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STUDIES OF OIL AND PROTEIN CONTENTS AND COMPOSITIONS IN GENETICALLY DIVERGENT SUNFLOWER GENOTYPES

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Summary

The study of eight different genotypes showed a large variability in oil contents of seed, composition of higher fatty acids in oil, structure of proteins in seed and components of protein.

Oil contents in seed ranged from 31.10% (S-59) to 52.18% (NS-H-26-RM).

Large differences were found in the composition of higher fatty acids. The largest variability in the tested genotypes was found for oleic (18:1) and linoleic (18:2) acids. Egyptian cultivar Giza had a high content of oleic acid (54.61%) and a low content of linoleic acid (36.32%). The lowest contents of oleic acid were found in the newly-developed hybrids NS-H-26-RM and NS-H-62-RM. These hybrids had highest contents of linoleic acid. The examined genotypes showed a large variability in the contents of 16:0 and 18:0. A consoderably smaller variability was found for 16:1, 20:0, 18:3 and 22:0.

Different correlations existed between the contents of certain fatty acids in sunflower oil. A significant positive correlation was found between 18:0 and 20:0 as well as between 16:0 and 18:2. A significant negative correlation was found between the most important acids, linoleic and oleic as well as between 20:0 on one side and 16:1 and 18:1 on the other, 18:1 and 16:0, and 18:0 and 16:1.

Besides the differences in the total contents of protein, the tested genotypes differed in the components of protein. The highest albumin content was found in the hybrid NS-H-62-RM. Globulin contents were highest in the cultivars Giza and Gricko, as well as in the line S-200. Alcoholic fraction of protein showed the smallest variability. There were large differences in the contents of glutenin. The hybrids NS-H-62-RM had only 12.89% of glutenin, the line S-200 even 31.97%. Our results show that there were large differences in the quality of certain protein components. The tested genotypes showed the highest variability in the quality of albumin.

Introduction

Besides achieving high seed yields of sunflower as an oil crop, emphasis is placed on oil content in seed, quality of oil, quality and content of proteins, as well as other substances in seed.

Most literature data discuss the variability of oil contents in sunflower seed. In recent years, a number of studies were conducted to determine oil quality in different sunflower genotypes. Attention has been paid to the composition of higher fatty acids in oil. Ivanov (1974), Konstantinov et al (1974), as well as other authors found differences in the composition of higher fatty acids in different sunflower genotypes. Fernandez, Martinez and Knowles (1976) found also a large variability in the composition of higher fatty acids in different wild sunflower forms.

Numerous literature data discuss effects of environmental factors on the composition of higher fatty acids in sunflower oil. A number of authors have confirmed that environmental factors largely affect the composition of higher fatty acids.

There are large differences in protein contents of sunflower seed among different genotypes. There are less literature data dealing with differences in protein components in sunflowers.

The objective of this study is to establish differences in the contents of oil in seed, higher fatty acids in oil, protein and protein components in different sunflower genotypes.

Material and Method

For this experiment, seed of eight different sunflower genotypes were used: three high-oil genotypes (cultivar NVIIMK 8931 and hybrids NS-H-26-RM and NS-H-62-RM) two non-oil genotypes (Giza and Gricko), and three genetically distant inbred lines. The seed for the experiments was taken from 1977 crop, produced in one locality. All analyses were performed in three replications and results were statistically processed.

Oil contents in seed were determined by NMR analyser (IJS-71), the composition of higher fatty acids by gas chromatography (Hewlett Packard gas chromatograph).

Protein fractionation was carried out according to the Osborn-Mendel procedure (1). The extraction procedure was the same as that reported by Godek and Wilson (2) except for different sizes of samples used. After fractionation an aliquot of 10 ml of the corresponding fraction was evaporated and the nitrogen content was determined by the seminiero-Kjeldahl method for polyacrylamide gel electrophoresis (PAGE) of subfraction (polypetides). Within each Osborne protein fraction the method of Weber and Osborne (3) was used. After evaporation of a certain aliquot of each fraction in order to get about 1 hg of protein, the residue was dissolved in 1 ml of solution containing 1% sodium dodecyl sulphate, 24% urea and 0.1-2% marcaptoethanol. The mixture was incubated at 37^{o}C for one hour. An aliquot of 50 ml was loaded at the top of the PAGE column. Electrophoretic runs were carried out at 8 mA per column for four hours. The gels were strained with colmassie brilliant blue. Straining and destraining were done by soaking gels in the straining and destraining solutions as described by Weber and Osborne (3).

TABLE 1. Oil content in seed and composition of higher fatty acids in different sunflower genotypes.

