COMMODITY BULLETIN
Journal homepage: https://c-bulletin.com.ua/en
DOI: 10.62763/ef/1.2024.44

Article's History: Received: 29.10.2023 Revised: 20.01.2024 Accepted: 26.04.2024

Vol. 17, No. 1, 2024, 44-54

UDC 637.05

Comprehensive assessment of the quality of Ukrainian-made sour-milk cheese

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Abstract. Comprehensive research of food products, as well as compliance with the rules and regulations in the food industry, are necessary to provide consumers with quality and safe products. The purpose of this article is to provide a comprehensive analysis of the quality and safety of sour-milk cheese, including the evaluation of organoleptic characteristics, physicochemical properties, and microbiological indicators. The study was conducted with one of the largest producers of milk powder and fermented milk products on the Ukrainian market, BIAGR LLC as its basis. To achieve the set goal, the following methods were used: organoleptic, physicochemical, microbiological, and measurement of the content of toxic elements (cadmium, arsenic, lead). At the beginning of the measurement of quality indicators, packaging and labelling were evaluated, which complied with the requirements of the national standard. During the study of the organoleptic quality indicators of sour-milk cheese with a fat content of 5%, it was found that its consistency is soft, without whey separation; distinctive fermented milk smell and taste are without extraneous odour and favour; the colour of the sample is uniformly white. At the second stage of the research, the mandatory physicochemical quality indicators were measured and evaluated, namely: mass fraction of fat – 5.0%; mass fraction of protein – 14.6%; mass fraction of moisture – 68.0%; titratable acidity – 176°T; phosphatase was absent. Since food safety is now an urgent issue in Ukraine, the following safety indicators were measured during the research: the number of lactic acid bacteria, which was 2×106 CFU per 1 g; Escherichia coli bacteria were not detected; the number of mould fungi was 1×101 CFU per 1 g; the amount of yeast was 1×101 CFU per 1 g; pathogenic microorganisms, including *Salmonella, Staphylococcus aureus, Listeria monocytogenes* were not detected. Thus, in terms of organoleptic,

Suggested Citation:
Remizova, N., Korsun, A., Kalashnyk, O., & Moroz, S. (2024). Comprehensive assessment of the quality of Ukrainian-made sour-milk cheese. *Commodity Bulletin*, 17(1), 44-54. doi: 10.62763/ef/1.2024.44.

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physicochemical and safety indicators, sour-milk cheese with a fat content of 5%, produced by BIAGR LLC, meets the requirements of regulatory documents. The results of the research can be used for quality control of dairy products and improvement of production processes

Keywords: organoleptic, physicochemical, microbiological indicators; standardisation; safety; Hazard Analysis and Critical Control Points

Introduction

Regardless of the level of socio-economic development, every country aims to solve the problem of providing its population with food. In developed countries, the production of agricultural products, their processing and storage is a key condition for food stability. The level of availability of quality food affects not only the socio-economic situation in the country, but also the well-being of citizens.

Current trends of the global market dictate the need to address the challenges of ensuring food quality and safety. Preventing products that do not comply with regulations and are unsafe from entering circulation is becoming one of the most pressing issues in Ukraine and worldwide (Puhach, 2019). Food quality and safety affect health, living standards, activity, demographics, morbidity, and ultimately the economy of Ukraine. This aspect is especially evident today, when the military aggression has destroyed raw materials, industrial enterprises, logistics links, changed the structure of demand, etc. In addition, consumers are decreasing their trust in the quality and safety of food products offered by manufacturers on the market. Therefore, the issue of assessing the safety of such a popular food product as sour-milk cheese is relevant (Remizova *et al*., 2023).

It is known that sour-milk cheese is a traditional food product in Ukraine, therefore the works of Ukrainian and foreign authors are devoted to the evaluation of organoleptic, physicochemical, microbiological quality and safety indicators of sour-milk cheese. In their work, V.P. Lyasota *et al.* (2020) investigated organoleptic, physicochemical and microbiological quality indicators of sour-milk cheese required by the national standard. The researchers studied sour-milk cheese samples with different fat content and produced by different manufacturers, including sample No. 2 with a fat content of 5% (produced by PJSC "Kremenchuk Dairy Plant"), which is similar to the object of this study.

The study of A.A. Samoilenko & O.P. Yudicheva (2019) is devoted to the establishment of stability at different seasons and compliance of organoleptic and physicochemical indicators of samples of Ukrainian-made sour-milk cheese with the requirements of regulatory documents. The advantage of their study is the determination of safety indicators, namely microbiological indicators and the content of toxic elements.

M.T. Khatun *et al.* (2019) evaluated and compared the physical (smell and taste, consistency, texture and colour), chemical (content of fat, moisture, proteins, carbohydrates, ash, total dry matter) and microbiological quality indicators of different types of cheese made from skimmed milk (0.1% fat) and partially skimmed milk (1%, 2% and 3% fat). The researchers also evaluated the shelf life of a cheese sample at room temperature. However, the study did not investigate microbiological quality indicators and the content of toxic elements, which are mandatory for assessing food quality and safety.

The monograph by M.D. Kukhtin & Y.V. Horiuk (2023) highlights the issues of hygiene of whole cow's milk and fermented milk products sold on the agro-food market. Experimental studies resulted in the establishment of microbiological safety criteria for sour-milk cheese, based on *Enterococcus* bacteria content. In their study, C.-R. Stefanou *et al.* (2022) reported the presence of *Listeria monocytogenes*, *Salmonella spp.*, lactic acid bacteria, and coliforms. It should be noted that these microorganisms were not detected in the samples of sour-milk cheese. The physicochemical quality indicators measured included the content of proteins, fats, carbohydrates, ash, and water. The samples of sour-milk cheese were also tested for contamination with heavy metals. High nutritional value of the research object was found.

