LITERATURE CITED

IVANOV, P. 1974. Biochemical differentation of sunflower varieties as a result of inbreeding. *Proceedings of the 6th International Sunflower Conference* (225 — 231), Bucharest.

KONSTANTINOV, K., RATKOVIC, S., KAPOR, S. 1974. Fatty acid composition of sunflower varieties and F1 plants. *Proceedings of the 6th International Sunflower Conference* (219 — 225), Bucharest.

FERNANDEZ-MARTINEZ, KNOWLES, P.F. 1976. Izmencivost zirnokislotnogo sastava masla semjan vidov *Helianthus. Materiali VII mezdun.konf.po podsolnecniku* (431 — 434), Krasnodar.

SOLDATOV, K.I. 1976. Ispoljzovanie himiceskogo mutageneza v selekcijii podsolnecnika. *Materiali VII mezdun. konf.po podsolnecniku* (179 — 182), Krasnodar.

SKORIC, D., VERESBARANJI, I., CUPINA, T. 1978. Inheritance of fatty acid composition in F1 generation of sunflowers. *Proceedings of the 8th International Sunflower Conference Minneapolis.*

T1982GEN06

VARIABILITY IN PROTEIN AND AMINOACID CONTENTS IN DIFFERENT SUNFLOWER INBREDS.

SUNCICA BEDOV
Faculty of Agriculture, Institute of Field and Vegetable Crops, Novi Sad, Yugoslavia.

ABSTRACT

A two-year study on the variability in protein and amino acid contents showed:— The examined cms lines differed in their contents of protein in seed. Also, significant differences among lines were observed during the experimental years. The majority of the lines had higher protein contents in 1980 and only a small number of lines had same or similar contents in both years.

The examined restorers differed in their protein contents in seed.

The restorers differed considerably in the composition of amino acids. The contents of all amino-acids save methionine increased with the increases in protein content in seed.

INTRODUCTION

Protein content in seed is a qualitative character which is largely dependent on genotype and environment. The presently grown varieties and hybrids have protein contents of 16 — 22%.

Plant proteins are increasingly gaining importance in human nutrition. Attempts to extract protein concentrates after oil extraction place sunflower among important sources of proteins. Concurrent breeding for oil and proteins should turn out hybrids with seed which should be larger and more easily dehulled. Such protein-oil hybrids could be used directly in the industrial production of ready-to-serve meals and pastries.

Pustavoit and Diakov (1971, 1972) found variability in protein content in seed of different sunflower varieties and recommended methods of breeding for increased protein yield per area unit. Diakov (1972, 1974) offered a model of protein behaviour in the process of seed forming and oil synthesis.

The objectives of this study were (1) to examine variability in protein content in seed of cms lines with high values of GCA, (2) to examine variability in protein and aminoacid contents in a group of restorers, and (3) to determine correlations between protein and aminoacid contents as well as between individual aminoacids in the restorers.

MATERIALS AND METHODS

Experiments were conducted in 1979 and 1980 in field conditions applying the same cultural practices in both years.

We examined 37 cms lines (A lines) with high values of GCA for seed yield and other important agronomic characters, of different genetic origins, in S12 generation of selfing. They were analysed for protein content in seed and the obtained results were statistically processed.

Fourteen restorers of different genetic origins, used for the development of hybrids, were analysed for protein and amino acid contents. Correlation coefficients r were calculated between protein and aminoacid contents as well as between individual aminoacids.

Kjeldahl's method was used to determine protein content in seed, aminoanalyser to determine the composition of aminoacids.

VNIIMK 8931 and NS-H-26-RM were used as controls.

RESULTS AND DISCUSSION

The examined 37 cms lines showed a large variability in protein content in seed which depended on the genotype and environmental factors. The line cms 2 had the lowest two-year average protein content (19.3%), cms 40 the highest (26.3%): the difference was 7%. A large number of the examined cms lines had significantly different protein contents in the two years.

In 1980, environmental factors were more favorable for protein synthesis than in 1979. In the latter year, cms 40 alone had an outstandingly high protein content. In 1980, cms 40 and 56 had much higher protein contents than in 1979. Some lines, as cms 18, had similar yields in both years. These results show specific genotypic reactions in protein synthesis to the changes in environmental conditions. The lines which were less sensitive to these changes should be used for breeding purposes. However, two-year results are insufficient to draw reliable conclusions on the real value of the examined lines.

The examined restorers displayed significant differences in protein content in seed (Table 2). The minimum content was 18.1%, the maximum 32.9%. The average content of 26.03% was quite high, indicating that the majority of them could be used in certain combinations for breeding hybrids with increased protein content.

