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ESTIMATION OF FATTY ACIDS AND *TRANS* FATTY ACIDS COMPOSITION IN CHOSEN DRY FOOD MIXES

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ABSTRACT

Quantity and quality of fat in every day diet influence human health. Recently particular attention is payed to *trans* fatty acids composition in ingested food. Modern, no time consuming, convenient food is widely used now. Seventeen chosen products like dry soups or sauces mixes from the market in Poland were analysed to estimate fat concentration and fatty acids composition including *trans* fatty acids. The products contained different amount of fat, from about 3g/100g to 24g/100g of product. The fat concentration as well as fatty acids composition varied dependently on the kind of product and producer too. The dominated group of fatty acids in

all analysed samples were saturated fatty acids (up to 50%). Monounsaturated fatty acids occured in the range from 15 to 40%, while polyansaturated from 2 to 6%. Four *trans* fatty acids were identified: 18:1, 6-*trans*, 18:1, 9-*trans*, 18:1, 12-*trans*, and 18:2, *cis*-9, *trans*-12. Only 18:1, 9-*trans* was estimated in all products at the range from 3.75% to 30,46%. The rest three *trans* fatty acids did not exceed 3%. The data obtained showed that some of the dry food mixes may be a significant source of fat in our diet and because of that the quality of the fat used for the production of such food has to be improved.

Key words: fat, fatty acids, *trans* fatty acids, dry food mixes

INTRODUCTION

Carbon to carbon double bonds of unsaturated fatty acids have two potential geometric isomer configurations *cis* and *trans*. In nature most unsaturated fatty acids are *cis* fatty acids, meaning the hydrogen atoms are on the same side of double carbon bonds. *Trans* isomers of unsaturated fatty acids are formed by biological or industrial hydrogenation [2]. They occur in the nature as the result of fermentation in grazing animals, so we eat them in the form of meat, eggs and dairy products. But *trans* double bonds are also formed during the hydrogenation of *cis* fatty acids in vegetable and fish oils. Variation in the geometric forms of these fatty acids confers different biological properties [13].

Many scientific studies were done [1,4,9,12,13,14,15,17] to test the hipothesis that *trans* isomers of oleic and linoleic acids increase the risk of suden cardiac death due to coronary artery disease. Most of them do not support the hipothesis, however *trans* fatty acids in food supply have recently generated controversy that appears to many nutritionists to have gained undue notoriety [2,9,12]. The most controversial appears to be the possible effect of *trans* fatty acids on high density lipoprotein (HDL) - cholesterol and on lipoprotein concentration, as well as the alliged link between *trans* fatty acids consumption and coronary heart disease. The study done by Kumerow et all [7,8] showed that the diet deficient in magnesium and containing a high amount of *trans* fatty acids t-18:1n9 and t,t-18:2 increaseas the calcification of endothelial cells, which is common hallmark of atherosclerosis. On the other hand scientifists suggest no poor effect of *trans* fatty acids on our health if they are supplied in daily food together with adequate amount of polyunsaturated fatty acids mostly *cis* linoleic and *cis* linolenoic acids [1,11,12,13,16]. The suggested proportion of saturated, monounsaturated and polyunsaturated fatty acids in our diet is 1:1:1, with limited daily intake of overall fat. The estimation of daily intake of *trans* fatty acids is not easy and the value differs in the wide range within countries [16], from few to almost 30g/person/day. In Poland it reaches the level of 10-14g/person/day. However the effect of *trans* fatty acids on human health is not proved enough, the level of their consumption has to be controlled. Thus we need information about the possible sources of *trans* fatty acids in food we eat. This knowlege is relatively wide in relation to various fat product; plant oils, hydrogenated oils, animal fat, eggs, meat and dairy products. But there are many other food products containing fat in different forms. Some of them we eat quite often. The modern, convenient foods, easy to prepare dry soups mixes or other dehydrated meals became very popular now. The question arises about the quality of such products.

The aim of this work was to evaluate the quality of several dry soups or sauces mixes from the market in Poland, on the basis of the estimation fat concentration and fatty acids composition, including *trans* faty acids.

MATERIALS AND METHODS

The study was perfomed with six kinds of dry food mixes coming from three different producers on the market in Poland (Table 1).

Table 1. Dry food mixes used as the experimental samples

Producer	Kind of product	Declared kind of fat used as an ingredient
A	I. Champignone soup	Plant and animal fat
	II. Tomato soup	Plant fat
	III. Borsch	Plant fat
	IV. Bouillon	Plant and beef fat
	V. Spaghetti sauce	Plant fat
	VI. Gravy sauce	No declaration
B	I. Champignone soup	Plant and beef fat
	II. Tomato soup	Plant and beef fat
	III. Borsch	Beef fat
	IV. Bouillon	No declaration
	V. Spaghetti sauce	Hydrogenated plant oil
	VI. Gravy sauce	Plant fat
C	I. Champignone soup	Beef fat
	II. Tomato soup	Beef Fat
	III. Borsch	Beef fat
	IV. Bouillon	Beef and poultry fat
	V. Gravy sauce	Plant fat

Fat was isolated from analysed samples by extraction according to Weibull-Stoldt method [6].