It is important to note that in the work of Y.V. Horiuk (2023), sour-milk cheese, which is sold on the agro-food markets of Ukraine, was chosen as the object of study. As a result of the conducted research, it was found that in sour-milk cheese made from whole cow's milk, the normal microflora consists of lactic acid microorganisms and enterococci (with *E. faecalis* being the dominant species among enterococci). In addition, the author presented the results of studies on various species and genera of microorganisms isolated from sour-milk cheese. In 97.7% of cases, its permanent microflora may include lactic acid bacteria and enterococci, fungi and spore-forming microorganisms; in 73.8% – it is contaminated with Escherichia coli group (BSCG); in 29.4% – it is contaminated with E. coli bacteria. *Staphylococcus aureus* was detected in approximately 20% of the sour-milk cheese samples, as well as the pathogenic microorganisms *Listeria monocytogenes* and *Salmonella spp.* were detected in 4.8% and 1.6% of the samples, respectively. Thus, this study is devoted only to microbiological quality indicators and aimed at improving the veterinary and sanitary control of the research object.

According to the list of toxic elements (Methodical Guidelines 4.4.4-108-2004, 2004), heavy metals and

arsenic are mainly subject to hygienic control. Among the toxic elements, lead, mercury and cadmium are of particular importance, as they are characterised by high toxicity and the potential for accumulation during long-term entry into the human body with food products. Therefore, emphasis is placed on the necessity of systematic monitoring and control of the levels of lead, mercury, and cadmium in food products in order to avoid negative impacts on human health.

According to the researchers N.V. Chuyen *et al.* (2022), arsenic is a chemical contaminant that deserves special attention due to its toxicity and bioaccumulation in food. In their study, the authors also provided the minimum, maximum, and average concentrations of arsenic in milk and dairy products. It was found that the average arsenic concentration for cheese is 221.38 ppb.

The team of authors N.B. Sarsembayeva *et al.* (2020) conducted a study to determine the amount of heavy metals and toxic elements in samples of milk and sour-milk cheese to monitor their quality and safety. As a result, it was found that the sour-milk cheese samples contained 0.0519 mg/kg of cadmium, 0.0117 mg/kg of lead, and no mercury or arsenic. In the work of researchers from Poland, M. Sujka *et al.* (2019), it is noted that the toxicity of heavy metals and their ability to accumulate in the human body necessitate monitoring their concentration in food. Therefore, the objectives of this study were to determine the amount of lead, cadmium, copper, and zinc in milk and dairy products such as kefir, sour-milk cheese and others, which are produced in different regions of Poland. The results of the study showed that the amount of lead ranged from 0.030 to 0.380 mg/kg, and cadmium – from 0.0010 to 0.0026 mg/kg. This paper also outlined the regions of Poland with low and high concentrations of these toxic elements.

Summarising the research data, we can conclude that researchers around the world are focusing on the issues of quality and safety of milk and dairy products, which are widely consumed food products. Therefore, the purpose of this research is to assess the quality level of sour-milk cheese according to the mandatory quality indicators of the national standard.

Materials and methods

The research was conducted in the laboratories of the Research and Testing Centre for Food Products of the SE Poltava Regional Research and Technical Centre of Standardization, Metrology and Certification. A comprehensive assessment of the quality of sour-milk cheese with a fat content of 5% was carried out at the end of September 2023 in accordance with the requirements of the regulatory document (DSTU 4554:2006, 2007).

The study covered products of the Ukrainian market, in particular, sour-milk cheese with a fat content of 5% produced by BIAGR LLC, one of the producers of sour-milk cheese in Poltava oblast (Fig. 1).

Figure 1. *Packaging of sour-milk cheese with a fat content of 5% produced by BIAGR LLC*
Source: *photo by the authors*

Modern analytical, organoleptic, physicochemical, and microbiological methods were used to conduct the research. The organoleptic evaluation was carried out according to the following indicators: texture and appearance, taste and smell, colour in accordance with DSTU 4554:2006 (2007).

Among the physicochemical indicators, the following were determined: mass fraction of fat according to Poltava Regional Research and Technical Centre of Standardization, Metrology and Certification (2022a); mass fraction of protein according to Poltava Regional Research and Technical Centre of Standardization, Metrology and Certification (2022b); mass fraction of moisture according to DSTU 8552:2015 (2017); acidity titrated according to Poltava Regional Research and Technical Centre of Standardization, Metrology and Certification (2021); phosphatase according to DSTU 7380:2013 (2014). The following equipment was used to study the physicochemical indicators of the quality of sour-milk cheese: laboratory balance VLR-200 manufactured by Gosmer (russia), titration unit – digital burette Solarus manufactured by Hirschmanm laboratory (Germany), laboratory universal centrifuge CLU-1 orbit manufactured by Impulse (Ukraine), drying cabinet SNOL 58-350 manufactured by AB Umega (Lithuania), Kjeldahl unit manufactured by Plurima (Ukraine).

