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INVESTIGACIÓN

Assessment of the fatty acid patterns in vegetable oils, fats and fat-rich foods commonly consumed in Egypt

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RESUMEN

Evaluación de ácidos grasos en aceites vegetales, grasas y alimentos ricos en grasas de consumo habitual en Egipto.

Cuarenta y una muestras de alimentos individuales fueron analizadas por su contenido en ácidos grasos mediante cromatografía gas-líquido usando columnas capilares. Las muestras pertenecieron a 5 grupos diferentes, incluyendo aceites vegetales, mantequilla y «ghee», grasas animales, productos lácteos, pescados, pollo y carnes, y otros platos populares. Los resultados mostraron que el aceite de maíz fue el que tuvo el más bajo contenido en ácidos grasos saturados totales (11%) y el más rico en ácido linolénico. Por otro lado, los ácidos grasos saturados totales alcanzaron el 42-62% de los ácidos grasos totales del sebo de cordero y camello respectivamente. Los ácidos grasos poliinsaturados de cadena larga (C20-C22) con dos a seis dobles enlaces estuvieron presentes solo en pescados. La estimación de la ingesta ascendió a 36 g por sujeto y día, y se presenta el porcentaje de contribución de las grasas analizadas. La relación de ácidos grasos poliinsaturados a saturados ascendió a 0.96; estando dentro del óptimo alimenticio.

PALABRAS-CLAVE: Aceite vegetal – Acidos grasos – Alimento – Análisis – Egipto - Grasa.

SUMMARY

Assessment of the fatty acid patterns in vegetable oils, fats and fat-rich foods commonly consumed in Egypt.

Forty-one individual food samples were analyzed for their fatty acid contents by gas-liquid chromatography using capillary tubes. The samples belonged to 5 different food groups and included vegetable oils, butter & ghee, animal fats, dairy products, fishes, chicken & meats and other popular dishes. The results show that maize oil was lowest in its total saturated fatty acid content (11%) and richest in linolenic acid. On the other hand, total saturated fatty acids made up 42-62 % of the total fatty acid patterns of the lamb and camel fat tallow, respectively. Long chain polyunsaturated fatty acids (C20-C22) with two to six double bonds were present only in fishes. Estimate of fat intake amounted to 36 grams per subject per day and the % contribution of the analyzed fats was presented. The ratio of polyunsaturated to saturated fatty acids amounted to 0.96; which falls within the optimum dietary goals.

KEY-WORDS: Analysis – Egypt – Fat – Fatty acids – Food – Vegetable oil.

1. INTRODUCTION

Egypt is located in the Mediterranean region; where the diet became known for its health promoting properties (Ferro-Luzzi and Sette (1989). One reason is the common use of vegetable oils in the typical Mediterranean diets and the minute quantities of butter entering the diet (Ferro-Luzzi and Sette 1989).

According to Food Balance Sheet total edible fat intake in Egypt amounts to 58.4 gram per caput per day for the period 1994/1996 (FAO, 1998). Average dietary fat intake was estimated to be 73.0 and 57.5 g among Egyptian male and female employees, respectively (Hussein *et al.*, 1995) while a respective figure of 69.7 g was obtained when an Egyptian total diet study was prepared and analyzed (Saleh et al., 1997).

The palm oil industry had benefited during the past decade from developments in technology and it ranks nowadays second only to soybean oil and is considered as a major vegetable oil. Refined palm oil and fractionated palm oils; palmolein (PO) and palmstearin (PS) are of growing importance in the world market (MacFarlane *et al.*, 1984). Palm oil and palm stearin are cheap palm products but are reported to be rich in the saturated fatty acids; palmitic and stearic (Edionwe and Kies, 1998).

In view of the fact that new oil products appear in the market, and since no systematic study has been published in Egypt on the fat composition of commercial oils and fats, we feel that the generation of accurate and precise data are essential to the project objective.

2. MATERIALS AND METHODS

2.1. Food consumption patterns of oils and fats

A Household Budget Survey comprising 469 households was selected from a stratified probability sample with family size averaging 6.0 (range between three to nine members). It was a subset of a larger project and was selected from the larger study population on the basis of their willingness to participate. Information on food consumption was obtained using a 2-day dietary record. In each household, the female head of the household was interviewed about all forms of oils and fats supplied or purchased during the course of the month to the members of the household. Households having milking animals prepared their own butter at home. The precise description of the oil brand was requested from the households during interviewing.

