tate-oleate peak (R = 0.8) with acetonitrile/water 9:1, but nearly completely resolved (R = 1.3) with solvent ratio 85:15. Table II compares the values of percent abundance of malvalate and sterculate in several samples obtained by HPLC, with the values obtained by the NMR-GLC method. As mentioned, NMR is used to obtain the total cyclopropene content of a sample, while the silver nitrate derivative (13) method is used only to determine the sterculate to malvalate ratio. Experience indicates that variation between samples can be considerable for the silver nitrate-GLC method and the mean value may differ from that for the NMR method by as much as 1-2%. Total cyclopropene content from NMR and HPLC analyses consistently agrees fairly well, but HPLC has the obvious advantage of distinguishing between malvalate and sterculate and providing a partial fatty acid profile.

ACKNOWLEDGMENTS

Thomas Eisele performed some of the $AgNO_3$/GLC analyses. This work was supported by Public Health Service Grants CA25766 from the National Cancer Institute and ES00550 from the Division of Environmental Health Sciences. Technical Paper No. 5375, Oregon Agricultural Experiment Station, Oregon State University Corvallis, OR 97331.

REFERENCES

1. Sinnhuber, R.O., D.J. Lee, J.H. Wales and J.L. Ayres, J. Natl. Cancer Inst. 41:1293 (1968).
2. Lee, D.J., J.H. Wales and R.O. Sinnhuber, Cancer Res. 31:960 (1971).
3. Sinnhuber, R.O., D.J. Lee, J.H. Wales, M.K. Landers and A.C. Keyl, J. Natl. Cancer Inst. 53:1285 (1974).
4. Schoenhard, G.L., D.J. Lee, S.E. Howell, N.E. Pawlowski, L.M. Libbey and R.O. Sinnhuber, Cancer Res. 36:2040 (1976).
5. Hendricks, J.D., R.O. Sinnhuber, J.E. Nixon, J.H. Wales, G.B. Putnam, P.M. Loveland, M.S. Masri and D.P.H. Hsieh, Fed. Proc. 37:451 (1978).
6. Sinnhuber, R.O., J.D. Hendricks, G.B. Putnam, J.H. Wales, N.E. Pawlowski, J.E. Nixon and D.J. Lee, Ibid. 35:305 (1976).
7. Lee D.J., N.E. Pawlowski, J.H. Wales and R.O. Sinnhuber, Ibid. 31:2 (1972).
8. Pawlowski, N.E., P.M. Loveland and R.O. Sinnhuber, JAOCS 58:692 (1981).
9. Coleman, E.C., and D. Firestone, J. Assoc. Off. Anal. Chem. 55:1288 (1972).
10. Coleman, E.C., Ibid. 56:82 (1973).
11. Carter, F.L., and V.L. Frampton, Chem. Rev. 64:497 (1964).
12. Pawlowski, N.E., J.E. Nixon and R.O. Sinnhuber, JAOCS 49:387 (1972).
13. Schneider, E.L., S.P. Loke and D.T. Hopkins, Ibid. 45:585 (1968).
14. Daniels, F., and R.A. Alberty, Physical Chemistry (3rd edn.), John Wiley & Sons, Inc., New York, (1966), p. 674-675.

Fatty Acid Composition of the Fat in Selected Food Items with Emphasis on *trans* Components[1]

M.G. ENIG, L.A. PALLANSCH, J. SAMPUGNA and **M. KEENEY**, Chemistry Department, University of Maryland, College Park, MD 20742

ABSTRACT

The fat in 220 samples from 35 food types has been analyzed for component fatty acids by gas liquid chromatography on a 15-m capillary column coated with SP-2340. The methodology permitted the determination of *trans*-octadecenoic fatty acids in the food samples. For food types in which the majority of samples contained *trans* fatty acids, the range (weight percent of methyl esters) of this class of acids arranged by fat content of the food types was: high fat levels (>70% fat) – animal and dairy fats, 0.3-6.6%, stick margarines, 15.9-31.0%, tub margarines, 6.8-17.6%, and vegetable shortenings, 8.7-35.4%; moderately high fat levels (40-70% fat) – diet margarines, 11.3-13.3%; moderate fat levels (10-40% fat) – breading mixes and fried crusts, 8.1-32.7%, cakes, candies and frostings, 3.2-33.2%, cream substitutes, 0.4-11.5%, cookies, 2.5-34.2%, crackers, 1.9-29.0%, pastries and pastry crusts, 0.6-31.2%, corn and mixed grain snack chips, 0.4-30.4%; low fat levels (<10% fat) – breads and rolls, 0.2-23.6%, pretzels, 10.8-29.2%, and puddings, 28.4-35.1%. The majority of samples in the following food types did not contain *trans* fatty acids, except in cases where the label indicated partial hydrogenation of the oil: mayonnaises and salad dressings, salad and cooking oils and potato chips. For samples in these three food types which contained *trans* fatty acids, the range was 0.2-23.2%. None of the peanut butters or pizza crusts analyzed contained *trans* fatty acids.

INTRODUCTION

The level and pattern of fat consumed by Americans has changed considerably during the 20th century. Between 1910 and 1978 there was a 27% increase in the total dietary fat intake with most of the increase being due to vegetable fats (1,2). In recent years the shift from animal fat to vegetable fat consumption has been encouraged with the intention of increasing the levels of dietary polyunsaturated fatty acids at the expense of saturated fatty acids. However, the resulting alterations are more complex than may be recognized, as the majority of vegetable fats consumed by Americans are modified chemically by partial hydrogenation procedures designed to convert the original oils to products with economically desirable physical properties.

These hydrogenation procedures result in the conversion of variable amounts of the naturally occurring *cis* polyunsaturated 18-carbon fatty acids into a variety of isomers of oleic and linoleic acid, including considerable quantities of *trans* fatty acids. Consequently, the fatty acid composition of the processed vegetable fat consumed is quite different from that listed in handbooks for the original oils.

With the advent of glass capillary gas liquid chromatography, it is now possible to obtain more information on the fatty acid composition of foods which contain *trans* fatty acids. Previously reported analyses have included butters, margarines, shortenings and oils (3-7) in addition to some fast foods (8,9) and meats (9). This report extends the data on the *trans* fatty acid content and fatty acid composition of the fats in these foods as well as a variety of foods not previously reported.

MATERIALS AND METHODS

Materials

Unless otherwise noted, all solvents employed in this study were reagent grade or better. Fatty acid methyl ester standards (99% purity) were purchased from Nu Chek Prep. Inc. (Elysian, MN). Food items were purchased over a 24-month period (1978-80) from local supermarkets, stores, bakeries, restaurants and fast-food outlets. An attempt was made to select primarily national brands of items purchased from supermarkets. A total of 220 different food items

[1]Presented in part at the ISF-AOCS World Congress, New York, April 1980.

