

Solid Fats with a Minimum Content of Trans Acids

Majidova Nargiza Kahramonovna*

Bukhara Engineering-Technological Institute, Bukhara City, Republic of Uzbekistan

***Corresponding author:** Majidova Nargiza Kahramonovna, Bukhara Engineering-Technological Institute, Bukhara City, Uzbekistan, Tel: +998652237884; Fax: +998652236197; Email: kafedra-03@mail.ru

Citation: Kakhramonovna MN (2017) Solid Fats with a Minimum Content of Trans Acids. Adv Biochem Biotechnol 2: 130. DOI: 10.29011/2574-7258.000030

Received Date: 12 June, 2017; **Accepted Date:** 13 July, 2017; **Published Date:** 20 July, 2017

Abstract

Consumption of excessive big quantity of trans-isomers leads to organism dysfunction at cellular level. It is established that trans-isomers metabolized in an organism much more slowly than natural cis-isomers. The work is aimed at research of technologies of reception of firm fats with the minimum maintenance of trans isomerized fat acids. At hydrogenation of vegetable oils there are various collateral reactions, including trans isomerization during which natural cis-isomers of fat acids turn to trans-isomers. Shown results of reception of fat-oils with the minimum maintenance of trans isomerized fat acids at hydrogenation of sample of cotton oil on the catalyst of new generation. Degree of trans-isomerization depends basically on conditions of hydrogenation: temperature, type, quantity and activity of the catalyst, pressure and quantity of hydrogen, intensity of agitation. Experimental researches establish positional distribution of Fatty Acids (FA) in Triacylglycerids (TAG) of initial cotton oil and hydrogenated fats. Conditions at which is possible to direct hydrogenation process by course of least formation of trans isomers are low temperature of process, high pressure of hydrogen and low concentration of the catalyst in raw materials. Technological parameters, at which formation of trans isomers is minimum (high pressure of hydrogen, high velocity of agitating, low concentration of the catalyst) at their sharing will lead to reception of non-selective hydrogenated fat-oil with the big maintenance of sated glycerides, high melting point and the low maintenance of non-saturated fat acids. Such fat-oil practically does not contain trans isomers, however cannot be used directly for manufacture of fatty basis of margarine.

Keywords: Catalysts; Food Value; Solid Fats; Technological Modes; Trans Acids

Introduction

Consumption of excessive big quantity of trans-isomers leads to organism dysfunction at cellular level. It is established that trans-isomers metabolized in an organism much more slowly than natural cis-isomers. Unlike cis-isomers, having bent spatial structure with bends of a carbon chain at double bonds and angle close to 30°, molecules of trans-acids are almost rectilinear and remind a spatial structure of the sated acids [1,2]. For the purpose of decrease the maintenance of trans-isomers is changed by hydrogenation conditions, replace the hydrogenated natural fats widely use interesterification and fractioning of fats [3]. The quantity of trans isomers in the refined oils is influenced by duration and temperature of refining process [4].

Purpose of Work: Research of technologies of reception of firm fats with the minimum maintenance of trans isomerized fat acids.

Research Course: At hydrogenation of vegetable oils there are various collateral reactions, including trans isomerization during which natural cis-isomers of fat acids (for example, oleic, linoleic) turn to trans-isomers. Thus, their hardness and melting point sharply vary: from liquid state at room temperature they turn into firm state. Such changes have been studied at catalytic hydrogenation of cotton oil on new generations of catalysts [5].

Results and Discussion

Table 1 are shown results of reception of fat-oils with the minimum maintenance of trans isomerized fat acids at hydrogenation of sample of cotton oil on the catalyst of new generation.

| Conditions of Hydrogenation | | Fat-acid structure (C) | | | | | Factor of selectivity, % | The maintenance of trans-acids, % |
|-----------------------------|---------------------------|------------------------|-------|-------|-------|-------|--------------------------|-----------------------------------|
| Pressure, kPa | Velocity of oil feed, h-1 | 14:00 | 16:00 | 18:00 | 18:01 | 18:02 | | |
| 100 | 1.6 | 0.6 | 22 | 6.9 | 53.9 | 16.6 | 91.2 | 17 |
| 300 | 1.6 | 0.6 | 21.7 | 8 | 51.4 | 18.3 | 90 | 15 |
| 300 | 1.1 | 1 | 22.4 | 6 | 63.6 | 7 | 94.8 | 13 |
| 100 | 1.1 | 1.7 | 22.2 | 8.2 | 50.3 | 18 | 89.3 | 14 |

Table 1: Reception of fat-oil on nickel-copper catalyst of new generation.

