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FATTY ACIDS ACCUMULATION AND METABOLISM IN SUNFLOWER HIGH OLEIC MUTAN

This paper presents the data of fatty acids accumulation and metabolism in the earlier unknown high oleic form of sunflower obtained in the Pustovoit Institute for Oil Crops in 1973 by a team of authors comprising K.I. Soldatov, L.K. Voskoboinik and L.N. Kharchenko.

It has been established that sunflower high oleic variety differs from the variety VNIIMK 8931 by absolute oil accumulation in seeds and intensity of its accumulation during the whole vegetation and at separate fruit-formation periods.

The high oleic form differs from earlier varieties by a high percentage of oleic acid (75-80%) both in the total lipids and in various groups of lipid complexes: triglycerides, phospholipids and sterin ethers. Linoleic acid predominates in the oil of known sunflower varieties with its content ranging from 55 to 65%.

It is known that the fat acid ratio in total lipids of seeds of modern sunflower varieties is changing during ripening: the relative content of saturated fatty acids is decreasing, that of linoleic acid is increasing and that of oleic acid is again decreasing, which results in the oil iodine number increase. We have obtained a similar pattern on the VNIIMK 8931 variety whose oil iodine number is increasing in the process of seed ripening from 90 to 130 units. On the other hand, the iodine number of oil in the ripening seeds of high oil sunflower form is decreasing from 129.9 to 94.5 units and in some years even to 90 units.

Unlike the variety, a relatively high oleic acid content (46 m %) has been observed in the total lipids of mutant sunflower seeds during the first

week after flowering, this content steadily rising as the seeds go on ripening, to reach 75-82 m %. Linoleic acid content is decreasing to the end of seed ripening by 2-2.5 times (Table).

Table

Change in the Oil Content of Mutant Sunflower Seeds Depending on Their Ripening Rate

VNIIMK, 1974-1975

Seeds age from the beginning of flowering	Iodine number	Fatty acids content, m %			
		C _{16:0}	C _{18:0}	C _{18:1}	C _{18:2}
6	129.9	13.9	8.9	46.2	31.0
10	100.2	5.4	4.6	63.6	26.4
18	89.8	6.6	4.8	72.0	16.6
25	92.7	4.0	2.3	78.2	15.4
45	93.8	4.4	1.5	79.3	14.8
NSR 0.95 %		1.15 3.43	0.96 3.67	1.82 0.73	1.58 2.19

The total of saturated fatty acids in the oil of high oleic sunflower is by 3-4 m % lower than in the oil of the variety. It is important to note that high oleic sunflower form also differs from the variety by the absolute accumulation of unsaturated fatty acids in the seeds during their ripening. This is shown by the data in Fig. 1.

Unlike the VNIIMK 8931 variety high content of oleic acid has been observed in triglycerides, phospholipids and mutant sunflower sterin ethers