TABLE I

Code Table

Sources	
S	Supermarket
B	Bakery
R	Restaurant or cafeteria
H	Health food store
W	Wholesale broker
V	Vending machine

Fat ingredient(s) according to label	
af	Animal fat
bf	Beef fat (tallow)
bu	Butter
co	Corn oil
cn	Coconut oil
cs	Cottonseed oil
h	Partially hydrogenated
ld	Lard
lf	Lamb fat (tallow)
m	Margarine
mo	Marine oil
oo	Olive oil
p	Palm oil
pk	Palm kernel oil
pn	Peanut oil
sf	Safflower oil
s	Soybean oil
su	Sunflower oil
sh	Shortening
uk	Unknown
vo	Vegetable oil
vs	Vegetable shortening

Food types[a]	
1.	Beef tallow, loin (80)
2.	Breads (2-4)
3.	Breadings and crusts (4-22)
4.	Butter (80)
5.	Cakes (12-30)
6.	Candy (6-15)
7.	Cereal (1-3)
8.	Cookies: animal or graham cracker (10)
9.	Cookies: wafer (15)
10.	Cookies: sandwich or tea (20)
11.	Cookies: shortbread (25)
12.	Crackers: soda (12)
13.	Crackers: savory (24)
14.	Cream substitutes (10-40)
15.	French fried potatoes (9-16)
16.	Frostings (6-15)
17.	Lamb tallow, loin (70)
18.	Lard (100)
19.	Margarine: diet (40-60)
20.	Margarine: stick (80)
21.	Margarine: tub or soft (80)
22.	Mayonnaise (80)
23.	Oils: commercial (restaurant and packing) (100)
24.	Oils: salad and cooking (home use) (100)
25.	Pastries: Danish or sweet roll (23)
26.	Pastries: doughnuts or piecrusts (33)
27.	Peanut butter (50)
28.	Pizza crusts (5-8)
29.	Pretzels (5)
30.	Pudding (2-5)
31.	Rolls (3-8)
32.	Salad dressing (40-80)
33.	Shortening (100)
34.	Snack chips: corn and mixed grains (25-35)
35.	Snack chips: potato (40)

[a]Number(s) in parentheses after food type is approximate or range of percent fat according to Agriculture Handbook No. 8, Agricultural Research Service, U.S. Department of Agriculture, Washington, D.C.

were analyzed. The type of food, percent fat content of the food, source and type of lipid (where known) have been tabulated in code from (see Table I).

Extraction and Analysis

Most food items were extracted and submitted to analysis shortly after they were purchased. When the time between purchase and analysis was longer than normally encountered in the home, foods were stored and refrigerated (4 C) or frozen (-20 C) as appropriate for the individual food item. Duplicate samples of all food items were extracted with methylene chloride containing 1% butylated hydroxytoluene (w/v) and filtered through anhydrous sodium sulfate. Samples such as oils were simply dissolved in the solvent, whereas others such as crackers were homogenized in the solvent.

Aliquots of the extracted, filtered lipid in 1.5 mL of methylene chloride were transesterified at room temperature for 72 hr in the dark, using 2 mL of 0.6 N sulfuric acid in methanol. After the addition of 4.5 mL of hexane and 2 mL of water the methyl esters were extracted, concentrated under N_2 and purified by thin layer chromatotraphy (TLC) using Silica Gel G (E. Merck, Elmsford, NY) as adsorbent and petroleum ether/diethyl ether (95:5, v/v) as the developing solvent. Following visualization under UV, the methyl ester band was scraped from the TLC plate, transferred to a column fitted with a plug of glass wool and the purified fatty acid methyl esters (PFAME) were eluted from the adsorbent with 4 column volumes of methylene chloride. The PFAME were concentrated under N_2 and dissolved in glass distilled isooctane (Burdick and Jackson Labs, Muskegon, MI) at a concentration of 25 mg/mL.

The PFAME were analyzed by glass capillary gas liquid chromatography (GCGLC) using 15-m GCGLC columns coated with SP-2340 (Quadrex Corp. New Haven,CT) and a Hewlett-Packard 5830A gas chromatograph (Avondale, PA) which was modified to accept glass capillary columns. Early in the study, appropriate correction factors were established using infrared spectrophotometry and combinations of GCGLC and argentation TLC. Complete details on the GCGLC procedure and the methods used to quantify the *trans*- and *cis*-octadecenoate components (*trans*- and *cis*-18:1) are published elsewhere (10).

RESULTS AND DISCUSSION

Analyses and Presentation Format

The 15-m capillary column used in these analyses gave excellent separation of *trans*- and *cis*-18:1, when only the 9-*trans* and 9-*cis* isomers were present. Due to the mixture of positional isomers present in samples derived from partially hydrogenated oils, the separation between the *trans*- and *cis*-18:1 peaks was less complete. Nevertheless, with the use of correction factors computed as described elsewhere (10), quantitative data could be obtained on fatty acid mixtures derived from samples containing 18:1 geometric isomers.

In addition, the 15-m column provided partial resolution of several other geometrical and positional isomers, which were not listed separately in Table II. Thus, PFAME derived from partially hydrogenated fats often yielded two peaks in the *cis*-18:1 area, a major one corresponding to 9-*cis*-18:1 and a minor peak which had a retention time identical to

TABLE II

Fatty Acid Composition of Fat in Selected Foods as Weight Percent of Methyl Esters[a]

