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CHOOSING FRUIT - BERRY FILLINGS FOR CONDENSED CANNED MILK WITH SUGAR

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Abstract: *The rheological and organoleptic properties of condensed canned milk with sugar and fruit fillings were determined. The syrups' and jams' usage in the technology of condensed canned milk with sugar reduces the viscosity of finished products and increase the length of the structures destruction in products with fruit jam. We studied the impact of fruit-berry jam on the indicators of conditional dynamic threshold fluidity and fluidity ratio of condensed canned milk with sugar and the possibility of losing the product's fluidity during storage. In the CCM recipes with sugar and fruit - berry fillings, the preference should be given to fruit-berry syrup.*

Keywords: *effective viscosity, fruit fillings, jam, rotational viscometer, syrup*

1. Introduction

Unbalanced diets, difficult psycho-emotional stresses, lack of sleeping, bad habits and many other factors with the significant deficiency of biologically valuable food nutrients influence the health of individuals and the health of the nation in general. Therefore, the focus on manufacturing the next-generation products with high nutritional, biological values is predictable in all sectors of food industry. Dairy industry is no exception to this trend.

Significant contributions to developing of the dairy industry were made by such scientists as Chekulaeva L.V. Radayeva I., Polansky K.K., L.V. Golubev and others [1]. They invented major types of condensed canned milk with sugar that are represented in Ukraine and are in demand among consumers.

It should be noted that canned milk have a low nutritional value despite on the popularity of these products among people from the countries of former Soviet Union. The reasons for the low nutritional value are thermal processing of raw milk for a long time; high carbohydrate content; caloric; unbalanced chemical composition of condensed canned milk with sugar produced by classical technology [2, 3]. All mentioned factors encourage producers to insertion the untraditional materials in production and manufacturing products with combined composition.

Today among the untraditional raw material, used in the technology of condensed canned milk (CCM) with sugar, we can mention soy concentrates vegetable fats, fillers (coffee, cocoa, chicory, pectin, and tea), structure-, sugar substitutes, and sweeteners [2].

The raw materials of plant origin usage - is a good way to cover the deficit of vitamins, minerals and other nutrients in the human diet. Insertion of these materials

will enable manufacturers to expand the range of flavoring products on the CCM market, to satisfy needs of more customers. So developing the technology of condensed canned milk with adding plant origin fillers is relevant for implementation in industrial production.

The nutritional value of processed fruit and berries and final product quality strongly depends on the quality of the feedstock. Many factors influence the chemical composition of fruits and berries, their size, color and other technical indicators. It should be considered in usage the particular type of raw material for the production of various fillers.

After the literary searching, we have established the basic criteria for selection of fruit - berry fillings (FBF), which include organoleptic and rheological parameters of condensed canned milk with sugar and fruit and berry fillings (Fig. 1).

2. Matherial and methods

Selection by the organoleptic characteristics.

Choosing the organoleptic characteristics as criteria was caused by the fact that it is the main factor in food choosing for majority of consumers taste. Rheological parameters were chosen since they provide the fullest characteristics of the structural and mechanical properties of developed products; moreover viscosity indicators are regulated by normative documents on canned condensed milk [4].

The indicators which are standardized by normative documentation for CCM with sugar also include indicators of microstructure, for example the size of the lactose crystals. Below in the work (Table 1) the influence of crystal size for lactose consistency in condensed canned milk and the quality of products will be considered.

