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A COMPARATIVE INVESTIGATION OF THE FATTY ACID COMPOSITIONS OF THE SEEDS OF A NUMBER OF LINES OF A GENETIC COLLECTION OF *Gossypium hirsutum*

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A comparative analysis has been made of the amounts of lipids and their fatty-acid compositions in the seeds of the lines of agenetic collection of cotton plants of the species *Gossypium hirsutum* and their hybrids and the variety Tashkent-1. The results obtained on the fatty-acid compositions of some hybrids make it possible to recommend the use of indiviudal lines of cotton plants as donors for improving the food-value indices of cottonseed oil.

In various branches of industry a demand exists for vegetable oils with a definite index of oxidation resistance, which depends on the level of polyunsaturated acids in the oil and their distribution in the triglyceride molecules. Thus, a high concentration of the monounsaturated oleic (18:1) acid is preferred in oils subjected to heat treatment (refractory oils),

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such as olive oil. Salad oils should contain a larger amount of the diunsaturated linoleic acid (18:2) or the 18:1 and 18:2 acids in equal amounts.

It is possible to change the fatty-acid (FA) composition by the selective breeding of oil-yielding crops. As the result of breeding work with respect to the characteristic of qualitative oil composition, oleic, acid-rich varieties of sunflower and flax, an erucic-acid-poor variety of Indian mustard, and an erucic-acid-free variety of rape have been created [1].

The amount of individual saturated and unsaturated faty acids in seed lipids are used as marker characteristics of genotypes [2]. In this connection it must be mentioned that in experiments with inbred lines the correlation of fatty-acid compositions must be made with allowance for the influence of seasonal-climatic conditions.

In the presnt communicatoin we give the results of comparative analyses of the amounts of lipids and their fatty-acid compositions in seeds of inbred lines of a genetic collection of cotton plants of the species Gossypium hirsutum in the V. I. Lenin Tashkent State University and of hybrids of them and also of the variety Tashkent-1. Information on the chemical composition of the seeds is compared with the morphological (marker) characteristics of the cotton plants.

The material was investigated in 1986; in lines – L-453, L-454, L-476, L-477, L-478, L-479 – three F_1 hybrids – L-454 × L-477, L-454 × L-479, and L-476 × L-479; in 1988; six lines – L-78, L-454, L-475, L-476, L-477, and L-479 – the variety Tashkent-1, and five F_1 hybrids – L-78 × L-479, L-475 × L-476, L-475 × L-477, L-476 × L-477, and Tashkent-1 × L-454.

The seeds of line L-479 contain no gossypol pigments, while the seeds of line L-78 have no linter and fiber.

It was necessary to determine the fatty-acid compositions of the seeds not only of the initial lines but also of the F_1 hybrids in order to select the most promising combinations of crossings that can be used in subsequent experiments to increase or decrease the levels of individual fatty acids. With this aim, the lipids were extracted from all the specimens and their fatty-acid and class compositions and, for the 1988 crop, their yields were determined. The qualitative compositions of the lipids in the samples were obtained by chromatographing aliquots of 15% chloroform solutions by the TLC method in systems 1 and 2.

According to the results of the analyses, the component compositions of the lipids of all the specimens were identical and included the classes that we had earlier detected in the seeds of Tashkent-1 cotton plants [3].

The FA compositions of specimens from the 1986 crop are given in Table 1. The comparison of the lines and hybrids was made on the basis of the 16:0, 18:1, and 18:2 levels with respect to the total degree of saturation or unsaturation. The lines investigated differed in their contents of the 16:0 acid – by 2.9% (from 25.8% in L-476 to 22.9% in L-477); the 18:1 acid – by 6.8% (from 20.7% in L-476 to 13.9% in L-479); and the 18:2 acid – by 8.7% (from 58.8% in L-477 to 50.1% in L-476). In the lipids of the L-454 line, which was used in crosses, the 16:0 and 18:1 levels were characterized by values close to the mean, while the 18:2 level was fairly high.

In the F_1 hybrid L-476 × L-479 the 18:1 content was the average of those of the parental lines, while the 18:2 content had changed slightly.