Numerous authors have found a negative correlation between oil and protein contents in sunflower seed. The results of our restorers confirm their findings. However, we found an exception, the restorer SNRF-141-1, which had the protein content of 32.9% and the oil content above 40%. This restorer could be used for breeding protein-oil hybrids. To illustrate the value of this restorer, let it be said that the controls, VNIIMK 8931 and NS-H-26-RM, had the protein contents of 20 and 18%, respectively.

Table 1. Protein content in seed of different cms lines, %.

Line	1979	1980	2-year average	Line	1979	1980	2-year average
cms 2	17.465	21.185	19.325	cms 42	21.045	22.175	21.610
cms 4	19.735	20.230	19.982	cms 44	22.290	24.890	23.590
cms 6	20.140	21.695	20.917	cms 46	29.180	20.155	24.667
cms 8	23.140	22.230	22.685	cms 48	19.855	20.905	20.380
cms 10	23.910	21.570	22.740	cms 50	22.340	26.060	24.200
cms 12	24.050	24.055	24.052	cms 52	22.305	27.380	24.842
cms 14	20.895	23.275	22.085	cms 54	17.130	24.065	20.597
cms 16	24.535	20.360	22.447	cms 56	16.145	29.785	22.965
cms 18	22.120	22.195	22.157	cms 58	23.105	28.875	25.990
cms 20	23.600	24.125	23.862	cms 60	24.075	25.665	24.870
cms 22	25.725	26.150	25.937	cms 62	19.335	22.795	21.065
cms 24	20.745	22.770	21.757	cms 64	20.340	21.235	20.787
cms 26	21.830	24.470	23.150	cms 66	23.065	24.290	23.677
cms 28	20.580	25.880	23.230	cms 68	26.215	24.450	25.332
cms 30	22.010	26.315	24.162	cms 70	22.805	25.590	24.197
cms 32	23.125	21.490	22.307	cms 72	22.280	28.000	25.140
cms 34	23.375	25.950	24.662	cms 74	23.765	28.620	26.192
cms 36	19.965	21.545	20.755				
cms 38	25.105	24.000	24.552				
cms 40	23.020	29.600	26.310	x̄	22.171	24.162	23.166

	Year	Line	Interaction
LSD	5% = 0.07%	5% = 0.42%	5% = 0.59%
	1% = 0.13%	1% = 0.55%	1% = 0.79%

Table 2. Variability in protein (%) and amino acid (gr) contents in different Rf lines.

Value	Protein content (%)	Phenylalanine	Thyroxine	Leucine	Isoleucine	Methionine	Valine	Alanine	Glycine	Proline	Glutamic acid	Serine	Threonine	Aspartic acid	Arginine	Histidine	Lysine
Max.	32.96	1.41	0.73	1.81	1.21	0.31	1.56	1.28	1.71	1.24	5.89	1.23	0.95	2.78	2.63	0.74	1.07
Min.	18.14	0.74	0.42	1.03	0.61	0.04	0.80	0.69	0.95	0.71	2.84	0.59	0.59	1.43	1.25	0.35	0.59
x̄	26.03	1.06	0.56	1.43	0.90	0.11	1.18	0.95	1.27	0.92	4.50	0.93	0.77	2.04	1.95	0.49	0.81
NS-H-26-RM control	18.14	0.74	0.42	1.03	0.61	0.31	0.80	0.69	0.95	0.75	2.84	0.59	0.59	1.43	1.25	0.38	0.59

The examined restorers had significantly different amino acid contents (Table 2). This paper includes only outstanding and average values. The contents of methionine were most variable. Several aminoacids two times larger contents in one year as compared with the other.

The increases in protein content brought about corresponding increases in amino acid contents, with the exception of methionine, as confirmed by the data in Table 2 and the correlations coefficients in Table 3.

Table 3. Coefficients of correlation (r) between protein content in seed and composition of amino acids.

Phenylalanine ***	Thyroxine **	Leucine ***	Isoleucine ***	Methionine	Valine ***	Alanine ***	Glycine ***	Proline ***	Glutamic acid ***	Serine ***	Threonine ***	Aspartic acid ***	Arginine ***	Histidine ***	Lysine **
0.94	0.74	0.87	0.85	0.16	0.91	0.85	0.83	0.84	0.93	0.82	0.85	0.86	0.96	0.78	0.74

Besides highly significant positive correlations between the contents of proteins and amino acids except methionine, there existed highly significant correlations between the amino acids themselves. Methionine was again an exception because it was not positively correlated with the other amino acids. There is a difficulty in sunflower breeding for improved amino acid composition in proteins because of an automatic increase in the contents of all aminoacids, not only of the desired ones. It is therefore necessary to mix sunflower proteins with other plant proteins, e.g., soybean proteins, in order to obtain the optimum composition of amino acids for human nutrition.

