УДК 637.146: 637.344
https://doi.org/10.31548/humanhealth.4.2024.7

РОЗРОБКА ТЕХНОЛОГІЇ СИРУ КИСЛОМОЛОЧНОГО ТА СИРОВАТКОВОГО НАПОЮ ІЗ ВИКОРИСТАННЯМ ОБЛІПИХИ

Акакі Бокерія
https://orcid.org/0009-0006-0777-3550
Грузинський технічний університет
0160, вул. Костава, 77, Тбілісі, Грузія.
Олександр Савченко
кандидат технічних наук, доцент
https://orcid.org/0000-0002-3940-6679
Національний університет біоресурсів і природокористування України
вул. Героїв Оборони, 15, 03041, Київ, Україна
Софіо Джнеладзе
https://orcid.org/0009-0005-0905-0586
Грузинський технічний університет
0160, вул. Костава, 77, Тбілісі, Грузія.
Ігор Устименко
кандидат технічних наук, доцент
https://orcid.org/0000-0003-0171-5780
Національний університет біоресурсів і природокористування України
вул. Героїв Оборони, 15, 03041, Київ, Україна
Олена Гамбарашвілі
https://orcid.org/0009-0006-8038-4877
Грузинський технічний університет
0160, вул. Костава, 77, Тбілісі, Грузія.

Анотація. *Одним з найважливіших завдань продовольчої безпеки є забезпечення населення молочними продуктами, зокрема, з високим вмістом білка. Серед таких продуктів виокремлюють сир кисломолочний. В той же час, актуальним є промислова переробка молока, яка базується на принципах безвідходного виробництва молочної продукції з підвищеними показниками якості та безпеки.*

Метою роботи є розроблення технології сиру кисломолочного та сироваткового напою з використанням обліпихи.

Об'єктом дослідження були зразки сиру кисломолочного та сироватковий напій, вироблені із використанням різної кількості обліпихової суміші (обліпиха + цукор) – 10 %, 15 % і 20 %.

Вироблений сир кисломолочний з використанням обліпихової суміші у кількості 15 % характеризувався високими органолептичними показниками якості, зокрема, смаковими властивостями порівняно зі зразками, отриманими з використанням 10 % та 20 % обліпихової суміші. Встановлено, що сир кисломолочний із використанням 15 % обліпихової суміші характеризується підвищеною масовою часткою білка на 1,2 % у порівнянні з контролем. Збільшення кількості (від 10 % до 20 %) обліпихової суміші призводить до збільшення вмісту вітаміну С у виробленому сирі кисломолочному – на 30-33 %.

Встановлено залежність масової частки білку у відділеній сироватці від кількості обліпихової суміші при виробництві сиру кисломолочного. Так, вміст білку у молочній сироватці становить 1,2 % після використання 10 % обліпихової суміші, 0,9 % – 15 % обліпихової суміші, та 0,45 % при використанні 20 % обліпихової суміші.

Сироватковий напій, вироблений з відділеної сироватки при виробництві сиру кисломолочного з використанням 15 % обліпихової суміші характеризується високим вмістом вітаміну С – 121 мг/100 г та більш жовтуватим кольором, приємним солодкуватим смаком у порівнянні з контролем.

Розроблено технологічну блок-схему виробництва сиру кисломолочного та сироваткового напою з використанням 15 % обліпихової суміші. Запропонована технологія дасть змогу розширити асортимент нових видів сиру кисломолочного та сироваткових напоїв.

Ключові слова: *молочний білок, коагулянт, органічні кислоти, вітамін С, харчова цінність, безвідходне виробництво*

UDC 637.146: 637.344

https://doi.org/10.31548/humanhealth.4.2024.7

DEVELOPMENT OF TECHNOLOGY OF COTTAGE CHEESE AND WHEY DRINK WITH THE USE OF SEA BUCKTHORN

Akaki Bokeria
https://orcid.org/0009-0006-0777-3550
Georgian Technical University
0160, Kostava Str., 77, Tblisi, Georgia.
Oleksandr Savchenko
PhD, Associate Professor
https://orcid.org/0000-0002-3940-6679
National University of Life and Environmental Sciences of Ukraine
03041, Heroiv Oborony Str., 15, Kyiv, Ukraine.
Sofio Dzneladze
https://orcid.org/0009-0005-0905-0586
Georgian Technical University
0160, Kostava Str., 77, Tblisi, Georgia.
Ihor Ustymenko
PhD, Associate Professor
https://orcid.org/0000-0003-0171-5780
National University of Life and Environmental Sciences of Ukraine
Heroiv Oborony Str., 15, 03041, Kyiv, Ukraine
Elene Gambarashvili
https://orcid.org/0009-0006-8038-4877
Georgian Technical University
0160, Kostava Str., 77, Tblisi, Georgia.

