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Technology of production and primary processing of milk in farm conditions

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Abstract. The introduction of new criteria for the safety of milk raw materials at the legislative level, on the one hand, made it possible to improve the supply of quality food to the population, and on the other hand, caused a decrease in the profitability of farms due to the deterioration of the marketability of milk and its price. Such a situation in the dairy business requires the search for solutions for commodity farms regarding possible ways to improve milk safety indicators as soon as possible in order to avoid a further reduction in the number of dairy cattle in Ukraine. The purpose of the research was to study the technology of obtaining and individual elements of the primary processing

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of milk for the number of somatic cells and the level of microbial contamination of milk raw materials. The work used general scientific methods, arbitration method, and the method of variational statistics. For this, combined samples of milk from 3 farms that used different approaches to keeping animals and technologies for obtaining milk from them, and a number of personal farms of the population were examined quarterly for one year to study the dynamics and relationships between indicators of raw material safety. A significant influence of paratypic factors on the number of somatic cells in milk was revealed, such as: milk production technology, seasonality of production, and the level of morbidity of animals for hidden forms of mastitis. At the same time, a direct correlation was established between indicators of the number of somatic cells and microbial contamination of milk at the level of 0.91 ($P<0.001$), which suggests that measures aimed at improving one of them will automatically improve the other. Violations of the requirements of the primary processing of milk caused a significant increase in the microbial load. Elimination of identified technological deficiencies will contribute to the increase of raw materials at milk processing enterprises

Keywords: number of somatic cells; raw milk; microbial contamination of milk; number of colony-forming units; correlation

INTRODUCTION

The dairy industry of Ukraine is a self-sufficient component of agrarian business, which is able to bring a stable income, despite the difficult economic and military factors that have developed at the moment. Milk production is provided both by large-scale dairy enterprises and individual peasant farms. Depending on the number of productive cows in the farm and the organization of the milking process, enterprises use different technological approaches to obtaining and further processing of dairy products. But, despite the differences in the organization of this process in farms of different types, the state provides uniform requirements for milk in terms of its quality and safety. Criteria for dairy raw materials supplied to processing enterprises are defined in a number of regulatory documents: Order of the Ministry of Agricultural Policy and Food of Ukraine No. 118 "On approval of the requirements for safety and quality of milk and dairy products" (2019) and DSTU 3662:2018 (State Standard of Ukraine, 2018). These requirements include control over technological indicators – freezing point, density of milk to prevent falsification, and more significant safety characteristics – the number of somatic cells and colony-forming units (CFU) of microorganisms per unit volume. More attention is paid to the latter indicators, which is evidenced by the reduction of threshold values of microbiological indicators in the latest editions of the above-mentioned by-laws.

If the technological parameters of dairy raw materials, in most cases, depend on the good faith of producers, then both genetic factors of animals from which milk is obtained and paratypical conditions of its production have a significant impact on safety indicators. The influence of genetic factors on the quality of milk raw materials in various breeds of cattle is traced in the work of M.N. Alhussien and A.K. Dang (2018). They note that the level of somatic cells was higher in high-yielding breeds (Holstein and Swedish) than in low-yielding breeds – Ayrshire, Jersey, and other breeds. Similar results were obtained in the work of M. Franzoi *et al.* (2020), who note the hereditary dependence between the number of somatic cells in animals of the Holstein, Swedish, and Simmental breeds, and the quality characteristics of the milk obtained from them.

The influence of economic (paratypical) conditions on the manufacturability of dairy raw materials is followed in the studies of A.R. Quintana *et al.* (2020), who revealed the influence of the general hygienic condition of the farm on indicators of microbial contamination of milk, and in the work of H. Yuan *et al.* (2022), which indicate the dependence of the quantitative and qualitative composition of raw milk microflora on the season. An equally important factor in ensuring the microbiological safety of dairy raw materials is its subsequent technological processing. In the work of L. Berhanu *et al.* (2021) indicates that during the storage and transportation of milk, an increase in both the total number of microorganisms and their individual species, including coliforms, was observed. Therefore, taking into account the significant difference in technological approaches to milking cows in different types of farms and ensuring optimal conditions for the productive keeping of animals for microbiological contamination of milk and the content of somatic cells in it, these indicators can become a criterion for the suitability of the applied milk production technology to the conditions of the farm, or for evaluating new technological solutions implemented in production.