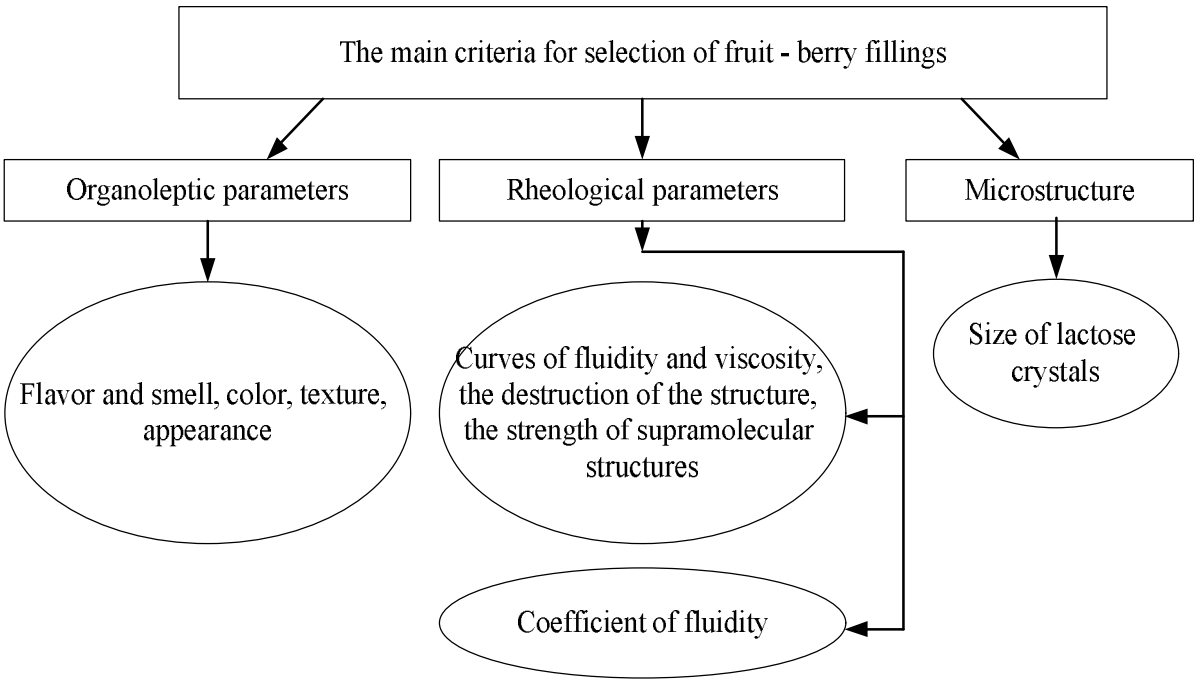

Fig. 1. The main criteria for selection of fruit - berry fillings

At the first stage concentrated juice, syrup, sauce, jam, suburbs, jams from such fruits - berries materials as cherries, apples, currants, raspberries, blueberries, rose,

pear, strawberry, hawthorn , apricot, orange were selected as fillers for condensed canned milk . Mass fraction of filler was justified by the mild taste in the developed samples and visually unchanged viscosity that was equal 15%.

At first, suitability of the mentioned fillers for the usage in the CCM technology with sugar was determined by the organoleptic characteristics.

Taking into account lack of scale for estimation of organoleptic characteristics for CCM with sugar and fruit - berry syrup (FBS) [2, 3], the author developed a 10-point scale. The evaluation criteria are listed in Table 1.

The organoleptic evaluation of CCM with sugar and fruit - berry fillings is shown in Fig. 2.

It was identified that after 3 ... 6 days storage in the studied samples with concentrated juice, puree, suburbs started the processes of mold and fermentation. The reason for the processes was a significant amount of free moisture that the fillers contained. It becomes available to the microorganisms that increase their livelihoods after osmoanabiozu.

Considering and summarizing organoleptic properties, it was found that such fruit – berry fillings like jams and syrups are suitable for usage in the technology of condensed canned milk with sugar.

Selection by the rheological parameters.

CCM is a long storage product during which it is necessary to ensure the stability of its structure and properties. By entering of FBF mass fraction of moisture, higher than the mass fraction of moisture in classic CCM, there exist a risk of unstable systems, tend for separation.

Table 1

Assessment of organoleptic characteristics for CCM with sugar and FBF

No.	Name of the evaluation criteria	Requirements for the product according to the criterion	Evaluation, scores
1	Flavor and smell	Sweet and pure with an expressed flavor of filler without foreign tastes and odors	5
		Sweet and pure with a strong flavor of the filler, without foreign tastes and odors	4
		Sweet, pure, with a weakly expressed flavor of filler without foreign tastes and odors	3
		Sweet, pure, with no expressed flavor of filler without foreign tastes and odors	2
		Sweet, with no expressed flavor of filler with other defects of taste and smell	1-0
2	Consistency	Homogeneous by all condensed mass, without impurities that are perceptible organoleptically	2
		Not homogeneous in all condensed mass of impurities that are perceptible organoleptically	0-1
3	Color	Homogeneous by all condensed mass, which corresponds to the type of filler, natural shades	1
		Not homogeneous in all condensed mass, not natural shades	0
4	Superficies	Glossy, smooth, net surface	2
		With a matte shade, smooth, net surface	1
		Uneven surface with not shades of natural color	0

Therefore, the new fillers insertion requires an examination of their influence on the structural and mechanical properties of the finished product.

