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Improvement of the Technology of Catalytic Hydrogenization of Cotton Oil

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Abstract

The continuous technology of hydrogenation of fats on stationary catalysts has been studied and improved, using them in the quality of for contact. A decrease in the content of trans-isomerized fatty acids in salomass was achieved. The quality of food salmons is improved and their nutritional value is ensured. The method of fore-contact hydrogenation of cottonseed oil produced food salomases with a content of trans-isomerized acids of 7-10% with specified physicochemical properties, corresponding to the quality requirements of the standards.

Keywords: hydrogenation technology; precontact hydrogenation; stationary catalysts; food salomass; quality and nutritional value

Introduction

In the world more and more attention is paid to research work on the catalytic modification of vegetable oils and fats with the aim of improving the quality and food safety of margarine products with a minimum content [1,2] of trans-isomerized fatty acids in their composition, modernizing production technology using new types of catalytic systems. The creation of new generation catalysts for the production [3,4] of high-fat edible fats with a minimum content of trans-isomerized fatty acids is an urgent problem. In this direction, research work is being made to improve the properties of high-fat edible fats, optimize their composition and technological processes in order to reduce the amount of trans-isomerized fatty acids in margarine products.

Edible fats are an important food. According to physiological norms, the recommended fat content in a person's diet is 30-33% of the total energy value of food [5].

Improving the quality and ensuring food safety of high-fat fats can be carried out by changing the triglyceride composition of oils and fats by various methods of their modification [6].

All the issues discussed in this paper are aimed at solving the problem of improving the quality and ensuring food safety of catalytically modified fats, which is very timely and timely.

The aim of the work was to study and improve the continuous technology of hydrogenation of fats on stationary catalysts, using them in the quality of forkontakt, reducing the content of trans-isomerized acids in salomass, improving their quality, nutritional value and increasing the productivity of technological equipment.

In this connection, the following main tasks have been set and solved in the work:

1. Selection and investigation of new modifications of stationary promoted nickel-copper-aluminum catalysts for the production of food saloms with a minimum content of trans-isomerized fatty acids.
2. Study of kinetic regularities (changes in activity, selectivity and isomerizing ability) of hydrogenation of cottonseed oil on new promoted stationary catalysts, determination of regimes for obtaining salomasses with specified properties.
3. Development of the technology of hydrogenation of cottonseed oil on stationary catalysts using them as for contact,

Modern physical, chemical and physical-chemical methods (IR, GLC, TLC) analysis and mathematical processing of experimental data were used [7,8].

The main raw material used in laboratory, pilot industrial and industrial conditions was refined cottonseed oil from Tashkent fat-and-oil plant.

Samples of refined cottonseed oil had a color ranging from 8 to 11 red, an acid number of 0.2-0.3 mg KOH / g and residual moisture but more than 0.15%. The iodine number of samples ranged from 105-112.

The acid composition of typical samples of refined cottonseed oil and their calculated iodine number are given in Table 1

Sample, №	Mass fraction of fatty acids, %			Iodine number (calculation), g J_2/100 g
	Unsaturated	$C_{18:1}$	$C_{18:2}$	
1	33,4	12,3	54,3	104,6
2	31,0	14,4	54,6	107,0
3	27,0	19,9	53,1	109,1
4	25,9	20,8	53,3	110,2
5	26,3	21,0	53,6	110,9

Table 1: Acid composition of samples of refined cottonseed oil.

The dependence of the hydrogenation rate of cottonseed oil on stationary catalysts on the normal hydrogen feed rate was studied. The experiments were carried out at a constant normal oil speed of 3 h^{-1}, a temperature of 170-180°C, a hydrogen pressure of 300 kPa and a hydrogen space velocity of 30, 75 and 90 h^{-1}. It was found that the rate of hydrogenation (decrease in the iodine number of the oil) increases with increasing hydrogen supply and only at high space velocities of hydrogen does the process speed increase. This means that the hydrogenation process was inhibited by diffusion of hydrogen, which coincides with the data of the doctoral dissertation of K.H.Mazhidov.

The nature of the effect of hydrogen pressure (Fig.1) also speaks of the limitation of the process by the diffusion of hydrogen. Only at pressures above 500kPa does the diffusion inhibition practically disappear.

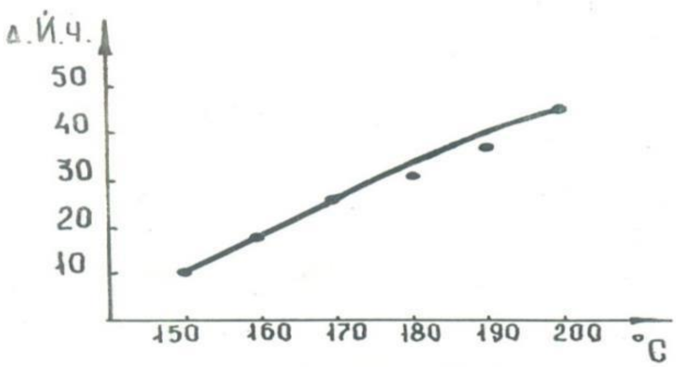

Figure 1: Dependence of the hydrogenation rate of cottonseed oil on a stationary catalyst (rhodium and vanadium promoters) under the pressure of hydrogen.

The volumetric rate of oil is 2 h^{-1}, the hydrogen space velocity is 60 h^{-1}, and the temperature is 175-180 ° C.