Trans-isomers are more similar to the sated acids than to cis-isomers. It also is reflected in structure of triglycerides in which trans isomers and the sated acids are mainly in 1st and 3rd positions, and cis-acids are localized in 2nd position [6].

Degree of trans-isomerization depends basically on conditions of hydrogenation (Table 2): temperature, type, quantity and activity of the catalyst, pressure and quantity of hydrogen, intensity of agitation [7]. Completely hydrogenated fats do not contain trans isomers. At incomplete hydrogenation, the maintenance of trans isomers is defined by thermodynamic cis/trans balance responding of 75 % from total number of double bonds.

| Conditions of modification | | | Y.n % J ₂ | Maintenance of trans-acids, % | Acid number, mg KOH /g | Melting temperature °C | Hardness g/cm |
|----------------------------|---------------|--------------------------------------|----------------------|-------------------------------|------------------------|------------------------|---------------|
| Temperature, °C | Pressure, kPa | Velocity of oil feed h ⁻¹ | | | | | |
| 200 | 300 | 1.8 | 74.1 | 11 | 0.2 | 34.5 | 420 |
| 200 | 300 | 1.5 | 72.1 | 14 | 0.21 | 36.1 | 500 |
| 200 | 100 | 1 | 64.2 | 18 | 0.27 | 37.2 | 540 |
| 180 | 100 | 1 | 63.7 | 19 | 0.29 | 37.1 | 600 |
| 180 | 100 | 1.2 | 66.4 | 21 | 0.35 | 38.3 | 620 |

Table 2: The characteristic of fat-oils, received by continuous modification of cotton oil on catalyst of new generation

Experimental researches establish (Table 3) positional distribution of Fat Acids (FA) in Triacylglycerids (TAG) of initial cotton oil and hydrogenated fats. It is established that at the first stage there is isomerization of linoleic acids in cis-9, trans 11-oktadecadien acid. This intermediate bond then is hydrogenated with formation of the mix consisting, mainly, from Elaidic acid. As a result of it in the hydrogenated oil contains from 2 to 8 % trans isomers.

There were established technological parameters of process of hydrogenation at which the maintenance of trans isomers can be reduced. However, formation of trans isomers is a property of modern selective catalysts: the more selectivity of process of hydrogenation, the more formed trans isomers and vice versa.

| Iodic number, % J ₂ | Acids C | The maintenance of acyls, mole % | | | |
|--------------------------------|---------|----------------------------------|------------------|------------------|------------------|
| | | In triglycerides | In SN-1 position | In SN-2 position | In SN-3 position |
| 110.9 (Initial oil) | 14:00 | 1.1 | 1.5 | - | 1.8 |
| | 16:00 | 28.5 | 42.3 | 3.3 | 39.9 |
| | 18:00 | 2.1 | 3.5 | - | 2.8 |
| | 18:01 | 17.8 | 16.9 | 25 | 11.5 |
| | 18:02 | 50.5 | 35.8 | 71.7 | 44 |
| 110.9 (Initial oil) | 14:00 | 1 | 1.5 | - | 1.5 |
| | 16:00 | 28.9 | 42.7 | 3.7 | 40.3 |
| | 18:00 | 3.9 | 5.5 | 2.2 | 4 |
| | 18:01 | 49.3 | 40.3 | 71.7 | 35.9 |
| | 18:02 | 16.9 | 10 | 22.4 | 18.3 |

| | | | | | |
|-------------------------------|-------|------|------|------|------|
| 68.4 (Highly firm fat-oil) | 14:00 | 1 | 1.4 | - | 1.6 |
| | 16:00 | 28.7 | 42.8 | 3.5 | 39.8 |
| | 18:00 | 15.9 | 14 | 15.6 | 18.1 |
| | 18:01 | 52.2 | 40.3 | 77.9 | 38.4 |
| | 18:02 | 2.2 | 1.5 | 3 | 2.1 |

Table 3: Positional Distribution of FA in TAG of Initial Cotton Oil and Refined Hydrogenated Fats.