In view of the above circumstances, the purpose of the work was to study the influence of genetic factors and paratypical conditions of keeping cows on indicators of the number of somatic cells and microbiological contamination of milk raw materials in farms with different technological approaches in the production and primary processing of milk.

LITERATURE REVIEW

A significant part of scientific studies, the authors of which studied the influence of technological aspects

on the productivity of cows in the conditions of individual farms, substantiated their analysis only with the involvement of individual indicators of milk yield and reproduction: the number of animals (Tse *et al.,* 2018; Ivanyos *et al.,* 2020), milk protein and fat content (Varpikhovskyi, 2019; Lutsenko *et al.*, 2021), reproductive indicators (Lyashenko *et al.,* 2022; Qi *et al.,* 2022) and others. Recently, more and more attention has been paid in publications to data on the safety of milk, in particular, the number of somatic cells in milk from different farms. The number of somatic cells (NSC) indicates the health of the mammary gland and serves as a marker of the development of a subclinical form of mastitis (Quality milk on..., 2020). Somatic cells include any cells or their remnants found in milk. They mainly include epithelial cells of the mammary gland and blood leukocytes (Alhussien & Dang, 2018). In the milk of healthy cows, the level of somatic cells is insignificant and does not exceed 250,000 cells per cm^3. When animals suffer from mastitis, the level of somatic cells increases several times, reaching the value of 1-1.5 million cells/cm^3 (Bublyk, 2019). The growth of NSC reduces the manufacturability of milk, it is not possible to produce high-quality dairy products from it. Studies conducted by G. Stocco *et al.* (2020) indicate that the quality of milk worsened with an increase in the number of somatic cells. In particular, a decrease in the content of milk fat, protein, casein, and casein index was noted, as well as an increase in the content of fatty acids in milk. Similar results were obtained by E. Kul *et al.* (2019).

At milk processing enterprises, NSC determination is carried out in collected milk, which makes it difficult to identify sick animals. In the research of M. Karavansky *et al.* (2021), it is indicated that with an increase in the number of somatic cells in the total milk sample, the incidence of mastitis in cows in the herd increases. They indicate a direct relationship between the average number of somatic cells in collected milk and the incidence of mastitis among animals in the herd. Different factors have a significant influence on NSC in milk. Thus, in the work of O.E. Admin and N.G. Admina (2022), a significant influence of the age of cows, the stage of lactation, the season of the year, and the conditions of keeping on the level of somatic cells was found, and in the studies of K.B. Sebastino *et al.* (2020) noted that the maximum level of somatic cells was observed in the warm season.

Recently, a new approach has been proposed to diagnose the subclinical form of mastitis – the differential number of somatic cells, which is based on the determination of only immune cells in milk. For differential diagnosis, automated devices are used to count them (Halasa & Kirkeby, 2020).

An equally important indicator for determining the safety of milk is the number of microorganisms and their species composition (Perin *et al.,* 2019). In Ukraine, before the abolition of martial law, milk in which the number of microorganisms does not exceed 300 thousand CFU/ml is allowed for processing (State Standard of Ukraine, 2018; Order of the Ministry..., 2019). Like the number of somatic cells in milk, the indicator of bacterial contamination largely depends on a number of paratypic factors (Yuan *et al.,* 2022). In the work of G. Celano *et al.* (2022), they found the predominance of microorganisms of the *Xanthomonadaceae*, *Enterobacteriaceae*, and *Pseudomonadaceae* families in the winter period, which leads to a decrease in milk quality. Whereas in the summer – *Streptococcaceae* (*Lactococcus*) and *Limosilactobacillus fermentum*, which contributed to better preservation of milk. J. McLauchlin *et al.* (2020) noted that an increase in the level of *Escherichia coli* in raw milk was correlated with an increase in the number of colony-forming units (CFU) of coagulase-positive staphylococci. Further primary processing of milk as reported by V. Mörschbächer *et al.* (2017) contributed to the improvement of the microbiological condition of raw milk and dairy products made from it.

