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α-Tocopherol, total vitamin A and total fat in margarines and margarine-like products

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Consumers' interest in dietary guidelines advising them to reduce their intake of fat has contributed to the development of new low- and fat-free margarine-like products. We measured vitamin E (α-tocopherol) and vitamin A (retinol and β-carotene) in margarines and margarine-like products labeled as containing 0–80% fat. Test portions were saponified, extracted with petroleum ether, and analyzed by high performance liquid chromatography. Margarines of approximately 80% fat content contained 4–30 IU α-tocopherol/100 g. Reduced-fat margarines (fat content 14–53%) contained 4–15 IU α-tocopherol/100 g, while fat-free margarines (< 1% fat) contained < 1 IU α-tocopherol/100 g. α-Tocopherol in the products varied both with total fat content and with the vegetable oil ingredients. Total vitamin A measured in margarine products fell between 59 and 196% of label declarations. Published by Elsevier Science Ltd

INTRODUCTION

The Department of Health and Human Services has as one of its goals for the year 2000 to "increase to at least 5000 brand items the availability of processed food products that are reduced in fat and saturated fat" (DHHS/PHS, 1990). Consumers' interest in dietary guidelines advising them to reduce their intake of fat has contributed to the development of many new low- and fat-free foods, including margarines.

Margarines are among the foods with a standard of identity (i.e. specifications defined in Federal regulations) that have been affected by recent changes in food labeling regulations. Regulations promulgated by the Food and Drug Administration (FDA) in response to the Nutrition Labeling and Education Act of 1990 (NLEA) amended the general provisions for food standards to prescribe a general definition and standard of identity for foods named by use of a nutrient content claim (e.g. 'fat-free') in conjunction with a traditional standardized name (e.g. 'margarine') (Federal Register, 1993). The agency took this action to assist consumers in maintaining healthy dietary practices by providing for modified versions of certain standardized foods that bear descriptive names that are meaningful to consumers.

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As a result of these changes, margarines, previously defined as products containing not less than 80% fat (Code of Federal Regulations, 1995), are now available in low-fat, reduced-fat and fat-free types. Fats used in margarines may be of vegetable or animal origin. In the early days of margarine manufacturing, beef fat was the predominant fat ingredient, but vegetable oil types are now more common (Diplock *et al.*, 1989).

Vegetable oils and their products have been found to be among the most significant dietary sources of vitamin E, an antioxidant vitamin that has been postulated to play a protective role in reduction in risk of chronic diseases such as cancer and cardiovascular disease (Lawson, 1995). The United States Department of Agriculture's Nationwide Food Consumption Survey (NFCS) of 1987–1988 (US Department of Agriculture, 1990) reported intakes of vegetable oils, partially hydrogenated vegetable oils, and shortenings used in household food preparation (e.g. cooking and salad oils), as well as intakes of margarines, mayonnaise, salad dressings, breakfast cereals, snack foods, and thousands of other foods. By combining the extensive intake data with food composition data, it was possible to estimate total amounts of selected nutrients consumed by survey participants and to estimate the contribution of specific categories of foods to total consumption of these nutrients. For example, data from the 1987–1988 NFCS (US Department of Agriculture,

1990) showed that regular stick and tub margarines provided about 13% of the total α-tocopherol equivalents available in the US diet. Other sources, such as regular mayonnaise made with soybean oil, vitamin E-fortified breakfast cereals, household vegetable shortening made with soy and cottonseed oils, and soybean oils and partially hydrogenated soybean oils used in salad and cooking oils, provided about 10, 6, 5 and 2%, respectively, of the total α-tocopherol equivalents (Sheppard *et al.*, 1992).

The content of fat, vitamin E (as α-tocopherol), and vitamin A of new modified-fat margarines has not been reported. The purpose of this study was to determine the total fat and vitamin E content of margarines and margarine-like products carrying 'reduced fat' and 'no-fat' claims and the vitamin E content of the oils used most commonly in their manufacture. Total vitamin A (as retinol and as retinol equivalents from β-carotene) also was determined in the same products, because the standard of identity for margarines requires the addition of vitamin A, and because vitamin A is a mandatory nutrient on the new food labels.

