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FATTY ACIDS COMPOSITION OF COMMERCIAL FOOD PRODUCTS OF ANIMAL ORIGIN

Introduction

Food of animal origin constitutes an essential element in the daily human diet. Of all the products available on the market, worthy of special attention is the meat of slaughter animals, mainly of pigs and cattle. The consumption of pork fluctuates between 60 and 70% and that of beef between ca. 20 and 25% of the total meat consumption. Meat is a rich source of protein and fat, with the latter being a carrier of fatty acids and vitamins, particularly from group B. Animal fat contains sterols, e.g. cholesterol which serves important functions in a human body, yet when occurring in excess becomes a factor stimulating diseases of the circulatory system. Fatty acids, polyunsaturated ones in particular (EFA – essential fatty acids), are the most favorable to human health from the nutritional point of view. EFA include linoleic acid (C18:2), linolenic acid (C18:3) and arachidonic acid (C20:4). The most important essential fatty acid is linoleic acid since it is used by the body to produce arachidonic acid [21]. In the body, unsaturated fatty acids serve a number of important functions, including structural and bioregulation functions. They participate in the transport and oxidation of cholesterol in the body and prevent the formation of vascular clots. The essential fatty acids are precursors of compounds inhibiting the aggregation of blood cells and those regulating blood flow through coronary vessels and contractility of the cardiac muscle. They also reduce blood pressure by acting on the walls of blood vessels. In addition, they participate in the transport of water and electrolytes through biological membranes [3, 9, 12, 22]. The composition of essential fatty acids determines the properties of fat and the quality of meat products.

Studies have been carried out into the improvement of pork quality. It can be achieved among others, through crossing suitable breeds of fatteners [10] or the selection of individuals for slaughter by age. Meat properties can also be modified, to a large extent, by introducing feed additives [5, 15].

An attempt at the modification of fatty acid composition in ruminant meat fat [16] and a decrease in the cholesterol and saturated fatty acids in meat products was also undertaken [19].

Beef is generally processed, however, it is often consumed raw or semi-raw. It is one of the meats of the highest nutritive value. It is leaner than pork and has medium caloric value – which is important considering the current food consumption trends [4, 5].

The aim of the study was to determine the composition of fatty acids in commercial meat products made of pork and beef obtained on the market in the city of Olsztyn.

Materials and methods

The experimental materials were products of animal origin consumed the most frequently by consumers: samples of pork (loin, shoulder blade) and samples of beef (roastbeef, shoulder blade) purchased at retail outlets in the city of Olsztyn in the years 2004–2005.

Six samples of each meat type were collected both in the period of autumn and winter and the period of spring and summer. Special attention was paid to ensure that the particular commercial products originated from various meat producers. In the laboratory, each sample was analysed in two replications.

Analytical methods: fat from comminuted samples of muscles analyzed in the study was extracted with a mixture of chloroform and methanol (2:1) as described by Folch [8]. Methyl esters of fatty acids were prepared with the method of Peisker [17]. The resultant esters were separated, identified and determined by means of gas chromatography using a PU 4600 chromatograph equipped in a flame-ionization detector and a Supelcowax capillary column.

Preparation of methyl esters of fatty acid

Esterification of the separated fat was performed with a mixture of chloroform, methanol and sulphuric acid according to Peisker's description [17]. The obtained esters were separated, identified and analyzed with the gas chromatography technique.

50–60 mg of the analysed fat was introduced into an ampule with the use of a glass capillary tube. 1.5 cm^3 of the methylating mixture (methanol – chloroform – concentrated sulphuric acid, in the ratio of 100:100:1) was added. The ampule tip was melted over a gas flame burner. After cooling of the sealed ampules they were checked for tightness and submerged in a boiling water bath for approx. 90 minutes. The content of the ampules was thoroughly shaken every 15 minutes.

A clear solution was subjected to a chromatographic analysis using an PU 4600 chromatograph with a flame-ionization detector, a capillary column Supelcowax 10 (length: 30 m, internal diameter: 0.32 mm). A carrier gas was helium-applied at a flow rate of 1.20 cm^3/min. The temperatures of separation were as follows: column 60°C (min)–180°C, Δt–8°C (min), detector – 250°C and injector – 225°C. Reference material BCR No 163 (Blef/pig FAT blend).

Identification of peaks was carried out by comparison with retention times of the standards (Supelco Bellefonte USA) of fatty acid methyl esters by Promochem.

Results and discussion

Percentage contribution selected fatty acids in pork loin and shoulder blade and beef shoulder blade and roastbeef from Olsztyn market are shown in Tables 1–4.