No.	Code	12:0	14:0	16:0	16:1	18:0	18:1t	18:1c	18:2i	18:2c	18:3c	Others[b]
Animal and dairy fats												
1.	S 1 bf	0.1	4.2	28.1	1.8	14.6	1.8	37.4	–	2.3	0.4	9.3
2.	S 17 lf	0.5	6.7	24.8	2.1	20.9	6.6	26.4	–	2.6	1.1	8.4
3.	S 4 bu	2.8	12.4	33.2	2.4	13.2	3.2	23.6	–	2.2	0.6	6.5
4.	S 4 bu	3.5	12.8	32.6	2.1	13.8	3.1	22.2	–	2.2	0.4	7.2
5.	S 4 bu	4.0	12.7	31.6	2.1	13.0	3.8	21.8	–	2.4	0.4	8.2
6.	S 18 ld, hld	–	1.4	24.8	3.2	14.2	0.3	42.4	–	12.0	–	1.6
Breads and rolls												
7.	S 2 hld	–	1.2	22.7	2.2	11.0	0.2	38.2	–	22.4	2.0	0.1
8.	S 2 hs	1.1	0.6	12.3	tr	7.0	10.8	28.8	2.0	35.6	1.6	tr
9.	S 2 hs	–	tr	11.2	tr	8.5	14.4	31.5	2.8	29.4	1.6	0.6
10.	S 2 hs,/hcs,/hp	–	0.3	26.9	0.2	4.6	3.3	26.4	–	35.0	3.2	0.1
11.	S 2 hs,/hcs,/hp	–	0.4	24.0	0.2	4.6	2.8	24.9	–	39.4	3.6	tr
12.	S 2 hs,hp,/hcs	–	0.5	14.2	tr	9.5	23.6	32.4	4.3	15.0	0.6	tr
13.	S 2 s	–	tr	11.2	tr	3.2	–	23.2	–	56.3	5.8	tr
14.	S 2 hs	–	tr	12.0	0.4	6.0	1.8	23.4	–	50.1	6.1	tr
15.	S 2 hs	11.2	6.2	12.3	tr	6.4	8.7	25.8	1.7	26.3	1.4	tr
16.	R 31 uk	5.0	2.2	12.3	tr	8.0	21.2	31.8	3.0	15.4	0.9	0.2
Breading mixes and fried crusts												
17.	S 3 hs,hcs	–	0.7	22.0	0.3	27.0	32.7	11.8	0.8	4.5	0.2	0.2
18.	R 3 uk	–	–	12.4	–	3.3	–	24.4	–	57.3	2.6	–
19.	R 3 vouk	–	–	11.1	–	2.4	–	46.2	–	35.0	1.4	4.4
20.	R 3 uk	–	–	11.2	0.2	4.0	–	23.6	–	54.6	5.6	0.4
21.	R 3 uk	tr	0.5	11.6	0.2	8.6	8.1	34.6	4.0	31.3	1.4	tr
22.	S 3 hs	tr	tr	10.9	tr	5.1	8.9	34.1	5.4	34.5	1.2	tr
23.	S 3 hs,hp/hcs	tr	tr	11.1	tr	5.6	11.4	36.5	3.8	30.6	0.9	tr
24.	S 3 shuk	tr	0.4	11.5	tr	12.8	25.4	36.0	2.6	11.1	tr	tr
Cakes												
25.	S 5 hs	7.9	3.2	9.8	–	3.8	9.3	46.5	0.8	16.4	0.3	2.1
26.	B 5 vsuk	0.4	0.4	21.6	–	11.4	20.8	39.0	0.7	5.7	–	–
27.	B 5 vouk	–	0.3	11.0	0.4	3.6	–	28.2	0.1	50.6	5.4	0.5
28.	B 5 vsuk	–	tr	15.4	0.5	10.5	21.1	38.1	2.9	11.4	tr	tr
Candy and frostings												
29.	S 6. hpn,hp	0.7	1.7	26.2	0.6	28.4	3.2	35.6	–	3.4	tr	0.1
30.	H 6 hcs,hs	2.8	1.4	16.6	0.2	11.8	33.2	26.8	5.4	1.4	–	0.4
31.	S 6 pk,bu	29.9	17.7	19.2	–	15.0	–	15.8	–	1.1	–	0.2
32.	S 6 hpn,hp	6.6	5.3	28.2	0.2	28.0	tr	29.8	–	1.8	–	–
33.	S 6 hvouk	0.5	3.3	27.6	1.0	25.4	4.1	34.2	0.2	3.6	–	tr
34.	H 6 vouk	–	tr	13.2	tr	9.8	20.6	38.3	3.6	14.4	tr	tr
35.	B 16 vsuk	0.3	0.2	16.0	–	13.6	26.3	37.1	1.6	5.0	–	–
36.	S 16 ld,hcn,hs,hpk,hp	20.5	9.4	16.0	0.8	13.1	11.0	22.5	0.6	5.1	–	1.4
37.	S 16 hcs,hs	–	0.4	16.2	0.4	14.0	26.6	28.6	6.1	8.0	–	0.4
Cream substitutes, cereals and puddings												
38.	S 14 hcn,hcs,hp,hpk,hsf/hs	46.7	24.4	12.7	–	12.5	1.4	0.5	–	–	–	1.8
39A.	R 14 vsuk	28.9	21.0	16.0	0.4	24.0	2.1	6.6	–	0.9	–	tr
39B.	R 14 vsuk	41.4	21.4	13.2	tr	19.2	1.4	3.4	–	tr	–	tr
40.	S 14 hcn,pk	44.3	20.0	12.6	–	17.8	0.4	0.4	–	tr	–	4.8
41.	S 14 hcs,hs	3.9	1.8	11.8	0.1	5.8	11.5	20.8	2.2	39.7	1.2	0.1
42.	S 7 hs	1.4	0.9	16.6	–	56.4	–	7.4	–	16.6	0.6	tr
43.	S 30 hs	0.6	0.3	9.9	–	7.5	28.4	45.2	2.1	6.0	–	–
44.	S 30 hs	–	–	12.4	–	16.5	35.1	32.2	1.0	2.6	–	0.2
Cookies												
45.	S 8 hs,hp,hcs	–	0.1	11.2	0.3	9.8	32.8	31.0	4.0	8.8	0.3	1.6
46.	S 8 hs,hp,hcs	–	0.1	11.8	0.3	8.3	31.0	34.2	3.6	8.9	1.1	0.7
47.	S 8 hs,p/ld	–	1.4	25.0	3.2	14.1	–	41.6	–	12.8	0.6	1.4
48.	S 8 bf	0.2	2.8	26.6	2.6	19.6	2.5	40.3	–	2.8	–	2.7
49.	S 8 hs,p,hp	–	0.1	10.0	0.2	8.8	31.6	35.3	5.8	8.5	0.2	–
50.	S 9 hs,hp,hcs	–	1.3	12.3	0.4	8.8	32.4	34.0	4.2	6.0	0.2	0.2
51.	R 9 uk	–	–	12.7	–	7.6	18.4	27.2	–	31.0	3.0	tr
52.	S 10 p,/s,/bf	–	2.8	22.6	1.6	8.3	13.5	36.4	3.8	9.4	0.3	0.4
53.	S 10 hbf/hs,/ld,/p	–	2.6	25.3	3.0	13.0	–	41.4	–	12.9	0.7	1.2
54.	S 10 hs,/p,/ld	tr	0.8	21.0	1.6	12.0	14.7	39.6	1.6	9.0	0.4	0.9
55.	S 10 hs,hcs,hp,hpn,/cn	0.1	0.4	19.8	0.6	8.9	15.4	43.4	3.4	7.8	0.3	0.3
56.	B 10 vsuk	1.1	0.8	19.8	0.2	11.0	15.9	36.4	5.0	9.8	–	–
57.	S 10 vsuk	0.6	1.3	14.8	–	13.4	27.6	24.2	–	18.2	tr	–
58.	S 10 hs,/p,/cs,/bf	–	0.1	14.2	–	12.2	29.8	38.4	0.5	5.0	–	–
59.	S 10 hs,/hcs,cn	20.0	8.3	15.5	–	12.7	15.2	25.1	0.1	2.0	0.4	0.9
60.	S 10 ld,hcn,hs,hpk,hp	6.0	4.0	22.3	2.0	13.5	3.6	33.5	–	10.5	0.3	4.3
61.	S 10 hp,/hs	–	0.8	19.2	1.4	13.3	17.8	35.6	1.3	9.8	0.2	–
62.	B 10 vsuk	1.7	3.0	16.6	0.6	11.8	18.8	30.5	3.8	12.8	0.2	0.3
63.	S 10 hs,hp,hcs	–	tr	10.2	tr	8.2	34.2	38.4	3.2	5.7	tr	tr
64.	S 11 ld,/hvouk/p	11.3	5.7	22.4	1.2	11.4	–	36.6	–	10.1	0.4	0.7
65.	S 11 hs,hcs	1.5	0.4	12.2	–	7.8	14.4	48.6	0.6	14.6	–	–