MATERIALS AND METHODS

Margarines and oils

Nineteen margarines and margarine-like products and five vegetable oils were purchased locally. The vegetable oils analyzed were those listed as ingredients in the margarines. Samples were taken from a number of different lots of the margarines and oil products. The numbers of lots of margarines sampled were 2–11 for analysis of vitamin E and 2–5 for analysis of retinol and β-carotene. At least 450 g (about 1 lb) of product from each lot was blended before sampling. Samples were blended in a dual-speed blender and stored refrigerated in tightly sealed glass containers. From two to four lots of each vegetable oil were sampled for analysis of vitamin E. Oils were purchased in 1 qt bottles and mixed well before sampling. All products were analyzed before their labeled expiration dates.

Standards and reagents

Vitamin A acetate capsules containing 33.46 mg all-*trans*-retinyl acetate per gram in cottonseed oil were obtained from the United States Pharmacopeia (USP), Rockville, MD, USA. The β-carotene (purity 99%), butylated hydroxytoluene (BHT), reagent grade ascorbic acid, (+)-γ-tocopherol (purity 96% by HPLC) and (+)-δ-tocopherol (purity 92.4% by HPLC) were obtained from Sigma Chemical Company (St Louis, MO, USA). D-α-Tocopherol (purity 99%) was obtained from Eastman Chemical Company (Rochester, NY, USA). All other chemicals were of reagent grade.

Total fat

Fat (crude) was determined gravimetrically on 2 or 4 g portions of each product by AOAC method 922.06 (AOAC, 1990). Results are expressed as percent fat in the products.

Retinol, β-carotene and tocopherol standard solutions

Retinol standard solution

Five USP vitamin A capsules were saponified in ethanolic potassium hydroxide (Bueno, 1997). The mixture was extracted twice with petroleum ether, the extracts were combined and washed, and dried by passing through anhydrous sodium sulfate. The concentrations of working solutions were determined from absorbance (Abs) measurements in a scanning UV/Vis spectrophotometer at 325 nm as follows: retinol, IU/ml = $Abs_{325} \times 18.3$ (Bueno, 1997; AOAC, 1995*a*, method 992.04).

β-carotene standard solution

A 5 mg portion of β-carotene was weighed into a 250 ml volumetric flask and dissolved in hexane. Several drops of chloroform were added to solubilize completely the β-carotene, and the solution diluted to volume with hexane. The absorbance of working solutions was measured with a scanning UV/Vis spectrophotometer from 390 to 520 nm. The concentration was calculated as follows: β-carotene, mcg/ml = $Abs_{450} \times 4.17$. The β-carotene was converted to retinol equivalents as follows: retinol equivalents from β-carotene, IU/ml = $Abs_{450} \times 4.17 \times (1/0.6)$ (Bueno, 1997; AOAC, 1995*b*, method 941.15).

Tocopherol standard solutions

Stock solutions of D-α-tocopherol, γ-tocopherol and δ-tocopherol were prepared in hexane and diluted as needed. A mixture was also prepared in hexane that contained by weight 0.0969 mg/ml α-tocopherol, 0.026 mg γ-tocopherol, and 0.273 mg δ-tocopherol. The concentration of D-α-tocopherol was calculated as follows: IU/ml = mg D-α-tocopherol/ml × 1.49 IU/mg (US Pharmacopeial Convention, 1985).

Saponification and extraction

Test portions of margarines (2–9 g) were weighed into Erlenmeyer or round-bottomed flasks. To the test portions were added 200 ml of ethanol, 0.5 g of ascorbic acid and 50 ml of 50% potassium hydroxide solution. The mixture was refluxed for 60 min with an air condenser and then cooled to room temperature. The contents of the flask were transferred quantitatively to a separatory funnel, the flask was rinsed with 100 ml of water followed by 50 ml of ethanol, and the rinsings were added to the funnel. The vitamins were extracted with petroleum ether as described by Bueno (1997).

