Shortenings based on hydrogenated cotton oils

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Abstract. A new composition of fat shortening based on hydrogenated cottonseed oil with different iodine numbers has been proposed. Palm oil and solid animal fat are used as an additional fat component. Changes in the content of solid triglycerides depending on their melting point were determined. Hydrogenated cottonseed oil is obtained by saturating cottonseed oil on dispersed and stationary catalysts. The plasticity range of shortenings was studied depending on the content of solid triglycerides. Shortening with hydrogenated cottonseed oil as hard fat, tempered at a temperature of 30.1°C, when measuring the studied parameters, are obtained close to shortening with palm oil, tempered at 26.7°C.

1 Introduction

Emulsion fats are mixtures of vegetable oils and fats with the addition of emulsifiers. [1,2]. Such fatty products are used for baking bakery products and frying agricultural products. [3-4]. The chemical composition of emulsion fats includes solid fats, which crystallize under the influence of low temperatures. [5-7]. Fat emulsions used for frying compared to margarine products. The finished product fried on it looks dry, not oily, due to the fact that the melting point is 40-49 ° C. Catering companies are using universal shortening as a cooking oil in an effort to reduce the number of types of raw materials supplied [8].

Differentiate between liquid shortenings and shortenings with plastic properties [9]. Fat emulsions similar to shortening fats are obtained on the basis of vegetable oils and fats with the implementation of a number of technological operations under various modes [10].

Fat emulsions similar to shortenings have a unique property for food ingredients - ample opportunities to replace one type of raw material with another in the production of many products. However, sometimes when replacing a certain oil in a given product with another, additional operations may be performed, which can increase the cost of raw materials and auxiliary materials. The needs of the food industry are met by the production of shortenings in three forms: plastic, liquid (suitable for pumping) and granular (in the form of flakes, powder). Almost all types of shortening can be supplied both in packaging and in bulk (in bulk) [11].

The development of the production of shortenings, which included emulsifiers, provided new areas of application for these products of the oil and fat industry and laid the foundation for the production of shortenings for specific products. The development of shortenings for a narrow application led to the further comprehensive development of the oil and fat industry, and shortenings have found application not only in the production of baked goods. New

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products have been created, such as milk fat substitutes, specialty fats for confectionery, catering and other applications, which have been successfully applied precisely thanks to the targeted development of shortenings for specific purposes.

Currently there are shortenings for individual food products, often even designed for a particular production technology. Shortenings and flake stabilizers have been developed to provide the special functional properties needed in certain manufacturing processes. Both of these products differ both from traditional shortening, which is in a solid state and having a plastic consistency, and from later developed liquid shortenings - both of them resemble flakes or chips in shape. Thanks to shortening in the form of flakes, it became possible to introduce new technologies for the production of puff pastry, which provide a flaky structure of the finished product. Stabilizers improve the functional properties and appearance of packaged fat and oil products, which provides them with a higher market demand. Advances in technology have increased the knowledge available about oils and fats, which has contributed to the introduction of improved products in all sectors of the food industry. With the help of specialized types of shortening, completely new food products have been created, and the range of products for retail and catering has been expanded. The word "shortening" is no longer associated with the function that a fat and oil product provides, and does not indicate the type or consistency of such a product. Currently, shortenings are produced both with a plastic consistency, and liquid, flaky and powdered. They can be designed for a wide variety of applications, such as the bakery, confectionery, dairy substitutes, snacks, dietary formulas and various prepared food products [12].

When producing a stable flowable slurry, it is important to consider the type and content of solids. For liquid shortening, unlike plastic shortening, a composition is desirable that is stable in the β-form, large crystals of which usually form a stable dispersion. Aeration of whipped dough for cupcakes using plastic shortening is achieved with a homogeneous plastic consistency, which is ensured by the use of oils that crystallize in the form, as well as rapid cooling and tempering, while aeration of liquid shortenings is due to the presence of an appropriate emulsifying system. Antioxidants are added to improve the resistance to oxidation of lubricating fat mixtures with a mild taste. A very effective defoamer is polydimethylsiloxane (E900), which also prevents oxidation, thanks to which the liquid opaque shortening acquires the functional properties characteristic of a plastic, refractory frying fat [13-14].

Emulsion fat shortenings are characterized by plastic properties. The plastic properties of emulsifiable fat products, i.e. fat shortenings, depend on the temperature during their processing. At temperatures above this range, shortening becomes brittle, at lower temperatures it becomes too soft. In both cases, the whipping and workability of the product is reduced. Plastic and convenient shortening with a solid fat content of 15 to 25%. This allows the shortening fat to remain plastic over a wider range of temperatures.