Abstract. *One of the most important tasks of food security is to provide the population with dairy products, particularly, with a high protein content. Among such products, cottage cheese is distinguished. At the same time, the industrial processing of milk, which is based on the principles of waste-free production of dairy products with increased quality and safety indicators, is relevant.*

The work aims to develop the technology of cottage cheese and whey drink using sea buckthorn.

The object of the study was samples of cottage cheese and whey drink produced using different amounts (10 %, 15 % and 20 %) of sea buckthorn mixture (sea buckthorn + sugar).

The cottage cheese produced using a 15 % sea buckthorn mixture was characterized by high organoleptic quality indicators, particularly taste properties, compared to the samples obtained using a 10 % and 20 % sea buckthorn mixture. it was established that cottage cheese using 15 % sea buckthorn mixture is characterized by an increased mass fraction of protein by 1.2 % compared to the control. An increase in the amount (from 10 % to 20 %) of the sea buckthorn mixture leads to an increase in vitamin C content in the produced cottage cheese – by 30–33%.

The dependence of the mass fraction of protein in the separated whey on the amount of sea buckthorn mixture during the production of cottage cheese was established. Thus, the protein content of whey is 1.2% after using a 10 % sea buckthorn mixture, 0.9 %–15 % sea buckthorn mixture, and 0.45 % when using a 20 % sea buckthorn mixture. Whey drink produced from separated whey during the production of cottage cheese with the use of 15 % sea buckthorn mixture is characterized by a high content of vitamin C – 121 mg/100 g and a more yellowish colour, a pleasant sweet taste compared to the control. A technological block scheme for the production of cottage cheese and whey drink using a 15% sea buckthorn mixture has been developed. The proposed technology will make it possible to expand the range of new types of cottage cheese and whey drinks.

Keywords: *milk protein, coagulant, organic acids, vitamin C, nutritional value, waste-free production*

INTRODUCTION. One of the most essential tasks of food security is providing the population with dairy products. Also, the main focus is on the availability of sufficient complete protein (Boland and Hill, 2020).

Cottage cheese is made from milk, characterized by a high content of complete protein (Ustymenko, 2019).

Today, the production of dairy products with increased quality and safety indicators, particularly with a high content of biologically active substances and improved taste characteristics, is relevant (Bal-Prylypko et al., 2023).

The dairy industry is a material- and energy-intensive branch of the national economy, and the integrated use of all milk components makes it possible to implement the principles of zero-waste technology in the dairy industry (Grek, 2011).

The most essential reserves for increasing the volume of products obtained from milk and increasing production efficiency are the industrial processing of milk, which is based on the principles of zero-waste production, in particular, the rational use of whey as a secondary raw material in the production of cottage cheese (Kuvshinova and Tkachenko, 2014).

Considering its chemical composition, milk is characterized by high nutritional value and unique biological properties (Pereira, 2014). This necessitates the use of all milk components for food purposes. There are several traditional technologies for the industrial processing of milk, in particular, cottage cheese, during the production of which a by-product is obtained – whey, which belongs to secondary resources and can be processed into food products, in particular, drinks based on it (Ubaydullaeva et al., 2024; Greek, 2011).

Significant amounts of whey obtained during production are usually returned to dairy farmers for various purposes, not food. If we consider the examples of other countries, in the EU countries, the return of whey is about 45 %, in Switzerland – 95 %, and in Great Britain – 20 % (Bélanger et al., 2012).

The following are the most common methods of whey processing (Krusir et al., 2014; Chand et al., 2015):

– drying;

– production of lactose;

– production of albumin.

