K.I. Soldatov, USSR

CHEMICAL MUTAGENESIS IN SUNFLOWER BREEDING

Fatty acid proportion in vegetable oil considerably affects its nutritional value. Soviet and foreign scientists have proved that oleic acid should prevail in "optimal" vegetable oil. The best quality olive oil is known to contain 70-80% of oleic acid. Sunflower oil of modern varieties displays the prevalence of linoleic acid (55-60%), oleic acid occupying the second place (25-30%), and saturated fatty acids the third (10-12%).

Studies conducted at the All-Union Research Institute of Oil Crops have shown that chemical mutagenesis can considerably alter the ratio of fatty acids in sunflower oil. Using this method we succeeded in a rapid development of initial breeding material with an increased oleic acid content in sunflower oil.

The initial plant of a high oleic acid form was screened in 1970 in M3 following the treating of VNIIMK 8931 seeds with 0.5% solution of mutagene (dimetylsulphate). It contained about 50% oleic acid. Later on, using individual selection and evaluation of progeny, with a subsequent cross pollination of the best plants, we increased the oleic acid content of oil to 67%.

The population average oleic acid content was increased through boosting the oleic acid content in individual plants and through accumulation of high oleic biotypes in population, as is shown in Table 1.

As can be seen, in the 1971 population the bulk of plants (61.1%) contained about 40-59% of oleic acid and only 22.2% of the plants contained over 60%. In 1972 the bulk of plants contained 50-69%, and in 1973 the most prevalent were the plants with 60-79% of oleic acid. The 60% level of oleic acid content was surpassed by 70.6% of plants, i. e. there were 3 times as ma-

Table 1

Accumulation of High Oleic Biotypes in Mutant Population of Sunflower

Years	Mean oleic acid cont. %	Percentage of plants containing oleic acid						
		under 40%	40-49%	50-59%	60-69%	70-79%	over 80%	over 60%
1971	51.4	16.7	33.3	27.8	16.6	5.6	-	22.2
1972	56.5	7.0	23.9	30.8	25.1	8.4	4.8	38.3
1973	67.4	2.0	7.9	19.5	22.9	27.1	17.5	70.6

ny such plants as in 1971. The oil of some plants had 80% and even 90% of oleic acid.

It was found that high oleic acid content is well maintained in further generations; this is evidenced by a close relation between oleic acid content of individual plants and their progeny, the correlation coefficient being +0.67.

Studies of correlations between oleic acid content and principal economic properties (oil content, huskness, seed size, productivity of one head) have shown that on the average there are no such correlations for the population as a whole. Calculated correlation coefficients were close on zero. However, analysis of conjugation of oleic acid with above properties in families has shown a close conjugation on some of them. This makes it possible to develop a sunflower variety with high oleic acid content and a good combination of other basic breeding properties.

On the basis of the initial breeding material with high oleic acid content we developed a high oleic sunflower variety Pervenets. According to results of competitive varietal testing this variety is less productive than Peredovik but its oil is of quite different quality (Table 2).

Table 2

Productivity of High Oleic Sunflower Variety Pervenets

	Pervenets			Peredovik		
	1974	1975	mean for 2 years	1974	1975	mean for 2 years
Seed yield. c/ha	31.2	30.8	31.0	34.0	32.2	33.1
Oleic acid in % in oil	72.5	75.4	73.9	28.4	32.0	30.2
Yield of oleic component, c/ha	11.0	12.0	11.5	5.8	4.7	5.3
Yield of high oleic oil, c/ha	15.1	15.9	15.5	0	0	0

The Pervenets variety has over 100% more oleic acid than Peredovik, retaining property during several years. In the oleic acid content the oil of the new sunflower variety is almost indistinguishable from the olive oil. For two years of testing the mean yield of the new variety was 31 c/ha, being somewhat lower than in Peredovik. The mean oil content of Pervenets seeds is about 50%, also somewhat lower than in Peredovik. High seed yields and high oil content gave in 1974 the yield of 1513 kg/ha of new quality oil and in 1975 - 1583 kg/ha.

The high oleic sunflower variety Pervenets shows an altered pattern of fatty acis accumulation in oil during the process of seed formation and ripening (Table 3).

The regionalized variety VNIIMK 8931 shows an increase of linoleic acid content from 21.0% to 54.3% and a reduction in oleic acid content from 62.0% to 35.9% during the process of seed formation and ripening. The high oleic variety Pervenets shows just the opposite pattern: the oleic acid content increases from 63.6% to 79.3% and the linoleic acid content decreases from 26.4% to 14.8%. These differences were also reflected in the iodine number of the tested varieties. The Peredovik increases the iodine number and the variety Pervenets reduces it.

As a result of changes in the fatty acid content the oil of the high oleic variety gained new valuable properties: increased resistance to oxidation at long storage, reduced accumulation of the products of thermic oxidation when used as frying fat.

Seeds of high oleic variety showed themselves to be rather stable in long term storage. We conducted a special experiment to study the acid number changes in relation to the seed moisture content in Pervenets and in Peredovik. The seeds of the varieties compared were moistened to 14, 17 and 20%. In 5 and 20 days we

Table 3

Changes of Fatty Acid Content of Oil in Relation to Phase of Development of Seeds

Seed age (days from flowering)	Iodine number	Fatty acid content, %		
		saturated	oleic	linoleic
	VNIIMK 8931			
10	90.0	17.0	62.0	21.0
22	109.0	10.0	54.0	36.0
30	124.8	10.0	37.4	52.6
45	125.1	9.8	35.9	54.3
	P E R V E N E T S			
10	100.2	10.0	63.6	26.4
22	93.7	8.5	74.3	17.2
30	97.4	5.3	76.4	18.3
45	93.8	5.9	79.3	14.8

have determined the acid number in each variant. Results are given in Table 4.

After 5 days of storage the Pervenets seeds changed negligibly in all variants of moisture content while the Peredovik seeds showed a considerable change of acid number, especially at the moisture content of 20%. In 20 days Peredovik seeds were spoilt: at the moisture level of 17% the acid number increased to 8.36 units, and at 20% moisture it increased to 11.46 units. At the same time acidity of Pervenets seeds at 14 and 17% moisture was not more than the admissible level, and only at 20% moisture the acid number grew to 4.38 units.

Table 4

Acid Number Changes in Relation to Moisture Content and Storage Time of Seeds

Seed moisture,%	In 5 days		In 20 days	
	Peredovik	Pervenets	Peredovik	Pervenets
14	1.31	0.51	2.29	0.94
17	1.54	0.52	8.36	1.46
20	2.42	0.61	11.46	4.38

Thus, at the All-Union Research Institute for Oil Crops during a relatively short period of time, with the help of chemical mutagenesis a unique initial breeding material had been developed to obtain new sunflower varieties. The material has a diverse ratio of basic fatty acids in oil. Using this material we developed the world first commercial sunflower variety with high oleic acid content in oil. Oil of this variety possesses new valuable properties and will be of great value for the food and canning industries.