Composition of fatty acids was estimated by gas chromatography. Fatty acids were separated in the form of methyl ester derivatives. Preparation of the samples was done from 0.15g of extracted fat, by saponification with 2ml 0.5N potasium hydroxide solution in methanol at 75°C, and following estrification with 1ml of sulfuric acid solution in methanol (2:10 v/v) at 75°C. The fatty acids methyl esters (FAME) were than *trans*ferred to hexane layer.

Gas chromatography separation was performed with Hewlett Packard 5890 II instrument, on Supelco capillary column SP 2560 (100m x 0.25mm x 0.2µm) in programmed temperature conditions: from 150°C - hold 1 min, with the rate of 2° C/min to 210°C - hold 60 min.

Identification of separated FAME was performed by comparison the retention data of separated compounds in the analysed samples with those obtained for standards solution. The standard solutions used for identification are given below.

Nu-Chek-Prep.,INC. (USA):
1. U-45-M (C18:1, 6-*trans*octadecanoic /methyl)
2. U-47-M (C18:1, 9-*trans*octadecanoic/methyl)
3. U-49-M (C18:1, 11-*trans*octadecanoic/methyl)

4. U-60-M (C18:2, 9-*trans*, 12-*trans*octadecadienoic/methyl)
5. UC-59 M (C18:2 9,11 and 10,12 octadecadienoic *cis* and *trans* configurated 99%/methyl)
6. U-63-M (C18:3 6*cis*, 9*cis*, 12*cis* octadecatrienoic/methyl)
7. U-64-M (C20:1 11-*trans*eicosenoic/methyl)
8. UT-68-M (C20:2 11,14-*trans*eicosenoic/methyl)
9. GC-85 Mix C4 - C22:6 Fatty Acid Methyl Esters

Supelco
Linolenic Acid Methyl Ester Isomer Mix
- 9*trans*, 12*trans*, 15*trans* - octadecatrienoic acid methyl ester
- 9*trans*, 12*trans*, 15*cis* - octadecatrienoic acid methyl ester
- 9*trans*, 12*cis*, 15*trans* - octadecatrienoic acid methyl ester
- 9*cis*, 12*trans*, 15*trans* - octadecatrienoic acid methyl ester
- 9*cis*, 12*cis*, 15*trans* - octadecatrienoic acid methyl ester
- 9*cis*, 12*trans*, 15*cis* - octadecatrienoic acid methyl ester
- 9*trans*, 12*cis*, 15*cis* - octadecatrienoic acid methyl ester
- 9*cis*, 12*cis*, 15*cis* - octadecatrienoic acid methyl ester

RESULTS AND DISCUSSION

The fat contents measured in the analysed samples varied significantly dependently on the kind of product and within the same kind among the producers too (Table 2). The lowest fat content (2.83g/100g of product) was stated in the borsch from producer B, while the highest (23.78g/100g of product) in the bouillon from producer A. It suggests that some of these products may be quite significant source of fat in our diet.

Table 2. Fat content estimated in the samples of dry soups and sauces mixes (g/100g of product)

Kind of product	Producer		
	A	B	C
Champignone soup	8.46 ± 0.11*	16.0 ± 0.87	10.4 ± 0.34
Tomato soup	5.0 ± 0.02	6.26 ± 1.33	11.33 ± 0.11
Borsch	6.4 ± 0.02	2.86 ± 0.11	4.93 ± 0.11
Bouillon	23.73 ± 0.23	19.33 ± 0.23	5.6 ± 0.20
Spaghetti sauce	3.93 ± 0.11	3.80 ± 0.20	-
Gravy sauce	7.46 ± 0.61	15.6 ± 0.72	11.93 ± 0.41

***- mean value ± standard deviation**

The fatty acid composition in the fat extracted from the products is presented in Tables 3-8, separately for every kind of products but together for all three producers. The type of fat used for the production influenced the composition of fatty acids. Twenty three fatty acids were identified, among them four *trans* fatty acids: 18:1, 6-*trans*, 18:1, 9-*trans*, 18:1, 12-*trans* and 18:2 *cis*-9, *trans*-12. Only one of the four 18:1, 9-*trans* was estimated in all analysed samples, but at the range from 3.75% in the tomato soup from producer C, to 30.46% in the spaghetti sauce from producer A. The 18:1, 12-*trans* fatty acid was noticed at the level about 2%, mostly in the samples from producer A. The last two identified *trans* fatty acids 18:1, 6-*trans*

and 18:2, *cis*-9, *trans*-12 occured rarely and at the range below 1% of total fatty acids. On the Figures 1-6 there are presented the data summarizing percentage composition of saturated, monounsaturated, polyunsaturated and *trans* fatty acids in all estimated samples. It is well seen that saturated fatty acids are dominated group of fatty acids, compose in all samples of soups and sauces about 40-50% of total fatty acids. Monounsaturated fatty acids occured in a wider range from 15 to 40%, while polyunsaturated fatty acids from 2 to 6% only. The most important observation there is high level of *trans* fatty acids in some products, ranged from 25% to over 30% of total fatty acids. These products like bouillons or gravy sauces contained high amount of fat declared most often as plant fat or plant and beef fat, only ones as hydrogenated plant oil or not declared.