The processing of whey to obtain beverages is promising in Georgia. Milk is a complex colloid-biological system that can form a gel under various factors. Under the action of acids, in particular, organic acids, temperature fluctuations, etc., protein molecule changes occur, casein micelles' stability is disturbed, and clots are formed as a result. Coagulants are used to precipitate milk proteins, which can perform several functions, but the main one is separating the dense milk fraction from the liquid fraction. As such coagulants, which are based on berry raw materials have become common since berries, according to their chemical composition, contain organic acids, which, as mentioned above, can precipitate milk proteins (Savchenko et al., 2020).

The advantages of precipitation of milk proteins under the influence of organic acids of coagulants based on berry raw materials are (Hnitsevich et al., 2017):

– exclusion from the technological process of coagulants of synthetic origin, which can affect the taste characteristics and safety indicators of the finished product;

– improvement of consumer properties of the finished product;

– increasing the nutritional value of the finished product.

It should be noted that berry raw materials are a source of biologically active substances, particularly vitamin C (Beattie et al., 2005).

Among raw berry materials used as a coagulant, we would like to draw special attention to sea buckthorn, which is widespread in Georgia (Maghradze et al., 2012).

Sea buckthorn berries contain 3.1–5.1 % organic acids, 1.9–7.1 % sugar, up to 211 mg/100 g of vitamin C, and 8–20 % oil (Tiitinen et al., 2005; Kawecki et al., 2004). The components of sea buckthorn berries have a multifunctional effect on human health and play an essential role in preventing cardiovascular disorders (Olas, 2018).

Sea buckthorn juice has several beneficial anti-inflammatories, anti-cancer, antioxidant and anti-atherosclerotic effects due to the presence of phenolic substances, vitamins, minerals, amino acids, fatty acids and phytosterols (Wang et al., 2016; Christaki, 2012).

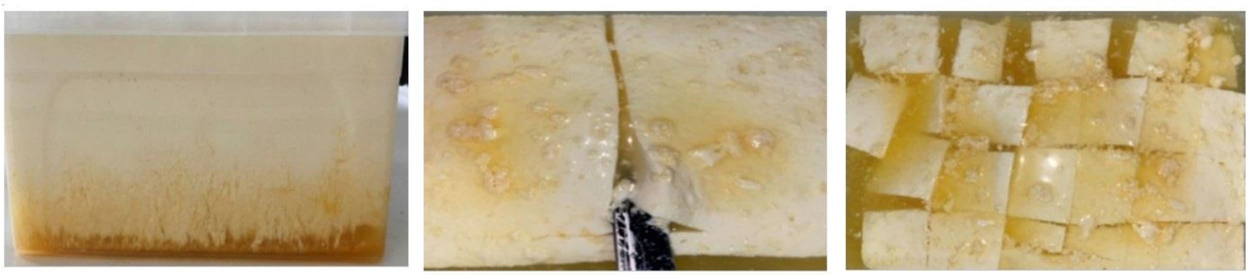
The availability of sea buckthorn berries makes it a raw material that can be used fresh for at least two seasons (the fruits ripen from August to September, although the fruits remain on the bush until spring).

Therefore, considering the high content of organic acids, sea buckthorn berries are a promising raw material that can be used as a coagulant to obtain cottage cheese and whey drinks with an increased content of biologically active substances, particularly vitamin C.

The work aims to develop the technology of cottage cheese and whey drink using sea buckthorn.

MATERIALS AND METHODS. The object of the study was samples of cottage cheese and whey drink produced using different amounts of sea buckthorn mixture – 10 %, 15 % and 20 %. The sea buckthorn mixture was prepared by cleaning and grinding it, adding sugar in a ratio of 1:1, and filtering to obtain the mix.

Cottage cheese was produced as follows. The milk was separated to obtain skimmed milk. Then, skimmed milk was normalized with cream, obtained after milk separation. Normalized milk was pasteurized and cooled according to the classic cottage cheese production technology. Sea buckthorn mixture was added to pasteurized and cooled milk. Later, leaven was introduced and mixed, and an aqueous calcium chloride solution was added. Then, rennet was added to the mixture with constant stirring. The resulting mixture was fermented until a cheese curd was obtained and cut into cubes (Figure 1).



a b c

Figure 1. The appearance of the cheese curd: a – received cheese curd, b – cutting of the curd, c – cut cheese curd

The crushed mass was mixed, as a result, cheese grain was obtained. Later, cheese grain and whey were separated by self-pressing. The obtained curd grain was cooled.