In accordance with the organoleptic characteristics the preference was given to jam and syrup. At this stage structural and mechanical properties and the ability to bundle in CCM with sugar and FBF were determined.

Taking into account that variability of tastes will not influence the rheology of finished product and considering its price accessibility and demand, the syrup of blackberry was chosen as an object of investigation.

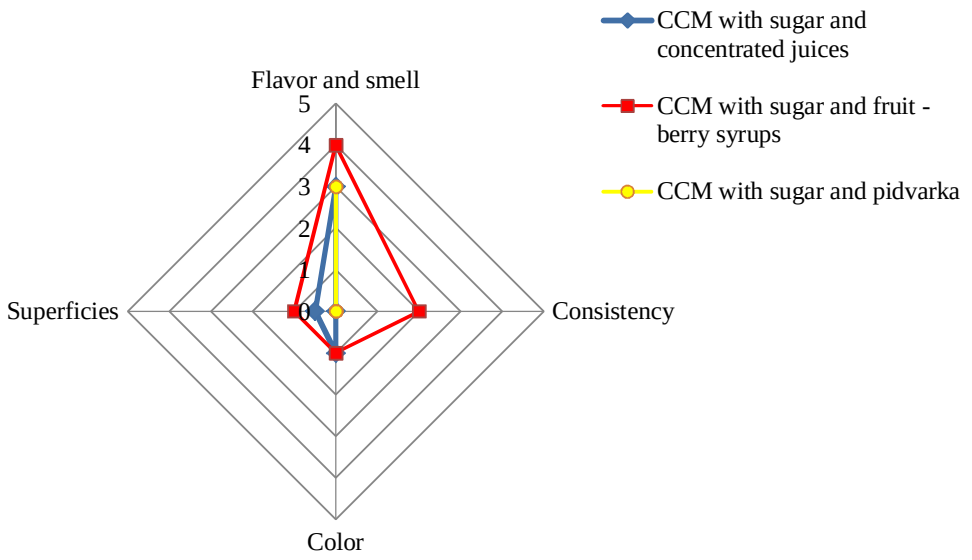

Fig. 2.a. Profile the organoleptic evaluation of condensed canned milk with sugar and FBF

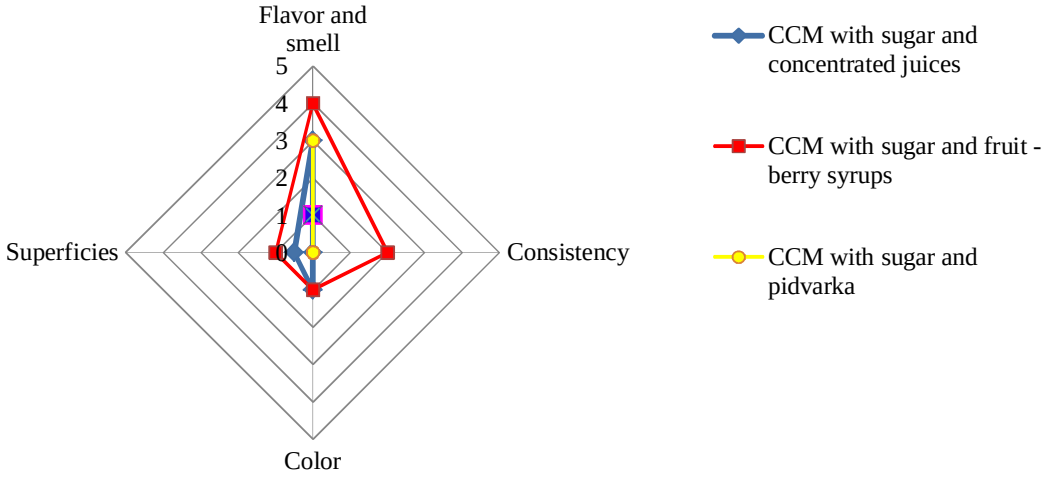

Fig. 2.b. Profile of the organoleptic evaluation of condensed canned milk with sugar and FBF

The effective viscosity is the main rheological indicator, which describes the structural and mechanical properties of the product. That's why the effective viscosity indicator was determined on a rotary viscometer "Reotest-2" for the samples, produced in the laboratory [5, 6, 7].