Briefly, a 200 ml portion of petroleum ether was added to the separatory funnel, the funnel was inverted, vented, then shaken vigorously, and the layers were allowed to separate. The bottom layer was drained into a second separatory funnel and 200 ml of petroleum ether was added; the mixture was extracted a second time, the layers were allowed to separate and the aqueous (bottom) layer was drained into a waste receptacle. The ether extracts were combined in the first, the second funnel was rinsed with petroleum ether, and the rinsings were added to the first funnel. Then, 400 ml distilled water were added to the ether extract, the funnel was not shaken, the layers were allowed to separate, and the water was drained to waste. An additional 400 ml of distilled water was added, the funnel was swirled or shaken, the layers were allowed to separate and the water layer was discarded. The ether extracts were repeatedly washed with water until the water was neutral to 1% phenolphthalein solution (no visible pink color). The extracts were then filtered through anhydrous sodium sulfate into a beaker or round-bottomed flask and the funnel was rinsed with an additional 50 ml of petroleum ether. The extracts were evaporated to dryness on a steam bath by a nitrogen jet or on a rotary evaporator. The residue was dissolved immediately in hexane, and the solution transferred quantitatively with hexane into a volumetric flask and diluted to volume with hexane. Standard solutions of pure α-tocopherol, retinol, and β-carotene were carried through the saponification and extraction procedures with each set of margarine or oil test samples.

HPLC conditions

Extracts were analyzed by high performance liquid chromatography (HPLC) in a Shimadzu HPLC system consisting of a pump, injector, UV/Vis detector, and a chart recorder or data acquisition system. HPLC conditions were as follows.

Tocopherols
μ-Bondapak C18 reverse-phase column, 10 μm, 4×250 mm (Water's Chromatography, Milford, MA, USA); mobile phase methanol:water 94:6 (v/v). In some instances, the mobile phase was changed to methanol: water 93:7 or 92:8 (v/v) for better resolution. Flow rate: 1.5 ml/min; detector at 280 nm; range: 0.02 AUFS; chart speed: 0.5 cm/min.

Retinol
μ-Bondapak C18 reverse-phase column, 10 μm, 4×250 mm (Water's Chromatography, Milford, MA, USA); mobile phase methanol:water 90:10 (v/v); flow rate: 1.5 ml/min; detector at 325 or 313 nm; range: 0.05 AUFS; chart speed: 0.5 cm/min.

β-carotene
LiChrosorb SI-60 column, 5 μm, 4.1×250 mm (Hewlett–Packard, Wilmington, DE, USA); mobile phase hexane:propanol 98.3:1.7 (v/v); flow rate: 1.0 ml/min; detector at 450 nm; range: 0.05 AUFS; chart speed: 0.5 cm/min.

Expression of results

Values for fat in the products were calculated from label declarations of 'g fat/serving' and compared with analyzed values. Values for vitamin A are declared on food labels as percent of the Daily Value (DV) for vitamin A (i.e. as percent of 5000 IU) per serving. A statement of the percent of vitamin A that is present as β-carotene is voluntary and may be listed parenthetically. Total vitamin A in food products was calculated by summing contributions from retinol and β-carotene and expressing the results as IU/100 g. Vitamin E is not a mandatory nutrient on the new food labels. Vitamin E content, when included on food labels, is expressed as a percent of the DV (%DV) for vitamin E (i.e. as percent of 30 IU α-tocopherol) per serving. Food label values for vitamin E were converted to IU α-tocopherol/100 g. Because of manufacturers' rounding of values for %DV, the nutrient concentrations calculated from label declarations (Tables 1–3) are not absolute.

Analytical results are expressed as percent (total fat) or as IU/100 g (retinol, retinol equivalents from β-carotene and α-tocopherol).

Recoveries

Test portions of pure α-tocopherol, retinol and β-carotene were carried through all procedures with each set of samples analyzed. Recoveries (%) for α-tocopherol, retinol and β-carotene were 94.3 ± 7.4 ($n = 24$), 95.5 ± 6.1 ($n = 23$) and 91.2 ± 8.6 ($n = 21$), respectively.

RESULTS AND DISCUSSION

Composition of the products

Ingredients
The 'ingredients list' on food labels lists ingredients in descending order of predominance by weight. In all margarine products of 50% or more fat content, individual liquid oils, or blends of several liquid oils and partially hydrogenated vegetable oils, were the first-listed ingredient(s) (Table 1). For products of 20–40% fat content, the ingredient lists identified water as the predominant ingredient and a vegetable oil or a blend of vegetable oils as the second ingredient. The most commonly used oils were corn, soybean and canola, or blends of these three oils. Sunflower and cottonseed oils were included in three of 19 products.