Whey drink was produced as follows. The whey separated from the cheese grain was heated, separated, filtered and cooled.

The mass fraction of protein was determined by the Kjeldahl method according to DSTU ISO 5983:2003, the mass fraction of fat – according to DSTU ISO 11870:2007, the mass fraction of sugar – according to DSTU EN ISO 22184:2022, the mass fraction of lactose – according to DSTU 8059:2015, vitamin content C – according to DSTU 7803:2015, titrated acidity – according to GOST 30648.4-99.

The organoleptic quality indicators were determined by the assessment conducted by the expert tasting committee of the Department of Meat, Fish and Marine Products of the National University of Life and Environmental Sciences of Ukraine.

RESULTS. The quality indicators of cottage cheese obtained using different amounts of sea buckthorn mixture are shown in Table 1.

Table 1. Quality indicators of cottage cheese obtained using different amounts of sea buckthorn mixture

Indicator name	**Control**	**Quantity of sea buckthorn mixture**		
		10 %	**15 %**	**20 %**
	Characteristic			
Organoleptic quality indicators				
Taste and smell	Typical sour-milk	Sour, sweet	Typical sour milk, pleasant sweet	Sour, excessively sweet
Color	White with a cream shade, uniform throughout the mass	Cheese grains with a slightly yellowish tint	Cheese grains with a yellowish tint	Cheese grains with a yellow tint
Consistence	Crumbling			
Physicochemical quality indicators				
Mass fraction of fat, %	8.5	9.4	9.0	8.3
Mass fraction of protein, %	16.7	17.2	17.8	18.0
Mass fraction of carbohydrates, %, including sugar	1.8 –	15.4 13.6	16.3 14.5	17.1 15.3
Titrated acidity, °T	170	156	160	165
Vitamin content				
Vitamin C, mg/100 г	0	12	14	16

Note. Cottage cheese obtained by classical technology served as a control.

The mass fraction of protein in the whey separated during the production of cottage cheese using different amounts of sea buckthorn mixture is presented in Figure 2.

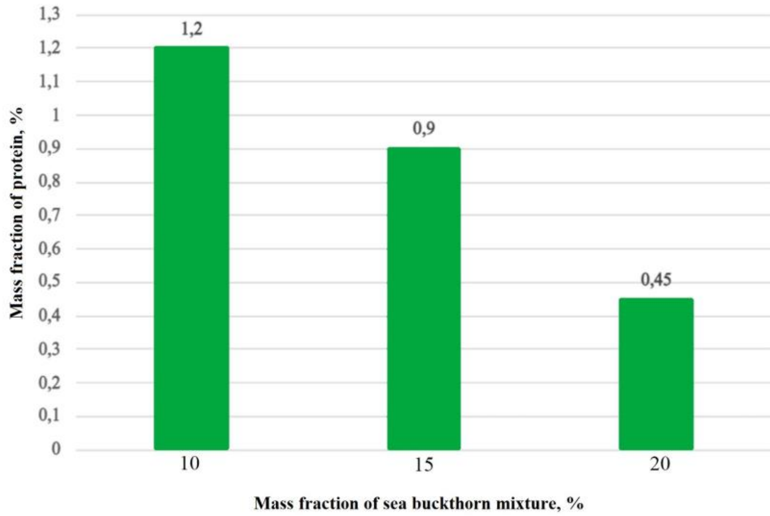


Figure 2. Mass fraction of protein in whey separated during the production of cottage cheese using different amounts of sea buckthorn mixture

The quality indicators of the whey drink obtained from the separated whey during the production of cottage cheese using a sea buckthorn mixture of 15 % are presented in Table 2.

Table 2. Quality indicators of whey drink

Indicator name	**Control**	**Whey drink**
	Characteristic	
Organoleptic quality indicators		
Taste and smell	Pleasant, fresh	Pleasant, sweet
Color	Greenish, uniform throughout the mass	Yellowish, uniform throughout the mass
Consistence	Liquid, homogeneous	
Physicochemical quality indicators		
Lactose content, %	4.5	4.5
Mass fraction of sugar, %	–	14.9
Titrated acidity, °T	46	52
Mass fraction of fat, %	0	0
Vitamin content		
Vitamin C, mg/100 г	0	121

Note. Whey separated during the traditional production of cottage cheese served as a control.