The microbiological study was carried out according to the indicators recommended as the number of lactic acid bacteria according to DSTU ISO 15214:2007 (2009). Kessler's medium was used for the indication of E. coli bacteria in accordance with DSTU 7357:2013 (2014). The number of moulds and yeast was determined on Sabouraud agar in accordance with DSTU 8447:2015 (2017). Pathogenic microorganisms, including *Salmonella,* were determined on brilliant green agar and bismuth sulfite agar in accordance with DSTU IDF 93A:2003 (2005); *Staphylococcus aureus* was detected in accordance with DSTU ISO 5944:2005 (2007) on Baird-Parker agar, and *Listeria monocytogenes* was determined on Oxford agar and PALCAM agar in accordance with DSTU ISO 11290-1:2003 (2004). The microbiological study was carried out using the following equipment: dry-air thermostat TS-

80M-2 manufactured by Medlabortechnika (Ukraine), thermostat TGU 02-200 manufactured by Impulse (Ukraine), scales A500 manufactured by Axis (Poland), homogenizer BagMixer manufactured by Interscience (France), microscope XY B-2 ULAB manufactured by ULAB (China). The content of toxic elements was studied according to the following regulatory documents: cadmium, arsenic according to Poltava Regional Research and Technical Centre of Standardization, Metrology and Certification (2022c); lead according to Poltava Regional Research and Technical Centre of Standardization, Metrology and Certification (2022d) using Avio 200 Inductively Coupled Plasma Optical Emission Spectrometer (ICP-OES) manufactured by PerkinElmer (the USA).

Results and discussion

One of the largest producers of milk powder and fermented milk products on the Ukrainian market is BIAGR LLC, located in Bilotserkivka, Poltava oblast. This enterprise starts preparatory processes in agricultural complexes with primary processing (cleaning, cooling, and reserving). In the work of O.A. Savchenko *et al.* (2018), it is stated that one of the most important operations of the preparatory process is cooling of milk – a raw material that affects the continuation of the bactericidal phase, and, accordingly, the quality, grade, and suitability for processing into sour-milk cheese. For the production of sour-milk cheese, BIAGR LLC uses extra-grade milk.

The first control point of the HACCP (Hazard Analysis and Critical Control Points) system at BIAGR LLC begins with strict incoming milk control. Then it is purified and sorted. For the production of sour-milk cheese, the enterprise uses milk – a raw material with a high protein content, which undergoes technological processing (Fig. 2).

Figure 2. *Equipment preparation at BIAGR LLC*
Source: *photo by the authors*

To prepare the equipment for the technological process at BIAGR LLC, an automated washing station is used, two-level control of the efficiency of sanitary treatment and the cleanliness of the surface of the technological equipment is carried out (express tests and parallel sowing by the cup method). The pasteurised mixture arrives at the cheese-making section, where another set of measures and techniques for the production of sour-milk cheese begins to be applied, such as fermentation, curdling, curd cutting, curd processing and boiling, curd grain cooling, curd grain dehydration, sour-milk cheese post-cooling, pre-packaging and packaging of sour-milk cheese, post-cooling of the packaged product, storage, and sale.

BIAGR LLC uses one of the two known methods for making sour-milk cheese, namely the acid method. This method involves the coagulation of protein with lactic acid, which is formed as a result of the activity of lactic acid bacteria added in the starter culture, and subsequent heat treatment, usually performed by boiling. Each operation performed in the sour-milk cheese production and packaging departments has a direct impact on the appearance and quality of the product throughout its shelf life:

- fermentation is one of the first and important technological stages. It lays the foundation for the correct course of further operations, and the main tool in this stage is the starter culture, which affects the speed of fermentation, the taste of sour-milk cheese, the physicochemical characteristics of the finished product and the continuation of the process in general;
- curdling and its course has specific technological indicators throughout the process, which are a sign of correctly carried out previous actions and will allow the conduct of subsequent ones applied in the further part of the technological process of making sour-milk cheese;
- curd cutting is one of the most important stages that determines the shape and size of the curd grain, the yield of the finished product, and the correctness and timing of subsequent processes;
- curd processing and boiling also affects size of the grain, the speed of boiling, the quality of the cheese and its characteristics (if improperly processed, it can result in overdried, dry grain; if insufficiently processed, it can result in grain with a high moisture content or 'boiled' grain, from which moisture cannot be released due to the disruption of the boiling process).

Strict adherence to a set of preparatory and technological operations, the implementation of the HACCP system enable BIAGR LLC to produce high-quality coarse-grain sour-milk cheese (Soloshenko *et al.*, 2019). Before measuring the quality indicators of the research object, its packaging and labelling were evaluated. Sour-milk cheese produced by BIAGR LLC was packed in an intact, undamaged package made of polymer film. The packaging indicated the material of manufacture – 05 PP – polypropylene. This complies with article 9.7 (DSTU 4554:2006, 2007).

The labelling of sour-milk cheese with a fat content of 5% produced by BIAGR LLC contained the following information (Fig. 3):

Figure 3. *Analysis of labelling details for sour-milk cheese with 5% fat content*

Note: *mandatory requisites: 1 – product name with indication of the mass fraction of fat; 2 – name and address of the manufacturer and place of manufacture; 3 – net weight of the package unit, g; 4 – product composition in the order of ingredient preference; 5 – information data on the nutritional and energy value of 100 g of the product; 6 – expiration date "Use by" or production date and shelf life; 7 – storage conditions; 8 – standard designation; 9 – trademark; 10 – bar code; additional requisites: 11 – batch number; 12 – information about GMOs in the composition of the food product (in accordance with the current legislation); 13 – a sign indicating that the manufactured product is certified and meets Halal requirements; 14 – a sign indicating the weight of the product without packaging (net weight)*

Source: *developed by the authors*

The analysis of the labelling requisites made it possible to conclude that the sour-milk cheese produced by BIAGR LLC with a fat content of 5% meets the requirements of DSTU 4554:2006 (2007). After analysing the labelling requisites, the organoleptic quality indicators of the product were evaluated. It is known that these properties of cheese are formed in the process of its production. Cheese with a sour-milk flavour and aroma is formed during heat treatment of milk due to the presence of aromatic compounds produced by microorganisms with the participation of starter cultures. The taste and smell of sour-milk cheese are determined during its fermentation, ripening, and storage. The intensity of the aroma depends on the composition and number of bacteria in the starter cultures, technological parameters, and storage conditions. Lactic acid and volatile fatty acids, in particular acetic acid, are responsible for the characteristic sour taste of cheese. Diacetyl and acetaldehyde create a specific aroma of fermented milk products, while alcohol and carbon dioxide give them a refreshing taste. Various flavour nuances of cheese arise due to variations in the content of acetaldehyde and ethanol, as well as the ratio of volatile fatty acids.

