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STUDY ON THE USE OF FOOD EMULSION AND XANTHAN GUM IN THE COMPOSITION OF YOGURT WITH BLENDED OIL

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Abstract. *The work is to study the use of food emulsion and xanthan gum in the composition of a yogurt with blended oil. To obtain the yogurt with blended oil, we used skimmed cows milk, skimmed cows milk powder, and a food emulsion consisting of drinking water, blended oil (sunflower and linseed), sodium caseinate, and an emulsifier (a mixture of polyglycerol esters and higher fatty acids). Xanthan gum was used as a stabilizer. The control was yogurt obtained from dairy raw materials.*

The titrimetric method determined the titrated acidity, which is based on the neutralisation of acids contained in the investigational product with a sodium hydroxide

solution in the presence of an indicator. The fatty acid content was determined by chromatographic. Organoleptic quality indicators were assessed by tasting and compared with standard indicators according to DSTU 4418. The number of viable lactic acid bacteria was determined by the method of sowing serial dilutions in agar nutrient media.

Samples of the milk-vegetable sour-milk base with 2.0 %, 4.0 % and 6.0 % fat content were obtained by fermenting the milk-vegetable normalized mixture, consisting of a food emulsion, cow's skimmed milk and cow's skimmed milk powder. It had been established that for the minimum value of the titrated acidity of the sour-milk curd of the milk-vegetable sour-milk base of 80 °T to be achieved, the fermentation duration of the milk-vegetable normalized mixture is different compared to the fermentation duration of the milk normalized mixture. Thus, the fermentation duration of the milk normalized mixture and the milk-vegetable normalized mixture with 2.0 % fat content is 8.0 hours and 10.5 hours, respectively, 4.0 % - 8.5 hours and 11.0 hours, respectively, 6.0 % - 8.5 hours and 12.0 hours, respectively. The samples of the obtained milk-vegetable sour-milk base with 2.0 %, 4.0 % and 6.0 % fat content have the number of viable lactic acid bacteria of 1.0 × 107 that corresponds to the standard indicator for the traditional yogurt. For obtaining the yogurt with blended oil of a homogenous, fine, creamy, thick consistency, 0.15-0.20 % xanthan gum should be added to the milk-vegetable sour-milk base with 6.0 % fat content. The content of omega-3 and omega-6 polyunsaturated fatty acids in the yogurt with blended oil with 6.0 % fat content is 1.06 % and 5.44 %, respectively, which is a higher indicator in comparison with the traditional yogurt.

The possibility of using a food emulsion as part of a yogurt-type product was established. The resulting yogurt with blended oil is characterized by normative indicators of titrated acidity, the number of viable lactic acid bacteria, organoleptic quality indicators and a high content of polyunsaturated fatty acids. The developed yogurt with blended oil will make it possible to expand the range of the milk-containing sour-milk products and it is recommended for the consumption as the finished product as well as for the use as the semi-finished product.

Keywords: *yogurt, blended oil, food emulsion, polyunsaturated fatty acids, xanthan gum.*

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ДОСЛІДЖЕННЯ ВИКОРИСТАННЯ ХАРЧОВОЇ ЕМУЛЬСІЇ ТА КСАНТАНОВОЇ КАМЕДІ У СКЛАДІ ЙОГУРТУ З КУПАЖОВАНОЮ ОЛІЄЮ

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Анотація. *У роботі досліджено використання харчової емульсії та ксантанової камеді у складі йогурту з купажованою олією. Для отримання йогурту з купажованою олією використовували знежирене коров'яче молоко, сухе знежирене коров'яче молоко та харчову емульсію, що складається з питної води, купажованої олії (соняшникової та лляної), казеїнату натрію та емульгатора (суміш ефірів поліцерину та вищих жирних кислот). В якості стабілізатора використовували ксантанову камедь. Контролем був йогурт, отриманий з молочної сировини.*

Титрометричним методом визначали титровану кислотність, яка заснована на нейтралізації кислот, що містяться в досліджуваному продукті, розчином натрію гідроксиду в присутності індикатора. Вміст жирних кислот визначали хроматографічним методом. Органолептичні показники якості оцінювали шляхом дегустації та порівнювали з нормативними показниками згідно з ДСТУ 4418. Кількість життєздатних молочнокислих бактерій визначали методом посіву серійних розведень на поживному середовищі.