TABLE II (continued)

No.	Code	12:0	14:0	16:0	16:1	18:0	18:1t	18:1c	18:2i	18:2c	18:3c	Others[b]
66.	H 11 vsuk,pn	–	–	11.9	0.4	6.9	11.4	41.2	2.5	23.8	–	1.6
67.	H 11 bu	1.4	7.4	31.1	0.6	7.8	tr	23.9	–	26.0	0.9	1.0
68.	B 11 vsuk	1.0	0.6	12.2	0.1	10.7	16.0	48.2	1.8	9.6	tr	tr
69.	B 11 vsuk	–	tr	13.9	tr	11.1	20.2	35.6	4.8	14.4	tr	tr
Crackers												
70.	S 12 ld/hs,p	–	1.4	24.6	3.3	11.9	–	42.3	–	14.5	0.6	1.1
71.	S 12 cn,/hmo,/pk,/vouk,/bf	1.1	2.8	23.2	3.4	17.2	3.9	37.8	–	8.0	1.6	1.1
72.	S 12 vsuk	–	tr	10.6	–	8.5	29.0	37.2	2.6	12.2	tr	tr
73.	S 13 hs/cn,ld	–	0.6	16.8	1.5	10.6	20.2	39.1	2.6	7.7	0.2	0.6
74.	S 13 hs,/hcs,/hp,/hpn,cn	36.1	17.9	16.8	0.1	4.2	2.2	15.6	0.6	4.4	0.1	2.0
75.	S 13 hs,/hcs,/p,/cn	–	0.3	11.8	0.4	9.2	15.4	38.8	3.4	20.0	0.4	0.4
76.	S 13 hs/cn,ld	–	0.3	13.3	0.6	9.6	19.6	39.6	4.2	12.4	0.2	0.3
77.	S 13 hs,hcn,hp,hcs	28.8	12.9	11.3	0.1	5.9	13.6	18.2	1.4	4.2	0.1	3.5
78.	S 13 hs,/p	1.4	0.6	9.7	0.3	5.6	3.0	39.0	–	38.0	1.2	0.8
79.	S 13 cn,ld	32.0	12.8	15.4	0.4	5.2	–	20.6	–	10.9	–	2.8
80.	S 13 hs,/hcs,/hcn	27.5	17.8	20.7	0.4	7.5	6.3	15.7	–	2.6	–	1.7
81.	S 13 hs,hcn,hp,hcs	32.0	14.6	11.7	–	5.4	13.6	16.4	0.5	4.0	–	1.7
82.	S 13 hs,/hp,/hcs	1.8	1.9	17.6	1.3	12.6	4.1	33.7	0.4	23.4	3.2	tr
83.	S 13 hs/cn,ld	–	0.8	15.1	0.9	10.0	21.8	38.6	2.6	10.4	tr	tr
84.	S 13 hs,hp,hcs	–	0.2	10.6	–	8.6	23.4	35.4	2.2	19.6	tr	tr
85.	S 13 cn,p,hs	20.4	9.0	11.2	tr	6.3	15.7	21.6	2.8	11.8	tr	1.2
86.	S 13 cn,bu,hs,hcs	37.8	17.8	13.6	0.4	5.4	3.7	13.6	0.2	3.9	tr	3.7
87.	S 13 bu,cn	32.2	19.4	20.4	1.0	6.4	tr	15.0	–	3.4	tr	2.2
88.	R 13 hs,hp,hcs	22.4	9.2	9.8	0.2	5.6	19.1	21.7	3.2	4.3	0.1	3.1
89.	V 13 ld,cn,/cs,/p	0.2	0.4	13.8	0.6	5.0	1.9	42.0	0.4	31.5	0.2	4.0
French fried potatoes												
90.	R 15 uk	–	3.0	31.0	2.5	20.8	4.6	34.0	–	1.6	–	2.4
91.	R 15 uk	–	0.8	14.8	1.0	10.6	10.2	33.4	3.2	24.5	1.4	tr
92.	R 15 uk	–	3.2	27.1	3.6	18.5	4.8	36.0	0.3	6.0	0.2	tr
93.	R 15 uk	–	3.5	29.0	3.9	19.7	4.8	35.7	–	3.4	–	tr
94.	R 15 uk	–	3.1	27.4	3.6	19.8	6.0	36.2	0.2	3.6	–	tr
95.	R 15 uk	–	0.2	13.5	0.8	5.7	11.8	36.6	2.4	27.8	1.4	tr
96.	R 15 uk	–	–	13.6	–	7.8	35.1	37.3	2.3	4.0	–	tr
97.	S 15 p/hs	tr	1.1	45.6	0.2	4.6	tr	37.8	tr	10.8	–	tr
98.	S 15 hs,hcs	–	tr	10.1	tr	7.9	33.6	42.8	2.6	3.0	–	tr
99.	S 15 p/hs	tr	1.0	45.2	tr	4.6	tr	39.4	–	9.8	tr	tr
100.	S 15 hs,hp/hcs	tr	tr	10.9	tr	4.2	16.5	39.1	2.9	25.6	0.7	tr
Margarines												
101.	S 19 hs,hp,p	tr	0.2	13.6	0.2	6.3	11.3	29.9	5.0	29.8	2.2	1.4