The organoleptic characteristics of sour-milk cheese produced by BIAGR LLC are presented in Table 1.

Table 1. *Organoleptic characteristics of sour-milk cheese with a fat content of 5%*

Indicator name	Characteristics		Compliance with the requirements DSTU 4554:2006
	according to DSTU 4554:2006	of a sample	
Consistency and appearance	Soft, creamy, or crumbly. Slight grittiness and slight whey separation are allowed	Soft, without whey separation	meets the requirements
Taste and smell	Characteristic fermented milk smell and taste, without extraneous odour and favour	Fermented milk smell and taste, without extraneous odour and favour	meets the requirements
Colour	White or with a creamy tint, uniform throughout the entire mass	White, uniform throughout the entire mass	meets the requirements

Source: *developed by the authors*

During the research of the organoleptic quality indicators of sour-milk cheese with a fat content of 5% produced by BIAGR LLC, namely consistency, appearance, taste and smell, colour, it was found that it meets the requirements of DSTU 4554:2006 (2007) in terms of these indicators.

According to M.T. Khatun *et al.* (2019), the appearance of sour-milk cheese should be uniform, smooth; its consistency should be not too hard, not too soft and pasty. In addition, the "ideal" sour-milk cheese should have the main taste similar to fresh, pure sour milk or cream. We also agree with this judgment, as evidenced by the research results presented in Table 2.

Similarly, scientists V.P. Lyasota *et al.* (2020), studying the mandatory (according to the national standard) organoleptic quality indicators of sour-milk cheese samples with a fat content of 5% – sample No. 2 (produced by PJSC "Kremenchuk Dairy Plant"), concluded that the consistency was medium-grained, with slight grittiness; the colour was white, uniform throughout the mass; the smell was pleasant, without extraneous odour; the taste was slightly sour, without extraneous favour, which met the requirements of the standard. That is, the organoleptic indicators determined in the work correlate with the conducted research and the obtained indicators.

The national standard DSTU 4554:2006 (2007) regulates the nomenclature of physicochemical quality indicators of the of sour-milk cheese, which serves as a source of information and allows to assess its quality level. Thus, the results of physicochemical indicators of the quality of sour-milk cheese produced by BIAGR LLC are shown in Table 2.

***Table 2**. Results of physicochemical quality indicators of the of sour-milk cheese with fat content of 5%*

Indicator name	Characteristics		Compliance with the requirements DSTU 4554:2006
	according to DSTU 4554:2006	of a sample	
Mass fraction of fat, %	More than 2 to 18	5.0	meets the requirements
Mass fraction of protein, %,	Not less than 14	14.6	meets the requirements
Mass fraction of moisture, %	65-80	68.0	meets the requirements
Titratable acidity, T	In the range of 170 to 250	176	meets the requirements
Phosphatase	Not allowed	absent	meets the requirements

***Source:** developed by the authors*

One of the quality indicators of sour-milk cheese is the activity of alkaline phosphatase, which demonstrates the quality and efficiency of heat treatment of dairy products, which suppresses the development of pathogenic microflora. Enterprises monitor the activity of alkaline phosphatase in dairy products, which determines compliance with the requirements of national and international standards.

The obtained results of the research of the physicochemical indicators of sour-milk cheese with a fat content of 5% produced by BIAGR LLC are close to the values reported in the work by V.P. Lyasota *et al.* (2020). A sample of sour-milk cheese No. 2 with a fat content of 5% has the following physicochemical quality indicators: a mass fraction of fat was 5.0 ± 0.27%, protein – 17.5 ± 0.72%, moisture – 69.0 ± 2.32%, titratable acidity was 171.0 ± 3.41°T, phosphatase was absent. Therefore, the physicochemical quality indicators of both manufacturers meet the requirements of the national standard DSTU 4554:2006 (2007).

The microbiological condition of fermented dairy products is an important aspect of their safety. The indicators regulated by current regulatory documents were studied on appropriate media. To determine the number of lactic acid bacteria, according to DSTU ISO 15214:2007 (2009), MRS (Man, Rogosa and Shappe) medium was used, and the obtained results indicate compliance with the standards for mesophilic lactic acid bacteria (DSTU 4554:2006, 2007). The formed colonies were stained by Gram method and subjected to microscopic analysis. On the obtained microslide (Fig. 4), oval-shaped cocci, individual, 0.5x0.5μm in size, and occasional diplococci with dimensions of 0.9x1.2μm were found, which is a typical picture for lactic lactococci (Fig. 5).

