

Fatty acid composition of beef, pork, and poultry fresh cuts, and some of their processed products

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SUMMARY. Numerous researchers have shown that dietary fats and oils may affect blood lipid levels and the development of cardiovascular diseases, but consumers are receiving mixed messages about the percentage of fat they should consume in their diets, and they can make proper food choices only when they have the right information. Fatty acid profiles of the meat food products in the Venezuelan diet were determined. Methyl esters were analyzed by gas chromatography on a PT 10% Silar-10C on Gas-Chrom Q 100/120 mesh column. Beef cuts presented a predominant presence of oleic acid (36.21%), palmitic (25.67%) and stearic (20.97). Oleic and palmitic acids are present in pork meat at 42.83 and 24.15% respectively; with lesser quantities of stearic and higher amounts of linoleic acid than beef. Poultry products showed a high content of linoleic (19.54%) and low content of stearic (8.22%) acids. Pork, poultry products, and beef liver presented a considerable amount of linoleic acid 11.85%, 19.54%, and 12.09%, respectively.

Key words: Lipids, fatty acids, food products, profile analysis.

RESUMEN. Perfil de ácidos grasos en cortes de carnes de bovino, porcino, aves y en algunos de sus productos manufacturados.

Numerosas investigaciones han señalado que las grasas y los aceites de la dieta pueden afectar los niveles de lípidos en sangre y el desarrollo de enfermedades cardiovasculares; a pesar de esto los consumidores reciben informaciones confusas acerca del porcentaje de grasa que deben consumir en su dieta y solo cuando tengan una información correcta, ellos podrán escoger los alimentos adecuados. Se determinó el perfil de ácidos grasos en carnes y en algunos de sus productos elaborados en Venezuela. Los ésteres metílicos fueron analizados por cromatografía de gases con una columna de PT 10% Silar en Gas-Chrom Q 100/1220 mesh. Los cortes de carnes de bovino presentaron principalmente ácido oleico (36.21%), palmítico (25.67%) y esteárico (20.97%). El ácido oleico y el palmítico están presentes en la carne porcina en un 42.83% y 24.15% respectivamente; encontrándose también en la carne de porcino menor cantidad de ácido estearico y mayor de linoleico con respecto a la carne de bovino. Los cortes de aves tienen alto contenido de ácido linoleico (19.54%) y bajo de estearico (8.22%). En la carne de cerdo, aves y el hígado de res se observó el mayor contenido de ácido linoleico 11.85%, 19.54% y 12.09% respectivamente.

Palabras clave: Lipidos, ácidos grasos, productos alimenticios, perfil analítico.

INTRODUCTION

There has been a dramatic evolution in the role of fats and oils in human health. Some time ago fats were treated only as a macronutrient. Today, not only saturated and unsaturated fats are important but also individual fatty acids. Consumers are receiving mixed messages about the percentage of fat they should consume in their diets, and they can make proper food choices only when they have the right information, some of which might be available on the product label. During the past 30 years a large amount of information has been gathered on the role that diet plays in health and chronic disease, especially coronary heart disease. Numerous researchers (1-3) have confirmed that there is a strong relationship between the lipids consumed in the diet and total plasma cholesterol. Elevated levels of total plasma cholesterol are associated with increase of coronary heart disease risk. These studies have firmly established the hypercholesterolemic role of saturate fatty

acids and the hypocholesterolemic role of polyunsaturated (ω -6 fatty acids), and monounsaturated fatty acids. More recent investigations (4,5) on the polyunsaturated fatty acids of the ω -3 series (eicosapentaenoic and docosahexaenoic acids) have determined that these fatty acids decrease the serum levels of triglycerides and cholesterol and that they have antithrombotic activity. This means that the quality of the lipids in the diet has a significant effect on the incidence of cardiovascular diseases. On the other hand many countries are enforcing nutritional labeling, with some mandatory and voluntary components (6) so the information on lipid composition of different food products in the diet is important for international trade.

The objective of the present study is to assess the fatty acid composition of fresh cuts of beef, pork and poultry, and some of their processed products on the Venezuelan market. Information, that is not available at the moment, and which will be of great importance for the international, regional, and

national food composition tables (INFOODS, LATINFOODS, VENEZUELANFOODS), as well as for nutritional labeling purposes.