The plastic properties of emulsion fats are set depending on the ratio and content of solid and liquid fatty products. Emulsion fat shortenings are quickly cooled at a temperature of 15-21 ° C, then they crystallize and become suitable for packaging and sale. [15-16].

2 Research methods

For the production of emulsion fat shortenings, natural vegetable oils and hard fats were used, the characteristics of which are given in Table 1.

Table 1. Comparative indicators of emulsifiable fat shortenings.

Name of fatty raw materials	**The number of constituent ingredients, %**						
	Vegetable raw materials			**A mixture of raw materials of animal and vegetable origin**			
Hydrogenated cottonseed oil, J_n 80	90.0	-	-	-	-	-	91.0
Hydrogenated cottonseed oil, J_n 88	-	88.0	-	-	-	89.0	-
Hydrogenated cottonseed oil, J_n 96	-	-	-	35.0	-	-	-
Hydrogenated cottonseed oil, J_n 109	-	-	-	14.5	-	-	-
Ro palm oil	-	-	91.0	55.0	-	-	-
Hard animal fat	-	-	-	-	82.5	-	-
Hydrogenated cottonseed oil, T = 60	10.0	-	-	-	-	-	-
Palm oil, T = 56	-	12.0	9.0	10.0	-	-	-
Hard animal fat, T = 59	-	-	-	-	3.0	11.0	9.0
Content of TTG, % at: 10.0°C 26.7°C 40.0°C	26 20 No less than 9	31 20 11		25 18 10		32 21 No less than 9	

Note. Ych - iodine number, rJ2/100 g; RO-refined and bleached; T – titer, °C.

The results of the analyzes given in the table indicate that fat shortenings based on cottonseed oil and products of its processing [15, 16]. It was established that the plasticity of fat shortenings depends on the iodine number of raw materials, as well as the content of solid and liquid fractions.

The content of solid liquid fractions and their ratio is determined by modern standard methods. It is established that these indicators depend on the temperature and duration of technological processing. The most effective results were obtained in the temperature range of 28-31 0C. The high hardness of the fat shortening fat emulsion was observed at a value of this indicator of 300 mm/10 g.

Shortening fats were obtained using interesterified fat and its mixture with linseed oil (Table 2). Table data. 2. indicate that the fat components used have a unique property for food ingredients - ample opportunities to replace one type of raw material with another in the production of shortening fats for various purposes.

Table 2. Physical and chemical parameters of shortenings obtained on the basis of interesterified fats.

Compositions and indicators fat shortening	**Getting shortened fats**	
	From interesterified fat, %	**From a mixture of interesterified fat with linseed oil, %**
High oleic linseed oil	55.0	30.0

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Solid fat from soybean oil, Tm = 63°C	45.0	–
Interesterified Fat	–	70.0
	Interesterification of fats	
Dropping point at:		
25°C	16.0	10.0
35°C	11.0	8.0
Iodine number, g J2/100 g	86.5	91.6
Total amount of saturated fatty acids, %, incl.	45.0	34.0
- stearic	40.2*	30.0*
- and others	4.8*	4.0*
Content of trans-isoacids, %	2.0	2.0

* Estimated value.

At the same time, shortening fats were obtained in three forms: plastic, liquid and granular (in the form of flakes, powder).

Plastic shortenings for general use were a mixture of hard fats and vegetable oils with a wide range of uses.

3 Research results

The tempering temperature is carefully selected to obtain the desired crystal matrix in the shortening. In the absence of this step, the crystal structure in the product continues to change with time and temperature during storage and transport.

The consistency of shortening changes even when properly tempered, when exposed to high or low temperatures. However, there is always some recovery of consistency when the product is brought back to its original storage temperature. Properly tempered shortening exhibits plasticity over a wider range of temperatures, as well as fluctuations in storage temperature.

Fat shortenings are also characterized by functional properties that also depend on the contents and the ratio of fatty raw materials at a temperature of 10 to 15°C was too hard and did not become too soft at 32-38°C. Solid shortenings in β'-crystalline form are used to expand the range of plastic deformation, increase the resistance of shortening to high temperatures and provide the required crystal shape. As a solid fat base that causes crystallization in the β` form, it helps to improve texture, consistency and whipping ability.

The use of solid fats obtained by hydrogenation ensured the resistance of shortenings to oxidation in the technology of frying products. The highest results were obtained with the use of fatty acids based on cottonseed oil processing products. As the hardness of lard increases, its amount in the recipe decreases, which is necessary to provide the desired consistency.