MATERIALS AND METHODS

The study of milk indicators from farms that differed in conditions of keeping, milking technology, and primary processing of milk was carried out during March-December 2022. For this, milk samples were taken every month from a number of farms in the Cherkasy region, from which milk raw materials were supplied to milk processing enterprises. Households were surveyed with the same periodicity, milk from which was sold on the agricultural market. Farms that had different technological conditions for milk production and animal productivity were selected for the study, but at the request of the owners and managers, the names of the farms are not indicated. The study included:

- Farm 1 – a herd of 376 dairy cows; the breed is Ukrainian black-spotted dairy, the average yield for the past year is 7734 kg, the animals are kept without tethering, milking is in the milking hall on the "Yalynka" type installation (Bratslav, Ukraine);
- Farm 2 – a herd of 175 dairy cows; breed – Ukrainian black-spotted dairy, yield for the past year – 6542 kg, maintenance – tethered, milking in the milk duct;
- Farm 3 – livestock of 58 cows; breed – Ukrainian black-spotted dairy, yield for the past year – 5219 kg, maintenance – tethered, milking in milk buckets.

Milk for research from personal peasant farms was purchased from animal owners at the agricultural market. There is no information on the breed and productivity of the cows, their maintenance depends on the use of pastures in the spring-autumn period. Milking using milking machines and manually. The selected milk samples were stored at a temperature of 4-6°C during transportation to the laboratory. Laboratory analysis was performed on the day of sample collection.

Microbiological studies and determination of the number of somatic cells in the combined sample were

carried out in the microbiological department of the state laboratory on food safety and consumer protection. The number of somatic cells was determined in accordance with DSTU ISO 13366-1/IDF 148-1:2014 (State Standard of Ukraine, 2014). To do this, the prepared smear of milk was dyed for 15 minutes in a Newman-Lampert dye solution, and after drying, the number of somatic cells was counted under a microscope with a magnification of 500-1000 times. Calculation of NSC was carried out in accordance with methodical recommendations (Harkavenko *et al.,* 2021). Examination of cows for the subclinical form of mastitis was carried out using the mastidine test. For this purpose, 2 ml of diagnosticum and tested milk from each quarter of the udder were poured into the tablet, mixed, and the result was evaluated by colour and consistency.

Determination of the number of mesophyllic aerobic and facultatively anaerobic microorganisms (NMAFAnM) and lactic acid bacteria was carried out using dry ready-to-use chromogenic media Compact Dry. 1 ml of diluted milk (in a ratio of 1:1000 with the buffer solution included in the research kit) was transferred to a cup with a dry medium and diffused over its entire surface. After that, the cups were placed in a thermostat at a temperature of 35±2°C for 48 hours. After incubation, the determination of the number of microorganisms was carried out by counting colonies stained red, which acquired this colour due to the metabolic reduction of the indicator – tetrazolium salts. This made it possible to differentiate them from extraneous residues that remained unstained. In the case of germination of numerous colonies, a further series of dilutions was carried out from a collective sample of milk to facilitate calculations.

Statistical analysis of research results was carried out using the method of variational statistics in Microsoft Excel and Minitab® 21.3.1 software. Average arithmetic values and their errors and other statistical indicators were determined.

RESULTS

When evaluating the milk productivity of cows, preference is given to the quantitative characteristics of milk – how much milk is obtained, the content of protein, and milk fat in it, but recently, the requirements for the quality of milk raw materials in Ukraine have significantly increased (State Standard of Ukraine, 2018). This is connected with an effort to bring the legislation into line with the requirements of the European Union regarding the veterinary and sanitary rules of production and circulation of milk, and to improve the quality of dairy products due to its safety indicators. Therefore, determining the number of somatic cells and microbiological contamination of milk when it enters the milk processing enterprise became mandatory elements of the research.