The oil or fat consumption was coded and converted into estimate for fat intake per caput per day.

2.2. Collection of oil and fat samples

The brands of (15) oil and fat brands collected and analyzed in the present study are based on the information collected during home visits and interviewing the households. The description and the names of the oil brands as they appeared on the package labels are listed in Table I. One kg consumer Oils and fat packages were purchased from the various types of outlet chosen by volume of sales and related population density information.

Table I

Mean fat content and fatty acid composition of commonly used vegetable oils and butter ghee

Source oils	Butter ghee		Cottonseed		Maize		Olive		Palm		Sunflower *
	Mean	S D	Mean	S D	Mean	S D	Mean	S D	Mean	S D	
Fat content, g %	74.85	0.92	83.80	3.68	91.95	4.60	87.10	8.20	91.20	4.80	94.70
C8:0	1.49	0.31									
C10:0	3.48	0.85									
C12:0	4.07	0.66									
Myristic C14:0	12.39	0.60	0.33	0.47					1.18	0.11	
C14: 1	0.93	0.10									
C15:0	1.23	0.13									
Palmitic C16:0	30.81	2.56	14.86	12.04	9.99	0.41	15.65	2.19	44.66	2.68	6.25
C16: 1	2.02	0.35									
C17:0	0.70	0.06			0.08	0.00	0.08	0.11	0.11	0.01	
Stearic C18:0	13.45	0.40	3.07	0.80	2.04	0.24	3.58	0.94	4.46	0.18	4.09
Oleic C18: 1	23.19	2.85	19.23	0.76	25.12	0.09	66.28	5.72	38.76	1.90	18.64
Elaidic C18: 1	5.26								0.21	0.47	
Linoleic C18: 2	2.02	0.35	60.79	11.12	60.89	1.26	11.55	4.25	9.31	0.98	69.58
Linolenic C18: 3	0.96	0.50	0.51	0.02	0.98	0.13	0.47	0.03	0.22	0.04	0.22
Decanoic C20:0	0.10	0.14	0.32	0.11	0.40	0.01	0.58	0.12	0.40	0.03	0.28
C20: 1	0.53	0.76	0.09	0.13	0.29	0.04	0.29	0.02	0.15	0.02	0.22
C22:0			0.44	0.34	0.15	0.05	0.14	0.01			0.72
Saturated	67.72	0.71	19.02	8.46	12.66	0.49	20.03	0.78	50.8	4.92	10.4
Mono-unsaturated	26.67	0.00	19.32	0.99	38.07	0.21	66.57	9.62	39.12	3.13	18.9
Poly-unsaturated	5.60	0.13	61.66	11.03	49.27	3.68	8.66	2.59	10.1	1.19	70.8
PU/S	0.08		3.24		3.9		0.43		0.2		6.85

* One single analysis

In addition animal fats less widely consumed that are of interest because of their unique composition were also collected and analyzed.

A second set of 26 samples comprising fat -rich foods including tallow (animal fats from bovine, camel and lambs), fishes (barboni, bolti, melouha and tuna); chicken, ducks, pigeon, rabbit and meat. Dishes included cabbage stuffed with rice; fat-rich cakes, coconut- rich sweets, faba bean cakes fried in vegetable oil, koshary (lentil-rice); lassagne (macaroni with dressing oven – baked) roasted peanuts, and pie stuffed with ground meat. Oils and fats were analyzed without prior treatment; whereas, the food samples were freeze-dried and ground prior to fat analysis.

2.3. Analytical methods

A. *Apparatus:* Hewlett Packard gas chromatograph (GC) equipped with Series 11 5890 GC, electronic pressure control (EEP), capillary split/splitless injection system with a FocusLiner™ (Glass liner, 4 mm id) for optimum needle tip wiping and sample transfer and flame ionization detector (FID); A HP 7673 controller with an automatic liquid sampler.

The two GC columns were SP 2330 and 2560, packed with Poly (80%- biscyanopropyl - 20% cyanopropylphenylsiloxane), 30 m x 0.25 cm id. and Poly (nonbonded - bisGyanopropyl polysiloxane), 100 meter x 0.25 mm id., 0.20 sum film, respectively.