102.	S 19 hs	tr	0.1	10.6	0.2	6.9	13.3	31.2	3.6	30.1	3.0	1.3
103.	S 19 hs,hco	–	0.1	11.0	0.2	7.0	11.3	25.8	1.4	37.8	4.0	1.3
104.	S 20 s,hs,hcs	–	0.1	12.2	0.2	7.6	22.0	28.6	2.2	24.2	2.5	tr
105.	S 20 hs,hp	–	0.2	14.5	0.2	8.2	19.8	28.5	4.9	22.4	1.2	tr
106.	S 20 hs	–	0.1	11.0	0.2	7.1	31.0	36.0	5.0	9.1	0.4	tr
107.	S 20 co,hco	–	tr	11.5	0.2	6.4	19.6	26.3	0.8	34.4	0.6	–
108.	S 20 sf,hs,hcs	–	0.1	9.2	0.2	8.5	15.9	21.2	2.1	42.4	0.2	–
109.	S 20 hs	tr	0.1	12.6	0.3	7.0	27.7	35.0	5.2	11.3	0.6	tr
110.	S 20 co,hs	0.1	0.1	11.8	0.2	6.9	19.1	26.7	1.4	33.2	0.4	–
111.	S 20 co,hco	–	tr	11.6	0.2	6.9	26.6	27.0	1.4	26.2	0.4	tr
112.	S 20 s,hs	–	0.1	10.8	0.2	9.0	22.4	27.6	2.4	25.2	2.2	tr
113.	H 20 s,hs	–	0.1	10.5	0.2	8.6	22.6	28.9	2.1	24.4	2.6	tr
114.	S 20 hs,hco	–	0.1	11.2	0.2	9.4	20.3	26.4	1.2	27.0	3.2	1.1
115.	S 20 hs,hco	–	0.1	11.2	0.2	9.8	19.9	27.1	1.7	26.1	2.6	1.1
116.	S 20 hs,hcs	–	0.7	11.8	0.3	8.4	27.8	38.9	3.4	8.2	0.2	0.2
117.	S 20 hs,hcs,s	–	0.5	14.6	0.7	10.2	23.2	28.4	4.9	14.8	1.5	1.3
118.	S 20 co,hco	–	tr	12.1	–	6.2	20.6	23.8	–	37.0	0.1	–
119.	S 20 s,hs	–	0.1	10.6	–	8.8	24.4	24.6	0.1	29.2	2.2	–
120.	S 20 s,hs	–	tr	10.8	–	8.0	24.6	26.8	–	27.4	2.1	–
121.	S 20 s,hs	–	–	10.2	–	8.3	22.6	23.2	–	33.4	2.4	–
122.	S 20 s,hs	–	–	10.4	–	8.8	23.2	24.4	–	30.6	2.6	–
123.	S 20 s,hs	–	0.1	11.4	0.2	9.6	22.0	26.6	1.0	26.4	2.6	0.4
124.	S 20,co,hco	–	tr	13.2	0.2	7.1	22.8	30.4	–	26.2	0.2	–
125.	S 20 hs,hco	–	0.1	13.0	0.1	11.6	24.2	23.7	1.3	24.2	1.8	tr
126.	S 20 hld	–	0.6	18.8	1.0	12.0	17.6	30.6	3.4	16.0	–	tr
127.	H 20 sf,hs	–	0.1	7.8	–	6.2	16.4	21.1	1.0	46.5	0.4	–
128.	S 21 s,hs	–	0.1	11.3	0.2	7.6	14.2	25.2	1.2	36.0	4.4	tr
129.	S 21 s,hs	–	0.1	11.4	0.2	6.9	10.5	29.2	1.2	36.7	3.8	tr
130.	S 21 hs	–	0.1	11.7	0.2	7.4	17.1	32.2	4.2	24.9	2.2	tr
131.	S 21 hs,hcs	–	0.1	10.4	0.2	4.9	6.8	32.6	3.8	37.7	3.4	tr
132.	S 21 hs	tr	0.1	11.1	0.2	6.8	13.2	31.0	3.4	30.4	3.4	0.9
133.	S 21 s,hs	–	0.1	11.6	0.2	7.8	17.6	27.5	2 2	29.9	2.6	0.9
134.	S 21 sf,hs,hcs	tr	0.1	8.6	0.2	6.6	12.2	21.3	2.2	48.4	0.3	0.4
135.	S 21 co,hco	–	tr	12.0	0.2	5.8	12.4	27.2	1.0	40.8	0.6	–
136.	S 21 hs,hcs	–	tr	11.2	–	7.0	12.0	35.9	1.7	30.8	1.2	tr
137.	S 21 s,hs,hco	–	0.1	10.7	0.2	6.6	10.2	26.0	1.0	38.2	4.6	1.5
138.	S 21 s,hs	–	–	18.1	0.2	10.0	13.0	50.0	–	8.6	–	–
139.	S 21 s,hs	–	–	10.4	–	5.9	12.6	23.8	–	44.0	3.2	–
140.	S 21 s,hs,hcs	–	–	10.6	–	5.4	13.8	23.6	0.1	43.8	2.7	–