Table 3. Fatty acids composition in dry champignone soup mix (in %)

Fatty acid	Producer		
	A	B	C
12:0	0.05 ± 0.01*	0.14 ± 0.01	-
14:0	0.95 ± 0.07	1.34 ± 0.02	2.18 ± 0.01
15:0	0.20 ± 0.01	0.16 ± 0	0.41 ± 0
16:0	17.56 ± 0.41	34.15 ± 0.05	26.32 ± 0.29
16:1	0.92 ± 0.01	0.82 ± 0.02	2.06 ± 0.06
17:0	0.50 ± 0.01	0.46 ± 0.01	1.12 ± 0.04
18:0	23.47 ± 0.01	16.16 ± 0.43	23.15 ± 0.66
18:1, 6 *trans*	0.09 ± 0	-	-
18:1, 9 *trans*	18.18 ± 0.57	14.70 ± 0.17	4.28 ± 0.02
18:1, 12 *trans*	2.57 ± 0	1.40 ± 0	-
18:1, 8 *cis*	4.48 ± 0.16	-	-
18:1, 9 *cis*	17.04 ± 0.96	26.25 ± 0.45	33.09 ± 0.31
18:1, 10 *cis*	2.29 ± 0	-	-
18:1, 11 *cis*	1.55 ± 0.07	1.17 ± 0.06	-
18:1, 12 *cis*	1.26 ± 0.09	0.41 ± 0.10	0.23 ± 0
18:1, 13 *cis*	0.37 ± 0	0.11 ± 0	-
18:2, 9 *cis*, 12 *trans*	0.29 ± 0.02	-	-
18:2, 6 *cis*	7.92 ± 0.31	2.69 ± 0.06	6.21 ± 0.19
18:3, 3 *cis*	0.30 ± 0.02	0.39 ± 0.01	0.31 ± 0
20:0	0.14 ± 0.01	-	0.27 ± 0
20:1, 9 *cis*	0.66 ± 0.01	0.21 ± 0.02	0.54 ± 0.03
22:0	0.41 ± 0.01	0.17 ± 0	-
24:0	0.09 ± 0	-	-

Table 4. Fatty acids composition in dry tomato soup mix (in %)

Fatty acid	Producer		
	A	B	C
12:0	0.33 ± 0.01	0.43 ± 0.02	-
14:0	0.12 ± 0	1.34 ± 0.01	2.21 ± 0.05
15:0	0.18 ± 0	0.24 ± 0.01	0.49 ± 0.01
16:0	22.76 ± 0.05	26.49 ± 0.02	26.02 ± 0.17
16:1	0.64 ± 0.05	0.70 ± 0.02	2.17 ± 0.01
17:0	0.52 ± 0.02	0.54 ± 0.02	1.36 ± 0.03
18:0	20.44 ± 0.10	21.27 ± 0.02	24.66 ± 0.19
18:1, 9 *trans*	21.82 ± 0.53	12.82 ± 0.04	3.75 ± 0.01
18:1, 12 *trans*	-	2.46 ± 0.02	-
18:1, 8 *cis*	1.93 ± 0.06	4.35 ± 0.16	-
18:1, 9 *cis*	22.94 ± 0.08	19.10 ± 0.02	33.40 ± 0.17
18:1, 11 *cis*	1.43 ± 0.03	1.86 ± 0.01	-
18:1, 12 *cis*	0.83 ± 0.07	1.26 ± 0.01	0.21 ± 0
18:1, 13 *cis*	0.07 ± 0	-	-
18:2, 6 *cis*	3.80 ± 0.07	5.06 ± 0.02	4.41 ± 0.03
18:3, 3 *cis*	0.50 ± 0.01	0.63 ± 0.02	0.32 ± 0.02
20:0	0.11 ± 0	-	0.30 ± 0.01
20:1, 9 *cis*	0.59 ± 0.01	0.81 ± 0.03	0.72 ± 0.01
22:0	0.29 ± 0.02	0.43 ± 0.01	-
24:0	0.09 ± 0.01	0.19 ± 0	-

*** mean value ± standard deviation**

Table 5. Fatty acids composition in dry borsch mix (in %)

Fatty acid	Producer		
	A	B	C
12:0	0.67 ± 0.06	-	-
14:0	0.92 ± 0.09	2.06 ± 0.04	1.97 ± 0.01
15:0	-	0.54 ± 0.07	0.49 ± 0.01
16:0	30.95 ± 0.64	25.19 ± 0.25	25.06 ± 0.04
16:1	0.25 ± 0	2.29 ± 0.10	2.20 ± 0.01
17:0	-	1.42 ± 0	1.4 ± 0.01
18:0	9.3 ± 0.15	24.9 ± 0.52	25.25 ± 0.01
18:1, 6 *trans*	0.25 ± 0	-	-
18:1, 9 *trans*	30.28 ± 0.14	4.36 ± 0.33	4.07 ± 0.02