One of the most significant innovations for milk producers was the almost two-fold reduction in the number of somatic cells in raw milk (State Standard of Ukraine, 2018). It is due to the reduction of permissible NSC in milk that the quality (merchantability) of milk in most farms has somewhat deteriorated. The results of research on the content of somatic cells in milk samples from controlled farms are shown in Table 1.

Table 1. *Indicators of the number of somatic cells in the milk of the collective sample in controlled farms (thousands)*

Household	Season of the year							
	Spring		Summer		Autumn		Winter	
	M±m	Cv, %	M±m	Cv, %	M±m	Cv, %	M±m	Cv, %
1	198±21.8	24	212±39.4	36	176±22.4	32	159±19.7	22
2	279±39.4	32	396±44.2	42	296±37.4	34	227±22.3	37
3	305±28.7	26	503±57.8	48	338±49.7	42	264±42.7	43
Single	156±21.3	18	166±19.6	22	144±16.6	21	124±15.4	19

Source: *compiled by the authors*

The obtained data indicate a significant influence on the level of somatic cells in the collective milk sample of the technology of its production. Thus, in the first farm, in any of the quarters of the year, NSC did not exceed the permissible requirements of regulatory documents for milk raw materials, while in the farm with milking cows in milk buckets, their number in all seasons was higher than the mentioned norm. At first glance, there is a direct relationship between the method of keeping and milking technology and NSC in milk raw materials. But the analysis of samples from private peasant farms, on the contrary, indicates a much better quality of milk from animals from single-person farms compared to those where more modern technological solutions are used for milking animals. Probably, this is a consequence of the stereotype that milk production on an industrial basis will always have better indicators than milk from cows from individual farms. After all, the technology of obtaining milk from cows, in addition to, in fact, the process of removing

the secretion of the mammary glands, also involves processing the udder before and after milking. The use of disposable napkins for dry processing of the skin of the mammary gland and preparations for disinfecting nipples contributed to the reduction of the number of subclinical cases of mastitis in the first farm. This was confirmed by the results of studies of the animal population with a mastidine sample (Table 2).

Table 2. *Results of detection of subclinical cases of mastitis in cows of the first farm, heads*

Indicator	Season of the year			
	Spring	Summer	Autumn	Winter
A total examined number of cows	344	327	362	359
Number of positive tests	20	27	19	16
% of mastitic cows	5.8	8.3	5.2	4.5

Source: *compiled by the authors*

Since the number of somatic cells in milk is an indicator of the inflammatory process in the mammary gland, and their increase in the combined sample indicates the intensity of mastitis in the herd. The obtained research results are correlated with the data on NSC in the collective sample of milk from the first farm specified in the first table. In the other two farms, only wet processing of the udder before milking was carried out, and there was no diagnosis of animals for hidden forms of mastitis, therefore there is no reliable information about the incidence of cows in those herds, but insufficient processing of the udder before and after milking could well be the reason for the growth of somatic cells in milk.

Despite the lack of specialized means for disinfecting the udders of cows in individual households, and the insufficiency of diagnostic measures aimed at detecting subclinical mastitis in them, milk from such animals had the best NSC indicators. This could be related to the daily monitoring of the state of the mammary gland and the quality of milk by the owner of the animal, and in the case of the slightest suspicions, its timely treatment.

An equally important indicator of the safety of milk is its microbial contamination, because, like the previous one, this indicator can be an indicator of both the sanitary and hygienic condition on the farm and the incidence of mastitis in animals. Therefore, in accordance with the requirements of regulatory documents regarding microbiological studies of milk raw materials, control over the latter is also entrusted to market operators – that is, milk processing enterprises. And accordingly, it also affects the quality of milk and, as a result, the profitability of the entire production of products. The results of microbiological studies of combined samples of milk from farms and the market are presented in Table 3.