TABLE II (continued)

No.	Code	12:0	14:0	16:0	16:1	18:0	18:1t	18:1c	18:2i	18:2c	18:3c	Others[b]
Mayonnaise and salad dressings												
141.	S 22 s	–	–	11.7	–	4.5	–	26.1	–	50.4	7.0	0.3
142.	S 22 s	–	0.4	14.3	–	5.4	–	29.6	–	40.8	6.5	3.0
143.	S 22 s	–	–	10.1	–	3.8	–	21.6	–	56.8	7.1	0.5
144.	S 22 s,hs	–	–	10.4	–	3.6	3.3	24.8	1.2	51.6	5.0	tr
145.	S 32 s	–	–	10.8	–	4.0	–	23.9	–	54.0	6.2	1.2
146.	S 32 vouk	–	–	11.0	–	4.2	–	23.1	–	54.4	6.8	0.5
147.	S 32 s	–	–	10.6	–	4.0	–	23.0	–	55.1	6.2	1.0
148.	S 32 s	–	0.4	11.0	–	4.0	–	22.8	–	54.5	7.2	tr
149.	S 32 s	–	–	10.5	–	4.0	–	23.2	–	55.6	6.8	tr
150.	S 32 s	–	–	10.4	–	3.8	–	22.8	–	55.8	7.0	tr
151.	S 32 s	–	–	11.2	–	3.6	–	22.0	–	56.4	5.8	1.0
152.	S 32 s,hs	–	–	9.6	–	3.6	2.8	25.2	1.8	50.6	6.4	–
Salad and cooking oils												
153.	R 23 cs	–	0.7	26.4	0.4	1.8	–	18.8	–	52.0	–	–
154.	R 23 cs	–	0.6	27.8	0.4	1.6	–	20.4	–	49.4	–	–
155.	S 23 vouk	–	0.4	14.4	0.9	4.9	–	29.7	–	44.9	4.4	0.3
156.	S 23 vouk	–	1.6	29.8	1.2	2.7	–	32.2	–	27.8	3.6	1.2
157.	S 24 s	–	–	10.8	tr	3.8	–	24.0	0.3	55.2	6.0	–
158.	S 24 hs	–	0.1	10.8	0.2	4.4	7.0	32.4	5.6	36.2	4.4	tr
159.	S 24 co	–	–	12.0	–	1.7	–	23.6	–	62.7	tr	–
160.	S 24 co	–	–	11.6	–	2.0	0.2	25.4	0.2	60.6	0.1	–
161.	S 24 pn	–	tr	9.9	0.1	2.5	–	47.6	–	35.4	–	4.3
162.	S 24 hs	–	tr	8.8	–	3.8	8.4	39.7	5.0	32.4	2.0	–
163.	S 24 oo	–	–	11.4	0.7	3.4	–	79.0	–	5.7	–	–
164.	S 24 sf	–	tr	6.7	–	2.4	–	10.8	–	80.0	–	–
165.	S 24 hs	–	0.1	10.3	0.2	3.8	8.7	35.6	3.9	33.4	2.6	1.1
166.	S 24 hs	tr	tr	10.0	–	3.2	9.4	31.4	1.6	42.5	1.8	–
167.	S 24 sf,s	–	–	7.6	–	4.6	–	19.3	–	66.8	1.6	–
168.	H 24 s	–	tr	11.5	tr	4.4	–	22.7	–	53.7	7.6	tr
169.	S 24 co	–	–	10.4	–	1.7	–	23.3	–	63.8	0.6	–
170.	S 24 su	–	–	5.8	–	3.8	–	20.8	–	69.6	–	tr
Pastries and pastry crusts												
171.	R 25 uk	0.1	0.6	14.9	0.1	6.6	32.1	35.4	2.5	8.0	–	–
172.	S 25 hs,/hcs,/hp	–	–	12.4	–	6.6	10.1	26.7	2.0	38.4	3.8	–
173.	R 25 uk	0.3	2.6	18.8	3.8	9.0	10.5	35.1	1.5	18.2	0.9	tr
174.	B 25 vsuk	44.4	18.0	11.0	–	20.4	1.4	2.0	–	1.1	–	1.5
175.	S 25 hs,/hcs	0.6	0.5	12.9	tr	15.0	15.5	33.8	2.6	18.2	0.6	tr
176.	S 26 bf,ld,s,cs/p	0.1	2.3	29.3	3.6	17.5	tr	41.1	–	6.0	tr	–
177.	S 26 hcn,/hs,/hp	2.4	1.1	13.1	–	13.1	23.4	39.0	2.4	4.8	tr	0.7
178.	S 26 hs,cs,bf, p,/ld	0.1	2.5	26.6	0.8	20.6	7.0	35.8	0.2	4.0	–	2.3
179.	R 26 uk	–	3.4	30.4	2.2	21.9	4.8	32.8	–	2.0	–	2.6
180.	S 26 hbf,/hld,hs,/hcs,/p	17.7	9.6	24.7	0.8	19.0	3.0	19.1	–	6.0	–	–
181.	S 26 shuk	–	1.5	25.4	2.4	17.6	2.7	36.2	–	13.2	1.0	tr
182.	S 26 ld	–	1.4	25.4	3.0	14.0	0.6	42.8	–	11.8	1.0	tr
183.	S 26 ld,hp,hs,bf	–	2.0	25.8	2.8	17.2	3.0	39.3	–	7.7	0.7	1.4
184.	S 26 hs,hcs	tr	tr	13.0	tr	16.6	19.2	30.4	1.4	18.6	0.9	tr
185.	S 26 shuk	tr	1.4	25.7	2.7	13.4	–	42.4	–	12.8	1.2	0.4
186.	S 26 hs,hcs,hp	tr	tr	13.2	tr	16.2	22.9	33.0	2.1	12.7	tr	tr
187.	S 26 ld,/bf,hs,/ld	–	1.6	21.6	2.2	13.9	7.3	36.4	0.2	14.8	1.2	1.0
188.	S 26 hs,cs,bf,/ld	–	2.8	23.8	2.7	19.6	6.1	34.2	tr	8.6	0.4	2.0
Peanut butters												
189.	S 27 hpn	–	–	10.0	–	6.0	–	45.7	–	34.8	–	3.5
190.	S 27 hvouk	–	–	10.8	–	3.8	–	44.5	–	36.1	–	4.6
191.	S 27 pn	–	–	10.1	–	2.2	–	48.8	–	34.9	–	4.0
192.	S 27 hvouk	–	–	10.4	–	4.0	–	47.8	–	33.4	–	4.4
193.	S 27 hvouk	–	–	10.2	–	3.8	–	47.8	–	33.6	–	4.6
194.	S 27 hvouk	–	–	10.6	–	3.6	–	47.4	–	34.2	–	4.2
Pizza crusts and pretzels												
195.	S 28 s	2.0	8.6	23.6	1.7	9.2	tr	26.0	–	24.0	2.0	2.9
196.	R 28 uk	0.2	2.0	20.6	0.9	3.8	tr	19.4	–	52.2	0.8	tr
197.	R 28 uk	1.0	4.4	19.6	1.6	7.7	tr	26.8	–	33.8	3.8	1.2
198.	S 29 hs/hp/hcs	–	–	12.6	–	7.6	29.2	25.5	2.2	21.5	1.3	–
199.	S 29 hs,/hcs	1.4	0.9	15.8	–	7.4	10.8	22.2	3.6	35.2	2.2	0.6
200.	S 29 hs,/hcs,/hp	–	tr	13.8	tr	6.0	12.8	29.4	2.0	34.0	1.8	tr
Vegetable shortenings												
201.	S 33 hvouk	0.2	0.5	14.5	0.5	10.0	21.6	40.0	4.2	8.6	0.2	tr
202.	S 33 hvouk	–	0.2	15.0	0.2	12.2	12.0	32.2	4.0	21.9	1.6	tr
203.	S 33 vouk	tr	0.6	20.0	0.6	8.4	32.0	31.0	3.6	3.0	tr	0.1
204.	S 33 hs,p	–	0.3	14.2	0.3	9.9	21.0	38.8	4.4	10.1	0.2	0.8
205.	W 33 hvouk	–	–	10.7	–	9.7	35.4	41.0	1.9	1.4	–	–
206.	R 33 hvouk	–	–	14.6	–	8.0	8.7	39.6	4.3	24.2	0.7	–
207.	W 33 vouk	–	–	13.0	–	11.6	21.3	33.5	2.8	17.8	tr	tr
Snack chips												
208.	S 34 co,pn,s/su	–	tr	12.2	0.3	3.3	–	35.8	1.2	40.4	2.7	3.8

TABLE II (continued)