MATERIALS AND METHODS

3 Samples of each high consumption products were obtained in local supermarkets during a period of 12 months February 1994 to January 1995.

All reagents were analytical grade.

Sample procedure

The crude sample (500 g) were homogenized by passing them twice through an Oster meat grinder and all the analysis were run triplicate. Total lipids from samples of the different products, containing approximately 0.5-0.7g of fat, were extracted by the method of Folch *et al.* (7). Moisture was determined by the AOAC method (8), in a Lab-line Imperial oven at 105°C.

Chromatographic analysis

The fatty acid profiles were determined in a Varian 3700 gas chromatograph and a flame ionization detector. Separation was carried out in a stainless steel column (1.83m length x 3mm I.D.) packed with PT 10% Silar-10C on GasChrom Q 100/120mesh. After holding the initial temperature (80°C) for 5 min, it was programmed to increase 4°C/min to 160°C, followed by 1°C/min to 200°C. Detector and injector

temperature 300°C. Nitrogen flow rate 60ml/min, 40psi of hydrogen, and 60psi of air. Methyl esters were quantified by a HP 3395 Integrator. 1µl- 3µl of sample were injected.

Fatty acid methyl ester standards (Sigma Chemical Co., St Louis, MO) were run in order to identify the fatty acids in the samples, using AOAC method (8) for quantification.

The methyl esters were prepared from the extracted fatty acids by adding a solution of 4% sulfuric acid in methanol (9) and heated in a water bath at 90°C for 2h. The samples were cooled in an iced bath, and 3 ml of cool water were added to separate the two phases. The aqueous phase was extracted three times with 3 ml of hexane. The hexane extracts were combined and made to volume in a 10ml volumetric flask.

RESULTS AND DISCUSSION

Table 1 presents the data of fresh beef cuts. Total lipids are in the range of 1.62 to 5.15%. The table shows that there is a predominance of the saturated fatty acids with an average value of 50.94%, with the palmitic acid as the major component (25.67%). Liver contains the least amount of saturated fatty acids (39.16%), an important quantity of linoleic acid (12.09%), and the highest amount of oleic acid (41.10%). The rest of the cuts presented saturated fatty acids values in the range of 49.29 for the heel round to 52.70% for the tip. Within this group the major fatty acid was palmitic acid (16:0) with an average of 25.67%.

TABLE 1
Moisture, total lipids, and fatty acid composition⁽¹⁾ of fresh beef meat cuts

	TIP	Flank	Round	Fore Shank	Tender-loin	Heel of round	Chuck	Sirloin	\bar{X}	DS	Liver ⁽²⁾
Moisture (%)	73.14	74.52	75.45	76.03	74.30	74.71	74.57	71.70	-	-	75.64
Lipid (%)	2.10	4.15	2.30	1.62	2.30	1.90	5.15	1.83	-	-	3.80
Saturated											
C 8:0	ND	ND	ND	ND	ND	ND	ND	ND	-	-	ND
C 10:0	0.05	0.08	0.07	0.08	0.05	0.06	0.08	0.09	0.07	0.02	0.10
C 12:0	0.09	0.15	0.13	0.09	0.13	0.18	0.08	0.10	0.12	0.03	0.22
C 14:0	4.30	3.91	4.13	3.45	5.40	4.70	3.50	3.70	4.14	0.66	2.00
C 16:0	28.10	26.70	25.38	24.22	25.11	25.50	26.10	24.08	25.67	1.32	24.56
C 18:0	20.16	19.70	23.37	22.90	19.10	18.85	21.00	22.66	20.97	1.80	13.28
Σ Sat.	52.70	50.54	53.08	50.74	49.79	49.29	50.76	50.63	50.94	1.31	39.16
Monounsaturated											
C 14:1	1.90	1.65	1.00	2.10	1.33	1.99	1.60	1.00	1.57	0.43	ND
C 16:1	5.70	7.13	5.73	5.36	6.35	6.03	6.23	4.90	5.93	0.68	3.56
C 18:1	34.50	35.15	36.24	36.62	35.80	37.10	35.93	38.30	36.21	1.17	41.10
Σ Mono	42.10	43.93	42.97	44.08	43.48	45.12	43.76	44.20	43.71	0.90	44.66
Polyunsaturated											
C 18:2	4.00	3.42	2.91	3.70	3.73	4.20	2.55	3.71	3.53	0.55	12.09
C 18:3	0.65	1.20	0.60	1.23	1.94	1.20	2.90	1.00	1.34	0.75	2.12
Σ Poly	4.65	4.62	3.51	4.93	5.67	5.40	5.45	4.71	4.87	0.68	14.21
C 20 or higher	0.53	0.70	0.43	0.43	0.55	0.20	0.91	0.47	0.53	0.21	0.81
P/S ratio	0.09	0.09	0.07	0.10	0.11	0.11	0.11	0.09	0.10	0.01	0.44
M/S ratio	0.80	0.87	0.67	0.87	0.84	0.92	0.86	0.85	0.86	0.04	1.04

