Centennial Symposium, presented at the AOCS Meeting, Minneapolis, October 1969.

TABLE II

Alpha-Tocopherol and PUFA Content of Retail Margarines, 1966

Code	Oil source	PUFA, g/100 g	Alpha-tocopherol, mg/100 g	Alpha-tocopherol, mg/g PUFA
A	S,C[a]	25.8	10.9	0.42
B	S,CR,C	19.9	19.0	0.95
C	CC,PK,P	9.5	3.16	0.33
D	S,C	12.3	11.0	0.89
E	S,C	21.1	19.9	0.75
F	S,C	14.7	11.8	0.80
G	S,C	14.2	12.3	0.87

[a] Abbreviations: S, soy; C, cottonseed; CR, corn; CC, coconut; PK, palm kernel; P, peanut; SA, safflower.

TABLE III

Alpha-Tocopherol and PUFA Content of Soft Retail Margarines, 1969

Code	Oil source	PUFA, g/100 g	Alpha-tocopherol, mg/100 g	Alpha-tocopherol, mg/g PUFA
H	SA,S[a]	31.7	22.2	0.70
I	S,C	21.0	32.7	1.55
J	CR	38.0	22.2	0.58
K	CR	25.9	10.1	0.39
L	C,S	31.4	21.0	0.67
M[b]	CR	17.0	9.3	0.55
N[b]	CR	18.3	13.1	0.72

[a] Abbreviations: see Table I.
[b] Imitation margarine.

butter. The wide acceptability of margarine, as well as the ease of tailor making it, suggest the consideration of wider distribution and possibly of specialty formulas. The fact that margarine is an excellent source of calories per unit weight suggests a complementary role with high protein foods to insure adequate calories to prevent wasteful conversion of proteins to calories in the underfed. This waste can occur because the first demand nutritionally is for calories and not protein.

Lysine

With respect to protein quality of the diet, there is considerable interest in the use of lysine and other limiting amino acids to upgrade the quality of cereal proteins. Of particular importance is the improvement of the wheat protein of bread by the incorporation of lysine into the flour. Losses of lysine, however, can occur in the baking process. Although these losses may not be serious when baking at moderate temperatures, the loss of lysine can become considerable when high baking temperatures, with associated increased amount of browning, are used. Toasting of bread can induce considerable additional losses of lysine. Adding lysine to margarine rather than to bread might be a means of attaining the same nutritional goal and avoiding the variable losses of lysine in the baking process. In addition, this technique would provide a means of improving protein quality of any bread with which it was used. The fortification of rice and noodles with lysine becomes especially difficult due to the losses of lysine which can occur in the cooking water. Again the use of lysine-enriched margarine in conjunction with these cooked foods would aid in the solution of this difficulty. The same concept could be extended to corn products as well. Thus margarine may be a good vehicle to get the limiting amino acids to people with fixed food habits. This could be especially important for people who grow their own crops and may not purchase flour, bread or other enriched cereal.

Turning to the quantitative aspects of the lysine enrichment of margarine, the addition of 1.5–3.0 g of lysine to a pound of margarine should be nutritionally adequate. If we assume that a 7 g pat of margarine is used on a 25 g slice of bread, a lysine level of 1.6 g/lb of margarine would provide the equivalence of 0.1% lysine in the bread. Although there may be certain technological and taste problems to consider, initial taste tests on margarine containing 1.6 g/lb were favorable. Since lysine hydrochloride imparts a slight salty taste, the usual salt levels of margarine could probably be reduced.

Other Possibilities

Vitamin C intake in the lower economic quartile in the U.S. is significantly below the RDA. The foods supplying vitamin C in large amounts per serving are few. Should specialized margarine be offered with vitamin C? Here, too, it would be necessary to prove satisfactory flavor and stability under typical use conditions before commercialization of the product.

Should the USDA purchase more margarine or margarine with higher vitamin A levels to improve vitamin A nutrition in the underfed, particularly in the infant to nine-year-old group?

These ideas are submitted as questions, not as answers. It is as much or more the responsibility of the food manufacturer to evolve a sound nutritional rationale for his product as it is for the FDA or the Food and Nutrition Board. The fortification of foods at conservative levels with clear, accurate labeling and promotion can be an economical method of up-grading food quality. The fact that margarine is a low cost food of wide acceptability suggests it can have a broader role in improving the diet of both the affluent and the underfed in the future.

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