For the identification of the peaks an electron ionization detector was used, with mass range 45:450 m/z. 70eV. For the fatty acid methylation, only new clear glass reaction vials, 16 mL with teflon lined green caps were used.

B. *Reagents Hexane*: GC grade; A 0.5M Sodium methoxide solution in methanol was prepared and stored at 2 to 8 ^{o}C; The Tritridecanoin ($C_{42}H_{80}O_6$) served as the triglyceride internal standard solution (5.0 mg/ml in $CHCl_3$) and was stable up to 1 month in freezer in a well-sealed amber bottle; Standard solution of total fatty acids methyl esters in heptane (FAMEs), 15.5 mg/ml.

C. *Chromatographic Conditions:* Initial oven temperature, 120 ^{o}C (hold 4 min), and final temperature 230 ^{o}C at a rate of 5.0 ^{o}C/min with final time of 10.0 min. Zone temperatures: injector, 250 ^{o}C; detector, 275 ^{o}C; hydrogen flow: 30 ml/min; carrier gas helium flow: 0.6 ml/min at 175 ^{o}C. The equipment was calibrated by auto tuning prior to each series of analyses.

D. *Direct Extraction of Lipid and Methylation:* The direct extraction methylation (DEM) method (Long *et al.*, 1988) combines the hydrolysis, extraction, and methylation procedure into an easily controlled, fast, one step operation.

(1) The triglyceride internal standard solution (300µL) was added to reaction vial and evaporated to dryness with nitrogen.

(2) The sample matrix (0.3 g) was accurately weighed into reaction vial, followed by the addition of 5.0 mL of sodium methoxide solution and 5.0 ml hexane.

(3) The reaction vial was screwed and heated to 80^{o} C for 15 min with interval shaking. Upon cooling, 6.0 ml saturated sodium chloride were added and the methylated FAMEs in the organic upper phase were separated by centrifugation.

(4) One microliter was injected into the gas chromatograph.

E. *GC/Flame Ionization Detector (FID) / GC/ Mass spectrometric Detector (MS):*

1. *Standard Solution*: One µL FAME standard solution was injected into GC apparatus. The 26 FAME peaks especially the C18: 1 bands / cis peaks were eluted and well resolved. Confirmation of these peaks was achieved by GC/MS. The relative retention times for each of the FAMEs in the mixed standard solution was determined relative to C13:0 (internal standard).

2. *Sample Extract*: 1.0 µL of the sample extract was injected onto GC column and the relative retention times was determined for each of the FAMEs and compared to the mixed standard solution relative to C13:0 (internal standard). The relative retention times are used to identify the FAMEs in the sample. The amounts of fatty acids were calculated from the peak areas using the procedure outlined below.

F. *Calculations of FAME s' concentration in sample:* The response factor for each fatty acid in the standard mixture (FAME) was calculated by dividing each peak area by the peak area of C13:0.

The amount of each fatty acid, Fi in the sample (g of methyl esters) was calculated according to the equation:

$$F_i = \frac{(A_{si})\,(C_{13})\,(Q_{13})}{A_{s13})\,(R_i)\,(1000)}$$

A_{si} = Peak area of the individual FAME in the sample

A_{S13} = Peak-area of C13:0 FAME in the sample

C_{13} = Concentration of C13:0 internal standard added in mg/mL

Q_{13} = Aliquot (µL) of C13:0 added in the sample

R_i = Response factor for fatty acid

The amount of each fatty acid (F_{ITG}) in the sample (as the corresponding triglyceride) was calculated according to the equation:

$$F_{I,TG}=(F_i)\,(F_{TG})$$

where F_{TG} = Theoretical conversion factors from FAMEs to their corresponding triglycerides

Statistical analysis: The arithmetic means and the respective standard error (SE) are given.

3. RESULTS

Table I presents the fat content and fatty acid composition of butter, ghee and 6 different vegetable oils.

The fat content of vegetable oils ranged between 83.8 and 94 % being lowest in cottonseed and highest in sunflower oils.