Water, skimmed milk, liquid corn oil and pectin were the primary ingredients in one of the fat-free products. A second fat-free product contained water, vegetable

mono- and diglycerides, gelatin and rice starch as the primary ingredients, while the primary ingredients in a third fat-free margarine were water, food starch and modified maltodextrin. Some 'performance characteristics' of the products of lowest fat content were markedly different from those of higher fat products. In general, the reduced fat margarines or spreads (those < ~45% fat) were recommended only for spreading or topping use and were not recommended for baking or frying. Several cautioned against freezing.

Fat

The standard of identity for margarine specifies that the product contain not less than 80% fat. While 'total fat' content must be declared on the new food labels, there are no specifications for levels of fat in the new modified-fat margarine-like products. However, use of claims on the products requires conformance with specific standards. Products bearing 'fat-free' claims must contain < 0.5 g of fat per serving, while products bearing 'lower in fat' or 'reduced fat' claims must contain at least 25% less fat than appropriate reference foods.

Total fat contents of the products, calculated from label declarations of g fat per serving of 14 g, ranged from 0 to about 80% (Table 1). Analyzed values for fat ranged from less than 3 to 81% and, with the exception of values for one product, agreed well with values calculated from the nutrition label. The analyzed value for

Table 1. Total fat and α-tocopherol in margarines and margarine-like products

Product		Ingredient oils in order listed on label	Total fat		Vitamin E (α-tocopherol)		
			Label value %	Found %	Label value IU/100 g	(*N*)	Found IU/100 g
1	Soft margarine	Corn	78.6	77.0	—	(8)	30.5 ± 7.3
2	Unsalted margarine	Corn	78.6	78.1	—	(2)	23.9 ± 1.1
3	Unsalted margarine	Corn, soybn	78.6	81.1	—	(2)	10.5 ± 1.2
4	Margarine	Canol/corn/soybn	78.6	80.2	—	(2)	7.6 ± 0.04
5	Vegetable margarine	Soybn	78.6	79.1	—	(2)	5.2 ± 1.6
6	Blended margarine	Canol/soybn/corn	78.6	77.4	—	(2)	4.3 ± 0.5
7	Vegetable oil spread	Sunflwr, soybn, cotnseed	71.4	68.5	32.1	(11)	23.1 ± 2.0
8	Vegetable oil spread	Soybn	71.4	68.7	—	(2)	6.9 ± 0.5
9	Corn oil spread	Corn	53.3	53.8	—	(2)	12.5 ± 2.3
10	Vegetable oil spread	Soybn	50.0	52.0	—	(2)	5.5 ± 0.1
11	Vegetable oil spread	Soybn	50.0	50.8	—	(3)	3.5 ± 0.8
12	Light margarine	Sunflwr, soybn, cotnseed	42.9	40.7	21.4	(5)	15.1 ± 1.4
13	Spread	Soybn	42.9	39.1	—	(2)	4.3 ± 0.4
14	Vegetable oil spread	Canol, soybn, sunflwr, cotnseed	28.6	24.8	—	(2)	4.0 ± 1.3
15	Lower fat margarine	Canol, corn	32.1	35.3	—	(4)	3.1 ± 0.8
16	Lower fat margarine	Canol, soy	14.3	19.1	—	(3)	4.5 ± 2.3
17	Fat-free spread	Corn	0	2.9	—	(4)	1.0 ± 0.3
18	Fat-free margarine	None	0	2.5	—	(8)	0.6 ± 0.2
19	Fat-free margarine	Vegetable mono-, diglycerides	0	2.6	—	(3)	0.5 ± 0.1

Total fat and vitamin E were measured as described above. Ingredient oils are listed in their order of appearance on product labels. The ingredient statement 'and/or' is represented by '/'. Values are means (fat) or means ± SD (α-tocopherol) of determinations on (*N*) lots of the products. Label values for total fat were calculated from label declarations of fat content per serving. Label declarations of vitamin E content were converted to IU α-tocopherol/100 g. '—' indicates that no value for vitamin E was included on the label. Abbreviations: Canol, canola; soybn, soybean; sunflwr, sunflower; cotnseed, cottonseed.