18:1, 12 *trans*	2.55 ± 0.04	-	-
18:1, 8 *cis*	4.59 ± 0.09	-	0.03 ± 0
18:1, 9 *cis*	11.12 ± 0.08	35.73 ± 0.20	43.69 ± 0.03
18:1, 11 *cis*	1.96 ± 0.19	-	-
18:1, 12 *cis*	0.85 ± 0.27	-	0.17 ± 0.01
18:1, 13 *cis*	0.63 ± 0	-	-
18:2, 6 *cis*	4.79 ± 0.02	2.52 ± 0.01	2.91 ± 0.05
18:3, 3 *cis*	0.53 ± 0.14	0.35 ± 0	0.32 ± 0.03
20:0	-	0.32 ± 0	0.37 ± 0.01
20:1, 9 *cis*	0.81 ± 0.26	0.58 ± 0.25	0.94 ± 0.01
22:0	-	-	0.14 ± 0.01

*** mean value ± standard deviation**

Table 6. Fatty acids composition in dry bouillon mix (in %)

Fatty acid	Producer		
	A	B	C
12:0	0.21 ± 0.02	-	-
14:0	0.85 ± 0.04	0.22 ± 0.01	1.75 ± 0.18
15:0	0.08 ± 0	-	0.36 ± 0.01
16:0	28.86 ± 0.42	12.93 ± 0.04	24.86 ± 0.86
16:1	0.83 ± 0.05	0.99 ± 0.01	2.34 ± 0.05
17:0	0.24 ± 0.01	-	1.00 ± 0.01
18:0	12.21 ± 0.23	22.69 ± 0.01	20.69 ± 0.24
18:1, 6 *trans*	-	0.22 ± 0	-
18:1, 9 *trans*	29.76 ± 0	23.24 ± 0.05	5.64 ± 0.10
18:1, 12 *trans*	-	3.51 ± 0.14	-
18:1, 8 *cis*	3.27 ± 0.83	6.61 ± 0.07	1.26 ± 0
18:1, 9 *cis*	17.86 ± 0.67	18.37 ± 0.03	32.50 ± 0.82
18:1, 10 *cis*	-	2.96 ± 0.04	-
18:1, 11 *cis*	0.99 ± 0.12	2.74 ± 0.02	-
18:1, 12 *cis*	0.55 ± 0.14	1.45 ± 0.01	0.75 ± 0
18:1, 13 *cis*	0.14 ± 0	-	-
18:2, 6 *cis*	2.85 ± 0.05	3.18 ± 0	8.91 ± 0.01
18:3, 3 *cis*	0.55 ± 0.04	0.45 ± 0.02	0.27 ± 0
20:0	0.31 ± 0	0.46 ± 0.02	0.24 ± 0
20:1, 9 *cis*	0.24 ± 0	-	0.62 ± 0.03
22:0	0.23 ± 0.03	-	-

*** mean value ± standard deviation**

Table 7. Fatty acids composition in dry spaghetti sauce mix (in %)

Fatty acid	Producer	
	A	B
12:0	0.36 ± 0.02	-
14:0	0.72 ± 0.06	-
16:0	31.33 ± 0.05	14.28 ± 0.27
18:0	10.15 ± 0.14	25.25 ± 0.23
18:1, 9 *trans*	30.46 ± 0.04	25.07 ± 0.05
18:1, 12 *trans*	2.49 ± 0.01	3.68 ± 0.11
18:1, 8 *cis*	4.46 ± 0.03	6.29 ± 0.02
18:1, 9 *cis*	11.39 ± 0.06	13.69 ± 0.02
18:1, 11 *cis*	1.93 ± 0.02	2.60 ± 0.07
18:1, 12 *cis*	0.68 ± 0.01	2.95 ± 0.04
18:2, 6 *cis*	4.27 ± 0.05	4.33 ± 0.20
18:3, 3 *cis*	0.85 ± 0.02	0.64 ± 0
20:0	-	-
20:1, 9 *cis*	0.87 ± 0.05	1.08 ± 0.02
22:0	-	0.76 ± 0

*** mean value ± standard deviation**

Table 8. Fatty acids composition in dry gravy sauce mix (in %)

Fatty acid	Producer		
	A	B	C
12:0	0.47 ± 0.14	-	-
14:0	0.81 ± 0	0.36 ± 0.01	0.82 ± 0.01
15:0	-	-	-
16:0	29.88 ± 0.01	11.73 ± 0.30	20.55 ± 0.06
16:1	-	0.20 ± 0.10	1.43 ± 0.05
17:0	-	0.12 ± 0	0.29 ± 0
18:0	9.17 ± 0	24.44 ± 0.29	17.60 ± 0.14
18:1, 6 *trans*	0.26 ± 0.01	0.25 ± 0	-
18:1, 9 *trans*	28.46 ± 0.22	28.56 ± 0.01	8.07 ± 0.33
18:1, 12 *trans*	2.28 ± 0.07	4.50 ± 0.19	1.20 ± 0
18:1, 8 *cis*	4.38 ± 0.09	7.57 ± 0.24	1.40 ± 0.40
18:1, 9 *cis*	12.40 ± 0.33	12.06 ± 0.11	33.78 ± 1.19
18:1, 10 *cis*	-	2.72 ± 0.02	4.11 ± 0.09