The fatty acid patterns of five palm oil products belonging to different brands were found to be almost identical with the saturated palmitic acid making up 42.0-48.3 % of the total fatty acid content of the oils. Oleic acid (C18: 1 cis) averaged 38.76 %, while elaidic (C18: 1 trans) made up 0.21 % of the palm oil total fatty acid pattern; respective figures of 38.2 and 0.9 % were also detected in sesame oil. Elaidic acid was not detectable in the oils of cottonseed, maize, olive or sunflower seeds.

The essential fatty acid linoleate (C18: 2) was the principal polyunsaturated fatty acid in vegetable oils, and also the fatty acid with the greatest variation, ranging from 9.3 (palm oil) to over 60 % in cottonseed, maize and sunflower oils.

The essential fatty acid linolenic (C18: 3) averaged 1 % in maize oil; whereas it was absent in sesame oil and low in palm and sunflower oils (0.22 % of total fatty acids). Table II presents the fat composition of animal fats, fat-rich animal foods and selected dishes.

Tallow from bovine and camel fats were characteristic with the high-saturated fatty acid

Table II

The fatty acid composition of selected 26 fat rich foods and dishes commonly consumed in Egypt

	Cheese, Hard Romy	Cheese, Processed	Yogurt	Fat,bovine	Fat,camel	Fat,camel	Fat,lamb	Fish-Fried-Bolti	Fish, Fried
C8:0	0,83	0,32	0,32	0,00	0,00	0,00	0,00	0,00	0,00
C10:0	3,06	0,84	0,84	0,10	0,10	0,10	0,11	0,00	0,10
C12:0	3,75	1,16	1,16	0,10	0,10	0,20	0,11	0,00	0,10
C14:0	14,31	5,07	5,07	2,59	5,34	6,61	3,26	1,26	1,37
C15:0	2,92	0,63	0,63	0,83	0,59	0,90	0,84	0,18	0,39
C16:0	38,33	41,82	41,82	21,99	24,23	29,46	23,68	21,94	16,21
C16:1	3,19	0,95	0,95	1,97	2,18	2,91	3,58	0,90	1,76
C17:0	3,06	0,74	0,74	5,08	1,68	2,51	4,53	0,36	0,68
C18:0	18,19	7,50	7,50	32,78	29,87	22,14	14,11	7,37	4,49
C18:1 cis	3,19	35,69	35,69	27,80	29,57	31,66	42,95	38,67	19,14
C18:1 trans	6,11	1,58	1,58	6,43	2,57	1,30	4,95	0,00	0,00
C18:2	0,00	2,01	2,01	0,00	2,77	1,30	1,05	4,50	50,88
C18:3	0,00	0,00	0,00	0,00	0,00	0,20	0,21	0,00	2,54
C20:0	2,36	0,84	0,84	0,10	0,20	0,20	0,21	0,72	0,39
C20:1	0,42	0,21	0,21	0,10	0,20	0,40	0,21	0,72	0,29
C20:2	0,00	0,11	0,11	0,00	0,10	0,00	0,00	0,36	0,00
C20:3	0,00	0,11	0,11	0,00	0,10	0,00	0,00	0,54	0,00
C20:4	0,00	0,11	0,11	0,00	0,10	0,00	0,11	5,22	0,00
C20:5	0,00	0,00	0,00	0,00	0,10	0,00	0,00	8,09	0,20
C22:0	0,28	0,00	0,00	0,00	0,00	0,00	0,00	0,72	0,29
C22:1	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
C22:4	0,00	0,11	0,11	0,00	0,10	0,00	0,00	0,72	0,10
C22:5	0,00	0,21	0,21	0,00	0,10	0,10	0,11	2,70	0,29
C22:6	0,00	0,00	0,00	0,00	0,00	0,00	0,00	5,04	0,78
C24:0	0,00	0,00	0,00	0,10	0,00	0,00	0,00	0,00	0,00
C24:1	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
SAT	87,08	58,92	58,92	63,69	62,12	62,12	46,84	32,55	24,02
MUFA	12,92	38,44	38,44	36,31	34,52	36,27	51,68	40,29	21,19
PUFA	0,00	2,64	2,64	0,00	3,36	1,60	1,47	27,16	54,79
P/S	0,00	0,04	0,04	0,00	0,05	0,03	0,03	0,83	2,28

