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COMPOSITON AND CORRELATION AMONG THE FATTY ACIDS IN SUNFLOWER SEED OIL OF VARIOUS INBRED LINES

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SUMMARY

For determination of the composition nof fatty acids of sunflower seed oil were used 44 male-fertile sunflower lines in various degrees of inbreding, being the creations of the Osijek Agricultural Institute.

Fatty acids were determined by Perkin-Elmer gas chromatography and the method of internal normalization of surfaces. The obtained data were used to calculate the aritmetic means, values of dispersion, coefficients of linear correlation and coefficient of determination.

Tje objective of this research was to demonstrate the form of interactions among the ratios i.e., correlation of the oleic, palmitic, stearic and linoleic acids.

The correlation intensity was determined according to the Roemer-Orphal classification. Linear regressions showed negative and mean correlation between the palmitic and oleic acid (r=-0.43). The correlation between the oleic and linoleic acid was negative and complete (r=-0.97). The positive and weak correlation was established between the stearic and oleic acid (r=0.30). According to the coefficient of determination (R^2=0.99) only 1% of the sum of the total deviations remained undefined by the correlation of the variables tested.

INTRODUCTION

Sunflower seed oil is composed primarily of higher fatty acids: linoleic, oleic, palmitic and stearic, of which the linoleic and oleic make almost 90% of the total share of fatty acids in the standard oil. Besides these, significant shares belong also to palmitoleic (up to 1%), linolenic (up to 2%) and myristic (up to 1%) acids. Occasionally, one can also find the arachidonic, behenic and lignoceric acids, being practically of irrelevant amounts.

The greatest effect on the quality of oil and thus on its potential use has been found with the ration between the oleic and linoleic acid. It is namely desirable that the oils used for thermal processing of food products contain the highest possible share of oleic acid, and at the same time a share of linoleic acid not higher than 40% of total fatty acids containted. Such an oil is then much more stable, and less susceptible to deterioration by oxidation and pirolysis. Due to this fact, they can be repeatedly used for the same purposes.

Contrary to this, the oils with a higher share of linoleic acid (62%) are less stable and are mainly used in the production of margarins, mayonnaise and similarly food products.

From the biological standpoint, a special role in the human food has been performed by higher unsaturated fatty acids of "linoleic acid order", antiatherogenic namely, because they reduce the level of total and LDL cholesterol in blood plasma, building thus the membrane lipids and serving as pre-grades biosynthesis of E" and F2 prostaglandins (responsible for blood pressure regulation and known as blood circulation promoters throughout the body. The body can not build higher unsaturated fatty acids de novo, the necessary daily amount of the essential fatty acids to be taken is 6 to 8 g (5).

It has been known that the growing conditions (differences between the daily and night temperatures, exposures to sun light and partial pressure of oxygen) could significantly affect the biosynthesis course of unsaturated fatty acids in the sunflower sed oil. At higher temperatures and by day light, the oleic acid synthesis occurs and further from it, during the night, by desaturation (2) linoleic acid is produced. this difference in timing of their coming out demonstrates the presence of two enzymatic systems (3), by means of which the biosynthesis of fatty acids has been performing.

A breeding work focused on specific ratio of higher fatty acids has been very difficult, because of the already-mentioned reasons. However, some research (9) has shown that besides the high variability (2.2-76.0%) in linoleic share, there is also a certain independence from environmental effects, which makes the breeding for this quality practically possible.

Relative independence from external factors has been also found for the share of oleic acid with the variety *Pervenec* that is almost an exclusive donor of genes for the quality in question. According to fick (3), a high share of oleic acid in sunflower seed oil is controlled only by one gene, namely O1, the effect of which is significantly modified by the female effects.

Urie (4), using the similar research material, has concluded that there is not a question of one dominant gene but in the fact that some lines created by inbreeding from the *Pervenac* variety carry the major inheritance factor and/or the modifying genes that cause significant variations in the share of the oleic acid. By analyzing the distribution of the oleic classes in F_{2}-, BC-, F_{3}-populations, created by the same parental components, Miller et al. (6) have concluded that the share of oleic acid is controlled by one major gene, being partially dominant (O1) as well as by the other one, the recessive gene (m1) namely. If O1 gene is present in the genetic material whilst the recessive gene has a stage of homozygote, the content of oleic acid increases up to 820 g/kg oil, or even higher. The most recent research (8) has demonstrated that still some further segregation relations have remained unclear and there is a question whether it is only the presence of two genes that affects the expression of this feature.