DISCUSSION. From Table 1, it can be seen that the cottage cheese obtained with the use of sea buckthorn mixture retained the appearance characteristic of the classic cottage cheese (control).

According to the organoleptic quality indicators, the cottage cheese obtained using sea buckthorn mixture of 15 % is characterized by a sour-milk, pleasant, sweet taste. At the same time, cottage cheese obtained with the use of sea buckthorn mixture in the amount of 20 % acquired a lovely taste due to the increase in the mass fraction of sugar, and cottage cheese obtained with the use of sea buckthorn mixture in the amount of 10 % acquired insufficiently pronounced taste characteristics. It should be noted that, compared to the control, the experimental samples of cottage cheese acquired a yellowish tint, which is explained by the yellow-orange color of the sea buckthorn mixture.

As for the mass fractions of fat in the experimental cottage cheese, these indicator decrease with an increase in the mass fraction of sugar due to using a more significant amount of sea buckthorn mixture.

The mass fraction of protein in cottage cheese with the use of sea buckthorn mixture in the amount of 15 % is higher by 1.1 % compared to the control, which is explained by the effect of organic acids of the sea buckthorn mixture on the protein.

With an increase in the sea buckthorn mixture, the amount of vitamin C in the experimental samples increases from 12 to 16 mg/100 g. However, this vitamin C content is not significant; a significant amount of vitamin C has probably gone into the serum since this vitamin is well soluble in water (Sulasmi et al., 2023).

In general, the physical-chemical indicators of cottage cheese obtained using sea buckthorn mixture are within the normalized control indicators. We offer an introduction of cottage cheese, obtained with the use of sea buckthorn mixture in the amount of 15 %, as this sample is characterized by high organoleptic quality indicators, mainly taste properties. As is known, during the production of cottage cheese, milk proteins are released into the whey (Yukalo et al., 2021). This may be the reason for the decrease in the finished product yield, provided that a significant amount of proteins is transferred to the serum (Mashkin and Vashchenko, 2019).

Therefore, studying the mass fraction of proteins in whey separated during the production of cottage cheese using different amounts of sea buckthorn mixture is of scientific interest.

The results (Figure 2) show that the separated whey in the production of cottage cheese using a sea buckthorn mixture of 10 % is characterized by the highest protein content – 1.2 %. At the same time, when the amount of sea buckthorn mixture is increased to 15 %, the mass fraction of proteins in the separated whey decreases – it is 0.9 %, and when using a seabuckthorn mixture in the amount of 20 %, the mass fraction of proteins in the serum is even less – 0.45 %. This is explained by the complex precipitation of casein and whey proteins of milk by the organic acids of the sea buckthorn mixture. These results correlate with scientists' research (Pshenichna and Grek, 2021), in which blackcurrant paste was used as a coagulant, with an increased amount of which the protein content in the separated serum decreased.

Such results again confirm the practicality of using a sea buckthorn mixture of 15 % in cottage cheese technology for the maximum yield of innovative cottage cheese.

Table 2 shows that the resulting whey drink, according to organoleptic quality indicators, is characterized by a more yellowish colour and a pleasant, sweetish taste and smell compared to the control. The use of sea buckthorn mixture explains this.

The obtained whey drink is characterized by vitamin C content in the amount of 121 mg/100 g.

A technological block scheme for producing cottage cheese and whey drink using sea buckthorn mixture was developed, presented in Figure 2.