CONCLUSIONS

Following conclusions may be drawn on the basis of the two-year study on protein content in seed of cms lines possessing high values of GCA for important agronomic characters and on protein and amino acid contents in seed of restorer lines:

The examined cms lines varied largely in their protein contents in seed.

Table 4. Coefficients of correlation (r) between amino acids.

	Phenylalanine	Thyroxine	Leucine	Isoleucine	Methionine	Valine	Alanine	Glycine	Proline	Glutamic acid	Serine	Threonine	Aspartic acid	Arginine	Histidine
Lisine	0.73**	0.69**	0.89***	0.82***	−0.05	0.87***	0.86***	0.81***	0.64**	0.72**	0.73**	0.80***	0.80***	0.77***	0.86***
Histidine	0.78***	0.73**	0.80***	0.79***	0.20	0.84***	0.75***	0.79***	0.71**	0.83***	0.67**	0.76***	0.79***	0.83***	
Arginine	0.95***	0.79***	0.92***	0.89***	−0.08	0.94***	0.85***	0.89***	0.84***	0.55***	0.87***	0.84***	0.85***		
Aspartic acid	0.84***	0.82***	0.84***	0.83***	−0.14	0.89***	0.88***	0.90***	0.82***	0.88***	0.81***	0.97***			
Threonine	0.84***	0.80***	0.84***	0.81***	−0.14	0.87***	0.88***	0.86***	0.87***	0.85***	0.80***				
Serine	0.86***	0.79***	0.88***	0.95***	−0.38	0.90***	0.82***	0.82***	0.69**	0.86***					
Glutamic acid	0.93***	0.74***	0.86***	0.88***	−0.08	0.92***	0.82***	0.85***	0.83***						
Proline	0.83***	0.63***	0.68***	−0.03**	−0.00	0.80***	0.81***	0.74**							
Glycine	0.88***	0.87***	0.90***	0.83***	−0.06	0.92***	0.87***								
Alanine	0.87***	0.79***	0.90***	0.82***	−0.18	0.93***									
Valine	0.94***	0.80***	0.97***	0.93***	−0.13										
Methionine	−0.11	−0.08	−0.17	−0.22											
Isoleucine	0.85***	0.78***	0.91***												
Leucine	0.92***	0.74**													
Thyroxine	0.76***														

Some lines had significantly different protein contents in the experimental years. A large number of the lines had a higher protein content in 1980, and a small number of the lines similar contents in both years.

The examined restorers differed in their protein contents in seed. The highest content of 32.9% was found in SNRF-141-1.

The restorers also differed in their aminoacid contents. The contents of all aminoacids except methionine increased with the increases in protein content in seed, as confirmed by the correlation coefficients (r) obtained. (Table 4).

LITERATURE CITED

DJAKOV, A.B. 1972. O predeljnoj maslicnosti semjan i perspektivah selekcii podsolnecnika. *Dokladi VASHNIL,* No 1 (19 — 22).

DJAKOV, A.B., POPOV, P.S., KASINA, E.N., BEHTER, A.T. 1972. Pricini nasledstvenih razlicij po nakopleniju masla v semenah podsolnecnika. *Seljskohozja i stvennaja biologija,* No 3 (323 — 328).

DJAKOV, A.B. 1974. Nakoplenie zira i belka v semenah podsolnecnika i voprosi selekcii na kolicestvenne priznaki. *Fiziologija rastenij,* No 7 (193 — 204), Moskva.

PUSTAVOJT, V.S., DJAKOV, A.B. 1971. Urazajnost podsolnecnika i puti jejo povisenija v processe selekcii. *Selekcija i semenovodstvo.* No 1 (25 — 29), Moskva.

PUSTAVOJT, V.S., DJAKOV, A.B. 1972. O selekcii podsolnecnika na soderzanie belka v semenah. *Rastenievodstvo i selekcija.* No 7 (11 — 15), Moskva.

SKORIC, D., KONSTANTINOVIC, K., BEDOV, S. 1978. Studies of oil and protein contents and compositions in genetically divergent sunflower genotypes. *Proceedings of 8th International Sunflower Conference,* Minneapolis.