MATERIAL AND METHODS

For determination of the fatty acids fractions in sunflower seed oil were used 44 male fertila sunflower lines created at the Osijek Agricultural Institute. The material of various inbreeding degrees from S_4 to S_{14} as analyzed to have the widest possible genetic base.

The fatty acids in the oil of sunflower lines were separated by the Perkin-Elmer gas chromatography, the model of apparatus 8700, and by the method of internal normalization of surfaces. the oil coming from the ground sunflower seeds was extracted by the Soxhlet method. The samples of sunflower oil after saponification were converted into volatile methyl esters of fatty acids by the ethod of borontrifluoride (9). Methyl esters of the fatty acids were determined by gas chromatography on filled column GP 10% 2DEGS-PS, on the carrier Supelcoport 80/100 mesh, diameter 2 mm and length 2 m with the following working conditions: Column temperature: 19 °C isothermal; Detector: FI D; Inj. & det. temperature: 250 °C; Flow of the carrier gas (nitrogen): 12 mL/min.; Air flow: 20 mL/min; Sensitivity: 10 x 32; Sample size: 0.2 μL; Solvent: n-Heptane.

RESULTS AND DISCUSSION

The results of determination of fatty acids determination in the sunflower seed oil of various lines are expressed in percentage by the method of internal surface normalization (Table 1).

From the data obtained we calculated the arithmetic means (X) the dimensions (measures) of dispersion (s), the coefficients of linear correlation and the determination coefficient (R^2). The results have shown that the share of palmitic acid (16:0) had a range from 5.63 to 8.45 (arithmetic means being 6.97%, variation coefficient 10.06%). It is very important to reduce the share of palmitic acid with regard to the total content of unsaturated fatty acids because it has the highest atherogenic index in oil of sunflower (10).

The share of stearic acid (18:0) in the analyzed sunflower lines was rather low (the arithmetic means 4.18%, variation coefficient 28.84 %). A view has prevailed for a long time that the stearic acid has got a strong atherogenic effect. However, it has been established that it does not have the atherogenic effect at all, yet does reduce the level of the total and LDL cholesterol by its fast desaturation transfer into oleic acid (1).

The arithmetic means of oleic acid (18:1) amounted to 26.03%, ranging from 16.70 to 34.47%, which is characteristic for usual sunflower oils available in our market. Using mutations, genetic origins of *Pervenac* or interspecies hybridization it is possible to broaden the genetic basis for this quality.

The mean value of linoleic acid (18:2) was found to be 61.67%, whereas the variation coefficient 8.42%. According to the ersults obtained form the analysis of 44 sunflower lines, 19 had a share of linoleic acid higher than the limit prescribed (62%), which represents a solid breeding basis for the implementation of the breeding program on sunflower for specific ratio of higher fatty acids.

Table 1. Fatty acids composition in the sunflower seed oil of various inbreed lines
Tablica 1. Sastav masnih kiselina u ulju sjemena suncokreta različitih samooplodnih linija