(1) Expressed as methylesters in 100 g sample. \bar{X} = mean of n=3; SD = Standard Deviation. (2) Not used in \bar{X} and SD calculation

Monounsaturated fatty acids showed the highest content with an average value of (43.71%), and ranged from 42.10 to 45.12 %, with 18:1 being the prominent fatty acid. The smallest average value was found for the polyunsaturated fatty acids (4.87%).

When the polyunsaturated/saturated fatty acids ratio (P/S) and monounsaturated/saturated fatty acids ratio (M/S) are

calculated, the high content of saturated fatty acids is reflected. These values present a range of 0.07 to 0.44 and of 0.67 to 1.04 for the P/S and M/S, respectively.

Table 2 shows the values for pork products, where the total lipid content was as expected, higher than for beef, and in the range of 2.15 to 3.20%, with the exception of the pork fat that had 80.16%.

TABLE 2
Moisture, total lipids, and fatty acid composition⁽¹⁾ of fresh pork cuts and processed products

	Loin	Fresh ham	\bar{X}	SD	Pork fat ⁽²⁾	Cooked ham ⁽²⁾	Smoked ham ⁽²⁾
Moisture %	71.29	73.94	-	-	3.93	73.87	71.71
Lipid %	3.20	2.15	-	-	80.16	5.04	4.12
Saturated							
C 8:0	ND	ND	-	-	ND	ND	ND
C 10:0	0.05	0.08	0.07	0.02	0.07	0.05	0.09
C 12:0	0.41	0.11	0.26	0.21	0.09	0.07	0.15
C 14:0	1.22	1.40	1.31	0.13	1.10	1.40	1.73
C 16:0	25.62	22.68	24.15	2.08	24.07	25.53	27.93
C 18:0	11.68	11.99	11.84	0.22	13.26	10.85	14.44
Σ Sat	38.98	36.26	37.62	1.92	38.59	37.90	44.34
Monounsaturated							
C 14:1	ND	ND	-	-	ND	ND	ND
C 16:1	4.20	3.23	3.72	0.69	2.41	3.89	4.02
C 18:1	43.23	42.43	42.83	0.57	43.21	43.92	46.24
Σ Mono	47.43	45.66	46.55	1.25	45.62	47.80	50.26
Polyunsaturated							
C 18:2	10.52	13.17	11.85	1.87	11.70	10.65	1.32
C 18:3	0.98	1.04	1.01	0.04	1.41	1.04	1.11
Σ Poly	11.50	14.21	12.86	1.92	13.11	11.68	2.43
C 20 or higher	2.10	3.52	2.81	1.00	2.69	0.67	2.00
P/S ratio	0.30	1.26	0.35	0.06	0.34	0.31	0.05
M/S ratio	1.22	1.26	1.24	0.03	1.18	1.2	1.13

(1) Expressed as methylesters in 100 g of sample, \bar{X} = Mean of n=3, SD= Standard deviation, (2) Not included in \bar{X} , and SD calculation.

The fatty acid profiles of fresh pork and pork products are presented in Table 2. The polyunsaturated fatty acids presented an average value of 12.86%, higher than that for beef, with a significant content of unsaturated fatty acids with a chain length of more than 20 carbons, probably eicosaenoic (20:1) and arachidonic acids (20:4), as has been reported by Nazer *et al.* (10). Saturated fatty acids presented an average of 37.62%, a much smaller value than the one found in beef (50.94%), with palmitic acid (16:0) being also the major fatty acid among the group. The monounsaturated and polyunsaturated fatty acids had an average value of 46.55% and 12.86% respectively. Within this group, again oleic acid was the predominant fatty acid. Polyunsaturated fatty acid values found in pork were higher than the ones for beef, as also was the amount of oleic acid. The calculation of the P/S and M/S ratios shows values higher than beef products, due to the difference in the amount of saturated, monounsaturated, and polyunsaturated fatty acids.