With a reduction in the dosage of solid fat, the range of plastic deformation decreases and the thermal stability of shortening decreases; therefore, an increase in oxidative stability is achieved while reducing ductility, and a wide range of plastic deformation is provided by oxidation resistance and frying stability.

The oxidative stability of a mixture is not an average of the stability of all its components. This characteristic is directly related to the content and type of unsaturated fatty acids present in the mixture. When solving this problem, it is necessary to choose the requirements that apply to shortening in the intended scope of its application.

The dependence of the range of plastic properties of the fat emulsion on the consistency of the raw materials used was studied; a liquid state of the fat emulsion was achieved using liquid raw materials in an amount of more than 60% by weight of the manufactured product.

At temperatures above this range, shortening becomes brittle, at lower temperatures it becomes too soft. In both cases, the whipping and workability of the product is reduced. Plastic and convenient shortening with a solid fat content of 15 to 25%. This allows the fat to remain plastic over a wider range of temperatures.

The ability to whip and the range of plasticity of shortening depend primarily on the correct choice of the fatty base - lard and hard fats, and secondly - on the condition of cooling and tempering. Shortenings with a wide range of plasticity are usually subjected to rapid cooling to a temperature of 15-21°C, followed by a crystallization or processing stage, then the shortening is packaged and tempered at a temperature of 27°C for 24-72 hours, depending on the size of the package.

The effect of tempering is shown in Figure 1, which shows the data of shortening stabilized with hydrogenated cottonseed oil with a titer of 60°C and palm oil with a titer of 56°C; tempering was carried out at a temperature of 26.7 and 29.4°C for 48 hours.

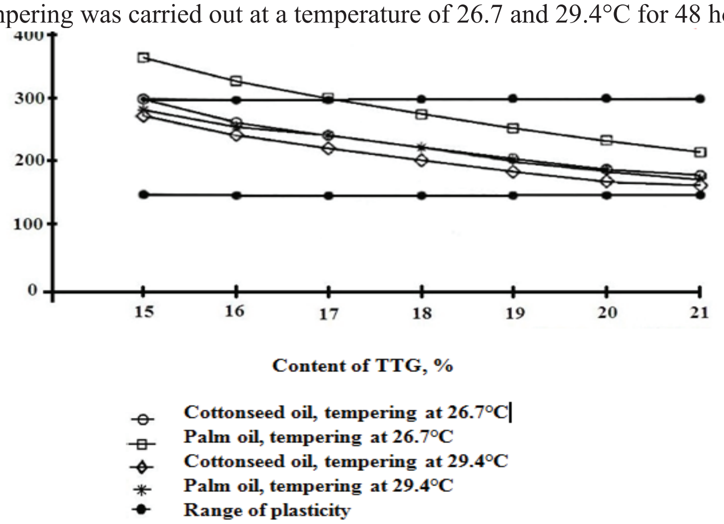

Fig. 1. The dependence of the plasticity of fat shortenings on temperature in the introduction of various fatty raw materials into their composition.

Consistency was assessed by measuring penetration at 26.7°C, with TSH content in both types of shortenings at 26.7°C ranging from 15 to 21%. The range of plastic deformation according to the method used is between penetration values from 150 to 300mm/10g (at penetration values below 150mm/10g the fat was too hard, above 300mm/10g too soft). The experimental results ensured the production of high quality emulsion fat shortenings with the required physical and chemical characteristics.

4 Discussion

More palm oil as a tallow than cottonseed oil is required to achieve the same TSH content. Shortenings based on hydrogenated palm and cottonseed oils with the same TSH content had different consistency measured by the penetration method. Shortening containing palm oil as solid fat turned out to be much softer than shortening with the same content of TSH, but obtained using cottonseed oil.

To achieve the same consistency, palm oil shortening should have about 2% more TSH than cottonseed shortening.

Shortening with hydrogenated cottonseed oil as a tallow, tempered at 29.4°C, measured penetration, showing results close to shortening with palm oil, tempered at 26.7°C. Shortening containing palm oil may have better functional properties if it is tempered at a lower temperature, especially if the TSH content is less than 17% at 26.7°C.

Penetration measurements taken at only one temperature cannot characterize the working range for a particular type of shortening. For its reliable assessment, it is necessary to carry out measurements at various temperatures, especially in the range in which shortening will be used at the consumer enterprise. Experimental studies have established that depending on the performance of emulsion shortenings on technological factors, in particular, the temperatures of their heat treatment.

5 Conclusions

The conducted experimental studies and their scientific results made it possible to develop the formulation of new emulsion fat shortenings based on fatty raw materials obtained by processing local types of oilseeds. These results provided the establishment of the main technological characteristics of fat emulsions for the production of targeted products.

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