No.	Cultivar	Oil content in seed %	Fatty acids - Percent							
			16:0	16:1	18:0	18:1	18:2	20.0	18:3	22:0
1.	VNIIMK 8931, Cont.	48.90	6.33	0.11	3.75	20.62	66.61	0.97	0.36	0.80
2.	Giza	37.57	4.34	0.14	2.40	54.61	36.32	0.61	0.40	0.84
3.	Gricko	31.55	5.86	0.10	3.45	22.67	65.44	0.97	0.50	0.77
4.	NS-H-62-RM	50.13	6.20	0.09	4.54	19.54	67.43	0.95	0.35	0.72
5.	NS-H-26-RM	52.18	6.70	0.11	4.08	18.64	68.16	0.85	0.39	0.69
6.	S-59	31.10	4.87	0.08	6.11	26.94	59.28	1.13	0.36	1.01
7.	S-200	36.29	6.77	0.11	5.30	28.36	56.58	0.94	0.35	1.37
8.	S-450	40.17	6.19	0.13	3.96	23.92	63.33	0.93	0.41	0.75
	LSD 5%	-	0.66	0.24	0.64	1.51	2.62	0.23	0.13	0.12
	1%	-	0.91	0.33	0.87	2.07	3.59	0.32	0.19	0.16

Results and Discussion

The tested sunflower genotypes varied in oil contents in seed. Highest oil content was found in the hybrid NS-H-26-RM, lowest in the line S-59. The tested genotypes with different oil contents in seed also had different contents of higher fatty acids in oil. It should be emphasized that there were differences in the contents of essential fatty acids, oleic (18:1) and linoleic (18:2), among the genotypes. The cultivar Giza showed the largest deviation in the content of oleic acid. The content of oleic acid of this cultivar almost doubled the content of oleic acid in VNIIMK 8931 (Table 1). Besides an increase in oleic acid, this cultivar showed a considerable decrease in linoleic acid (only 36.32%). The lines S-59, S-200, and S-450 also had significantly higher contents of oleic acid than the standard (VNIIMK 8931). Only the newly-developed hybrids NS-H-26-RM and NS-H-62-RM had the positive feature of having smaller contents of oleic acid as compared with the standard. It should be emphasized that these two hybrids had the highest contents of linoleic acid (18:1). The tested genotypes also differed in the contents of 18:0 and 16:0. The highest content of 18:0 was found in the line S-59 (16.11%), of 16:0 in the line S-200. The lowest contents of 16:0 and 18:0 were found in the cultivar Giza.

The contents of 16:1, 20:0, 18:3, and 22:0 were by far more uniform in the tested genotypes than the previous fatty acids, even though some differences did occur.

It is not enough to know only differences in contents of higher fatty acids in different sunflower genotypes but also their relationship. Our results show different degrees of correlation between higher fatty acids of the tested genotypes. A highly positive correlation was found between 18:0 and 20:0, a significant positive correlation between 16:0 and 18:2. There was a high negative correlation between 18:1 and 18:2. This fact is important and may help sunflower breeders to improve oil quality in model hybrids (cultivars). Significant negative correlations were found between a) 18:1 and 20:0; b) 16:1 and 20:0; and c) 16:1 and 18:1.

TABLE 2. Correlation Coefficients for fatty acids oil of different sunflower genotypes.

No.	Fatty Acids	1. 16:0	2. 16:1	3. 18:0	4. 18:1	5. 18:2	6. 20:0	7. 18:3
8.	22:0	-0.089	-0.300	0.611	0.243	-0.355	0.262	-0.152
7.	18:3	-0.356	-0.167	-0.226	0.135	-0.297	0.013	
6.	20:0	0.117	-0.761*	0.785**	-0.647*	0.590		
5.	18:2	0.726*	-0.285	0.231	-0.992***			
4.	18:1	-0.738*	0.344	-0.337				
3.	18:0	-0.001	-0.786**					
2.	16:1	0.200						

The tested genotypes did not differ only in the contents of oil in seed and its quality but also in the contents of proteins and their components. The highest content of protein was found in the line S-59, the lowest in the hybrid NS-H-62-RM.

TABLE 3. Protein content and amounts of Osborne protein fractions in different sunflower genotypes.

No.	Cultivar	Percent					
		Protein Content	Albumin	Globulin	Alcohol soluble fraction	Glutelin	N-content in Residue
1.	VNIIMK 8931 (Control)	13.3	8.75	15.85	1.19	21.45	52.76
2.	Giza	13.4	8.77	18.14	1.50	20.16	51.43
3.	Gricko	13.8	9.84	18.11	1.53	20.44	51.08
4.	NS-H-62-RM	12.7	10.77	11.39	2.79	12.89	62.76
5.	NS-H-26-RM	13.3	7.65	14.90	1.40	15.48	60.57
6.	S-59	23.1	6.38	14.48	1.72	23.29	60.45
7.	S-200	20.7	4.34	18.04	1.94	31.97	43.68
8.	S-450	20.6	5.24	16.98	2.16	27.94	57.68

The large differences in albumin fraction (water soluble proteins) were found among the tested genotypes. The hybrid NS-H-62-RM had the highest albumin content (10.77%). The second highest albumin content was found in the protein of the cultivar Gricko. An outstandingly low content of albumin was found in the protein of the line S-200, only 4.34%. Qualitative and quantitative differnces in albumin contents of the genotypes may be observed on genes.