At the first stage of processing experimental data the shear stress system of P was calculated by the equation:

$$P = Z \times \alpha \qquad (1)$$

where Z - constant of inner cylinder (shown in the passport of the device); α - eaning of the scale on the indicator device.

The next step in analyzing of received results was calculation of the dynamic viscosity. For the calculation the Newton's equation was used. It looks like this:

$$\eta = \frac{P}{\varepsilon} \times 10 \qquad (2)$$

where η - coefficient of dynamic viscosity, Pa · s; P - shear stress, Pa; ε - shear rate, 1/s.

3. Results and discussion

From represented rheological viscosities curves the parameters η_0 (most of viscosity with not destroyed structure) and η_m (minimal viscosity systems with almost destroyed structure) were determined for each sample.

To display the status of the CCM system with sugar and fillers the dynamic viscosity that reflects the complexity of the process of the system flow under the influence of external forces was determined. The research results are presented in Fig. 3.

According to Fig. 3 it was determined that the structure decreases in a very wide range of voltages (from 1000 to 5000 Pa) with increasing shear rate of viscosity, and after the total destruction of structure that corresponds to the critical stress P_{cr}, the viscosity remains constant [1].

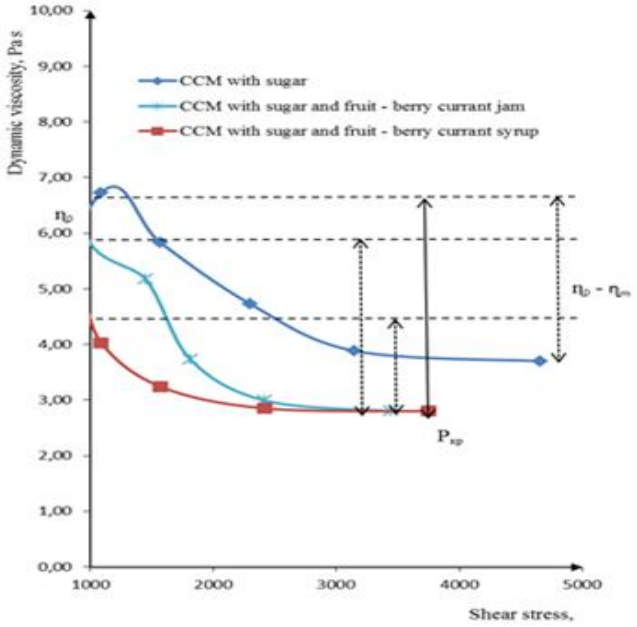

Fig. 3. Rheological viscosity curves of condensed canned milk with sugar and fruit filling

Analysis of the rheological curves of test samples of CCM viscosity indicates that the largest CCM viscosity with sugar is equal to 6.6 Pa·s, for CCM with sugar and jam - 5.8, with syrup - 5.4 Pa·s; while the lowest viscosity that destroyed structure of the control sample was 3.7 Pa·s, and for the condensed canned milk with sugar and FBS for both types the indicates were lower by 24% and were equal to 2.8 Pa·s.

The calculation results of basic rheological characteristics of the systems with different FBF are shown in Table. 2.

It is known that the value of the difference parameters (η_0-η_m) characterizes the strength of formed systems of supramolecular structures. So we can conclude that supramolecular structure of CCM with jam and controls is the strongest (3.0 and 2.9 Pa·s, respectively), and the addition of fruit-berry syrup makes it slightly weaker (η_0-η_m =2,6 Pa·s). The difference in the impact nature of different fruit-berry filling types on rheological indicators of the CCM can be explained by

different dynamic viscosity of the added FBF.

In order to determine the stability of the samples of formed condensed canned milk with sugar and fruit-berry fillers comparing with the control, rheological fluidity curves were built on the next stage (Fig. 4).

Depending on the character of the rheological fluidity curves it is possible to say that the structure of the systems can be classified as weakly structured (visco-plastic) type as Pk1>0.

Analysis of rheological fluidity curves showed that the major parameters of conditional dynamic threshold fluidity (Pk2) and the strength of the structural framework of supramolecular ties (Pm) sample was characterized by the CCM with sugar and jam for which these indicators were higher by 8 and 6% comparing to classic CCM with sugar.