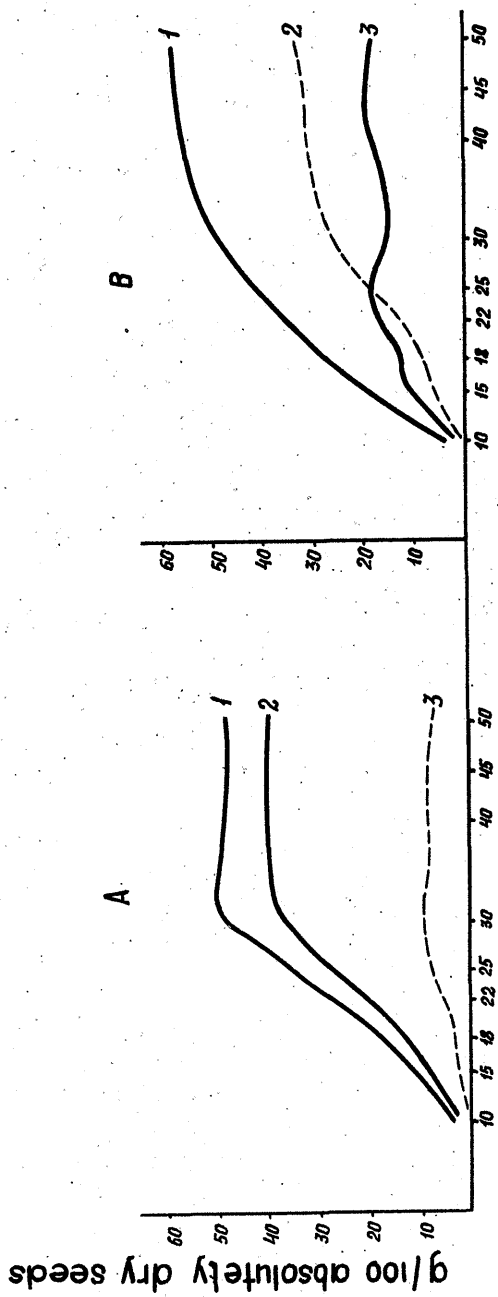


Fig. 1. Absolute accumulation of dry matter and fatty acids in sunflower seeds:

A - high oleic mutant; B - VNIIMK 8931

1 - dry matter accumulation; 2 - oleic acid; 3 - linoleic acid

both during the first week after flowering and the during the following period of seed ripening. In the afore-mentioned lipid groups the oleic acid content naturally increases by the end of seed ripening, amounting to 75-82 m % in triglycerides, 82 m % in phospholipids and 53 m % in sterin ethers.

The predominating fatty acid in triglycerides, phospholipids and sterin ethers of seeds of the VNIIMK 8931 variety is linoleic acid, its content increasing by the end of seed ripening, while the quantity of oleic acid is decreasing.

It has been established that regardless of a particular variety in both varieties fatty acids of phospholipids and sterin ethers are more saturated during the whole period of seed ripening than fatty acids of triglycerides owing to a high content of palmitic, stearic, margarine and fatty acids of the $C_{20}-C_{26}$ type.

Accumulation of oleic acid in mutant phospholipids and of linoleic acid in phospholipids of a variety is of the same character as in total lipids.

Sterin ethers of a variety and mutant differ from phospholipids and glycerides by the higher content of saturated fatty acids. Thus at the first stage of oil formation (15 day seeds) the sum of saturated fatty acids in sterin ethers of the sunflower mutant form and the VNIIMK 8931 variety constitutes 38 and 40 m. % respectively, decreasing by the end of such ripening several-fold.

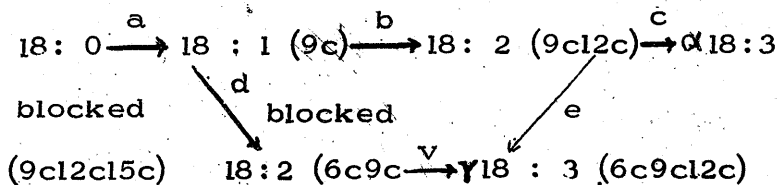
Oleic and linoleic acid accumulation in sterin ethers of mutant sunflower and the VNIIMK 8931 follows the same pattern as observed in other lipid groups, differing just in the level of accumulation of these acids at different stages of seed ripening.

Owing to the fact that in the known sunflower varieties the relative content of oleic acid in oil and its absolute content in seeds decreases when the quantity of linoleic acid in-

creases, several authors (N.F. Lublyanskaya, 1966, A. I. Ermakova, E.V. Popova, 1972). arrived at the conclusion that the linoleic acid biosynthesis takes place at the expense of oleic acid. In a number of cases this conclusion has been proved experimentally with the help of radioactive carbon both on intact spinach chloroplasts and on certain organs of higher and lower plants (A.T. James, 1962; C.J. Kannangaria, P.K. Stumpf, 1972; B.S. Jacobson, C.S. Kannangaria, P.K. Stumpf, 1973; A. Cherif, T.P. Dubacg, R. Mache, A. Ouzsel, 1975).

Generalizing the data in sources and our own data concerning the accumulation and metabolism of fatty acids in sunflower seeds during their ripening, we arrived at the conclusion that the activity of enzyme systems effecting the transformation of oleic acid into linoleic one is blocked in the new sunflower form seeds.

If a biosynthesis scheme of unsaturated fatty acids at higher plants (Hitchcock, B.W. Nichols, 1971) is taken as a basis, then the synthesis of main unsaturated fatty acids in the oil of high oleic sunflower seeds may be presented in the following way:



We believe that in mutant sunflower seeds enzyme systems effecting transformation of oleic into linoleic acid are blocked during intensified synthesis of oleic acid. This results in an intensive accumulation of oleic acid in all groups of lipids containing complex-ether link: triglycerides, phospholipids and sterin ethers, which proves that there is a certain connection in the metabolism of these lipids.