Зразки молочно-рослинної кисломолочної основи жирністю 2,0 %, 4,0 % та 6,0 % отримували шляхом ферментації молочно-рослинної нормалізованої суміші, що складається з харчової емульсії, молока коров'ячого знежиреного та сухого знежиреного молока коров'ячого. Встановлено, що тривалість ферментації молочної нормалізованої суміші та молочно-рослинної нормалізованої суміші жирністю 2,0 % становить відповідно 8,0 год і 10,5 год, 4,0 % - відповідно 8,5 год і 11,0 год, 6,0 % - 8,5 год і 12,0 год відповідно. Зразки отриманої молочно-рослинної кисломолочної основи жирністю 2,0 %, 4,0 % та 6,0 % мають кількість життєздатних молочнокислих бактерій 1,0 × 10^7, що відповідає нормативному показнику для класичного йогурту. Для одержання йогурту з купажованою олією з однорідною, густою консистенції до молочно-рослинної кисломолочної основи жирністю 6,0 % слід вносити 0,15-0,20 % ксантанової камеді. Вміст поліненасичених жирних кислот омега-3 та омега-6 в йогурті з купажованою олією жирністю 6,0 % становить 1,06 % та 5,44 % відповідно, що є вищим показником у порівнянні з класичним йогуртом.

Встановлено можливість використання харчової емульсії у складі продукту по типу йогурту. Отриманий йогурт з купажованою олією характеризується нормативними як до йогурту показниками титрованої кислотності, кількістю життєздатних молочнокислих бактерій, органолептичними показниками якості та підвищеним вмістом поліненасичених жирних кислот. Розроблений йогурт з купажованою олією дозволить розширити асортимент молоковмісних кисломолочних продуктів та рекомендований до споживання як готовий продукт, так і для використання у якості напівфабрикату.

Ключові слова: *йогурт, купажована олія, харчова емульсія, поліненасичені жирні кислоти, ксантанова камедь.*

Introduction

To this date, there appears a tendency to increase the production of the milk-containing products, in the composition of which milk fat is replaced by vegetable fats because of the volume reduction of the milk production as a raw material (Novgorodska & Bernyk, 2022).

Such products make it possible to provide for the needs of consumers of all social groups due to a reduced price in

comparison with the dairy products (Ustymenko et al., 2023).

Furthermore, the addition of sour-milk products, in particular, yogurt, which is a popular product, in the diet, can solve the bacterial equilibrium in the human body, as such products contain probiotics that are useful for the human body (Şanlier, Gökcen, & Sezgin, 2019; Zheplinska et al., 2021).

Analysis of recent researches and publications

The fats that do not have a high biological value, since they contain the saturated fatty acid by the fatty acid composition, are used as non-dairy fats in the production technologies of the milk-containing sour-milk products, such as yogurt-type products (Boeck, Sahin, Zannini, & Arendt, 2021).

Having analysed the population diet structure, one can say that there is a shortage of the polyunsaturated fatty acids, especially the omega-3 family contained in vegetable oils, against the background of excessive consumption of saturated fatty acids (WHO, 2018).

The entire volume of the mixture, which consists of vegetable fats and skimmed milk base, is usually emulsified without the use of emulsifiers in the technologies of the milk-containing products. With this emulsification type, the finished product can have the sizes of fat globules less than 2 μm, which subsequently will negatively impact on the organoleptic quality indicators and the instability of the fat phase while storing. Due to the emulsification of non-dairy fats, provided that fat globules with a medium size of no more than 2 μm are obtained, the nutritional characteristics of the finished product are increased, as well as its physicochemical quality indicators are improved, in particular, while storing (Samoichuk et at., 2020; Michalski, & Januel, 2006).

