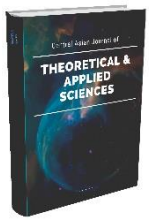

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Dependence of the Content of Trans-Isomerized Fatty Acids on Hydrogenate Indicators

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Abstract: *There is a growing demand in the world for vegetable oils and products of their processing, in particular, hydrogenated fats. The production of vegetable oils in 2020 was 20.5 million in the USA, 4.8 in Russia, 38.0 in China, 72.6 in Central Asia and 28.0 million tons in Europe. Taking into account the increase in the production of vegetable oils, the demand for the production of margarine products and confectionery fats, which are based on target edible hydrogenated fats, is increasing.*

In the world, more and more attention is paid to research work on the catalytic hydrogenation of vegetable oils and fats to obtain target fats and improve their quality and ensure food safety on their basis of margarine products with a minimum content of trans-isomerized fatty acids in their composition, modernization of production technology using new types of catalytic systems. The development of new-generation catalysts for the production of targeted high-hard edible fats with a minimum content of trans-isomerized fatty acids is an urgent problem. In this direction, scientific research work on improving the properties of target highly-hard edible fats, optimizing their composition and technological processes in order to reduce the amount of trans-isomerized fatty acids in margarine products obtained on their basis, is undergoing significant development.

Key words: *hydrogenation technology, catalysts, isomerization processes, trans-isomerized fatty acids, target fats, food safety, high hardness.*

Introduction. Consuming the unnecessarily large amount of trans-isomers leads to dysfunction of the body at the cellular level. It was found that trans-isomers are metabolized in the body much more slowly than natural cis-isomers. Unlike cis-isomers having a curved spatial structure with bends of the carbon chain at double bonds and an angle of about 30°, the molecules of trans-acids are almost straightforward and resemble the spatial structure of saturated acids. [1, 2] Due to this, during crystallization they can be packed into very dense structures with a rather powerful intermolecular interaction. A higher melting temperature of the transforms increases the viscosity of cell membranes, changes their permeability, and disrupts the metabolism of the cell as a whole [3]

Purpose of work. The scientific work is aimed at improving the quality and ensuring food safety of oil-fat mixtures obtained by hydrogenation of cottonseed oil by selecting scientifically based high-performance technologies.

Objects of study. Scientific and experimental studies were carried out on modern laboratory and pilot plants.

In experimental studies on the catalytic modification of cottonseed oil, various catalytic systems have been used.

The catalytic hydrogenation of cottonseed oil was carried out in identical technological modes (Table 1).

Table 1: Conditions for evaluating the hydrogenating properties of catalysts

Hydrogenation conditions parameters	Measurement unit	Value
Temperature	^{0}C	200
Pressure	kPa	300
Volumetric feed rate of raw material	hour^{-1}	1
Volumetric flow rate of hydrogen	hour^{-1}	60
Volume of the catalyst	ml	1000
The average particle size of the catalyst	mm	6
Height of catalyst layer	mm	765
Diameter of the reactor	mm	50

Methods and materials. For the analysis and assessment of quality, physical-chemical characteristics and food safety of raw materials, intermediate materials, hydrogenated oil-fat mixtures modern methods of physical-chemical analysis were used [5-7]

Results and discussion. The degree of trans-isomerization depends on the iodine number of the hydrogenated fat (Table 2). Fully hydrogenated fats do not contain trans-isomers. With incomplete hydrogenation, the content of trans-isomers is determined by the thermodynamic cis-/trans- equilibrium corresponding to 75% of the total number of double bonds.

Table 2: The dependence of the content of trans-isomerized fatty acids on the iodine number of hydrogenate

Iodine number % J_2	Trans-acids content, %	Acid number, mg KOH/g	The melting temperature, ^{0}C	Hardness, g/cm
74.1	11	0.20	34.5	420
72.1	14	0.21	36.1	500
66,4	21	0.35	38.3	620
64,2	18	0.27	37,2	540
63.7	19	0.29	37.1	600

Selectively hydrogenated fats with a low content of trans-isomers were obtained on the studied catalysts at temperatures of 180-200^{0}C and pressures of hydrogen up to 300 kPa.

High hard fat, which has a higher melting point and significantly higher hardness (Table 3), is also differed by a high content of monounsaturated and disaturated glycerides.

Table 3: Dependence of the content of trans-isomerized fatty acids on the content of unsaturated fatty acids

Fatty-acid composition (C),					Selectivity coefficient, %	Content of trans-acids, %
14:0	16:0	18:0	18:1	18:2		
0.6	22.0	6.9	53.9	16.6	89.3	13
0.6	21.7	8.0	51.4	18.3	90.0	14
1,0	22.4	6.0	63.6	7.0	91.2	15
1.7	22.2	8.2	50.3	18.0	94.8	17

To ensure high quality and food safety of food fats, the decrease in the content of trans-isomerized monoenic fatty acids in the process of hydrogenation of cottonseed oil was studied.

The results are shown in table 4.

Table 4: The content of trans-isomers of acids at the modification of cottonseed oil

Indicators	Hydrogenation Selectivity, %				
	98	98	97	95	90
L, %	6	3	5	17	21
(L_o - L)	47	44	42	30	26
T, %	24	21	15	11	9
Calculation	26	23	17	12	10
The melting temperature, ^{0}C	35	34	33	29	25
Hardness, g/cm	400	300	270	140	70

Under these conditions (Table 4), the accumulation of trans-isomerized fatty acids, which determine the hardness of selectively modified oils, occurs not only due to the hydrogenation of linoleic acid, but also due to the parallel cis-trans- isomerization of all monounsaturated acids - initial and formed in hydrogenation.

When using the regenerated catalyst, the content of trans-isomers in modified fats is approximately equal to the decrease in the content of linoleic acid (Table 5): $T = L_o - L$.

Table 5: Change in iodine number and content of trans-isomerized acids of oil-fat mixturesin regeneratedfats

Indicators	Iodine number of oil-fat mixture			
	63	67	71	80
The melting temperature, ^{0}C	36	32	26	24
Hardness, g/cm	180	180	-	-
L, %	6	12	17	22
(L_o – L)	48	42	37	32
Trans, %	17	13	9	7

Conclusions: To produce hydrogenated fats with a low content of trans-isomers, it is necessary to change the technological mode of the hydrogenation process.

The parameters studied will result in selectively hydrogenated oil-fat mixtureswith a high content of saturated glycerides, a low melting point and a low content of unsaturated fatty acids. Such oil-fat mixturescontain almost no trans-isomers.

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