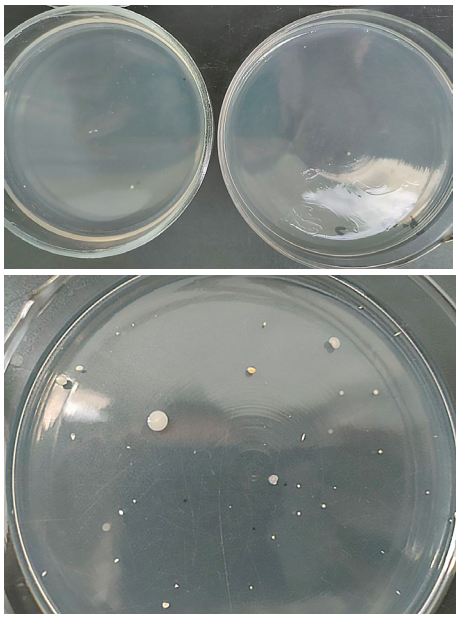
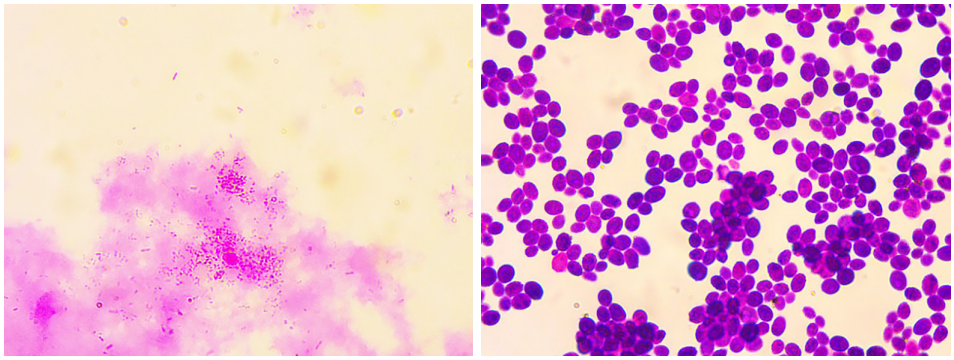


***Figure 4.** Photographic image of colonies of lactic acid bacteria and yeast found in samples of sour-milk cheese with a fat content of 5%*

***Source:** photo by the authors*



1 2

Figure 5. *Photographic image of colonies of lactic acid bacteria (1) and yeast cells (2) (Gram staining x100) found in samples of sour-milk cheese with a fat content of 5%*

Source: *photo by the authors*

The results of the studies of microbiological indicators of the quality of sour-milk cheese with a fat content of 5% produced by BIAGR LLC are presented in Table 3.

Table 3. *Results of microbiological indicators of the quality of sour-milk cheese with fat content of 5%*

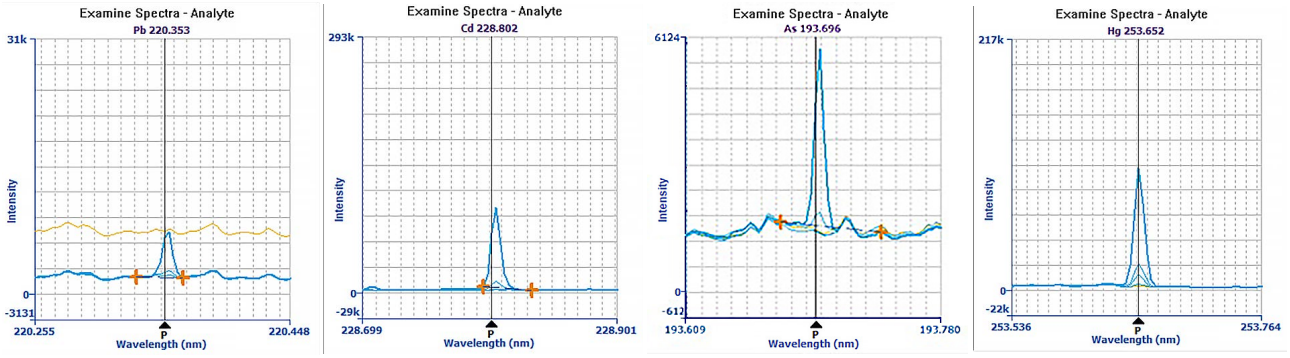
Indicator name	Characteristics		Compliance with the requirements DSTU 4554:2006
	according to DSTU 4554:2006	of a sample	
The number of lactic acid bacteria, CFU per 1 g of product	Not less than 1×10^6	2×10^6	meets the requirements
Escherichia coli bacteria	Not allowed	Not detected	meets the requirements
The number of mould fungi, CFU per 1 g of product	No more than 50	Less than 1×10^1	meets the requirements
The amount of yeast, CFU per 1 g of product	No more than 100	1×10^1	meets the requirements
Pathogenic microorganisms, including *Salmonella*, in 25 g of product	Not allowed	Not detected	meets the requirements
Staphylococcus aureus, in 0.01 g of product	Not allowed	Not detected	meets the requirements
Listeria monocytogenes	Not allowed	Not detected	meets the requirements

Source: *developed by the authors*

Additionally, besides compliance with the national standard, the obtained research results demonstrate similarity with those of sample No. 2 of sour-milk cheese presented in the work by V.P. Lyasota *et al.* (2020), in which the presence of lactic acid bacteria was $(0.49 \pm 19.2)\times10^5$ CFU/g, and coliform bacteria of the Escherichia coli group, mould fungi, yeast, and pathogenic microorganisms, including *Salmonella* and *Staphylococcus aureus*, were not detected. Similar results were obtained during our study, as evidenced by the data presented in Table 3. Therefore, the samples of sour-milk cheese from both manufacturers met the requirements of the national standard.

Thus, as a result of conducting studies of microbiological quality indicators of sour-milk cheese with a fat content of 5%, it was established that the microbiological safety of this food product meets the requirements of DSTU 4554:2006 (2007). This indicates a high level of production culture and the effectiveness of the implemented HACCP system.

The next stage of research and assessment of the safety level of sour-milk cheese produced by BIAGR LLC was the detection of toxic elements in the samples. The specialists of the Research and Testing Centre for Food Products have developed validated methods for the determination of toxic elements, namely for cadmium, arsenic, mercury – Regional Research and Technical Centre of Standardization, Metrology and Certification (2022c); lead – Regional Research and Technical Centre of Standardization, Metrology and Certification (2022d) using Avio 200 ICP-OES (Fig. 6). The conducted study of toxic elements in sour-milk cheese samples makes it possible to determine their level and establish their compliance with the mandatory requirements of the national standard (Table 4).