No.	Code	12:0	14:0	16:0	16:1	18:0	18:1t	18:1c	18:2i	18:2c	18:3c	Others[b]
209.	S 34 hs	tr	0.3	11.1	–	4.9	13.4	42.7	8.2	19.4	–	–
210.	S 34 cs,co,pn,hcs/s	0.3	0.8	12.5	0.4	7.6	20.4	50.6	1.6	3.3	0.6	2.2
211.	H 34 s	–	–	9.7	0.2	4.1	24.7	47.0	1.6	11.6	–	1.2
212.	S 34 s,/co	–	–	10.9	–	3.0	0.4	25.6	0.4	56.7	3.2	0.2
213.	S 34 hs,/hcs	0.2	1.2	16.8	–	6.4	30.4	33.6	3.0	8.2	tr	tr
214.	S 34 p/hs	–	0.2	12.1	0.1	7.2	18.8	36.8	3.0	21.0	0.4	0.2
215.	S 35 cs,co,pn,hcs/s	–	–	10.9	0.3	2.7	–	49.9	0.3	30.0	0.4	5.2
216.	S 35 cs	–	0.7	27.3	0.5	2.5	–	18.5	–	50.9	–	tr
217.	S 35 hcs	–	0.4	24.6	0.2	6.8	23.2	37.2	4.2	3.3	–	–
218.	S 35 hcs,/s,/p,/co	–	0.7	22.7	0.6	2.4	–	15.8	–	57.5	0.2	–
219.	S 35 cs,/p,/co	–	0.8	24.6	0.6	2.6	–	17.4	–	54.9	0.2	–
220.	S 35 cs	0.1	0.8	23.6	0.6	2.6	–	16.4	–	55.8	0.2	0.1

[a]Number preceding colon is carbon chain length; number following colon is number of double bonds; t designates fatty acid containing a *trans* double bond; c designates fatty acid containing only *cis* double bonds; i designates positional and geometrical isomers of linoleic acid.

[b]Includes odd carbon, branch-chain, short-chain and long-chain fatty acids and unknown fatty acids.

tr = Trace, <0.1%.

11-*cis*-18:1; however, these were included as one item in the table. Similarly, the item listed as 18:2i usually consisted of three peaks which had retention times corresponding to the *trans, trans-, cis,trans-* and *trans,cis* isomers of linoleic acid. Based on capillary GLC (75-m SP-2340), argentation TLC, infrared and ultraviolet spectroscopy (unpublished results), the isomeric octadecadienoic acids (Table II, 18:2i) are known to contain *trans* geometrical isomers and possibly unusual *cis* positional isomers. No evidence exists for the presence of conjugated isomers in the 18:2i region, although small levels of conjugated fatty acid isomers have been detected in some samples. A combination of the results obtained by Scholfield (11) and Johnston et al. (12) supports the supposition that the majority of the isomeric octadecadienoic acids found in partially hydrogenated fats contain at least one *trans* double bond.

The 220 foods analyzed were grouped into 17 different food categories and the fatty acid compositions are shown in Table II. In addition to a sample number, the 220 food items have been identified by a code. The code consists of the source from which the item was obtained, the food type, and the fat ingredient(s) according to the label (see Table I). When the fat in some samples was identified on the label with vague terms such as "processed" or "refined", these have been given the partial hydrogenation code if it was apparent from the fatty acid composition that they were in fact partially hydrogenated. Terms such as "hardened" or "hydrogenated" are included with partially hydrogenated since they appeared to be used interchangeably. In only one instance (#42) were the levels of saturated fatty acids high enough to indicate the addition of a totally hydrogenated fat to the blend; this sample, however, was labeled partially hydrogenated. Some samples (#52,203, 207,211) were obviously partially hydrogenated but were not so labelled. Two (#15, 25) had labels that stated that the fat was partially hydrogenated soybean oil but the presence of short- and medium-chain fatty acids indicated palm or coconut oil had been used in a blend. The values given in the table represent the averages obtained from duplicate samples, except for sample #39 (see discussion on coffee creamers).

Tabulated Data

Animal and dairy fats. Six samples of butter and animal fats were analyzed in these studies. One sample (#126), identified as a margarine containing 100% partially hydrogenated lard, will be discussed below (see margarines). The range of *trans* fatty acids in these animal fats was from 0.3 to 6.6% of the total methyl esters quantified; the highest level was found in a lamb tallow (#2). The values obtained for *trans* fatty acids in the butter samples (3.1-3.8%) are overestimates since components with chain lengths less than C-12 (ca. 10% of the total) were not quantified in these studies. There was no evidence for *trans* fatty acids other than 18:1, although trace amounts (ca. 0.2%) of other *trans* fatty acids have been reported in butter samples (13).

Bread and rolls. Data obtained on breads and rolls indicate that eight were made with partially hydrogenated vegetable fat, one from partially hydrogenated lard and one from unprocessed soybean oil. The latter (#13) was the only one which did not contain *trans* fatty acids. Only 0.2% *trans* fatty acids were found in the fat from one prepared with partially hydrogenated lard (#7). The range for *trans* fatty acids for the fats in others was from 1.8 to 23.6%. Two of the samples which contained fairly low levels of *trans* fatty acids (#10 and #11) yielded relatively high levels of 16:0 (palmitic acid) and probably were prepared from blends of palm oil and partially hydrogenated soybean oil.

Breading mixes and fried crusts. Several samples of breading or crusts were analyzed. Two of the three foods that did not contain *trans* fatty acids were deep-fried in Chinese restaurants (#18 and #20); the third (#19) was from a fast-food fish restaurant that is part of a national chain. The five samples containing *trans* fatty acids were popular supermarket items.

Cakes. All of the cakes examined contained *trans* fatty acids. One probably contained an oil that was not partially hydrogenated (#27) but may have been refined to the extent of forming small amounts of isomeric polyunsaturated fatty acids. These isomers have been reported by Ackman (14) to result from deodorization. However, these components were not always present in refined oils indicating wide variations in refining practices.

Candy and frostings. Data for 9 candies and frostings were analyzed. Of the 220 foods analyzed in these studies, the highest level of *trans*-18:1 plus 18:2i fatty acids (38.6%) was found in the fat of a carob malt ball (#30). Substantial levels of *trans* fatty acids (greater than 25%) were also found in two of the three frosting fats analyzed. One of these (#37) had the highest level of isomeric octadecadienoates observed in any of the samples analyzed in our work. Only traces of *trans* fatty acids were detected in one sample (#32) even though the label listed partially hydrogenated vegetable fat as an ingredient.

Cream substitutes, cereals and puddings. Data on fat from

miscellaneous foods such as cereal, coffee creamers, a sour cream substitute and puddings are presented. The pudding fats contained high levels (greater than 28%) of *trans* fatty acids. There were no detectable *trans* fatty acids in sample #42, a popular sugared cereal, even though it was labeled as containing partially hydrogenated soybean oil. The fat in this sample undoubtedly consisted in part of a completely hydrogenated oil as the level of stearic acid (18:0) was 56.4%, the highest encountered in any food analyzed in these studies. Samples 39A and 39B were the only examples of duplicates which did not yield similar fatty acid compositions. The duplicates were in fact two separate packets of the same coffee creamer obtained from the same restaurant with only enough in each packet for one analysis. Although these coffee creamers were obtained at the same time, they appear to be from separate batches.

Cookies. The fatty acid compositions of fat from the 25 cookies analyzed in our work indicated that one-fifth of these contained levels of *trans* fatty acids above 30%. The four that did not contain detectable levels of *trans* fatty acids were labeled as containing lard or butter. The sample which contained butter (#67), had a fatty acid composition that indicated an additional source of linoleic acid (18:2) which was probably due to the walnuts in the cookie.

