PREPARATION OF NEW MODIFIED FATS

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The transformation of glyceride systems on the principle of the uniform distribution of the fatty acid residues in the molecule of the glycerides to obtain a fat with given structural and mechanical properties is of great scientific and practical interest. Since fats are mixtures of various triglycerides, the composition and quantitative ratio of the fatty acid radicals in the triglycerides exert an influence on their physical properties. The quantitative ratio of the four groups of glycerides GS_3, GS_2U, GSU_2, and GU_3 differs in oils with different triglyceride compositions and it may be brought into a state of equilibrium by transesterification. In the transesterification of fats under suitable conditions, a change in their glyceride composition takes place; an equilibrium composition is formed which corresponds to the amounts of saturated and unsaturated fatty acids.

The phenomenon of the transesterification of triglycerides as esters of mixtures of fatty acids and glycerol has previously attracted the attention of many workers [1-3]. We have studied the transesterification of animal fats and of mixtures of them with vegetable oils.

Fat*	Mp, °C	Hardness,† g/cm
Beef	47.5 / 39.1	630 / 410
Mutton	48.1 / 39.8	640 / 395
Bone	40.2 / 33.6	204 / 85

On transesterification, as a result of intermolecular and intramolecular rearrangements of the acid radicals in the triglycerides of animal fats, not only does their melting point fall, but so also does their hardness [4].

The glyceride compositions (%) of beef and mutton fats before and after transesterification are given below.

Fat	GS_3	GS_2U	GSU_2	GU_3
Beef	14.1 / 11.6	53.4 / 45.3	29.0 / 34.7	3.5 / 8.4
Mutton	18.9 / 14.8	39.1 / 42.3	32.7 / 36.0	8.3 / 6.9

These figures show that the transesterification of animal fats under the given conditions leads to an intermolecular redistribution of the fatty acid radicals in the triglycerides of the fats.

Thus, by the transesterification of high-melting animal fats it is possible to obtain modified fats completely satisfying the requirements relating to melting point and hardness set for fatty bases for bakers' and confectioners' articles. To obtain different modified fats with given properties it is desirable to subject to transesterification not only individual fats of plant or animal origin, but also various mixtures of them.

*Here and below, the numerator corresponds to the fat before transesterification and the denominator after.
†Hardness calculated by Kaminskii's method.

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TABLE 1

Mixture, %		Mp, °C	Acid No., mg KOH	I No., %
beef fat	cotton-seed oil			
10	90	9,2 / 19	0,30 / 0,39	103,1 / 104,6
20	80	19,4 / 28,2	0,34 / 0,46	86,06 / 88,76
40	60	39,1 / 34	0,57 / 0,66	79,9 / 83,6
50	50	41,5 / 36,4	0,62 / 0,81	74,1 / 78,3

TABLE 2

Mixture, %		GS_3	GS_2U	GSU_2	GU_3
beef fat	cotton-seed oil				
50	50	17,1 / 7,6	39,2 / 34,3	31,3 / 44,1	13,4 / 14,0
40	60	15,3 / 6,3	32,2 / 29,7	34,3 / 43,8	18,2 / 20,2

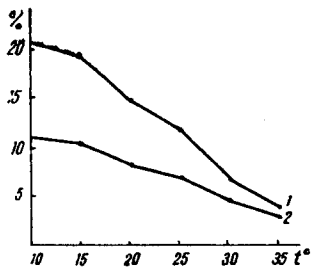

Fig. 1. Dilatometric curves of a mixture of cottonseed oil and beef fat. 1) Before esterification; 2) after esterification.

In order to obtain a finished free base for the production of margarine, we have transesterified mixtures of natural cottonseed oil with beef fat in various proportions (Table 1).

It can be seen from the tables that in the transesterification of a mixture of cottonseed oil and beef fat the unsaturated acids readily substitute the saturated fats, leading to a fall in the melting point. The glyceride compositions of two of the mixtures before and after transesterification are given in Table 2.

The ratio between the amounts of solid and liquid phases in the mixture before and after transesterification (50:50) was determined dilatometrically (Fig. 1). A parallelism exists between the dilatation and the consistency of a fat. According to the literature [6], in fats the melting of which takes place over a narrow range of temperatures, the curve of the dilatation as a function of the temperature is almost vertical. In fats possessing good plastic properties, the dilatometric curves are horizontal, which shows that the given fat melts over a wide range of temperatures. It can be seen from the graph that the transesterification product obtained from a mixture of cottonseed oil and beef fat approximates to an ideal plastic fat.

Transesterification is not usually a reaction that takes place spontaneously; in fats, for example, it takes place only under the action of catalysts.

The exchange of fatty acid radicals can take place only when a definite activation energy is available. Consequently, under ordinary conditions the reaction takes place extremely slowly, at a practically immeasurable velocity. Catalysts sharply lower the energy barrier of the activation of the fat particles, and the acid radicals in the triglycerides undergo exchange at comparatively low temperatures with rates fully sufficient for the performance of the transesterification process under industrial conditions.

EXPERIMENTAL

For the transesterification of animal fats and mixtures of them with cottonseed oil we used as catalyst sodium methoxide in powdered form (0.2% of the weight of the fat, calculated as metallic sodium). Transesterification was performed at 45-55°C in a laboratory transesterification apparatus fitted with a mechanical stirrer with four necks for the introduction and discharge of inert gas, a thermometer, and funnel for the addition of oil and catalyst.

SUMMARY

It has been established that by the esterification of natural fats and of mixtures of them it is possible to obtain new, modified, fats with given structural-mechanical properties.

LITERATURE CITED

1. C. Van-Zoon, V. S. P., 1, 873, 513 (1926).
2. G. A. Norris and K. F. Mattil, J. Amer. Oil Chemists' Soc., 24, 274 (1947).
3. Ja. Marcinkiewicz and H. Niwiadomski, "Influence of the transesterification reaction on the structure of the glycerides of fats," Rocz. Technol. i Chem. Zyw., 17, 21 (1969).
4. E. Ebbot and A. P. Gamby, U.S. Patent No. 2,442,588 (1947).
5. P. A. Artamonov, V. N. Grigor'eva, and R. T. Grigorchuk, in: Catalytic Reactions in the Liquid Phase, Alma-Ata (1967).
6. N. I. Kozin et al., The Use of Emulsions in the Food Industry [in Russian], Moscow (1966).