1 2 3 4

Figure 6. *Results of the study of toxic elements in a sample of sour-milk cheese with a fat content of 5%*
Note: *1 – lead; 2 – cadmium; 3 – arsenic; 4 – mercury*
Source: *developed by the authors*

Table 4. *Results of the study of toxic elements in a sample of sour-milk cheese with a fat content of 5%, mg/kg*

Indicator name	Levels of toxic elements		Compliance with the requirements DSTU 4554:2006
	maximum permissible according to DSTU 4554:2006	in a sample	
Lead	0.3	Less than 0.001*	meets the requirements
Cadmium	0.2	Less than 0.0001*	meets the requirements
Arsenic	0.2	Less than 0.001*	meets the requirements
Mercury	0.02	Less than 0.001*	meets the requirements

Note: ** method sensitivity limit*
Source: *developed by the authors*

Arsenic is recognised as one of the most hazardous elements, and its accumulation can result in a number of illnesses and other health impacts (Bjørklund *et al.*, 2020). Comparison of the obtained results regarding arsenic concentration for sour-milk cheese presented in the work of N.V. Chuyen *et al.* (2022), led to the conclusion that the measured data comply with the regulatory documents and have approximately the same levels: less than 0.001 mg/kg for the sample of sour-milk cheese with a fat content of 5% produced by BIAGR LLC and 0.002 mg/kg for the sample studied by N.V. Chuyen *et al.* (2022).

According to I.G. Yaroshovych *et al.* (2020), mercury is a hazard class 1 substance, and its vapours are particularly harmful. As for the results of determining the mercury content in the samples, it is also several times lower than the normative value of the national standard. Similar levels (0.51 ± 0.07 mg/kg) were obtained in the study of the Polish researcher U. Pankiewicz (2012). Thus, the analysis of the results showed that the level of toxic elements in the sample of sour-milk cheese produced by BIAGR LLC with a fat content of 5% exceeds the norm established by the requirements of DSTU 4554:2006 (2007).

According to I.M. Trakhtenberg *et al.* (2015), lead is one of the most dangerous environmental pollutants and belongs to toxins with a polytropic mechanism of action. It has a toxic effect on all organs and systems of the human body. Based on I.I. Kolosova *et al.* (2020), cadmium is characterised by a high migration rate and biochemical activity. It has a polytropic toxic effect and the ability to accumulate in various organs and tissues. Additionally, in the study by I. Suhani *et al.* (2021), it is noted that over time, cadmium accumulates and its concentration in the human body increases. In the study by M. Radzymińska & S.S. Smoczyński (2006), it is indicated that in all dairy products, including sour-milk cheese that comes from the pasture-fed cows, the average metal content ranged from 0.009 to 0.011 mg/kg for lead and from 0.001 to 0.004 for of cadmium.

Thus, summarising the results of the laboratory studies, it should be noted that the content of toxic elements in the samples of sour-milk cheese with a fat content of 5% produced by BIAGR LLC is much lower than the maximum permissible concentrations and meets the requirements of regulatory documents. Therefore, this food product is of high quality and safe for consumption.

Conclusions

A wide range of research methods was used in this study, which made it possible to assess the level of quality and safety of the research object. Conscious consumer choice begins with visual perception, preferences, and appearance of food products. Therefore, the evaluation of packaging material and the quality of labelling details is one of the factors shaping consumers' perception of the product. During the evaluation of the packaging, its compliance with the national standard was confirmed. According to the requirements of the national regulatory document, the research

object was found to comply with organoleptic indicators such as consistency (soft), appearance (no whey separation), taste and smell (fermented milk smell and taste, without extraneous odour and favour), colour (uniform white throughout the entire mass). During the study of physicochemical quality indicators, it was found that the mass fraction of fat is 5.0%; the mass fraction of protein is 14.6%; the mass fraction of moisture is 68.0%; titratable acidity was 176°T; phosphatase was absent. Thus, all mandatory physical and chemical quality indicators meet the requirements of the national standard.

In modern conditions, the mandatory indicators of the quality and safety of fermented milk products include their microbiological condition and the content of toxic elements. During the research, it was found that the number of lactic acid bacteria in 1 g of product is 2×10^6 CFU; the number of mould fungi and yeast in 1 g of product is the same – 1×10^1 CFU. Escherichia coli bacteria, pathogenic microorganisms, including *Salmonella* (in 25 g of product), *Staphylococcus aureus* (in 0.01 g of product) and *Listeria monocytogenes* were not detected. Regarding toxic elements, namely lead, cadmium, arsenic and mercury, in the sample of sour-milk cheese with a fat content of 5%, it was found that their content does not exceed their maximum permissible concentrations.

Compliance with a set of preparatory and technological operations, as well as the implementation of the HACCP system, enables BIAGR LLC to produce sour-milk cheese that meets the requirements of current regulatory documents in terms of organoleptic, physicochemical, microbiological and safety indicators. The studied product quality indicators demonstrate a high level of responsibility of the enterprise regarding the quality and safety of its products, which is important in the context of the general problem of food safety in Ukraine and worldwide.

For further research, comparative testing of sour-milk cheeses with the same fat content from different manufacturers is planned. This will allow us to study consumer demand and provide necessary, reliable, accessible, and timely information to consumers regarding the quality and safety of this food product.

Conflict of interest

None.

Aknowledgements

None.

References

[1] Bjørklund, G., Oliinyk, P., Lysiuk, R., Rahaman, M.S., Antonyak, H., Lozynska, I., Lenchyk, L., & Peana, M. (2020). Arsenic intoxication: General aspects and chelating agents. *Archives of Toxicology*, 94, 1879-1897. doi: 10.1007/s00204-020-02739-w.