Table II **Continued**

	Fish-Tuna-Oven	Fish-Salted-Fermented	Meat, camel	Meat,Lamb-Intestine-Stuffed	Meat,Luncheon	Chicken-thigh	Duck-Fried	Piegon-Stuffed Rice	Rabbit meat
C8:0	0,00	0,00	0,00	0,23	0,00	0,00	0,00	0,00	0,00
C10:0	0,00	0,00	0,00	0,86	0,10	0,00	0,00	0,11	1,45
C12:0	0,22	0,18	0,00	1,25	0,10	0,12	0,13	0,34	1,16
C14:0	1,08	11,63	1,52	6,39	5,27	0,97	0,63	2,48	5,07
C15:0	0,36	0,99	0,46	0,94	0,99	0,12	0,13	0,34	1,30
C16:0	23,07	19,75	22,71	20,58	24,95	29,54	30,50	25,90	39,13
C16:1	2,82	5,32	1,52	1,95	5,07	8,84	3,88	12,61	4,49
C17:0	0,43	0,54	2,13	2,03	2,68	0,12	0,25	0,23	1,88
C18:0	5,86	3,88	20,73	12,63	15,11	7,99	12,75	8,56	11,74
C18:1 cis	26,25	11,45	47,71	24,24	37,38	51,45	51,00	47,75	32,32
C18:1 trans	0,00	0,99	2,13	2,42	3,48	0,12	0,00	1,24	0,58
C18:2	29,93	11,09	0,00	24,55	3,38	0,00	0,00	0,00	0,00
C18:3	3,90	0,00	0,00	1,17	0,00	0,00	0,00	0,00	0,00
C20:0	0,43	0,45	0,30	0,55	0,70	0,12	0,25	0,34	0,29
C20:1	0,51	10,37	0,30	0,00	0,40	0,61	0,50	0,11	0,58
C20:2	0,14	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
C20:3	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
C20:4	0,43	0,00	0,00	0,08	0,20	0,00	0,00	0,00	0,00
C20:5	1,01	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
C22:0	0,14	0,18	0,46	0,00	0,00	0,00	0,00	0,00	0,00
C22:1	0,00	19,75	0,00	0,00	0,00	0,00	0,00	0,00	0,00
C22:4	0,14	0,36	0,00	0,08	0,00	0,00	0,00	0,00	0,00
C22:5	0,29	0,00	0,00	0,08	0,20	0,00	0,00	0,00	0,00
C22:6	2,24	0,90	0,00	0,00	0,00	0,00	0,00	0,00	0,00
C24:0	0,00	0,18	0,00	0,00	0,00	0,00	0,00	0,00	0,00
C24:1	0,72	1,98	0,00	0,00	0,00	0,00	0,00	0,00	0,00
SAT	31,60	37,78	48,32	45,44	49,90	38,98	44,63	38,29	62,03
MUFA	30,30	49,76	51,68	28,60	46,32	61,02	55,38	61,71	37,97
PUFA	38,11	12,35	0,00	25,95	3,78	0,00	0,00	0,00	0,00
P/S	1,21	0,33	0,00	0,57	0,08	0,00	0,00	0,00	0,00