Thus, it is relevant to use the vegetable oils as a source of the polyunsaturated fatty acids precisely in dispersed form in order to obtain new yogurt types with non-dairy fat content.

Thus, the technology of the finely dispersed food emulsion with a mass fraction of blended oil of 50 % was developed, which is an emulsion-type fat concentrate with a medium-sized fat globules of no more than 2 μm and a stability index of 100 %. High quality indicators of the food emulsion are achieved by means of the use of the composition of different-nature emulsifiers (sodium caseinate + a mixture of polyglycerin and higher fatty acids) and specified homogenization modes (Ustymenko, 2019; Mushtruk, Deviatko, Ulianko, Kanivets, & Mushtruk, 2021).

It should be highlighted that the vegetable oils, in particular, blended ones, do not have properties for the food system to be structured in comparison with the milk fat (Huppertz, & Kelly, 2006). Therefore, taking this feature into account, stabilizers and/or thickeners should be used in the composition of new yogurt types with the vegetable oils (Bakry, Chen, & Liang, 2019; Rogoskii, 2020).

The work is to study the use of food emulsion and carrageenan in the composition of a yogurt with blended oil.

Materials and methods

To obtain the yogurt with blended oil, we used skimmed cows milk, skimmed cows milk powder, bacterial drug to prepare the yogurt "Vegan yogurt VIVO", and a food emulsion consisting of drinking water, blended oil (sunflower and linseed), sodium caseinate, and an emulsifier (a mixture of polyglycerol esters and higher fatty acids).

The food emulsion was obtained according to the technology (Ustymenko, 2019; Bober, 2020) according to which it consists of drinking water, blended oil (sunflower and linseed oils), sodium caseinate, oleophilic emulsifier (a mixture of polyglycerol esters and higher fatty acids) and is characterized by high dispersion - the average size of fat globules is no more 2 μm.

Xanthan gum was used as a stabilizer. The control was yogurt obtained from dairy raw materials.

The titrated acidity of the protein-fat base samples was determined by the titrimetric method, which is based on the neutralization of the acids contained in the product under study, with a solution of sodium hydroxide in the presence of an indicator (Fahmid, Sajjad, Khan, Jamil, & Ali, 2016).

The fatty acid content was determined by chromatographic according to (DSTU ISO 15885/IDF, 2008).

Organoleptic quality indicators were assessed by tasting and compared with standard indicators according to (DSTU 4343, 2004).

The number of viable lactic acid bacteria was determined by the method of sowing serial dilutions in agar nutrient media according to (GOST 10444.11, 1989).

Results

The obtainment of the milk-vegetable sour-milk base for the yogurt with blended oil, consisting of cow's skimmed milk, cow's skimmed milk powder and food emulsion, was substantiated at the first stage of the scientific research.

The milk-vegetable sour-milk base and the control sample were obtained by fermentation in a mixture thermostat (Table 1) at a temperature of 38 °C within 14 hours. Every two hours of the fermentation process the titrated acidity was determined in the milk-vegetable mixture and the control sample.