18:1, 11 *cis*	1.69 ± 0	2.79 ± 0.02	-
18:1, 12 *cis*	0.79 ± 0.21	1.50 ± 0.02	0.63 ± 0
18:1, 13 *cis*	0.32 ± 0.14	0.67 ± 0	-
18:2, 6 *cis*	8.44 ± 0.02	1.91 ± 0.13	9.18 ± 0.06
18:3, 3 *cis*	0.61 ± 0.02	0.55 ± 0.01	0.36 ± 0.01
20:0	-	-	0.81 ± 0.01
20:1, 9 *cis*	0.48 ± 0.07	-	0.52 ± 0.07
22:0	0.28 ± 0.05	0.58 ± 0	-

*** mean value ± standard deviation**

Figure 1. Percentage composition of saturated, cis-monoenic, cis-polyenic and sum of trans fatty acids in dry champignone soup mix

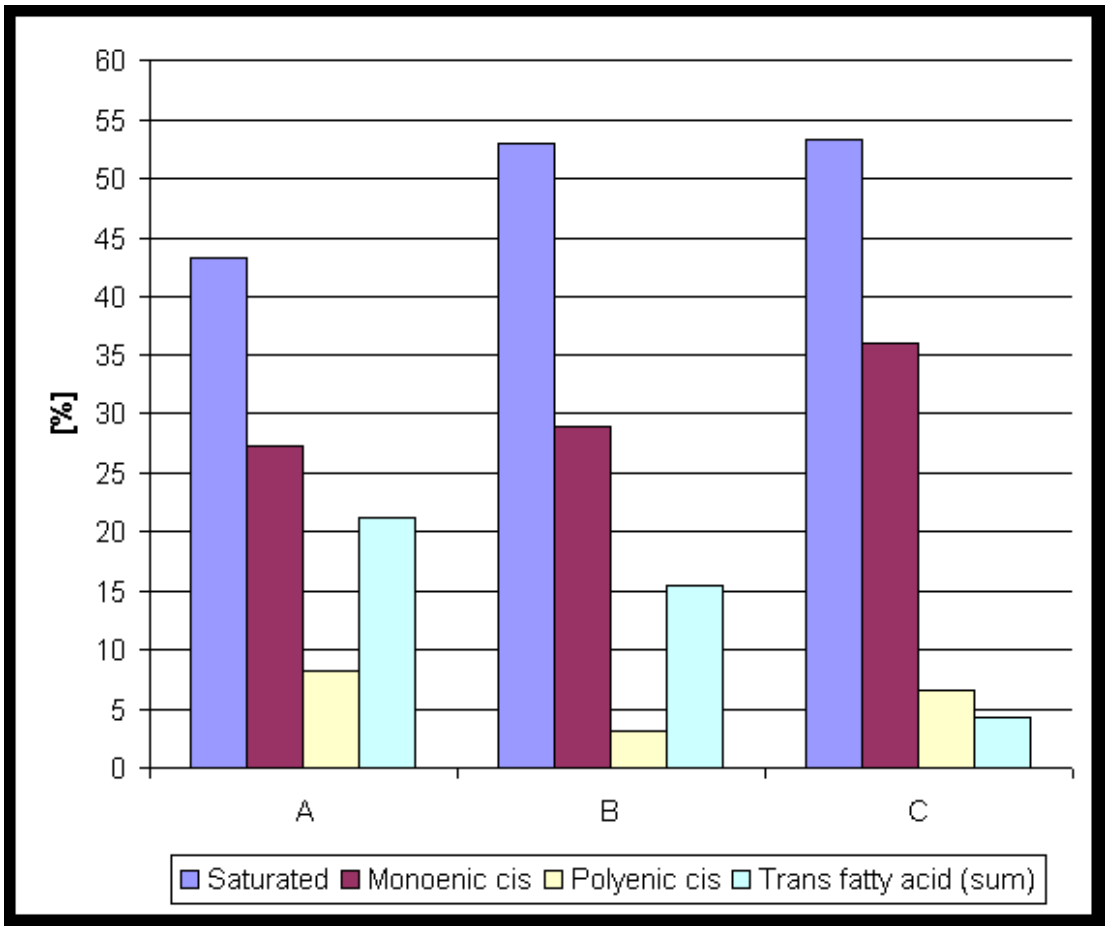


Figure 2. Percentage composition of saturated, cis-monoenic, cis-polyenic and sum of trans fatty acids in dry tomato soup mix