The margarine product made from of fat-oil, received on bases of cotton oil, differs with the high maintenance of isomerized fat acids, lowered concentration of natural linoleic acids, is insufficiently plastic and, as a rule, has macrocrystalline, unstable at storage structure. For the best understanding of processes at hydrogenation of the fats influencing commodity properties of fat-oil, we will consider the mechanism of interactions in system « triglyceride (fat acid) - hydrogen - catalyst». In the beginning the hydrogen dissolved in oil, will be sorbing on nickel. During sorbing process hydrogen molecules dissociating to very active atoms. Let's consider the major factors influencing to change of energy condition.

At high pressure, enough quantity of hydrogen should move from vials of the gas arriving in an autoclave through oil to particles of the catalyst, covering them almost completely. Usually semihydrogenated intermediate product finds set of atoms of the hydrogen kept by nickel in proximity to it for immediately enter reaction with one of atoms of the carbon, located on the neighborhood with to what the first atom of hydrogen is already bonded. Most likely it can happen before the molecule will be developed round C—C bond which at first was double. For this reason, in the conditions of a high pressure can be formed very small quantity trans isomers. Accordingly, at low pressure upon the surface of nickel deprived of hydrogen the semi hydrogenated intermediate product not always will find atom of hydrogen for immediate reaction. In this case more intermediate product will have possibility to round C—C bond and to form trans isomers.

At low concentration of hydrogen on a nickel surface it is improbable that at meeting of triglyceride with a catalyst particle second bond in this molecule would be hydrogenated (for example in linoleic acid). Hence, at low pressure of hydrogen more triglyceride molecules will leave the catalyst only with one hydrogenated double bond, than at high pressure. At high pressure possibility of joining of the second, the third and even more numbers of atoms of hydrogen is more probable, therefore in these conditions is formed more tristearin. Thus, selectivity of hydrogenation inversely proportional to pressure of hydrogen.

At temperature rise of reaction will be increased its velocity. Thus, concentration of hydrogen on a catalyst surface decreases. As a result of it increase velocity of formation of trans isomers and selectivity of process. At increase of concentration of the catalyst the hydrogen expense increases. Thus, formation of trans isomers and selectivity will rise with increase in concentration of the catalyst.

Conclusion

Conditions at which is possible to direct hydrogenation process by course of least formation of trans isomers are low temperature of process, high pressure of hydrogen and low concentration of the catalyst in raw materials.

For development of the hydrogenated fats with the low maintenance of trans isomers it is necessary to change technological mode of process of hydrogenation, to suppress diffusive reaction braking (on hydrogen), having transferred it in kinetic area. For this purpose, it is desirable to apply autoclaves of periodic action with the increased velocity of rotation of the mixing device (more than 120 rpm) at elevated pressure of hydrogen.

Technological parameters, at which formation of trans isomers is minimum (high pressure of hydrogen, high velocity of agitating, low concentration of the catalyst) at their sharing will lead to reception of non-selective hydrogenated fat-oil with the big maintenance of sated glycerides, high melting point and the low maintenance of non-saturated fat acids. Such fat-oil practically does not contain trans isomers, however cannot be used directly for manufacture of fatty basis of margarine.

References

1. Ipatova, LG, Kochetkova AA, Nechaev AP (2006) New directions in creation of functional fat products, Fat-and-oil industry: 12-14.
2. Levachev MM, Yazeva LI (1993) Nutritional value of modified fats. Fat-and-oil industry 11: 6-8.
3. Arutyunyan NS (1999) Technology of processing of fats. Pishchepromizdat: 452
4. Tyutyunnikov BN, Gladky FF (1992) Chemistry of fats. Kolos: 448.
5. Mazhidova NK (2010) Improving the quality and ensuring food safety of saloms obtained by hydrogenation of cottonseed oil. Cand. Tech. Sciences: 26.
6. Mazhidova NK, Shokhidoyatov FK., Ashurov FB (2001) On the processes of isomerization of fatty acids in the technology of hydrogenation of cottonseed oil. Chemistry of natural compounds. Special Issue: 21-22.
7. Majidov KH (1987) Research and improvement of the technology of hydrogenation of cottonseed oil on modified alloy stationary catalysts. Dis. Doc-techn. Sciences: 48.