If we compare another hybrid combination, L-454 × L-479, there was a slightly different tendency in the inheritance of these acids: in the hybrid the 18:1 level exceeded those of both parental lines, while the 18:2 level was low in comparison with L-454 and L-479. Thus, in the first hybrid an intermediate inheritance of the 18:1 content and in the second a heterotic effect were observed.

On the basis of this series of experiments, for subsequent experiments we selected the lines L-454, L-476, L-477, and L-479, supplemented by those given above.

The results of analyses of specimens of the 1988 crop are given in Table 2.

The amounts of lipids in the seeds of the lines invetigated, with the exception of L-476, were higher than in the variety Tashkent-1 (T-1), and in three (L-78 × L-479, L-476 × L-475, and T-1 × L-454), out of the five F_1 hybrids it had not decreased or had even increased in comparison with the parental lines.

TABLE 1. Fatty-Acid Compositions of the Seeds of Lines and Hybrids of a Genetic Collection of Cotton Plants, 1886 Crop

Line, hybrid	Amounts of the acids (%, GLC)							
	14:0	16:0	16:1	18:0	18:1	18:2	Σ_{unsat}	Σ_{sat}
L-453	0,3	24,5	0,9	1,2	17,5	55,6	74,0	26,0
L-478	0,3	25,0	1,4	1,8	19.4	52,1	72,9	27,1
L-454	0,3	24,4	0,6	1,1	15,8	57 8	74,2	25,8
L-454× L-477	0,4	24,9	0,8	1,2	16,9	55,8	73.5	26,5
L-477	0,3	22,9	1,9	1,6	14,5	58,8	75,2	24,8
L-454×L-479	0,4	26,3	0,5	1,1	16.7	55,0	72,2	27,8
L-479	0,2	25,5	2,8	1.4	13,9	56,2	72,9	27,1
L476× L-479	0,4	25,9	2,1	2,0	17,7	51,9	71,7	28,3
L-476	0,3	25,8	1,7	1,4	20,7	50,1	72,5	27,5

TABLE 2. Fatty-Acid Compositiosn of Seeds of Lines and Hybrids of the Genetic Collection of Cotton Plants for 1988

Line, hybrid, variety	Yield of lipids	Amounts of the acids (%, GLC)							
		14:0	16:0	16:1	18:0	18:1	18:2	Σ_{unsat}	Σ_{sat}
L-479	20,4	Tr.	37,2	1,3	2,6	17,6	41,3	60,2	39,8
L-78× L-479	20,9	0,2	36,4	3,2	1,7	26.5	32,0	61,7	38,3
L-78	19,9	0.6	43,2	1,7	1,5	26,9	26,1	54,7	45,3
L-476	16,5	0,2	34,2	1,8	1,8	20,6	41,4	63,8	36,2
L-476× L-475	18,4	0,2	24,3	1,0	1,4	19,1	54,0	74,1	25,9
L-475	17,6	0,1	20 7	0,8	2 4	19,3	56,7	76,8	23,2
L-477× L-475	19.5	0,2	26,3	1 5	1,5	14,3	56,2	72,0	28,0
L-477	20.4	0,3	28 7	1,8	2,1	11,3	55.8	68,9	31,1
L-476×L-477	18,7	0,4	24,5	1,2	4,4	16.8	52.7	70,7	29,3
L-454	17.5	0,1	25,1	1,8	2,6	16,7	53,7	72,2	27,8
T-1× L-454	21,5	0,1	24,3	1,0	0.9	19,1	54,6	74,7	25,3
T-1	16.1	0,4	28,2	2,0	1,8	19,7	47,9	69,6	30,4

The composition of the fatty acids from the linter-free line L-78 differed sharply from that of the other lines analyzed, by the lowest content of the 18:2 acid and the highest of the 18:1 and 16:0 acids.

It must be mentioned that the degree of total unsaturation of the FAs of the seeds of identical lines was considerably lower in 1988 than in 1986. In comparison with 1986, the 1988 season was characterized in the period of the formation and ripening of the seeds by a lower index of average daily humidity and a higher one of the temperature.