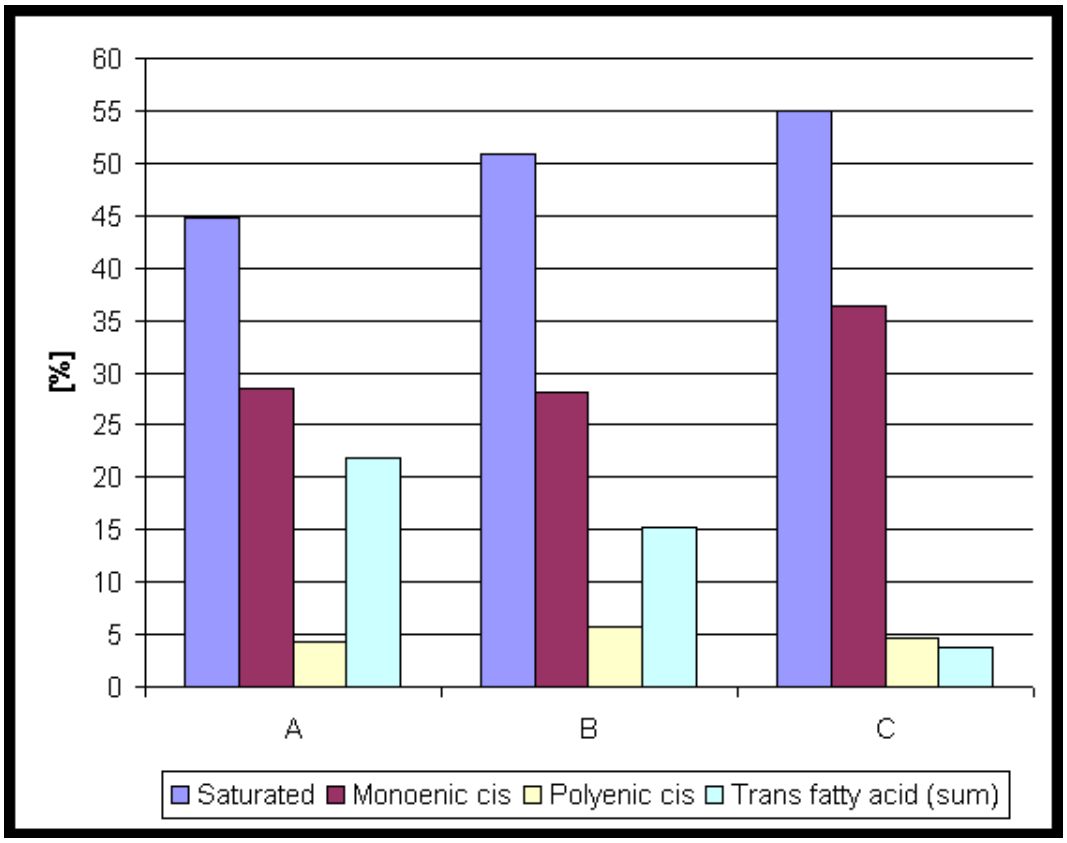


Figure 3. Percentage composition of saturated, cis-monoenic, cis-polyenic and sum of trans fatty acids in dry borsch mix

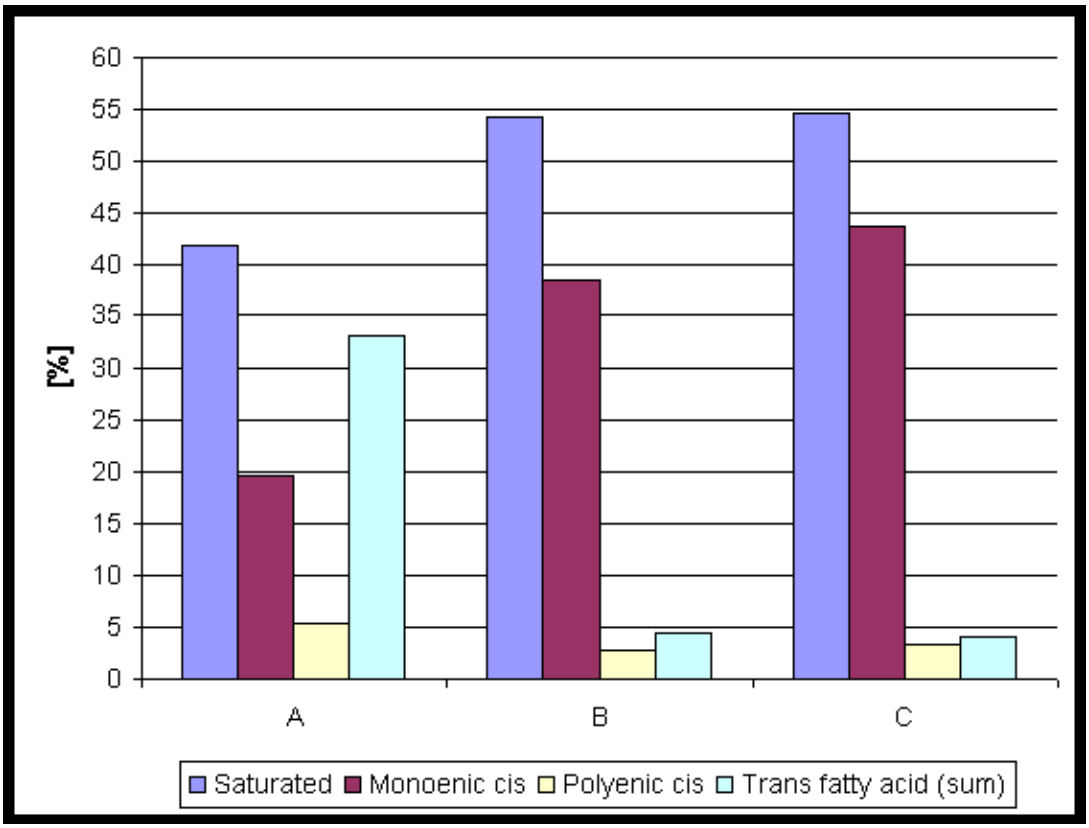


Figure 4. Percentage composition of saturated, cis-monoenic, cis-polyenic and sum of trans fatty acids in dry bouillon mix