[2] Chuyen, N.V., Ba, N.V., Trung, N.H., Trang, N.T.T., Truong, H.T., Minh, T.D., Anh, L.T., Hang, D.T.D., Chinh, V.D., & Dien, N.D. (2022). Assessment of arsenic contamination of milk and dairy products. *Cuban Journal of Military Medicine*, 51(3), article number 02201977.

[3] DSTU 4554:2006. (2007). *Cottage cheese. Technical specifications*. Retrieved from https://online.budstandart.com/ua/catalog/doc-page.html?id_doc=72416.

[4] DSTU 7357:2013. (2014). *Milk and dairy products. Methods of microbiological control*. Retrieved from https://online.budstandart.com/ua/catalog/doc-page.html?id_doc=84675.

[5] DSTU 7380:2013. (2014). *Milk and dairy products. Methods for determining the presence of peroxidase and phosphatase (alkaline and acidic)*. Retrieved from http://surl.li/tsvlc.

[6] DSTU 8447:2015. (2017). *Food products. Method for the determination of yeast and moulds*. Retrieved from https://online.budstandart.com/ua/catalog/doc-page?id_doc=84597.

[7] DSTU 8552:2015. (2017). *Milk and dairy products. Methods for determination of moisture and dry matter.* Retrieved from https://online.budstandart.com/ua/catalog/document.html?id_doc=71700.

[8] DSTU IDF 93A:2003. (2005). *Milk and dairy products. Definition of Salmonella*. Retrieved from http://surl.li/tsvkl.

[9] DSTU ISO 11290-1:2003. (2004). *Microbiology of food and animal feed. Horizontal method for the detection and enumeration of Listeria monocytogenes. Part 1: Detection method*. Retrieved from https://online.budstandart.com/ua/catalog/doc-page.html?id_doc=98911.

[10] DSTU ISO 15214:2007 (2009). *Microbiology of food and animal feed. Horizontal method for counting mesophilic lactic acid bacteria at 30°C*. Retrieved from http://surl.li/tsvks.

[11] DSTU ISO 5944:2005 (IDF 60:2001). (2007). *Milk and milk-based products. Determination of the number of coagulase-positive staphylococci by the most probable number method.* Retrieved from https://online.budstandart.com/ua/catalog/doc-page.html?id_doc=101904.

[12] Horiuk, Y. (2023). Microbiological quality of sour-milk cheese made from raw cow's milk. In *Theoretical and practical aspects of science development* (pp. 431-461). Riga: Baltija Publishing. doi: 10.30525/978-9934-26-355-2-32.

[13] Khatun, M.T., Rahman, M.M., Pramanik, M.A.H., & Wadud, A. (2019). Qualitative study on the cottage cheese prepared from partially skimmed milk. *International Journal of Natural and Social Sciences*, 6(3), 1-10.