Table 2. α-Tocopherol in vegetable oils

Product	Ingredient oils in order listed on label	Vitamin E (α-tocopherol)		
		Label value IU/100 g	(*N*)	Found IU/100 g
Sunflower oil	Sunflwr	—	(3)	37.6 ± 1.0
Blended vegetable oil	Canol/sunflwr/soybn	42.9	(2)	32.7 ± 0.9
Canola oil	Canol	—	(2)	28.4 ± 1.6
Corn oil	Corn	32.1	(3)	22.4 ± 2.0
Vegetable oil	Soybn	21.4	(4)	9.2 ± 1.0

Vitamin E was measured as described above. The ingredient statement 'and/or' is represented by '/'. Label declarations of vitamin E content were converted to IU α-tocopherol/100 g; '—' indicates that no value for vitamin E was included on the label. Values for α-tocopherol are means ± SD of determinations on (*N*) lots. Abbreviations: Canol, canola; sunflwr, sunflower; soybn, soybean.

fat in one reduced-fat margarine product (#16) was about 34% higher than the value calculated from the label.

Vitamin E

The HPLC system used in this study separated the primary isomers of tocopherol (e.g. α-, γ- and δ-tocopherol) (Fig. 1, panel A). The patterns of tocopherol isomers found in various margarines and margarine-like products are shown in Fig. 1, panels B and C, and in Fig. 2, panels A–C. The predominant isomer in the products examined in this study was γ-tocopherol. Figure 1, panel B shows the profile of an extract of product 14, a vegetable oil spread containing 29% fat and labeled as containing canola, soybean, sunflower, and cottonseed oils. Figure 1, panel C shows the profile of an extract of product 16, a margarine of 14% fat content labeled as containing canola and soy oils. γ-Tocopherol is the predominant isomer in both products 14 and 16; the relative heights of the δ and α peaks differ. Figure 2, panel A shows the profile of an extract of product 8, a vegetable oil spread of 71% fat content labeled as containing soybean oil; Fig. 2, panel B shows the profile of an extract of product 4, a margarine of 79% fat content labeled as containing a blend of canola and/or corn and/or soybean oils; and Fig. 2, panel C shows the profile of an extract of product 3, an unsalted margarine of 79% fat content labeled as containing corn and soybean oils. The δ-isomer is particularly apparent in products 8 and 4. Among the oils studied, soybean oil is the richest source of δ-tocopherol.

The α-tocopherol contents of the margarines and margarine-like products are shown in Table 1. The products are listed in order of decreasing fat content (calculated from label declarations) and, within groups of products of similar fat content, in order of decreasing α-tocopherol content. Two of the 19 products analyzed declared vitamin E content on their labels. Of the three products containing the highest levels of vitamin E (20–30 IU/100 g), only one declared this nutrient on the label. Levels of 20–30 IU α-tocopherol/100 g provide 9.3–14.0% of the DV for vitamin E per serving.

Three other products contained 10–20 IU/100 g (equivalent to 4.7–9.3% of the DV for vitamin E per serving, and the remaining products had negligible levels ($< 5\%$DV per serving).

Among the vegetable oils examined, sunflower oil had the highest concentration of α-tocopherol, followed by canola, corn and soybean oils (Table 2). Speek *et al.* (1985) and Carpenter (1979) analyzed vitamin E isomers in seed oils and commercially processed vegetable oils. Concentrations of α-tocopherol in seed oils were reported in the order sunflower > safflower > maize germ > soybean (Speek *et al.*, 1985). In processed