We studied the effect of temperature on the rate of saturation of cottonseed oil in the presence of stationary promoted nickel-copper-aluminum catalysts at a pressure of 300 kPa, a hydrogen feed rate of 60 h^{-1}, and an oil flow rate of 2 h^{-1}. The results of the study are shown in Fig.2.

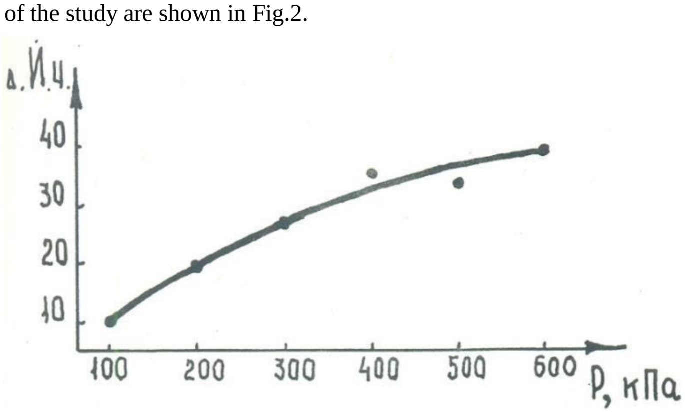

Figure 2: Dependence of the hydrogenation rate on stationary catalyst from temperature.

As can be seen from Fig.2, with increasing temperature, the saturation rate practically increases linearly, with an intensive rate increase observed up to 200°C. This indicates that the hydrogen diffusion process is limited.

The results of the studies showed that within the studied temperature (150-200°C) the selectivity of continuous hydrogenation on promoted catalysts ranged from 60-80% depending on the temperature and depth of hydrogenation of the oil.

The selectivity of hydrogenation on stationary catalysts is low, but remains acceptable for deep hydrogenation of cottonseed oil, iodine number not higher than 85.

Reduction of the selectivity of hydrogenation is accompanied by the accumulation of trisaturated glycerides. However, in the case of shallow hydrogenation, the accumulation of trisaturated glycerides is insignificant.

Hydrogenation under these conditions is accompanied by a relatively small formation of trans isomers.

From these data it follows that hydrogenation on stationary catalysts is accompanied by the formation of stearic acid directly from linoleic acid, as shown in Fig.3.

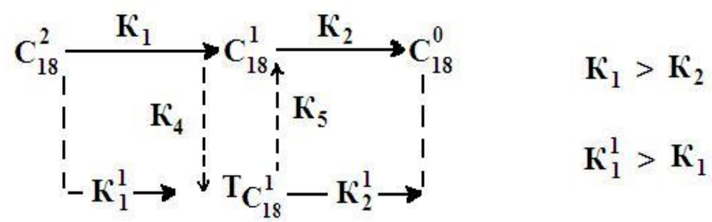

Figure 3: Staged mechanism of hydrogenation of esters linoleic acid on a dispersed catalyst.

This scheme differs from the stage mechanism of hydrogenation of linoleic acid on powdered catalysts, when stearic acid is not directly formed from the acid (Fig. 4).

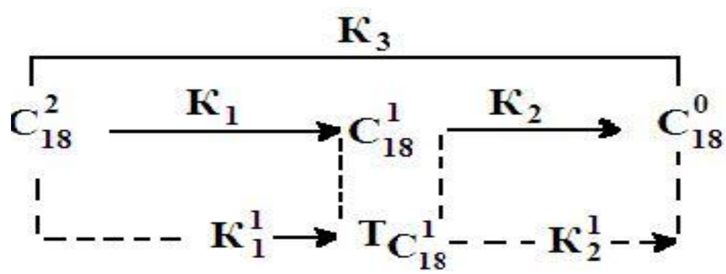

Figure 4: Staged mechanism of hydrogenation of esters linoleic acid on a fixed catalyst.

From the data obtained, it is also follows that partial hydrogenation of a cotton oil with a high space velocity (up to 2 h^{-1}) on new stationary catalysts is carried out at a temperature of 150-180°C and a hydrogen pressure of 200-400 kPa. In this mode, a partially hydrogenated liquid oil, or a low melting point, can be found containing minimal amounts of trans-isomers and trisaturated glycerides.

Such hydrogenates are expediently further subjected to low-temperature, highly selective hydrogenation on a powdered catalyst in order to obtain a variety of high-quality salomases with a decrease in the content of trans-isomerized unsaturated acids.

Conclusion

The continuous technology of the precontact hydrogenation of cottonseed oil on stationary and powdered nickel-copper catalysts was studied and developed for the first time. It is established that the recommended technology allows to significantly increase the productivity of hydrogenation plants and reduces the content of trans-isomerized fatty acids in salomass. This provides an increase in the physiological and nutritional value of margarine products based on food salomass.

The influence of technological regimes (temperature, pressure, oil and hydrogen feed rate) of hydrogenation of cottonseed oil on nickel-copper-aluminum promoted catalysts was studied. On the basis of the results obtained, the technological parameters for the production of food and confectionery salmons by a combination of stationary and suspended catalysts are established.

A study of the regularities of the continuous technology of the contact hydrogenation of cottonseed oil establishments of the mechanism and kinetics of the process of nonselective hydrogenation of unsaturated fatty acids. Subsequently, by increasing the hydrogenation of the partially hydrogenated oil on the powdered catalyst, an increase in the process of selectivity is provided.

By way of the fore-contact hydrogenation of cottonseed oil, food salomasses (the content of trans-isomerized acids 7-10%) with the given physicochemical properties, were obtained.

On the basis of obtained salomas, confectionery products with high quality indices are made.

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