Values were in the range of 0.05 to 1.26 (P/S) and 1.13 to 1.26 (M/S).

Table 2 also includes manufactured products such as cooked and smoked ham, where the values for the cooked ham are similar to the fresh one, while the smoked ham presented great differences. It is interesting to notice that the linoleic acid value obtained for smoked ham is rather low (1.32%) when compared to the rest of the products of the same type, like fresh and cooked ham.

The results for poultry are presented in Table 3. It can be seen that there is a great variability for total lipids, with average values between 1.00% for breast and 82.39% for chicken fat. There is also a predominance of the monounsaturated fatty acids, with the oleic acid (35.43%) as the major component. From the three types of meat, poultry is the one that has the highest content of polyunsaturated fatty acids (21.46%), with the prominent fatty acid being linoleic

acid (19.54%). Linoleic acid (C18:2) have an important nutritional value in the diet as an essential fatty acid. Saturated fatty acids ranged from 29.28% for liver to 36.40% for breast.

The P/S and M/S ratios varied from 0.55 to 0.81 and from 1.19 to 1.61, respectively.

TABLE 3
Viscera, and turkey ham moisture, total lipids and fatty acid composition⁽¹⁾ of chicken fresh cuts

	Leg	Breast	\bar{X}	SD	Fat ⁽²⁾	Liver ⁽²⁾	Gizzard ⁽²⁾	Skin ⁽²⁾	Turkey Ham ⁽²⁾
Moisture %	76.22	76.52	-	-	13.15	75.64	80.33	46.86	76.21
Lipids %	2.55	1.00	-	-	82.39	4.77	1.68	29.60	2.85
Saturated									
C 8:0	ND	ND	-	-	ND	ND	ND	ND	0.02
C 10:0	ND	ND	-	-	ND	ND	ND	ND	ND
C 12:0	0.09	0.12	0.11	0.02	0.07	0.05	0.15	0.07	0.03
C 14:0	2.00	1.26	1.63	0.52	1.20	1.62	1.99	1.75	1.06
C 16:0	22.08	24.86	23.47	1.97	19.90	22.43	24.17	23.80	25.37
C 18:0	6.28	10.16	8.22	2.74	9.77	5.18	4.98	5.55	4.84
Σ Sat	30.45	36.40	33.43	4.21	30.94	29.28	31.29	31.17	31.31
Monounsaturated									
C 14:1	ND	ND	-	-	ND	ND	ND	ND	ND
C 16:1	10.00	8.79	9.40	0.86	7.65	13.02	11.18	10.00	2.65
C 18:1	36.28	34.58	35.43	1.02	38.10	33.73	39.30	34.70	35.11
Σ Mono	46.28	43.37	44.83	2.06	45.75	46.75	50.48	44.70	37.76
Polyunsaturated									
C 18:2	20.79	18.29	19.54	1.77	21.05	21.34	15.70	21.16	28.33
C 18:3	1.95	1.88	1.92	0.05	1.90	2.50	2.15	2.70	0.62
Σ Poly	22.74	20.17	21.46	1.82	22.95	23.84	17.85	23.86	28.95
C 20 or higher	0.58	0.08	0.33	0.35	0.40	0.15	0.42	0.28	1.54
P/S ratio	0.75	0.55	0.65	0.13	0.74	0.81	0.57	0.77	0.92
M/S ratio	1.52	1.29	1.36	0.23	1.48	1.60	1.61	1.43	1.21

(1) Expressed as methylesters in 100g of sample, X= Mean of n=3, SD= Standard deviation, (2) Not included in X, and SD calculation

A poultry product made with turkey and called "turkey ham" is also included in Table 3 and the values, in general, are similar to the ones in fresh chicken cuts with the exception of polyunsaturated fatty acids that presented higher values due to the linoleic acid content.

The results obtained in this study are similar to those reported previously by Reyes and Bosch (11), with the exception of the stearic and linoleic acid content of beef, that were present in higher and lesser quantities respectively.

Pork and chicken results were also similar to the ones reported by Sheppard *et al.* (12).

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