Table 3. Vitamin A in margarines and margarine-like products

Product			Vitamin A — label values			Vitamin A — analyzed values		
			Retinol	As β-carotene	Total vitamin A	Retinol	Retinol eq. from β-carotene	Total vitamin A
		(*N*)	IU/100 g	IU/100 g	IU/100 g	IU/100 g	IU/100 g	IU/100 g
1	Soft margarine	(2)	—	—	3571	2860 ± 670	1050 ± 210	3910 ± 880
2	Unsalted margarine	(2)	2500	1071	3571	2990 ± 110	1020 ± 50	4010 ± 160
3	Unsalted margarine	(2)	—	—	3571	1680 ± 60	640 ± 140	2320 ± 200
4	Margarine	(2)	—	—	2143	3180 ± 110	1010 ± 40	4190 ± 150
5	Vegetable margarine	(2)	—	—	3571	3200 ± 160	1260 ± 50	4460 ± 210
6	Blended margarine	(2)	—	—	2857	2020 ± 210	330 ± 0	2350 ± 210
7	Vegetable oil spread	(5)	2142	1429	3571	2210 ± 170	1320 ± 230	3530 ± 140
8	Vegetable oil spread	(2)	—	—	3571	2040 ± 109	1060 ± 170	3100 ± 280
9	Corn oil spread	(2)	2667	666	3333	3140 ± 210	650 ± 60	3790 ± 270
10	Vegetable oil spread	(2)	—	—	3571	3150 ± 300	670 ± 30	3810 ± 270
11	Vegetable oil spread	(2)	—	—	3571	2790 ± 270	980 ± 70	3770 ± 350
12	Light margarine	(2)	2142	1429	3571	1610 ± 190	1140 ± 50	2740 ± 230
13	Margarine	(2)	—	—	3571	2590 ± 180	410 ± 30	3010 ± 210
14	Vegetable oil spread	(4)	2500	1071	3571	2580 ± 390	400 ± 30	2980 ± 410
15	Lower fat margarine	(4)	357	3214	3571	3040 ± 440	660 ± 30	3700 ± 460
16	Lower fat margarine	(2)	2678	893	3571	2410 ± 320	600 ± 0	3010 ± 330
17	Fat-free spread	(3)	2334	999	3333	2030 ± 590	620 ± 110	2640 ± 690
18	Fat-free margarine	(3)	2500	1071	3571	1740 ± 230	370 ± 50	2110 ± 190
19	Fat-free margarine	(2)	3035	536	3571	2640 ± 10	530 ± 20	3170 ± 010

Label values for retinol and retinol equivalents from β-carotene were calculated from label declarations of vitamin A and β-carotene content. For ease of comparison, label declarations were converted to IU/100 g; '—' indicates that no value was included on the label. Analyzed values for retinol and retinol equivalents from β-carotene are means ± SD of determinations on (*N*) lots of the products. 'Total vitamin A' was calculated for each analysis of each product by summing the values for retinol and retinol equivalents from β-carotene. Calculations were then performed to obtain the mean ± SD for all measurements of retinol and β-carotene and for all calculated values for total vitamin A. Values were then rounded. In four instances (products 10, 12, 13 and 17), the sum of the rounded mean values for retinol and β-carotene differ slightly from the rounded total vitamin A values obtained as described above. Abbreviations: β-caro, β-carotene; eq., equivalent.

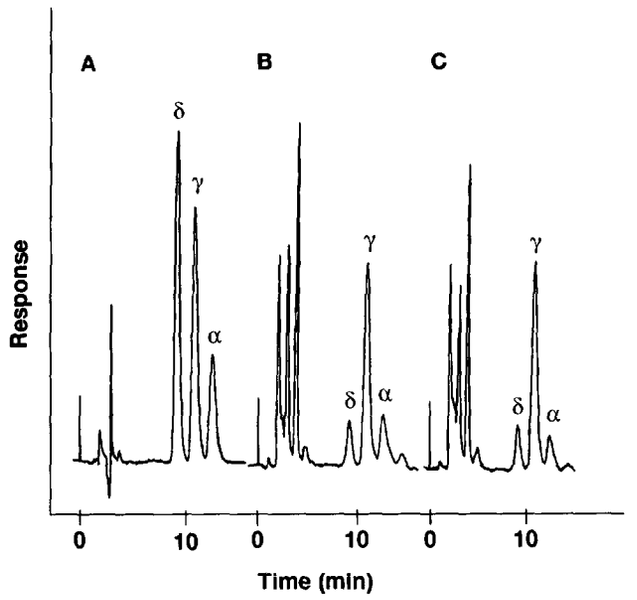

Fig. 1. Separation of α-, γ- and δ-tocopherols by reverse-phase HPLC on a μ-Bondapak column with methanol:water 94:6 as the mobile phase. Panels (A)–(C) show profiles of vitamin E isomers from: (A) mixture of pure standards of α-, γ- and δ-tocopherols; (B) extract of product 14, a vegetable oil spread of 29% fat content labeled as containing canola, soybean, sunflower, and cottonseed oils; (C) extract of product 16, a margarine of 14% fat content labeled as containing canola and soy oils.