[14] Kolosova, I.I., Rudenko, K.M., & Shatorna, V.F. (2020). Cadmium is a threat to living organisms (literature review). In *Perspectives of world science and education. Abstracts of the 5th International scientific and practical conference* (pp. 433-442). Osaka: CPN Publishing Group.
[15] Kukhtin, M.D., & Horiuk, Y.V. (2023). Microbiology of dairy products made from raw cow's milk: Monograph. Ternopil: Ternopil National Technical University named after Ivan Puluj.
[16] Lyasota, V.P., Bukalova, N.V., Bohatko, N.M., Tkachuk, S.A., Savchuk, L.B., Prilipko, T.M., Tyshkivska, N.V., & Bohatko, L.M. (2020). Evaluation of conformity and identification of the naturalness of sour-milk cheese and curd products. *Scientific Reports of the National University of Bioresources and Nature Management of Ukraine*, 2(84). doi: 10.31548/dopovidi2020.02.018.
[17] Methodical Guidelines 4.4.4-108-2004. (2004). *Frequency of control of food raw materials and food products by safety indicators*. Retrieved from http://surl.li/mhboa.
[18] Pankiewicz, U. (2012). Monitoring of total mercury level in selected dairy products from the south-east regions of Poland. *Ecological Chemistry and Engineering. A*, 19(1-2), 129-136. doi: 10.2428/ecea.2012.19(01)014.
[19] Poltava Regional Research and Technical Center of Standardization, Metrology and Certification. (2021). *Method for determination of acidity in food products*. Poltava: State Enterprise "Poltava Regional Research and Technical Center of Standardization, Metrology and Certification".
[20] Poltava Regional Research and Technical Center of Standardization, Metrology and Certification. (2022a). *The method of determining the mass fraction of fat in food products*. Poltava: State Enterprise "Poltava Regional Research and Technical Center of Standardization, Metrology and Certification".
[21] Poltava Regional Research and Technical Center of Standardization, Metrology and Certification. (2022b). *The method of determining the mass fraction of protein*. Poltava: State Enterprise "Poltava Regional Research and Technical Center of Standardization, Metrology and Certification".
[22] Poltava Regional Research and Technical Center of Standardization, Metrology and Certification. (2022c). *Determination of elements by inductively coupled plasma atomic emission spectrometry*. Poltava: State Enterprise "Poltava Regional Research and Technical Center of Standardization, Metrology and Certification".
[23] Poltava Regional Research and Technical Center of Standardization, Metrology and Certification. (2022d). *Testing of products for the content of toxic elements by the voltammetric method*. Poltava: State Enterprise "Poltava Regional Research and Technical Center of Standardization, Metrology and Certification".
[24] Puhach, V.O. (2019). The causes of the worsening food safety problem and ways to reduce it. In *Innovative development and security of the enterprise in the conditions of the neo-industrial society: Materials of the International science and practice conference* (pp. 668-670). Lutsk: Eastern European National University named after Lesya Ukrainka.
[25] Radzymińska, M., & Smoczyński, S.S. (2006). Stall and pasture feeding as a factor potentially affecting the content of detrimental chemical compounds in selected dairy products. *Polish Journal of Food and Nutrition Sciences*, 15/56(1), 179-182.
[26] Remizova, N.L., Korsun, A.Ya., & Kalashnyk, O.V. (2023). Study of the level of toxic elements in sour-milk cheese of domestic production. In *Modern science. Abstracts of the 59th International scientific and practical conference* (pp. 73-76). Poznan: Scientific Thought.
[27] Samoilenko, A.A., & Yudicheva, O.P. (2019). Study of sour milk cheese quality indicators. In *Current issues of expert and evaluation activity: Materials of the 1st International science and practice conference* (pp. 312-315). Poltava: PUET.
[28] Sarsembayeva, N.B., Abdigaliyeva, T.B., Utepova, Z.A., Biltebay, A.N., & Zhumagulova, S.Zh. (2019). Heavy metal levels in milk and fermented milk products produced in the Almaty region, Kazakhstan. *Veterinary World*, 13(4), 609-613. doi: 10.14202/vetworld.2020.609-613.
[29] Savchenko, O.A., Grek, O.V., & Krasulya, O.O. (2018). *Modern technologies of dairy products*. Kyiv: CP "Comprint".
[30] Soloshenko, K.I., Slobodian, O.P., & Matiyaschuk, O.V. (2019). Use of principles of HACCP for manufacture of sour milk cheese. *SWorldJournal*, 1, 22-31. doi: 10.30888/2410-6615.2019-01-01-044.
[31] Stefanou, C.-R., Bartodziejska, B., Gajewska, M., & Szosland-Fałtyn, A. (2022). Microbiological quality and safety of traditional raw milk cheeses manufactured on a small scale by Polish dairy farms. *Foods*, 11(23), article number 3910. doi: 10.3390/foods11233910.
[32] Suhani, I., Sahab, S., Srivastava, V., & Singh, R.P. (2021). Impact of cadmium pollution on food safety and human health. *Current Opinion in Toxicology*, 27, 1-7. doi: 10.1016/j.cotox.2021.04.004.
[33] Sujka, M., Pankiewicz, U., Kowalski, R., Mazurek, A., Ślepecka, K., & Góral, M. (2019). Determination of the content of Pb, Cd, Cu, Zn in dairy products from various regions of Poland. *Open Chemistry*, 17(1), 694-702. doi: 10.1515/chem-2019-0072.
[34] Trakhtenberg, I.M., Dmytrukha, H.M., Chekman, I.S., Kupriy, V.O., & Doroshenko, A.M. (2015). Lead is a dangerous pollutant. The problem is old and new. *Modern Problems of Toxicology*, *Food and Chemical Safety*, 3, 14-24.

[35] Yaroshovych, I.G., Tchaikovskyj, B.P., Mykychak, B.M., & Yaroshovych, T.S. (2020). The influence of mercury on the human body and animals. *Scientific Bulletin of the LNUVMB named after S.Z. Gzhitskyi. Series: Economic Sciences*, 22, article number 94. doi: 10.32718/nvlvet–e9406.

Комплексне оцінювання якості сиру кисломолочного українського виробництва

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Анотація. Всебічне дослідження продукції харчування, а також дотримання правил та нормативів у харчовій промисловості є необхідними для забезпечення споживачів якісними та безпечними товарами. Метою статті є комплексний аналіз якості та безпеки кисломолочного сиру, включно з оцінкою органолептичних характеристик, фізико-хімічних властивостей та мікробіологічних показників. Дослідження проводилося на прикладі одного із потужних виробників сухого молока та кисломолочної продукції на ринку України ТОВ «БІАГР». Для досягнення поставленої мети були використані наступні методи: органолептичні, фізико-хімічні, мікробіологічні та вимірювання вмісту токсичних елементів (кадмій, миш'як, свинець). На початку вимірювань показників якості було оцінено його пакування та маркування, яке відповідало вимогам національного стандарту. Під час дослідження органолептичних показників якості сиру кисломолочного із вмістом жиру 5 % було з'ясовано, що його консистенція м'яка, без виділення сироватки; виражений кисломолочний смак та запах без сторонніх присмаків і запахів; колір зразка рівномірний білий. На другому етапі проведення досліджень були виміряні та оцінені обов'язкові фізико-хімічні показники якості, а саме: масова частка жиру – 5,0 %; масова частка білку – 14,6 %; масова частка вологи – 68,0 %; кислотність титрована – 176 °Т; фосфатаза – відсутня. Оскільки безпечність продуктів харчування зараз є актуальним завданням і в Україні, то під час досліджень були виміряні такі показники безпечності, як кількість молочнокислих бактерій, що становила 2×106 КУО в 1 г; бактерії групи кишкової палички не виявлено; кількість пліснявих грибів – 1×101 КУО в 1 г; кількість дріжджів, продукту – 1×101 КУО в 1 г; патогенні мікроорганізми, зокрема Salmonella, Staphylococcus aureus, Listeria monocytogenes – не виявлено. Отже, за органолептичними, фізико-хімічними показниками та показниками безпечності сир кисломолочний із вмістом жиру на рівні 5 %, який виробляється ТОВ «БІАГР» відповідає вимогам нормативної документації. Результати дослідження можуть бути використані для контролю якості молочної продукції та вдосконалення виробничих процесів

Ключові слова: органолептичні, фізико-хімічні, мікробіологічні показники; стандартизація; безпечність; Hazard Analysis and Critical Control Points