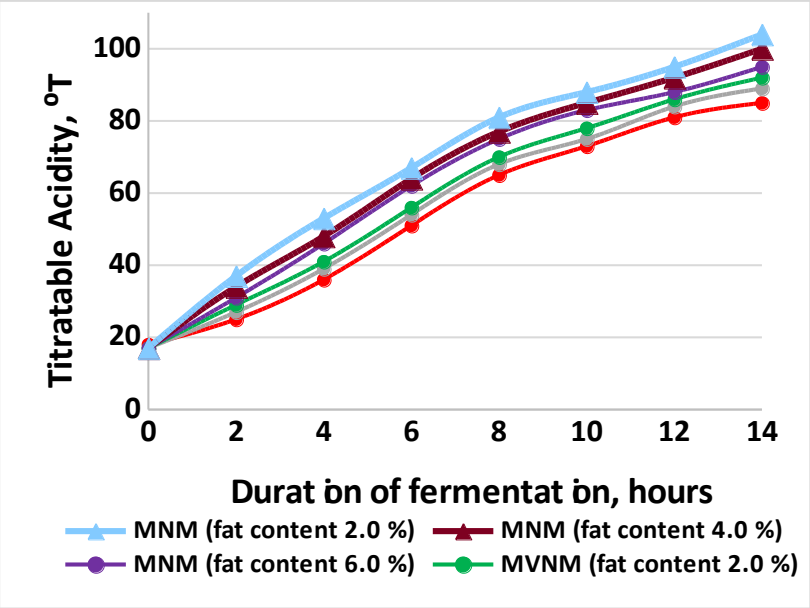
Table 1. Recipe compositions of experimental samples and controls

Components	Mass fraction of fat		
	2.0	**4.0**	**6.0**
Milk normalized mixture (control sample)*			
Cow's skimmed milk, %	93.0	88.0	83.0
Cow's milk cream (40% fat content), %	5.0	10.0	15.0
Cow's skimmed milk powder, %	2.0	2.0	2.0
Total, %	100	100	100
Milk-vegetable normalized mixture*			
Cow's skimmed milk, %	93	89	75.0
Food emulsion, %	4	8	12
Cow's skimmed milk powder, %	3.0	3.0	3.0
Total, %	100	100	100

*Bacterial drug for direct application. It is not indicated in the recipe composition.

Since milk proteins and fat are involved in the formation of the sour-milk curds and as a result of its quality indicators, in particular, the titrated acidity (Lisbeth Meunier-Goddik, 2004; Shanina et al., 2020) there appears a scientific interest in comparing the duration of the fermentation process of the milk-vegetable normalized mixture with blended oil in the form of the food emulsion and the milk normalized mixture with milk fat.

The sour-milk curd with the titrated acidity of 80 °T, which meets the applicable normative requirements for the yogurt, was obtained during the fermentation process with the use of the milk-vegetable normalized mixture and the milk normalized mixture (DSTU 4343, 2004) (Figure 1).



MNM – Milk normalized mixture; MVNM – Milk-vegetable normalized mixture.

Figure 1. Titrated acidity indicator for samples of milk-vegetable normalized mixture and milk normalized mixture within 14 hours of fermentation process

Number of viable lactic acid bacteria in milk-vegetable sour-milk base is presented in Table 2.

Table 2. Number of viable lactic acid bacteria in milk-vegetable sour-milk base

Sample		**Number of viable lactic acid bacteria (*Lactobacillus bulgaricus, Streptococcus thermophilus*), CFU/g**	**The norm, no less than** (DSTU 4343, 2004)
Milk-vegetable sour-milk base	fat content 2 %	1.0×10^7	1.0×10^7
	fat content 4 %		
	fat content 6 %		

Organoleptic quality indicators of milk-vegetable sour-milk base of various fat content is presented in Table 3.

Table 3. Organoleptic quality indicators of milk-vegetable sour-milk base of various fat content

Indicator	**Normal value** (DSTU 4343, 2004)	**Mass fraction of blended oil, %**		
		2.0	**4.0**	**6.0**
Taste and aroma	Clean, sour-milk, without foreign tastes and aromas	Clean, sour-milk, without foreign tastes and aromas		
Consistency	Homogenous, fine, with a broken or unbroken curd, moderately dense, without gas formation	Homogenous, fine, with a broken curd, without gas formation		Homogenous, insufficiently thick
Colour	From white to light-yellow	White	Creamy	

Thus, the sample of the milk-vegetable sour-milk base with 6.0 % fat content was chosen in order to improve the consistency by using the thickener and stabilizer of the structure - xanthan gum, which will make it possible to obtain the yogurt with blended oil with the maximum possible content of polyunsaturated fatty acids that are useful for the human body.