No	Sunflower lines	Fatty acid - Masne kiseline %			
Br.	Linije suncokreta	$C_{16:0}$	$C_{18:0}$	$C_{18:1}$	$C_{18:2}$
1.	CX-II 89-274	6.90	2.75	22.06	61.21
2.	C-XII-34	6.62	2.78	28.17	61.38
3.	C-XII-228/II	5.83	2.40	24.59	66.15
4.	C-XI-326	7.58	3.81	22.32	65.23
5.	C-XI-60	7.22	3.15	29.55	59.61
6.	C-IV-84	6.75	5.95	21.19	65.16
7.	C-XIV-102	6.44	4.41	21.13	67.00
8.	C-XIV-170	7.03	3.26	22.73	66.61
9.	C-XIV-220	6.66	3.19	29.10	59.70
10.	C-XIV-218	6.33	5.30	34.28	52.79
11.	C-VII-42	7.60	3.46	19.66	69.04
12.	C-XIV-104	6.54	4.72	21.54	66.09
13.	Co-62	6.03	4.04	33.01	55.89
14.	Co-14	7.58	3.24	20.38	68.41
15.	Co-13	5.93	7.55	33.71	51.99
16.	O2	7.11	4.60	23.25	64.19
17.	O3	8.45	3.11	20.60	67.36
18.	RHA-278	5.70	5.09	20.10	68.08
19.	G-MF	7.69	4.09	17.88	69.59
20.	M1MF	7.88	4.36	20.87	65.83
21.	14-785 M	7.46	4.01	25.86	61.57
22.	15-100 G	5.94	4.87	32.20	56.12
23.	15-110 M	6.15	4.17	32.46	56.18
24.	15-158 M	6.97	5.19	26.47	60.31
25.	15-43 M	7.78	4.45	25.29	61.39
26.	16-124 M	6.70	5.57	32.49	53.41
27.	15-45 M	7.80	4.81	28.87	57.36
28.	15.176 G	5.63	5.13	23.97	64.36
29.	15-188 M	6.02	7.99	34.47	50.18
30.	12.159 M	7.51	3.48	31.98	56.11
31.	15-106 M	7.63	3.05	21.07	67.38
32.	15-159 M	7.49	3.37	31.24	57.25
33.	15-114 M	8.14	2.52	22.24	66.00
34.	15-157 G	6.96	4.48	30.17	57.95
35.	16-69 M	6.95	3.95	26.70	61.10
36.	16.64 M	6.92	3.14	28.67	60.26
37	16-75 M	7.35	4.53	26.59	59.48
38.	16.68 M	6.44	2.67	29.25	60.85
39.	16-118 M	7.24	5.58	19.13	65.96
40.	16-81 M	7.53	3.19	16.70	70.57
41.	16-26 M	7.14	3.68	27.34	59.94
42.	16-85 M	6.42	3.58	29.33	59.80
43.	16.40 M	7.02	4.22	27.46	59.57
44.	16-112 M	7.16	5.22	29.34	57.03
	x	6.97	4.18	26.03	61.79
	C.V./%	10.06	28.84	19.02	8.42
	S.D.	0.70	1.20	4.90	5.20

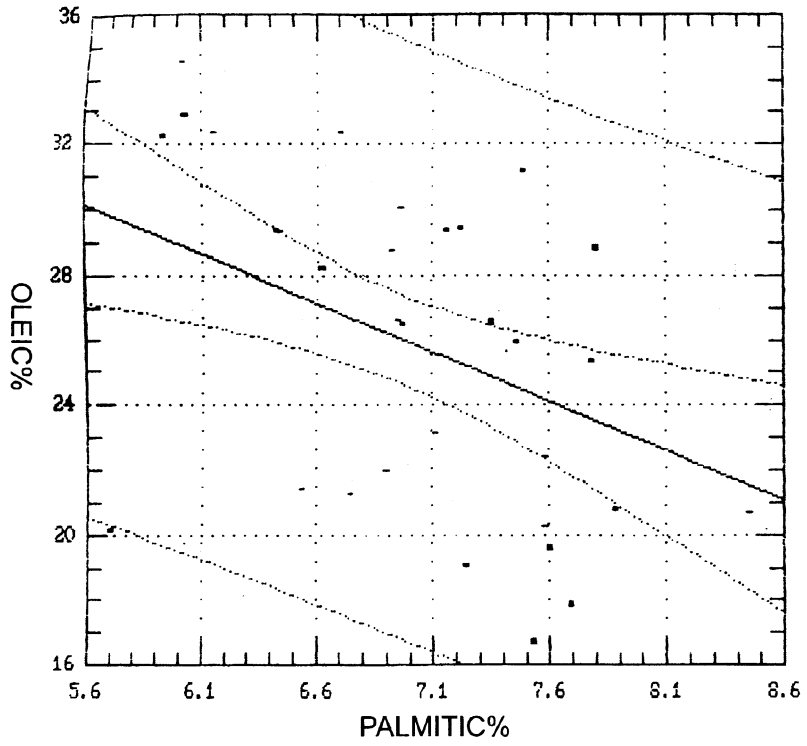
The following equations were obtained by linear simple regresion of oleic acid and other fatty acids at the level of 99% statistic reliability:

oleic acid % = 47.107 – 3.026 (palmitic acid %)

oleic acid % = 20.901 + 1.226 (palmitic acid %)

oleic acid % = 82.886 – 9.921 (palmitic acid %)

Fig.1. Relation between oleic and palmitic acid in the sunflower seed oil of various inbred lines
Slika 1. Odnos oleinske i palmitinske kiseline u ulju sjemena suncokreta različitih samooplodnih linija



Negative mean correlation was found between palmitic and oleic acids (r= –0.43) (Fig. 1). A positive and weak correlation was established between stearic and oleic acids (4=0.30) (Fig 2). The correlation between linoleic and oleic acid was negative and high (r=–0.97) (Fig 3).