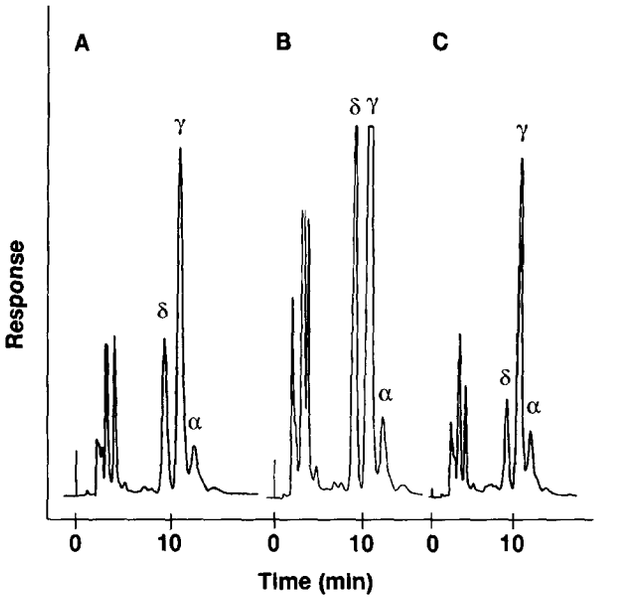

Fig. 2. Separation of α-, γ- and δ-tocopherols by reverse-phase HPLC on a μ-Bondapak column with methanol:water 94:6 as the mobile phase. Panels (A)–(C) show profiles of vitamin E isomers from: (A) extract of product 8, a vegetable oil spread of 71% fat content labeled as containing soybean oil; (B) extract of product 4, a margarine of 79% fat content labeled as containing a blend of canola and/or corn and/or soybean oils; (C) extract of product 3, a margarine of 79% fat content labeled as containing corn and soybean oils.

vegetable oils, α-tocopherol concentrations varied as follows: sunflower > cottonseed > safflower > corn > soybean (Carpenter, 1979). Our findings of α-tocopherol levels in oils in the order sunflower > canola > corn > soybean are in general agreement with those reported above.

When the margarines and margarine-like products in the present study were arranged by vitamin E (α-tocopherol) content within groups of margarines of similar fat content, it can be seen that those labeled as containing corn, sunflower, and cottonseed oils had the highest levels of vitamin E. Products labeled as containing soybean oil contributed less vitamin E.

Vitamin A and β-carotene

According to the standard of identity for margarine, margarines must include vitamin A in such quantity that the finished margarine contains not less than 15 000 international units per pound (i.e. about 3304 IU/100 g). Under regulations implementing the NLEA, food labels must declare the amount of vitamin A present. Current labeling regulations also allow a voluntary statement of the percent of vitamin A in a product that is present as β-carotene.

All margarines and margarine-like products contained vitamin A (added as the palmitate) in concentrations ranging from 5 to 10% of the DV per serving (i.e. 250–500 IU/14 g). Analyzed concentrations of total vitamin A in the products were 59–196% of amounts declared on the labels (Table 3).

β-Carotene, a commonly used, stable food colorant, also provides a source of vitamin A. All products identified β-carotene as a colorant. Although regulations do not require the identification of the percent of total vitamin A present as β-carotene, this information was provided for 10 of the 19 products examined. With one exception, these amounts ranged from 20 to 40% of the total vitamin A content. The label of one product (product 14) stated that 90% of the vitamin A was present as β-carotene. However, analysis showed that retinol was the predominant form of vitamin A in the product, with β-carotene representing about 20% of the total, rather than 90%.

CONCLUSIONS

The results of the analysis of 19 margarine or margarine-like products containing 3–80% fat indicated that α-tocopherol content was highly variable. α-Tocopherol varied among traditional margarines (those of 80% fat content) because of differences in α-tocopherol content of the oils (e.g. corn, canola, soybean, etc.) used in their manufacture. The highest α-tocopherol contents among the higher-fat margarines were found in products labeled as containing corn and sunflower oils. Among

oils of similar composition, α-tocopherol content declined with decreasing fat content (e.g. products 1 and 9). Products labeled as containing soybean oil had among the lowest levels of α-tocopherol measured.

Among the products examined, values for total vitamin A (retinol plus retinol equivalents from β-carotene) were 59 (product 18) to 196% (product 4) of label values.

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