It is known that with a rise in the temperature of the geographic growth zone the level of unsaturated FAs falls and that of saturated FAs rises. This tendency is retained in a variation of the seasonal climatic conditions of a single growth zone [4].

A comparative analysis of the results of the two-year experiment enabled preliminary conclusions to be drawn on the adaptation properties of the reserve lipids of the lines of the genetic collection that were investigated. Thus the smallest fall in the total unsaturation was observed for the FAs of L-454 (Σ_{unsat} = 2%), while the greatest senstiivity to a change in the seasonal climatic conditions was shown by the gossypol-free line L-479 ($\Delta\Sigma_{unsat}$= 12.7%). The decrease in the unsaturation of the FAs for line L-476 took place through a fall in the amount of the 18:2 acid, alone; for L-477 both the 18:2 and 18:1 acids were involved; and for lines L-479 and L-454 there was a decrease in the amount of the 18:2 acid but, simultaneously, a slight increase for the 18:1 acid. Thus, the levels of adaptation for these lines were different and, obviously, more appreciable quantitative changes in the FA correspond to a higher level of adaptation.

In the seeds of the F_1 hybrid L-78 × L-479, the amount of the 18:1 acid was closer to L-78 and the amount of saturated acids to L-479, while the amount of the 18:2 acid occupied an intermediate position.

A somewhat different tendency was observed for the cross L-476 × L-475. In the lipids from this hybrid the amounts of the monoenic, dienic, and saturated acids were practically the same as in L-475.

In the seeds of the hybrid L-477 × L-475, the level of the 18:2 acid had not changed in comparison with the parental lines, while the amount of the 16:0 acid was closer to that for L-477 and that of the 18:1 acid (14.3%) was lower than for L-475 (19.3%) but higher than for L-477 (11.3%).

Interesting changes were observed in another hybrid combination, L-476 × L-477. In the parents the amount of the 16:0 acid was 34.2 and 28.7%, respectively, and in the hybrid it was considerably lower (24.5%); the unsaturated acids occupied an intermediate position. The level of the 16:0 acid (24.3%) in the T-1 × L-454 hybrid was inherited from the L-454 (25.1%), and that of the 18:1 acid (19.1%) from the T-1, while the 18:2 acid occupied an intermediate position.

Thus, an analysis of the FAs of the seeds of cotton-plant lines has shown that the lines differ appreciably with respect to the amounts of the main components that they contain and also to the degree of variability of the FA composition under the influence of the conditions during the period of the formation and ripening of the seeds. At the same time, the clear differences in the amounts of individual FAs between F_1 hybrids permit certain lines to be recommended as donors for improving the food-value indices of cottonseed oil.

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ANALYSIS OF THE HYDROXYACYLDIACYLGLYCERIDES OF SEA BUCKTHORN SEED OIL

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The TMS derivatives of the hydroxyacyldiacylglycerides of sea buckthorn seed oil have been analyzed by mass spectrometry. On the basis of charcteristic fragments it has been established that an acyl residue of one of the seven hydroxy acids found previously in hydrolysis products by the GC–MS method is attached in one of the positions of the hydroxyacyldiacylglycerides. The remaining positions are substituted by acyl radicals of the $C_{18:1}$, $C_{18:2}$, $C_{18:3}$ and $C_{16:0}$ acids. The 24 most probable components of the triglycerides include these acyl and hydroxyacyl substituents. Features of the fragmentation of the components due to presence of polyunsaturated acids have been revealed.

On the basis of the composition of the hydroxy acids of sea buckthorn seed oil obtained by the alkaline hydrolysis of the hydroxyacyldiacylglycerides and studied by mass spectrometry [1] and chromato-mass spectrometry [2], we have attempted to analyze the total hydroxyacyldiacylglycerides (o-TAGs) without preliminary hydrolysis. In this we used the laws of fragmentation under EI of glycerol trircinoleate and its TMS derivative [3].

The o-TAGs were isolated from sea buckthorn seed oil by column chromatography on silicagel. The fraction was repeatedly purified by TLC to eliminate accompanying substances.

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