Table II **Continued**

	Cabbage stuffed	Cake	Coconut-sweets	Faba Bean Cake	Lentil/Rice/Dish	Macaroni Oven	Peanuts-roasted	Pie stuffed	Sesame butter tahina
C8:0	0,00	0,00	2,81	0,00	0,00	0,09	0,00	0,59	0,00
C10:0	0,00	0,11	3,28	0,00	0,00	0,09	0,00	1,78	0,00
C12:0	0,10	0,43	23,15	0,00	0,11	0,00	0,00	2,87	0,00
C14:0	2,16	1,85	16,12	0,67	0,32	1,59	0,09	7,69	0,00
C15:0	0,82	0,11	1,03	0,00	0,00	0,35	0,00	0,76	0,00
C16:0	19,46	47,34	18,56	34,67	11,76	14,16	9,07	23,50	14,97
C16:1	1,24	0,33	0,66	0,89	0,21	1,33	0,09	1,27	0,16
C17:0	3,71	5,54	0,94	0,22	0,11	0,97	0,92	0,85	0,16
C18:0	44,90	0,43	8,81	7,56	3,68	6,99	3,30	8,62	8,60
C18:1 cis	23,58	40,83	13,87	47,11	27,42	24,60	47,62	24,94	1,43
C18:1 trans	3,30	0,22	1,12	0,00	0,11	1,33	0,00	2,54	60,83
C18:2	0,00	2,39	8,90	6,44	54,62	47,35	31,87	22,74	11,94
C18:3	0,00	0,00	0,19	0,00	0,21	0,00	0,27	0,00	0,00
C20:0	0,62	0,00	0,37	0,89	0,42	0,53	1,47	0,93	0,96
C20:1	0,10	0,22	0,00	0,67	0,21	0,27	1,01	0,25	0,32
C20:2	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
C20:3	0,00	0,00	0,00	0,00	0,00	0,00	0,18	0,00	0,00
C20:4	0,00	0,00	0,00	0,00	0,00	0,00	0,27	0,00	0,16
C20:5	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
C22:0	0,00	0,11	0,09	0,67	0,63	0,27	2,29	0,42	0,16
C22:1	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
C22:4	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
C22:5	0,00	0,00	0,00	0,00	0,00	0,00	0,09	0,00	0,16
C22:6	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
C24:0	0,00	0,11	0,09	0,22	0,21	0,09	1,47	0,25	0,16
C24:1	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
SAT	71,78	56,03	75,26	44,89	17,23	25,13	18,59	48,27	25,00
MUFA	28,22	41,59	15,65	48,67	27,94	27,52	48,72	28,99	62,74
PUFA	0,00	2,39	9,09	6,44	54,83	47,35	32,69	22,74	12,26
P/S	0,00	0,04	0,12	0,14	3,18	1,88	1,76	0,47	0,49

Percent of total fatty acids, (SAT) saturated, (MUFA) monosaturated and (PUFA) total poly fatty acids.
Ratio of P/S (PUFA/SAT).

Table III
Estimates of total, saturated, mono and polyunsaturated fats from major oil and fat contributors in the Egyptian diet (grams /subject /day)

	% Fat content	Daily intake, g	Weighed intake g/subject /day	SFA	MUFA	PUFA	P / S
Animal fat	99	2.89	2.86	1.21	1.46	0.157	0.13
Butter +Ghee	74.85	6.38	4.77	3.23	1.27	0.27	0.08
Cotton Seed	83.8	12.22	10.24	1.94	1.98	6.41	3.30
Maize	91.95	2.51	2.3	0.29	0.88	1.13	3.9
Margarine*	80	7.27	5.82	2.33	1.07	1.26	0.54
Palm	91.2	3.42	3.12	1.58	1.22	0.31	0.2
Sunflower	94.7	1.32	1.25	0.13	0.24	0.88	6.8
Total Sum		36	30.36	10.71	8.12	10.417	0.97

* Literature data (SLOVER, *et al.*, Lipids in margarines and margarine- like foods).

contents, which amounted to 60.3 and 61.2 % of the total fatty acids, respectively.

The fish samples were low in total saturated fatty acids (24.1 % of the total fatty acids); with the two essential unsaturated fatty acids; oleic; linoleic and linolenic dominating. Fishes contained also considerable proportions of the long chain polyunsaturated fatty acids (C20: 4; C20: 5; C22: 6).

Estimates of the daily intakes of dietary total saturated and polyunsaturated fatty acids are presented in Table III.

4. DISCUSSION

The fat content in the vegetable oils analyzed in the present work was above 80 % fat and sunflower oil was richest in its fat content (94 %). Butter ghee which is prepared by heating butter to reduce its water content, contained 99.8 % fat.

In the US, margarine must conform to a legal definition, which requires that they contain at least 80 % fat (Slover *et al.*, 1985).

Food labelling regulations in the United States have called for «fat» to be calculated from available fatty acid data; consequently the amount of each individual fatty acid must be determined (Thompson, 1996). Recent publications adopted this guideline (Taber *et al.*, 1998; Al-Khalifa and Al-Othman, 1999).

The mean fatty acid patterns of the palm oil samples analyzed in the present work were compared with published data (Edionwe and Kies, 1998) (Table IV).

