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THE CHANGE IN THE PROPERTIES OF FATS ON THERMAL TREATMENT

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Plant oils containing a large amount of polyunsaturated fatty acids rapidly oxidize even at relatively low temperatures and are extremely unstable to the action of high temperatures. On the other hand, animal fats, which contain a large amount of saturated fatty acids, possess a high resistance to oxidative processes, but they are assimilated less readily.

A variety of artificial mixtures of fats consisting of cottonseed oil and mutton fat, which is widely used in the diet of the population of Central Asia, enables a food fat to be obtained which is more stable than cottonseed oil and is better assimilated than animal fat. The production of a modified fat by the catalytic transesterification of such a mixture has been considered by Mirkhalikov et al. [1].

One of the authors of the present paper has previously established that the optimum, from the point of view of technical properties, is a ratio of the components of a mixture of cottonseed oil and mutton fat of 1:1 [2]. In addition, M. N. Ismailov [3] has shown that the addition to the diet of a fat with such a ratio of the components lowers the level of lipids and the concentration of vitamin A in the blood and increases the resorbability of fat and protein to 92-94%.

We have investigated the initial mixture of cottonseed oil and mutton fat (1:1) and that subjected to thermal treatment (Table 1). As can be seen from Table 1, when the fats are mixed the amounts of unsaturated and saturated fatty acids and their ratio change. Thus, while cottonseed oil contains 25% of saturated fatty acids and 75% of unsaturated fatty acids and mutton fat contains 68% and 32%, respectively, in the new fat the composition is 43% of saturated fatty acids and 57% of unsaturated.

The qualitative and quantitative fatty-acid composition of the mixture changed. In the new mixture of fats capric, lauric, pentadecanoic, arachidic, margaric, linolenic, and myristoleic acids, which are absent from cottonseed oil, were detected, in addition, the amount of such fatty acids as myristic, palmitic, stearic, oleic, and palmitoleic increased while the amount of linoleic acid decreased.

Thus, the mixing of the fats led to a more uniform ratio of saturated and unsaturated fatty acids and, as compared with the cottonseed oil, the amount of unsaturated fatty acids fell, which increased the resistance of the fats to the action of heat. However, as compared with mutton fat the amount of unsaturated fatty acids – oleic and linoleic – had risen. This must improve the assimilability of the mixture.

Another advantageous factor in the mixing of the fats in the given proportions is the fall in the melting point as compared with mutton fat. The mixture of fats obtained had mp 38-40°C as compared with 54-63°C for mutton fat. As a result of heating the amount of linoleic acid in the samples of fats investigated fell, but in cottonseed oil the fall in its amount took place intensively during each 10-h period of heating, and in the mixture of fats it took place only in the first 10 h, after which the amount of this acid was stabilized.

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TABLE 1. Change in the Fatty-Acid Composition of Cottonseed Oil and a Mixture of Cottonseed Oil with Mutton Fat in a Ratio of 1:1 in the Heating Process, %.

Acid	Cottonseed oil				Mutton fat	Mixture of mutton fat with cottonseed oil			
	initial	after heating for, h				initial	after heating for, h		
		10	20	30			10	20	30
10:0	—	—	—	—	0,7	0,4	0,3	0,2	Tr.
12:0	—	—	—	—	0,4	0,3	0,3	0,2	Tr.
14:0 (iso)	—	—	—	—	Tr.	Tr.	Tr.	Tr.	Tr.
14:0	1,1	1,0	1,2	0,9	5,7	3,3	2,9	2,9	3,2
14:1	—	—	—	—	0,6	0,3	0,4	Tr.	0,4
15:0 (iso)	—	—	—	—	0,7	0,3	0,4	Tr.	0,4
15:0	—	—	—	—	1,2	0,3	0,4	Tr.	0,5
16:0 (iso)	—	—	—	—	Tr.	Tr.	Tr.	Tr.	Tr.
16:0	22,4	25,6	25,8	25,1	25,4	27,0	27,5	28,4	24,1
16:1	1,2	0,8	1,1	1,2	2,9	2,0	2,3	2,3	2,5
17:0	—	—	—	—	1,2	0,6	1,0	1,0	1,2
18:0 (iso)	—	—	—	—	Tr.	Tr.	Tr.	Tr.	Tr.
18:0	1,8	2,2	2,3	2,2	29,9	10,3	14,2	15,4	16,0
18:1	19,2	17,9	18,7	19,8	26,1	21,2	21,6	21,6	23,0
18:2	54,3	52,5	50,9	50,8	1,5	33,3	28,7	28,0	28,7
18:3	—	—	—	—	0,9	0,6	Tr.	Tr.	Tr.
20:0	—	—	—	—	2,7	Tr.	Tr.	Tr.	Tr.