A relationship between oleic acid and palmitic, stearic and linoleic acids was determined according to the Roemer-Orphal classification by multiple regression equation:

oleic acid % = 99.145 – 0.99 (palmitic acid) – 1.10 (stearic acid) – 0.99 (linoleic acid)

According to the coefficient of determination (R^2 = 0.99= only 1% of the sum of the total deviations remained undefined by the total deviations remained undefined by the correlation of the variables tested.

Fig. 2. Relation between oleic and stearic acid in the sunflower seed oil of various inbred lines
Slika 2. Odnos oleinske i stearinske kiseline u uliu siemena suncokreta različitih samooplodnih linija

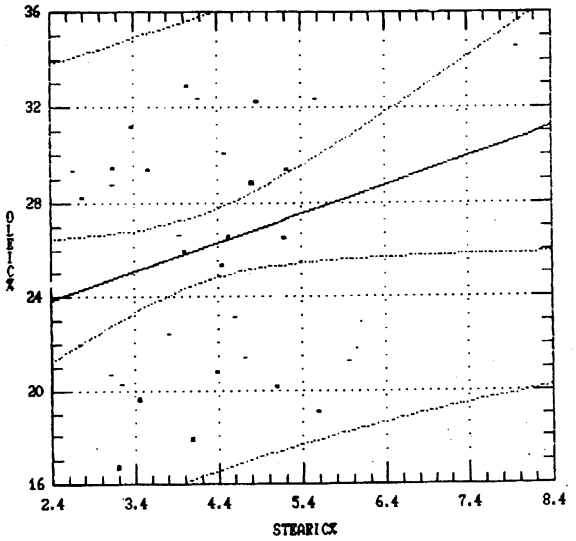
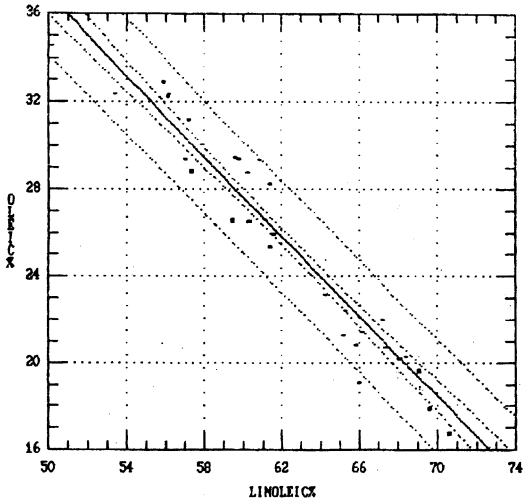


Fig. 3. Relation between oleic and linoleic acid in the sunflower seed oil of various inbred lines
Slika 3. Odnos oleinse i linolne kiseline u uliu siemena suncokreta različitih samooplodnih linija



CONCLUSIONS

The results of the analysis of fatty acids in sunflower seed oil deriving from 44 male-fertile sunflower lines created at the Osijek Agricultural Institute have offered the highlights and shown the possibilities to the breeders to chose and use certain genetic material in creation of new sunflower hybrids with less linoleic acid composition.

SASTAV I ODNOS MASNIH KISELINA U ULJU ZRNA SUNCOKRETA RAZLIČITIH SAMOOPLODNIH LINIJA

SAŽETAK

Za određivanje sastava masnih kiselina u plodu suncokreta upotrebljene su 44 muško-fertilne linije suncokreta u različitim stupnjevima samooplodnje, stvorene na Poljoprivrednom institutu u Osijeku. Masne kiseline određene na plinskom kromatografu tvrtke Perkin-Elmer primjenom metode unutrašnje normalizacije površina.

Na temelju dobivenih podataka izračunane su aritmetičke sredine, mjere disperzije, koeficijenti linearne korelacije i koeficijent determinacije.

Cilj je rada bio prikazati oblik međusobne ovisnosti udjela oleinske palmitinske, stearinske i linolne kiseline. Intenzitet korelacije je određen prema Roemer-Orphalovoj klasifikaciji. Linearne regresija je pokazala negativnu i srednju korelaciju između palmitinske i oleinske kiseline (4=–0.43). Veza između oleinske i linolne kiseline bila je negativna i potpuna (r=–0.97). Pozitivna i slaba veza ustanovljena je između stearinske i oleinska kiseline (r=0.30). Prema izračunatom koeficijentu determinacije (R^2=0.99) samo je 1% od zbroja ukupnih odstupanja nedefinirano vezom između ispitivanih varijabli.

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