From the fatty acid pattern, it is clear that the brands available on the Egyptian market fall under the category of «palm oils». Palm has been reported to have a 50: 50 ratio of mono and saturated fatty acids and its ingestion is associated with high fecal fat excretion (Edionwe and Kies, 1998). According to the same investigators, rats fed diets containing

Table IV
Fatty acid composition of palm oil and its fractions

Fatty Acids	Palm Oil	Palmstearin	Palmolein	Egyptian brands
	Literature data (Edionwe and Kies, 1998)			Present work *
	% of total Fatty Acids			
C12:0	0.70	0.11	0.20	—
C14:0	1.2	1.13	1.01	1.18
C16:0	43.5	54.30	39.16	44.66
C16:1	0.30	0.10	0.18	—
C18:0	4.30	4.70	4.12	4.46
C18:1	37.6	21.93	43.09	38.97
C18:2	9.30	6.24	10.70	9.31
C18:3	0.20	0.14	0.20	0.22
C20:0	0.20	0.26	0.38	0.40

* Means of four different brands.

Table V
Fatty acid content (% of total fatty acids) in selected meats and fishes as compared to published data

Fatty acid	Beef fat #			Camel Fat #		Lamb meat #		Fish	
	Present study	Literature data		Present study	Literature data	Present study	Literature data	Present study	Literature data
		Khalifa *	Taber **		Khalifa *		Khalifa *		Khalifa *
C14:0	2.2	4.60	3.30	5.35	9.59	2.6	2.01	1.2	4.62
C16:0	21.2	34.00	28.57	26.95	35.30	22.5	20.47	16.6	19.66
C18:0	31.6	10.60	17.78	26.15	12.05	13.4	3.36	4.6	5.29
C20:0	0.1	0.08		0.20	0.00	0.2	0.09	0.4	1.56
C18:2	2.6	2.28	4.17	1.45	4.10	4.7	2.29	41.4	8.42
C18:3	0.2	0.62	0.22	0.20	1.43	0.3	0.31	5.2	1.68
C20:4	0.1	0.22	1.0	0.05	1.53	0.3	0.76	0.6	3.89
SFA	60.3	49.33	50.1	61.20	56.94	42.40	25.94	24.1	30.35
MUFA	36.1	46.73	43.8	36.75	33.84	51.20	70.50	22.2	32.60
PUFA	3.4	3.88	6.06	1.80	9.21	5.50	3.54	52.7	36.80
PU/S	0.06	0.078	0.12	0.03	0.16	0.13	0.13	2.19	1.20

* Al-Khalifa and Al-Othman, 1999
* * Taber *et al.*, 1998

either palm or soybean oil showed no significant differences in the chemistry of blood lipids.

The fatty acid patterns of different meat cuts and meat organs of Saudi beef, camels, lambs and fishes had been studied and reported (Al-Khalifa and Al-Othman, 1999).

It is evident that the total saturated fatty acids (% of total fatty acids) were significantly higher in the beef (60.3%) and lamb (42.4 %) fats analyzed in the present study compared to respective mean figures reported for Saudi Arabia (Table V). On the other hand, beef and lamb meats from Saudi Arabia were characterised by high proportion of monounsaturated fatty acid pattern.

The pattern of camel meat and fat from Saudi Arabia and Egypt, respectively are in fair agreement. However, camel meats from Saudi Arabia contained high proportion of the PUFA (9% of total fatty acids).

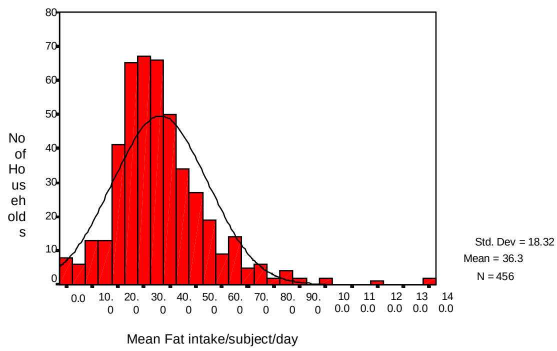

Figure 1
Average fat consumption on the household level.