On heating the mixture of fats, the amount of oleic acid was fairly stable in different periods of heating.

The amount of stearic acid in the cottonseed oil did not change during the heating process, while in the mixture of fats its relative amount had risen by 3.9% after 10 h and by 5.7% after 30 h as compared with the initial sample.

It was also observed that as the result of heating the amount of margaric acid in the mixture of fats rose.

After heating for 30 h the total amount of saturated fatty acids in the cottonseed oil amounted to 28% and of unsaturateds to 72%, while in the mixture of fats the corresponding figures were 45% and 55%. It must be observed that in the mixture of fats even after heating the previous more uniform ratio of saturated and unsaturated fatty acids was retained. The changes in the relative amounts of the fatty acids are explained by the formation of numerous products when cottonseed oil [6] and its mixture with mutton fat are heated.

The extinction coefficient E_1 characterizing the amount of isomers of acids with two conjugated ethylenic bonds, peroxides, hydroperoxides with conjugated bonds, etc., rises continuously as cottonseed oil is heated; in the mixture, it rose during the first 20 h of heating and then the curve fell.

The extinction coefficient E_2 characterizing the formation of secondary oxidation products rises with an increase in the time of heating for cottonseed oil, and the samples have three maxima in the absorption region of 268 nm. For the mixture of fats this index rose less intensively.

The results of an analysis of the magnitude E_1/E_2 as a function of the time of heating permit the change in the rate of formation of secondary oxidation products in the fats to be judged; the rate of increase in the amount of secondary oxidation products in cottonseed oil is higher than in the mixture of cottonseed oil and mutton fat. The UV spectra of the initial and heated fats confirm that, on heating, fatty acids with two and three conjugated double bonds accumulate in the cottonseed oil faster than in its mixture with mutton fat. This shows the higher intensity of the thermal oxidation of cottonseed oil.

EXPERIMENTAL

The methyl esters of the fatty acids were prepared as described by Vereshchagin et al [4].

To determine fatty acids with conjugated double bonds we recorded the spectra of the initial and the thermally treated mixtures of fats on a Specord UV-Vis spectrophotometer. The solvent used was hexane free from aromatic and carbonyl compounds. The amounts of fatty acids were determined by standard methods [5].

The solutions were diluted so that the optical density ranged between 0.2 and 0.8. The extinction coefficients were calculated at λ 232 and 268 nm.

The fatty-acid compositions were determined by the GLC method in the Fats Research Laboratory of the Moscow branch of the All-Union Institute of Fats on a Hitachi model K-53 chromatograph with a flame-ionization detector.

The thermal treatment of the fats was performed at 180-190°C in communal feeding enterprises at a ratio of fat and product of 4:1 and a replaceability of the fat of 0.6. The time of use of the fat was 30 h. The time of cooking the articles was 2-3 min.

SUMMARY

The fatty-acid composition of a mixture of cottonseed oil and mutton fat in a ratio of 1:1 before and after thermal treatment has been studied. It has been established that the mixture obtained is more resistant to the action of heat than cottonseed oil.

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PHOSPHOLIPIDS OF THE SEEDS OF TWO SPECIES OF *Erysimum*

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Continuing an investigation of the phospholipids (PL's) of the seeds of plants of family Cruciferae [1-3], we have studied the PL's of the seeds of *Erysimum diffusum* Ehrh. (collected in the environs of the village of Tobolino, Chimkent oblast) and of *Erysimum sylvestris* (L.) Bess. (collected in the environs of Burchmulla, Bostanlykskii region, Tashkent oblast).

The combined PL's from the seeds were obtained and freed from accompanying carbohydrates by the methods usually used [1, 3].

The yield of total PL's freed from carbohydrates was 0.5% from the seeds of *E. diffusum* and 1% from *E. sylvestris*. The amount of phosphorus in the combined material [4] was 3.3% in both cases. The qualitative and quantitative compositions of the total PL's were established by two-dimensional TLC in systems 1 and 2 followed by the determination of the phosphorus in the spots [5]. In each case, six phosphorus-containing spots were detected: three main ones – phosphatidylcholines (PC's), phosphatidylinositols (PI's), and phosphatidylethanolamines (PE's) – and three minor ones – N-acylphosphatidylethanolamines (N-acyl-PE's), N-acyllysophosphatidylethanolamines (N-acyllyso-PE's], and lysophosphatidylcholines (lyso-PC's). The quantitative distributions of these components in the combined materials from the plants investigated are given below (%).

Phospholipid Fraction	*E. diffusum*	*E. sylvestris*
N-Acyl-PE's	3,2	7,0
N-Acyllyso-PE's	2,1	5,2
PE's	19,3	19,2
PC's	49,1	45,2
PI's	21,3	16,4
Lyso-PC's	5,0	7,0

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