Table 1. Percentage contribution selected fatty acids in pork loin from Olsztyn market

FATTY ACIDS	Consecutive number of samples						Average
	1	2	3	4	5	6	
C16:0	26.13 ab	23.28 b	27.36 a	26.68 ab	24.95 ab	24.25 ab	25.44
C16:1	3.39 b	3.68 b	5.18 a	3.49 b	3.87 b	3.56 b	3.86
C18:0	13.79 ab	12.21 b	13.14 b	15.46 a	13.82 ab	13.21 b	13.61
C18:1	47.51 ab	51.20 a	46.00 b	44.68 b	45.98 b	49.87 a	47.54
C18:2	5.70 ab	5.56 ab	4.37 c	5.42 b	6.63 a	5.71 ab	5.57
C18:2sp	0.00 c	0.07 a	0.00 c	0.00 c	0.05 b	0.00 c	0.019
C18:3	0.18	0.25 ab	0.19	0.27 a	0.30	0.20	0.23
P:S ratio	0.14 a	0.19 a	0.13 a	0.13 a	0.21 a	0.16 a	0.16

a, b, c – statistically significant differences at $p = 0.05$

Both pork (loin, shoulder blade) and beef (roast-beef and shoulder blade) available on the market were characterized by a diversified composition of fatty acids.

The prevailing saturated fatty acids turned out to be palmitic acid C 16:0 and stearic acid C 18:0. The highest average quantity of C16:0 was in roast-beef 26.96% and C18:0 was in beef shoulder blade 15.52%. The maximal amount of C16:0 and C18:0 reached 28.41% and 20.9% respectively.

Table 2. Percentage contribution selected fatty acids in pork shoulder blade from Olsztyn market

FATTY ACIDS	Consecutive number of samples						Average
	1	2	3	4	5	6	
C16:0	23.30 ab	24.39 a	22.45 ab	23.47 ab	23.61 a	20.94 b	23.03
C16:1	3.76 a	3.88 a	3.74 a	3.64 a	3.62 a	3.34 a	3.66
C18:0	12.87 a	11.43 b	10.65 b	11.11 b	11.36 b	10.28 b	11.28
C18:1	47.28 b	48.85 ab	50.23 a	44.65 c	44.16 c	48.50 b	47.28
C18:2	8.17 b	7.22 c	7.78 bc	11.97 a	12.02 a	11.74 a	9.81
C18:2sp	0.00 b	0.00b	0.08 a	0.00 b	0.00b	0.00 b	0.014
C 18:3	0.48	0.40	0.38	0.54	0.53	0.94 a	0.54
P:S ratio	0.24 b	0.26 b	0.24 b	0.37 a	0.37 a	0.40 a	0.31

a, b, c – statistically significant differences at $p = 0.05$.

Table 3. Percentage contribution selected fatty acids in roastbeef from Olsztyn market

FATTY ACIDS	Consecutive number of samples						Average
	1	2	3	4	5	6	
C16:0	27.54 a	28.41 a	26.29 a	24.35 a	27.53 a	27.62 a	26.96
C16:1	5.14 ab	5.21 ab	3.33 b	3.59 b	6.80 a	5.61 a	4.95
C18:0	13.33 b	11.81 b	20.36 a	18.25 a	11.19 b	13.46 b	14.73
C18:1	41.27	45.56	36.86	30.66	43.84	42.00	40.03
C18:2	2.92 b	1.63 b	3.68 ab	10.62 a	1.79 b	2.15 b	3.80
C18:2sp	0.27 a	0.15 b	0.23 a	0.32 a	0.31 a	0.36 a	0.27
C18:3	0.79	0.28	1.98	3.30	0.42	0.67	1.24
P:S ratio	0.10 b	0.05 b	0.12 ab	0.37 a	0.06 b	0.09 b	0.13

a, b, c – statistically significant differences at $p = 0.05$.

The major unsaturated fatty acid was oleic acid C18:1, the concentration of which in pork accounted for 47% (range 44.65–51.2) and in beef – for ca. 41% (range 30.66–50.23).

Fatty acids composition in commercial meat products made of pork and beef from Olsztyn market presented in Table 5.

A lower content of saturated fatty acids was reported in the fat of pork than in that of beef, i.e. 40.89% in loin and 36.63% in shoulder blade of pork as well as 46.43% in roast-beef and 45.38% in shoulder blade of beef, respectively.

The concentration of unsaturated fatty acids in pork was determined at a level of 59.09% in loin and 63.72% in shoulder blade. A considerably lower contribution of unsaturated fatty acids was observed in beef, i.e. 53.56% w roast-beef and 54.62% in shoulder blade.