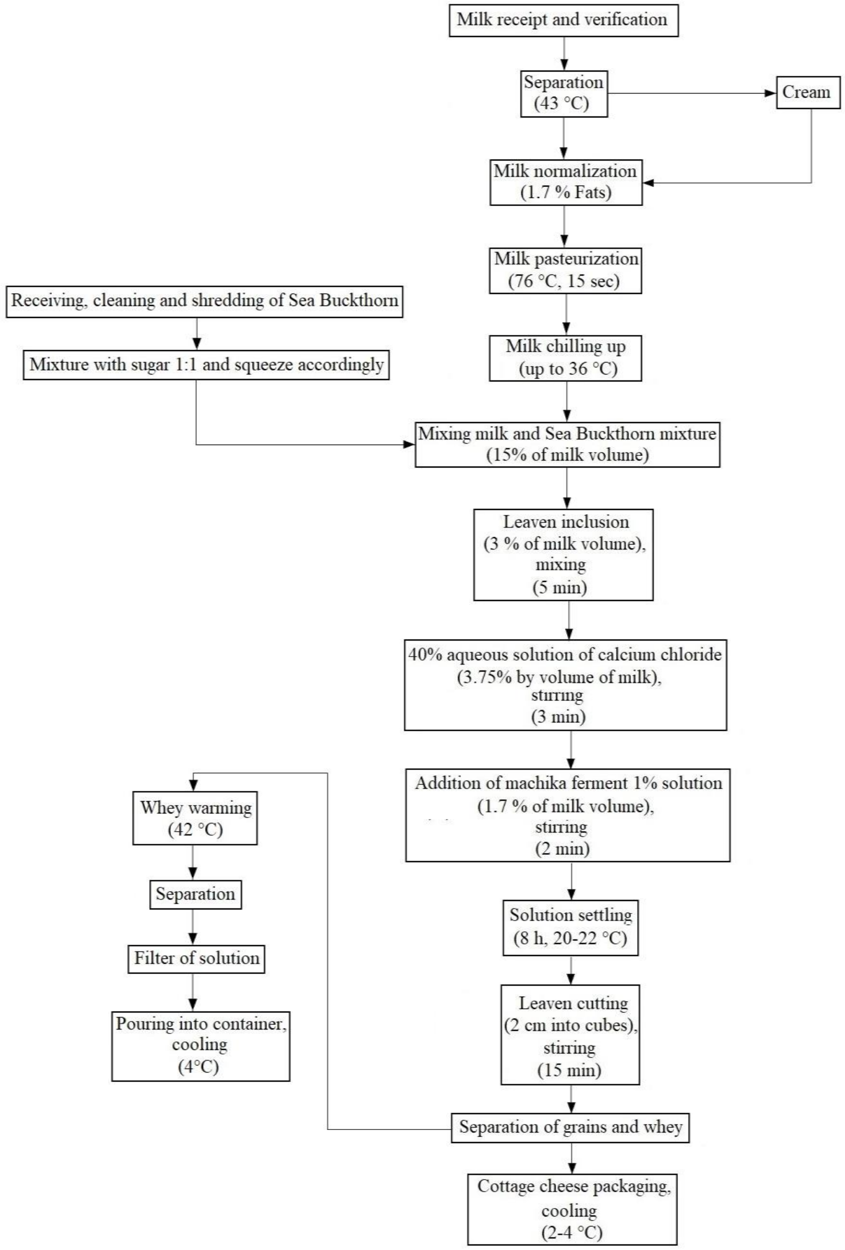


Figure 3. Technological block scheme of production of cottage cheese and whey drink using sea buckthorn mixture

The developed technology will interest entrepreneurs, as it can be used to obtain dairy products with original taste and enriched with vitamin C – cottage cheese and whey drink.

Conclusions.

1. It was established that cottage cheese obtained using a sea buckthorn mixture of 15 % is characterized by high organoleptic quality indicators compared to samples obtained using a sea buckthorn mixture of 10 % and 20 %. The mass fraction of protein in cottage cheese using sea buckthorn mixture in the amount of 15 % is higher by 1.2 % compared to the control. With an increase in the sea buckthorn mixture, the amount of vitamin C in sour milk increases from 12 to 16 mg/100 g.

2. Separated whey in the production of cottage cheese produced using a 10 % sea buckthorn mixture is characterized by the highest protein content (1.2 %). At the same time, when the amount of sea buckthorn mixture is increased to 15 %, the mass fraction of proteins in the separated whey decreases (0.9 %), and when using a sea buckthorn mixture in the amount of 20 %, the mass fraction of proteins in serum is even less (0.45 %).

3. The produced whey drink is characterized by a high content of vitamin C (121 mg/100 g) and a more yellowish colour, with a pleasant sweet taste compared to the control.

4. A technological block scheme for the production of scheme and whey drink using a sea buckthorn mixture in the amount of 15 % was developed, which will make it possible to expand the range of scheme and whey drinks with pleasant taste properties and an increased content of vitamin C.