Globulins (proteins soluble in NcCl) in the tested genotypes ranged from 11.39% (NS-H-62-RM) to 18.14% (Giza). Differences in globulin fraction were also found on genes - electrophoregrams of the tested sunflower genotypes.

Alcoholic fraction (proteins soluble in propanol) in the tested genotypes showed the smallest variability.

Glutenin content of protein (proteins soluble in NaOH) in the genotypes ranged from 12.89% (NS-H-62-RM) to 31.97% (S-200). Quality differences were found among glutenin fractions of the tested genotypes (Fig. 1-B).

It should be emphasized that all tested sunflower genotypes had high contents of nitrogen in residues. (Table 3).

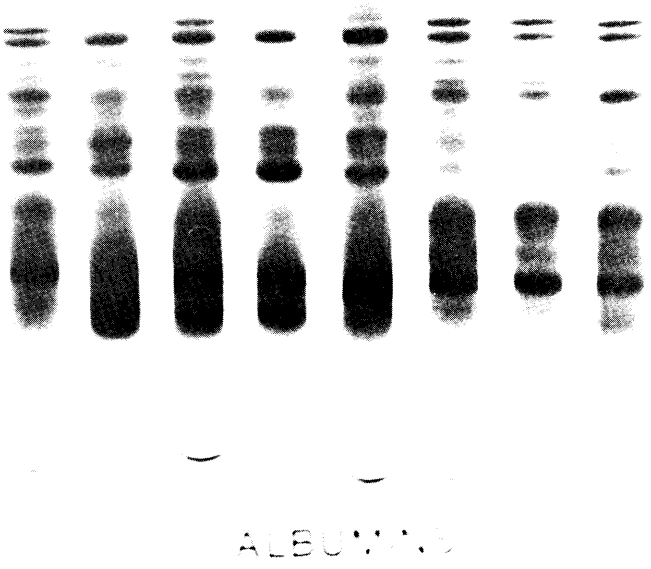


FIGURE 1-A. Differences in albumin quality

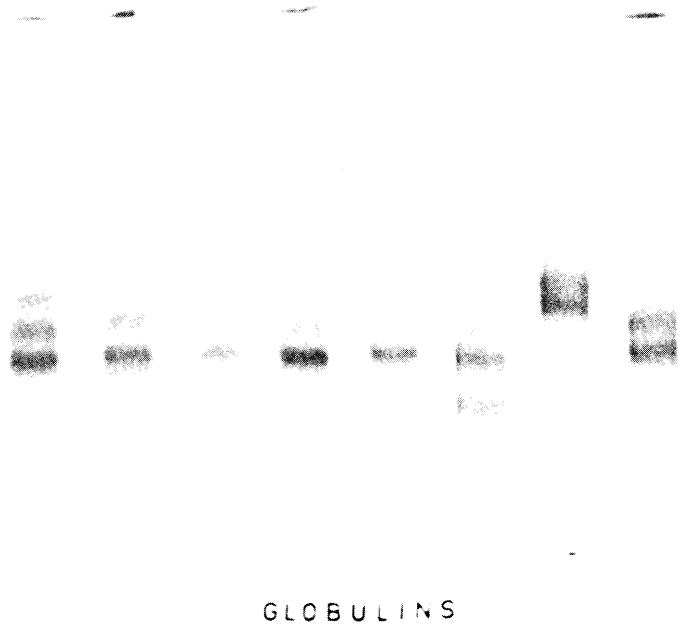
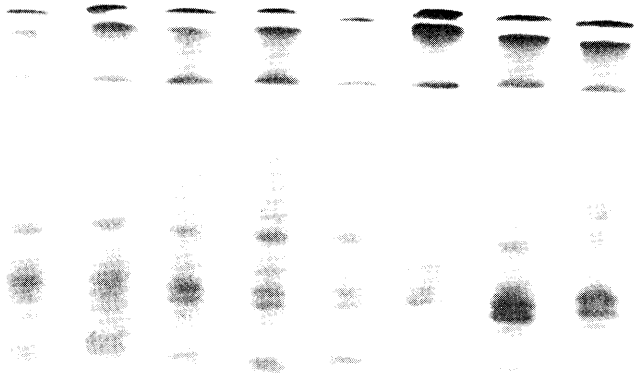


FIGURE 1-B. Differences in globulin quality.



ALKOHOL

FIGURE 1-C. Differences in the quality of alcoholic fraction.

FIGURE 1-D. Differences in glutemin quality.

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