The use of xanthan gum as part of the milk-vegetable sour-milk base with the obtainment of the yogurt with blended oil was substantiated at the second stage of the scientific research.

Organoleptic quality indicators of yogurt with blended oil with 6.0 % fat content with different contents of xanthan gum is presented in Table 4.

Table 4. Organoleptic quality indicators of yogurt with blended oil with 6.0 % fat content with different contents of xanthan gum

Indicator	**content of xanthan gum, %**				
	0.05	**0.10**	**0.15**	**0.20**	**0.25**
Appearance and consistency	Homogeneous mass, insufficiently thick		Homogeneous, fine, thick, creamy mass		Homogeneous, jellylike mass
Taste and aroma	Clean, sour-milk, without foreign tastes and aromas				
Colour	Creamy, uniform over the full mass				

Content of omega-3 and omega-6 polyunsaturated fatty acids in yogurt with blended oil in comparison with control sample is presented in Figure 2.

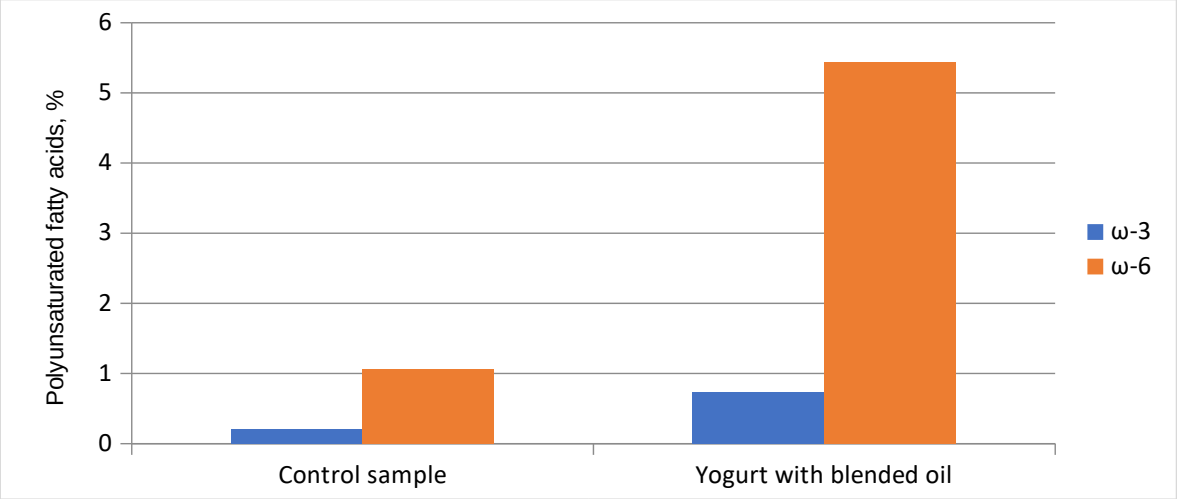


Figure. 2. Content of omega-3 and omega-6 polyunsaturated fatty acids in yogurt with blended oil in comparison with control sample

Discussion

It should be noted that the duration of the fermentation process of the milk-vegetable normalized mixture and the milk normalized mixture in order to achieve the titrated acidity from 80 °T was different - the duration of the fermentation process of the milk normalized mixture with 2.0 %, 4.0 %, 6.0 % milk fat content is 8, 8.5, 8.5 hours, respectively, of the milk-vegetable normalized mixture with 2.0 %, 4.0 %, 6.0% blended oil is 10.5, 11.0, 12.0 hours, respectively (Figure 1). Therefore, the components of the milk-vegetable normalized mixture hinder the development of lactic acid microflora during the fermentation process. It should be also noted that, in order to obtain sour-milk products, in particular, yogurt, the quality development process of lactic acid microflora is caused by lactose during the fermentation process (Barros, 2019). Therefore, it can be concluded that the lactose content in the milk-vegetable normalized mixture is sufficient to obtain the sour-milk curd with the titrated acidity of 80 °T.