Crackers. Compared to cookies, the fats used in crackers appeared to contain somewhat lower levels of *trans* fatty acids. Of the 19 crackers representing 15 different brands, only one fat sample (#72) contained *trans* fatty acids approaching 30%.

French fried potatoes. Eleven samples of French fried potatoes were analyzed. Of the 7 which came from fast-food restaurants, one fat contained over 35% *trans* fatty acids and four contained less than 7% *trans* fatty acids. One of the fats from a sample (#98) purchased from a supermarket also had high levels of *trans* fatty acids (33.6%).

Margarines. A total of 40 margarines were analyzed. Data for 24 stick margarines, 13 soft margarines and 3 diet margarines are presented. The range for *trans* fatty acids found in our margarine samples (6.8-31.0%) is in general agreement with values reported by others for similar samples in the United States and Canada (4,6). One of the stick margarines (#126) was labelled as containing partially hydrogenated lard; however, the level of palmitic acid and myristic acid (14:0) in this sample was significantly lower than that obtained for the other lard sample (#6) and its fatty acid composition was quite different from literature values for lard (15). The accuracy of the label on this margarine is questionable, as the fatty acid composition resembled a mixture of lard and partially hydrogenated soybean oil.

The level of *trans* fatty acids in the stick margarines ranged from 15.9-31.0% of the total fatty acids and nearly half of these contained *trans* fatty acids between 20 and 25% of the total. Some of these margarines contained relatively high levels of isomeric polyunsaturated fatty acids. Four of the stick margarines had 18:2i of ca. 5% and 6 others had values above 2%.

In contrast to stick margarines, the soft and diet margarines contained lower levels of *trans* fatty acids (6.8-17.6%). However, several of these had levels of isomeric polyenoic fatty acids as high as that found in the stick margarines. One of the soft margarines (#138) gave an unexpected fatty acid composition. Although the label indicated that it consisted of liquid and partially hydrogenated soybean oil, the percentage of 16:0 was too high for that expected of a margarine consisting solely of soybean oil.

Mayonnaise, salad dressings, salad and cooking oils. Relatively few of the mayonnaise and salad dressings contained *trans* fatty acids. All of the samples were labelled as containing soybean oil and contained relatively high levels of linolenic acid. One mayonnaise (#144) and a hamburger sauce (#152) were the only samples in this category which contained detectable *trans* fatty acids. Only 5 of the 18 salad and cooking oils examined contained *trans* isomers.

Pastries and pastry crusts. Eighteen pastry samples were analyzed. These included 11 sweet pastries, 6 pie or pastry crusts and one meat pie crust. There was a wide variation in *trans* fatty acid values in the fats from these, ranging from a trace to 32.1%, depending on whether the fat ingredient was an animal fat, animal fat/vegetable fat mixture or a vegetable fat.

Peanut butters, pizza crusts and pretzels. There was no evidence for *trans* fatty acids in peanut butter samples and only traces were found in the pizza samples analyzed. All of the pretzels analyzed contained *trans* fatty acids as well as 18:2 isomers.

Vegetable shortenings. Seven shortenings were analyzed and they all contained *trans* fatty acids, ranging from 8.7 to 35.4%. Although we did not find the high levels (53.2%) of *trans* fatty acids reported for some German shortenings (7), relatively high levels of *trans* fatty acids as well as 18:2i were found in most of the shortenings examined.

Snack chips. Data for 13 snack chips indicated that most of the potato products did not contain *trans* fatty acids; however, the fat from most of the corn products did. The fat from one snack chip (#211) contained 24.7% *trans* fatty acids even though the label listed only soybean oil with no mention of any form of processing.

General Comments

Of the 220 food items analyzed, only 53 did not contain measurable levels of *trans* fatty acids. Within specific food categories there were wide variations of *trans* fatty acid percentages; but despite these variations, if the product label indicated partial hydrogenation or hardening of the oil, with rare exception, *trans* fatty acids were found. It should be noted that the ranges of *trans* fatty acids for the food groups reported in this study represent minimum levels, since a majority of the processed fats were observed to contain isomeric octadecadienoic acids, some of which are *trans* isomers.

This work was conducted to extend our knowledge of *trans* fatty acid content of foods commonly consumed by Americans. Because wide ranges of *trans* acids are found in the majority of foods studied, it was nearly impossible to predict levels of *trans* fatty acids present in a food labelled as containing partially hydrogenated vegetable fat. At present, it would appear that individuals interested in dietary intake of *trans* fatty acid isomers must be content to work with ranges of *trans* fatty acids expected for typical food categories unless they conduct complete analyses of the specific food items involved.

ACKNOWLEDGMENTS

Supported in part by the National Live Stock and Meat Board and Lipid Nutrition Laboratory, Beltsville Human Nutrition Research Center, ARS-USDA. This is scientific article no. A-3271; contribution no. 6343 of the Maryland Agriculture Experiment Station.

REFERENCES

1. Rizek, R.L., B. Friend and L. Page, JAOCS 51:244 (1974).
2. Enig, M.G., R.J. Munn and M. Keeney, Fed. Proc. 37:2215 (1978).

3. Smith, L.M., W.L. Dunkley, A. Franke and L. Dairiki, JAOCS 55:257 (1978).
4. Carpenter, D.L., and H.T. Slover, JAOCS 50:372 (1973).
5. Carpenter, D.L., J. Lehman, B.S. Mason and H.T. Slover, JAOCS 53:713 (1976).
6. Sahasrabudhe, M.R., and C.J. Kurian, J. Inst. Can. Sci. Technol. Aliment. 12:140 (1979).
7. Heckers, H., and F.W. Melcher, Am. J. Clin. Nutr. 31:1041 (1978).
8. Lanza, E., and H.T. Slover, Lipids 16:260 (1981).
9. Slover, H.T., and E. Lanza, JAOCS 56:933 (1979).
10. Sampugna, J., L.A. Pallansch, M.G. Enig and M. Keeney, J. Chromatogr. 249:245 (1982).
11. Scholfield, C.R., JAOCS 58:662 (1981).
12. Johnston, A.E., H.J. Dutton, C.R. Scholfield and R.O. Butterfield, JAOCS 55:486 (1978).
13. Patton, S., and R.E. Jensen, in Progress in the Chemistry of Fats and Other Lipids, Vol. XIV, part 4, edited by R.T. Holman, Pergamon Press, Oxford, 1975, p. 255.
14. Ackman, R.B., S.M. Hooper and D.L. Hooper, JAOCS 51:42 (1974).
15. Hilditch, T.P., and P.N. Williams, in The Chemical Constitution of Natural Fats, 4th edn., Chapman and Hall London, 1964, p. 131.

[Received August 23, 1982]