Reports from Saudi Arabia showed that the pattern of the three essential fatty acids linoleic; linolenic and arachidonic were in several fold excess (2.8:1; 7.1:1 and 30.6:1, respectively) compared to the respective pattern obtained in the present study.

This discrepancy could be attributed either to differences in the food specimen collected from each region. In the present study analysis was carried out on tallow collected from bovine, camel and lamb fats; whereas published data from Saudi Arabia were based on meat cuts including beef sirloin and beef steak; camel shoulder & camel leg; lamb feet (Al-Khalifa and Al-Othman, 1999). A further source of variation could be due to differences in animal breeds, feeding practices and analytical techniques.

Estimated daily intakes from visible vegetable oils and fats amounted to 36.0 gram per subject. By multiplying the % fat content of the oils with the respective intake an estimate of 30 grams of total fats (as triglyceride) per subject per day was obtained (Table III). This figure is in fair agreement with the figure of 27.0 g (21.5g vegetable oils + 4.6 g butter & ghee + 0.9 g animal fats) reported in the food balance sheet (FAO, 1998); Visible oils and fats made up approximately 43 % of the total fat intake of 69.7 grams reported for the Egyptian diet.

The ratio of intakes of polyunsaturated to saturated fatty acids or the P/S ratio, is considered a measure of the atherogenicity of the diet; i.e. the lower the estimated ratio, the more atherogenic is the diet. Mead (1985) considered oleate not a good PUFA precursor since its further desaturation is largely suppressed.

In the USA, dietary goals have been formulated (Gordon *et al.*, 1985) recommending that 30% of the

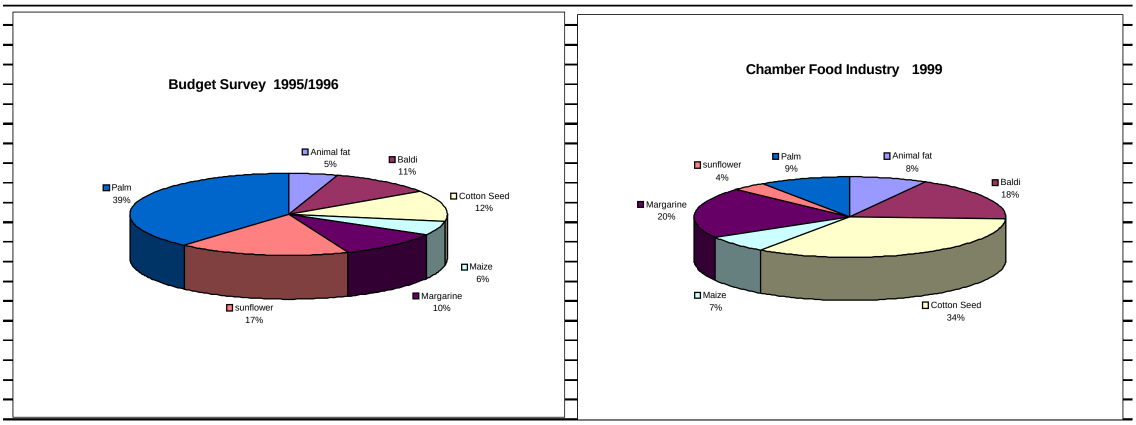

Figure 2
Major fat contributors

energy be derived from fat, with equal contribution from PUFA, SEA and MUFA, a P/S ratio of 1.0.

Based on the informations collected during the household budget survey. (1995/1996) concerning the different oil shares in the daily diet and their fatty acid composition, the ratio of polyunsaturated to saturated fats had a mean ratio of 0.96.

This ratio is liable to modification, since recent statistical reports indicate changes in the pattern of oil shares in the daily diet, with palm oil dominating (38.8 % of total vegetable oils) as the major contributor to visible fat followed by sunflower (17.5 %), cottonseed oil (12.2); soybeans (10.4 %); butter and ghee (10.6 %), animal fats (5%) (Egyptian Chamber of the Food Industries, 1999).

The present study is the first systematic study in Egypt to analyse edible fats for their fatty acid composition and to relate the content to their proportion in the daily diet of the population. The findings are quite valuable since they provide time trends in the evolution of the food consumption patterns. More work is warranted to carefully monitored fatty acid composition in major fat contributors by analytical accuracy coupled with statistically based sampling strategies to assure confident values.

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