The samples of the milk-vegetable sour-milk base after the fermentation process have the number of viable lactic acid bacteria, which corresponds to the normalized indicator for the yogurt obtained according to the classical technology (Table 2).

When the mass fraction of blended oil is increased from 2 % to 6 %, the consistency of the milk-vegetable sour-milk base is deteriorated (Table 3). The milk-vegetable sour-milk base with the mass fraction of blended oil of 6 % acquires the insufficiently thick consistency. From our point of view, this

consistency characteristic was influenced by the content of blended oil, which, compared to milk fat, is not able to form the appropriate yogurt structure (Tirado et al., 2018; Mushtruk et al., 2023).

Xanthan gum, as a thickener and stabilizer of natural origin, forms the gel solution that has a high mobility, which will make it possible to achieve the appropriate consistency of the yogurt with blended oil (Cortez-Trejo, 2022). For obtaining the yogurt with blended oil of a homogenous, fine, creamy, thick consistency, 0.15-0.20 % xanthan gum should be added to the milk-vegetable sour-milk base (Table 4). The content of xanthan gum in the milk-vegetable sour-milk base of more than 0.20 % provides a homogeneous, but gel-like consistency due to the significant binding of water in this food system by this food additive.

In the yogurt with blended oil, the content of omega-3 and omega-6 polyunsaturated fatty acids is 1.06 % and 5.44 %, respectively, and is higher in comparison with the control sample (Figure 2). Research (Balić, Vlašić, Žužul, Marinović, & Bukvić Mokos, 2020) found that omega-3 and omega-6 are not synthesized in the human body and are involved in the prevention and treatment of many diseases.

Conclusions.

The possibility of using the finely dispersed food emulsion with 50 % fat content based on blended oil (sunflower oil + linseed oil) and xanthan gum as part of the yogurt-type product – yogurt with blended oil - has been proven.

It has been established that in order to achieve the minimum value of the titrated acidity of the sour-milk curd of the milk-vegetable sour-milk base of 80 °T, the duration of the fermentation process of the milk-vegetable normalized mixture, in comparison with the duration of the fermentation process of the milk normalized mixture, is different - for the milk normalized mixture and for the milk-vegetable normalized mixture with 2.0 % fat content is 8.0 and 10.5 hours, respectively, 4.0 % – 8.5 and 11.0 hours, respectively, 6.0 % – 8.5 and 12.0 hours, respectively.

According to the organoleptic quality indicators, it has been established that the sample of the milk-vegetable sour-milk base with blended oil of 6.0 % content is characterized by a homogeneous, but insufficiency thick consistency.

It has been established that the samples of the obtained milk-vegetable sour-milk base with 2.0 %, 4.0 % and 6.0 % fat content have the number of viable lactic acid bacteria of 1.0×10^7 that corresponds to the standard indicator for the traditional yogurt.

It has been established that for obtaining the yogurt with blended oil of a homogenous, fine, creamy, thick consistency, 0.15-0.20 % xanthan gum should be added to the milk-vegetable sour-milk base with 6.0 % fat content.

According to the study of omega-3 and omega-6 content in the yogurt with blended oil with 6.0 % fat content, an increased number of these polyunsaturated fatty acids has been

found – 1.06 % and 5.44 %, respectively, in comparison with the yogurt obtained according to the traditional technology.

The developed yogurt with blended oil will make it possible to expand the range of the milk-containing sour-milk products and it is recommended for the consumption as the finished product as well as for the use as the semi-finished product.

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