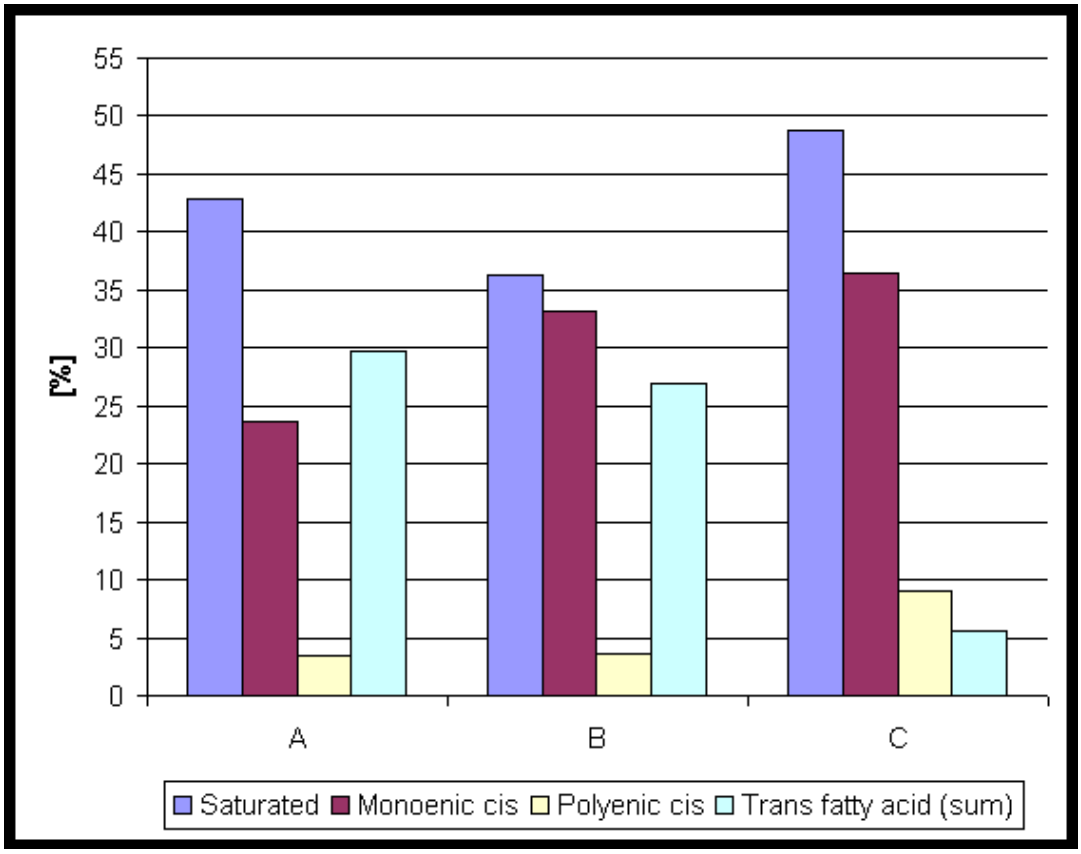


Figure 5. Percentage composition of saturated, cis-monoenic, cis-polyenic and sum of trans fatty acids in dry spaghetti sauce mix

