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GENETIC AND ECOLOGICAL FACTORS EFFECTING A QUALITATIVE CHANGE OF THE SUNFLOWER SEED PROTEIN COMPLEX CONTENT

There have been substantial changes in seeds during sunflower breeding for high oil content. Modern varieties have up to 63% of oil in seeds (kernel) and protein and oil taken together total 80-83%. The change correlation of oil and protein in seeds was accompanied by substantial changes in the quality of both oil and gel part of seed. The proportion of linoleic acid increased from 45 to 60% as the seed oil content rose.

Protein in modern sunflower varieties is of a higher quality. Sunflower breeding for a high oil content has led to a quantitative redistribution of a protein fractions with a considerable increase in the proportion of water soluble components. The quantity of water soluble fraction quantity in high oil seeds is by 20-30% more than that of the low oil varieties. High oil varieties differ from low oil varieties by the accumulation level of separate components performing diverse physiological functions in seeds, rather than by a total quantity of synthesized protein (Table 1).

The water soluble fraction is the principal one in the protein complex in the first days of seed development, during their growth. While seeds are maturing, the relative content of water soluble proteins is gradually lowering. During the seed growth period the salt soluble proteins are minimal in quantity. This holds true both for high and low oil varieties. But the accumulation level of some protein components is different in such seeds. Since the first days of their development high oil seeds have a

Table 1

Protein and Seed Fraction Content of Sunflower High and Low Oil-Bearing Content

Quality indicators	Varieties	
	Peredovik	Kruglic A-41
Oil content, per cent	62.0	55.7
Protein per cent	21.7	21.8
Fractions, per cent from total protein		
water soluble	56.4±4.3	24.6±3.6
salt soluble	27.3±4.1	58.6±3.2
leach soluble	16.3±2.1	16.8±0.2
lysine g per 100 gram of protein	3.3	2.7

higher content of water soluble proteins than low oil varieties and this situation persists till full maturing (Fig.). The heterogeneity of water soluble fraction has been determined by electrophoresis in poliacrilamide gel. The fraction has 6-15 components at different stages of seed maturing. Apparently, this fraction contains protein playing an active part in the oil formation process. The synthesis of protoplasmatic proteins functioning as catalyst largely occurs during the seed growth period. The quantity of proteins synthesized at that time to some extent predetermines the level of fat accumulation in seeds. Salt soluble proteins intensively accumulating in seeds during their filling function as reserve proteins. During seed filling reserve proteins also appear in the water soluble fraction, as evidenced by a change in its amino acid content.

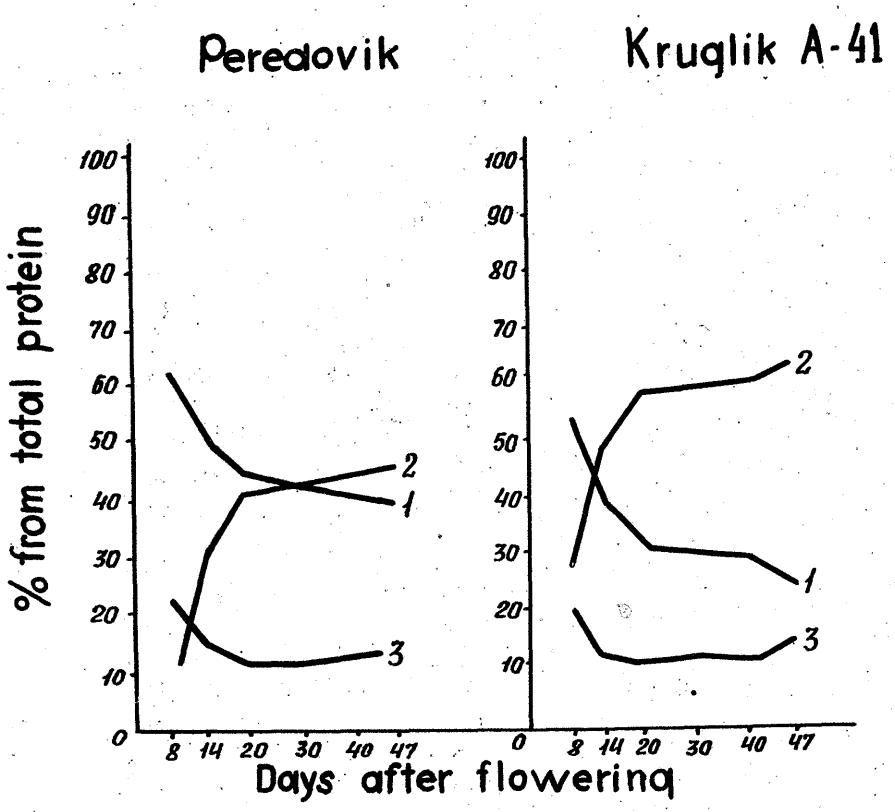

Fig. Dynamics of protein fraction accumulation in sunflower seeds with high and low oil content
1 - water-soluble proteins; 2 - salt-soluble proteins;
3 - alkali-soluble proteins

Each protein fraction is characterized by a certain amino acid content. More considerable differences have been observed between the amino acid content of the water soluble and the salt soluble fractions. Water soluble proteins have almost twice as much lysine as salt soluble ones, while the latter have more glutaminic acid. Sunflower breeding for high oil content involved a more intensive synthesis of water soluble components, which increased the nutritive total protein of modern sunflower varieties.

At all stages of sunflower maturing its nitrogen-containing substances are represented, apart from protein, by two more forms, (1) soluble non-protein compounds (mainly free amino acids) and non-soluble residue. Extractive (soluble) compounds account for half of all nitrogenous substances in growing seeds. Subsequently, when intensive synthesis of soluble protein begins, their percentage drops to 16.8-16.9%. Of much interest are the proteins we included in the non-soluble residue of nitrogen-containing compounds. Proteins serving as structural elements of cell probably belong to this group. Here also belong non-soluble proteins forming the cell structural basis in combination with polar lipids. The content of non-soluble nitrogen compounds is higher in seeds of high varieties than in those of low oil ones. The analysis of the qualitative content of non-soluble residue has shown that it contains all proteinogenic amino acids.

We have analysed productive and perspective sunflower seeds. It has been proved that sunflower seed protein has a high proportion of indispensable amino acids. The limiting amino acid is only lysine with the average content of 3.4±0.4%. High oil sunflower (varieties) grown in similar soil-climatic conditions have a slight difference in the amino acid content, with varying coefficients of separate amino acids ranging from 2.5 to 7.5%.

The environmental factors, particularly plant water supply, greatly influence the quality of

sunflower seed protein complex. With the increase of soil moistening the proportion of salt soluble proteins drops and the relative quantity of the water soluble fraction grows. Studies of the seed amino acid content showed that under deficient water supply (40% of full soil water consumption in vegetation experiments) globulin accounts for over 50% of total protein and the content of the bulk of indispensable amino acid is diminishing. Plant growing under optimal moistening helps enhance the protein nutritive value owing to a big accumulation of the water soluble fraction. Moreover, the content of scarce amino acid increases by almost 20%, including lysine, methionine and tryptophane. Mineral nutrition considerably influences the protein accumulation in sunflower seeds and the quality of protein. Predominance of nitrogen in plant nutrition results in more protein in seeds thanks to the salt soluble fraction. In this case the nourishment value of total protein decreases.

A positive correlation has been established between the content of the water soluble fraction in the protein complex, the amount of lysine in protein and the seed oil content. Consequently, the upgrading of the seed oil content both by the methods of breeding and conditions of sunflower growing enhances the biological value of protein.