References

Bal-Prylypko, L. V., Ustymenko, I. M., Yemtsev, V. I., Yemtseva, G. F., Golembovska, N. V., Kryzhova, Yu. P., Savchenko, O. A., Israelyan, V. M., Menchynska, A. A., Ivanyuta, A. O., Shtonda, O. A., Tolok, G. A., & Ryabovol, M. V. (2023). Scientific rationale for improving the technology of meat, fish, dairy and milk-containing products with increased nutritional value: monograph. Kyiv: CPU "Comprint".

Beattie, J., Crozier, A., & Duthie, G. (2005). Potential Health Benefits of Berries. *Current Nutrition & Food Science*, 1, 71–86. https://doi.org/10.2174/1573401052953294.

Bélanger, V., Vanasse, A., Parent, D., Allard, G., & Pellerin, D. (2012). Development of agri-environmental indicators to assess dairy farm sustainability in Quebec, Eastern Canada. *Ecological Indicators*, 23, 421–430. https://doi.org/10.1016/j.ecolind.2012.04.027.

Boland, M., & Hill, J. (2020). Chapter 1 – World supply of food and the role of dairy protein, Eds: Boland, M., Singh, H. Milk Proteins (Third Edition), Academic Press. https://doi.org/10.1016/B978-0-12-815251-5.00001-3.

Chand, P., Sirohi, S., & Sirohi, S. K. (2015). Development and application of an integrated sustainability index for small-holder dairy farms in Rajasthan, India. *Ecological Indicators*, 56, 23–30. https://doi.org/10.1016/j.ecolind.2015.03.020.

Christaki, E. (2012). *Hippophae Rhamnoides L.* (Sea Buckthorn): a Potential Source of Nutraceuticals. *Food and Public Health*, 2, 69–72.

Grek, O. V. (2011). Technology of products from skimmed milk, whey and buttermilk. Kyiv: NUFT.

Hnitsevich, V., Yudina, T., & Deynychenko, L. (2017). Technology and biological value of products from milk protein concentrate. *Goods and markets*, 1, 139–148.

Kawecki, Z., Szałkiewicz, M., & Bieniek, A. (2004). The common sea buckthorn – a valuable fruit. *Journal of Fruit and Ornamental Plant Research*, 12, 181–193.

Krusir, G. V., Shevchenko, R. I., & Ruseva, Y. P. (2014). Food industry waste management technologies. Odesa: Astroprint.

Kuvshinova, A. O., & Tkachenko, T. P. (2014). Problems of resource conservation management organization at the enterprise. Scientific Bulletin of the Kherson State University. Kherson: Kherson State University.

Maghradze, D., Bobokashvili, Z., & Kvaliashvili, V. (2012). Minor and underutilized fruits in Georgia and their wild relatives. *Acta Hortic*, 948, 41–48. https://doi.org/10.17660/ActaHortic.2012.948.3.

Mashkin, M. I., & Vashchenko, G. V. (2019). Study of the pasteurization temperature of milk to produce sour-milk cheese. Materials of the 20th International scientific and practical conference "Modern directions of technology and mechanization of processing and food production processes". Kharkiv: KhNTUSG.

Olas, B. (2018). The beneficial health aspects of sea buckthorn (*Elaeagnus rhamnoides (L.) A.Nelson*) oil. *Journal of ethnopharmacology*, 213, 183–190. https://doi.org/10.1016/j.jep.2017.11.022.

Pereira, P. C. (2014). Milk nutritional composition and its role in human health. *Nutrition (Burbank, Los Angeles County, Calif.*, *30*(6), 619–627. https://doi.org/10.1016/j.nut.2013.10.011.

Pshenichna, T. V., & Grek, O. V. (2021). Technological characteristics of colored whey. Challenges of today and innovations in food technologies and hotel and restaurant business: a collection of abstracts of the scientific and practical conference of students, postgraduates and young scientists with international participation. Kyiv: KKIBP.

Savchenko, O. A., Grek, O. V., & Pshenichna, T. V. (2020). Innovative technological aspects of processing milk into protein concentrates and whey drinks. Kyiv: CP "Comprint".

Sulasmi, S., Muchlisyam, M., & Haro, G. (2023). Simultaneous Analysis of Tablets Content Vitamin C and Zinc in Visible Spectrophotometry. International Journal of Science, Technology & Management, 4(2), 386-392. https://doi.org/10.46729/ijstm.v4i2.782.

Отримано 17.09.2024 р., прийнято до друку 14.11.2024 р.