It was identified that the syrup adding to CCM lowered the threshold fluidity of the product and weakened the strength of the structural frame, which is consistent with durability of formed supramolecular structure data and is explained by FBS chemical composition.

Table 2

Basic rheological properties of condensed canned milk with sugar and fruit-berry fillings

№	Name of the sample	η_0, Pa·s	η_m, Pa·s	$\eta_0-\eta_m$, Pa·s	P_{k1}	P_{k2}	P_m	P_{k1}/P_{k2}	P_m/P_{k2}
1	CCM with sugar	6.6	3.7	2.9	138	4050	4900	0.034	1.21
2	CCM with sugar and fruit - berry currant jam	5.8	2.8	3	180	4400	5200	0.041	1.18
3	CCM with sugar and fruit - berry currant syrup	5.4	2.8	2.6	183	3350	4500	0.055	1.34

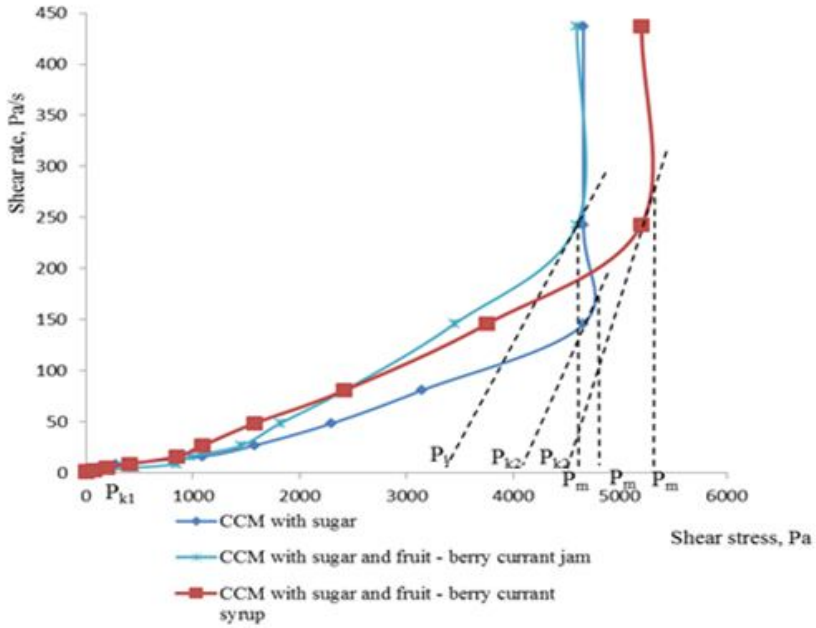

Figure 4. Rheological curves fluidity of condensed canned milk with sugar and fruit-berry fillings

At the same time the types of fruit and berry fillings had no significant effect on the strength of structural connections (R_{k1}/P_{k2}) and the range of stress in which were the system's destruction (R_m/P_{k2}) [8].
Considering the mentioned threshold dependence of the dynamic fluidity from type of filling and importance of this indicator for long-term storage products, we determined the rate of fluidity next.
Fluidity is a characteristic of condensed canned milk with sugar, which is characterized by a coefficient (K_f) that is measured by the mass of the product (m), which flows out of the hole with diameter defined by R in unit time (τ) [9].

$$K_f = \frac{\tau R^{2,58}}{m} \quad (3)$$

It was defined that the rate of fluidity for condensed milk with sugar (control sample) was 7.0 ... 7.1 units; for CCM with sugar and FBS - 6.9 ... 7.0; CCM with sugar and fruit-berry jam - 6.2 ... 6.4.

4. Conclusion

The investigated canned condensed milk with sugar and fruit fillings can be attributed to weakly structured fluids in terms $P_{k1} > 0$, which indicates the nature of the formed system, and is consistent with the data of CCM with sugar of classic range.
The investigated fruit does not have a significant effect on the strength characteristics of condensed canned milk with sugar structure fillings in there amount of 15% of weight of the finished product.
Considering the impact of fruit-berry jam on the indicators of conditional dynamic threshold fluidity and fluidity ratio of CCM with sugar and possible losing the fluidity of the product during storage, the preference should be given to fruit-berry syrup in the CCM recipes with sugar and FBF development.

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