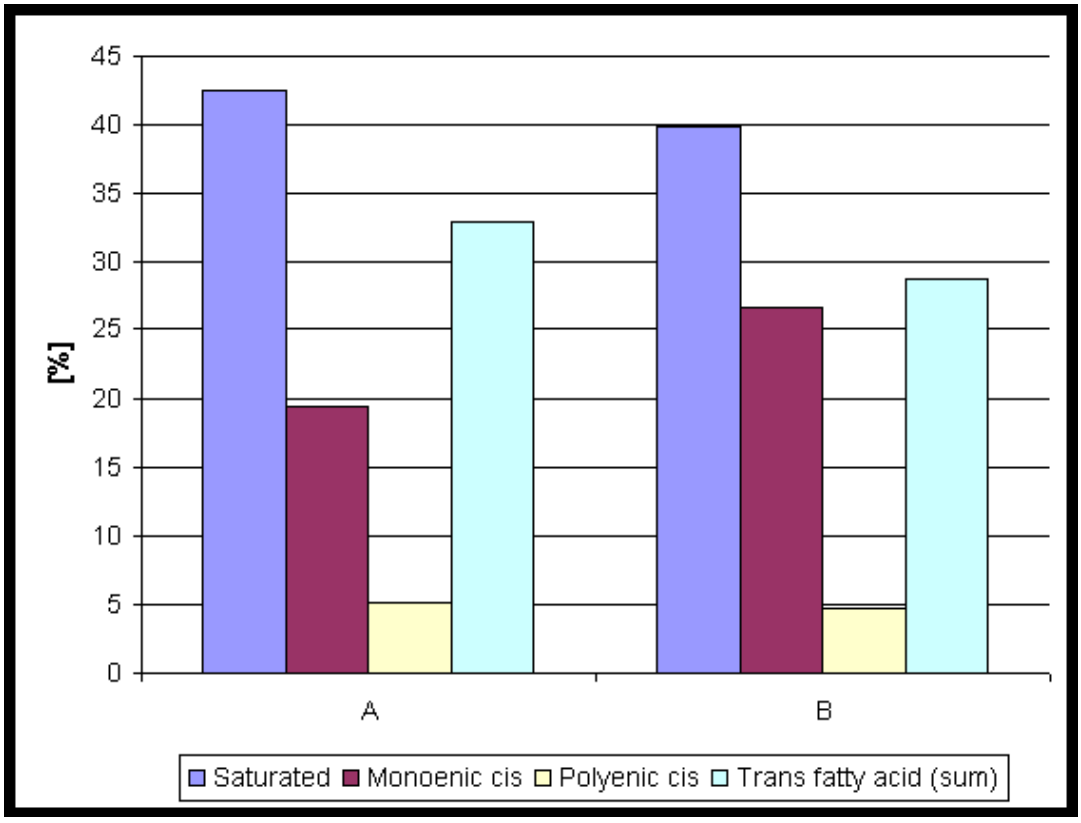
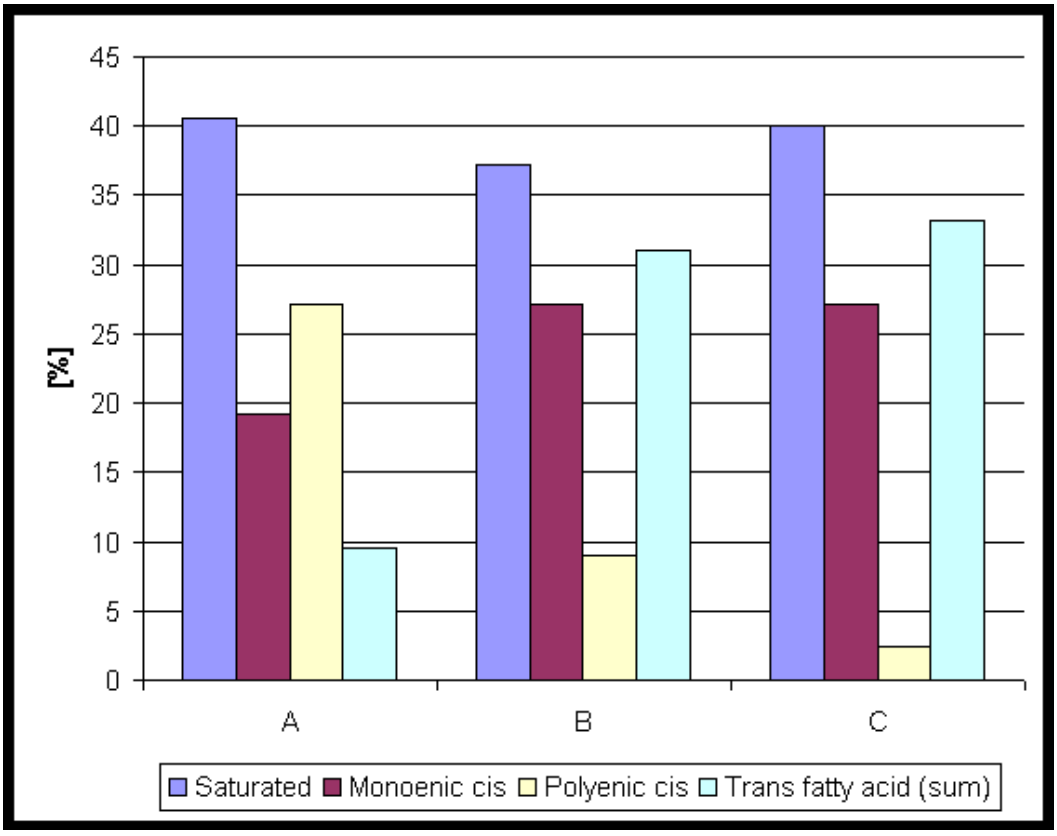


Figure 6. Percentage composition of saturated, cis-monoenic, cis-polyenic and sum of trans fatty acids in dry gravy sauce mix



It is no doubt that both quantity and quality of ingested fat may influence important biochemical processes in human body including alteration of serum lipid level [9]. The beef tallow used previously in production of dry food mixes, for its good stability and sensory properties is very often replace by plant oil, because of cholesterol. But the solid plant oil obtained by hydrogenation may contain *trans* fatty acids.

The concentration and composition of *trans* fatty acids were estimated by many authors in such products like margarines, deep frying fats, boiling fats, cakes, pastry, salad oils, butter alternatives, chips, snacks [3]. Average ranges of *trans* fatty acids content of margarines - the main possible source of *trans* faty acids - in Poland are from a few to over 30% [16]. The recent advantages in technology of oil hydrogenation allow to go down with the *trans* fatty acids level. Our data shown rather poor quality of fat used for the production of dry food mixes, which has to be improved according to present-day feeding demand, particularly because the consumption of these products is growing now.

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