Table 4. Percentage contribution selected fatty acids in beef shoulder blade from Olsztyn market

FATTY ACIDS	Consecutive number of samples						Average
	1	2	3	4	5	6	
C16:0	27.67 a	27.36 a	22.45 b	24.68 ab	25.76 ab	26.78 ab	25.78
C16:1	4.28 a	3.86 a	3.74 a	3.19 a	3.33 a	4.91 a	3.88
C18:0	14.67 cd	15.61 c	10.65 e	20.90 a	18.10 b	13.18 d	15.52
C18:1	40.14	43.90	50.23	34.29	40.25	40.83	41.61
C18:2	4.70 c	2.12 e	7.78 a	6.55 b	4.01 d	4.94 c	5.02
C18:2sp	0.22 b	0.19 b	0.08 c	0.31 a	0.19 b	0.29 a	0.21
C18:3	1.03	0.46	0.38	0.28	0.80	1.05	0.60
P:S ratio	0.16 c	0.06 e	0.12 a	0.16 c	0.12 d	0.18 b	0.13

a, b, c – statistically significant differences at $p = 0.05$.

Table 5. Fatty acids composition in commercial meat products made of pork and beef from Olsztyn market (%)

FATTY ACIDS	PORK		BEEF	
	LOIN	SHOULDER BLADE	ROASTBEEF	SHOULDER BLADE
SATURATED	40.89 a	36.63 b	46.43 a	45.38 a
UNSATURATED	59.09 a	63.72 b	53.56 a	54.62 a
MONOUNSATURATED	52.62 a	52.46 a	47.13 b	47.57 b
POLYUNSATURATED	6.46 a	11.26 b	6.43 a	7.05 a

The content of polyunsaturated fatty acids in the analyzed meat products was at a level of ca. 7%, except for pork shoulder blade, where it reached 11.26%. C18:2 fatty acid reached even 12.02% in pork meat.

The fatty acids composition in pork and beef meat reported here is similar to research other authors. Pork meat have high levels of polyunsaturated fatty acids PUFA in adipose tissue and muscle, which different authors' investigations confirm [7, 20].

Average P:S ratios in beef meat was 0,13 but in pork loin and shoulder blade was 0.16 and 0.31, respectively.

According to Banskalieva et al. the P:S ratios ranged between 0.11–0.40 for beef meat and a range of 0.25–0.65 for pork meat [2].

The type of feeding regime used in animal production, can influence the lipids in meat due to the fatty acid composition of the feed. Mann et al. showed that pasture feeding of Australian cattle maximizes omega-3 PUFA content and minimizes trans 18:1 fatty acid levels relative to grain feeding [14].

The modification of fatty acids composition in meat is possible to obtainment through additives of oils to fodder for animals, for example including 5% soy bean oil in pigs diets increased the polyunsaturated fatty acids in ion of pork [1]. Other studies have been completed to evaluate the use of linseed and tuna oil as a possible n–3 source in pig nutrition or in beef production [11, 13].

The composition of fatty acids of pork and beef meat can be changed by the type of culinary frying fat. Ramirez and Cava reported that C12:0, C14:0 and C16:0 fatty acids increased (11, 2.6 and 1.1–fold, respectively) in pork loin chops fried in butter; C18:1 increased 1.4–fold in samples fried in olive oil, while C18:2 increased 3.8-fold in samples fried in sunflower oil [18].

Conclusions

The breeding process of slaughter animals – pigs and cattle – differentiates fatty acid composition to an extent that changes the nutritional quality of culinary meat available on the market.

Shoulder blade of pork characterized better profile of fatty acids composition, the lowest content of saturated fatty acids and 2-times higher content of polyunsaturated fatty acids in comparison to the other kinds of research material.

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SKŁAD KWASÓW TŁUSZCZOWYCH W RYNKOWYCH PRODUKTACH POCHODZENIA ZWIERZĘCEGO

Streszczenie

W artykule przedstawiono wyniki badań składu kwasów tłuszczowych w rynkowych produktach z mięsa wieprzowego i wołowego zakupionych w punktach handlowych miasta Olsztyn. Dostępne na rynku olsztyńskim mięso wieprzowe (polędwica, łopatka) i mięso wołowe (rostbef i łopatka) charakteryzowało się zróżnicowanym składem kwasów tłuszczowych. Niższa zawartość nasyconych kwasów tłuszczowych (ok. 20%) i wyższa zawartość nienasyconych kwasów tłuszczowych (ok. 13%) została stwierdzona w tłuszczu mięsa wieprzowego w porównaniu do mięsa wołowego. Proces hodowli zwierząt rzeźnych – trzody chlewnej i bydła – różnicuje skład kwasów tłuszczowych w stopniu zmniejszającym jakość żywieniową mięsa kulinarnego.