Table 3*. Indicators of microbial contamination of raw milk of a collective sample in farms under control (CFU, 10^4)*

Household	Season of the year							
	Spring		Summer		Autumn		Winter	
	M±m	Cv, %	M±m	Cv, %	M±m	Cv, %	M±m	Cv, %
1	4.1±0.3	31	9.7±0.5	39	7.2±0.4	29	3.9±0.3	24
2	14.8±0.7	35	17.6±0.9	45	13.6±0.9	37	12.9±0.7	34
3	15.6±0.5	29	22.4±0.5	51	18.7±0.2	34	14.7±0.3	27
Single	71.6±16.7	58	157.3±35.2	107	72.1±15.2	88	52.4±3.8	49

Source: *compiled by the authors*

From the analysis of the presented material, it can be stated that regardless of the conditions of keeping animals and the technology of obtaining milk in the controlled farms, the microbiological indicators in all of them were within the permissible limits. Bacterial contamination of dairy raw materials turned out to be 2-3 times lower in the first farm compared to the others. That is, compliance with proper sanitary and hygienic conditions during the preparation of animals for milking guarantees a decrease in the level of microorganisms in milk raw materials. In parallel studies of combined milk samples from farms, the number of mesophyllic aerobic and facultatively anaerobic microorganisms (NMAFAnM) was correlated with the results of the number of somatic cells. The correlation coefficient between indicators was 0.91 ($P<0.001$) (Fig. 1).

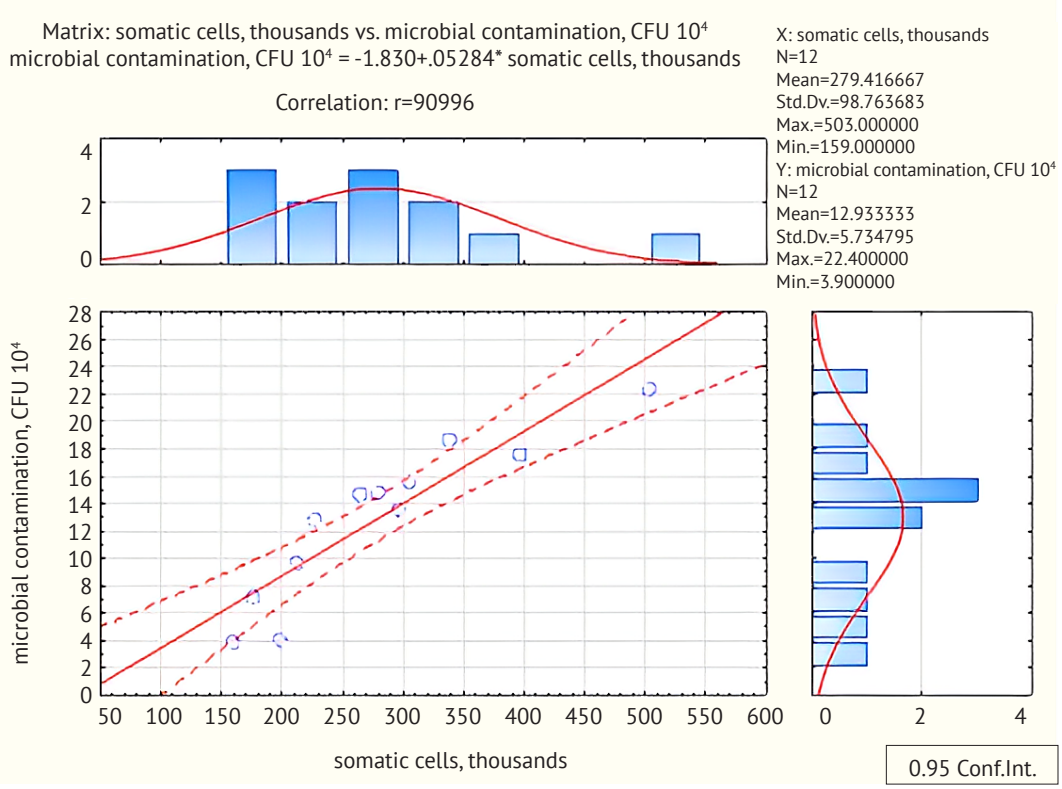

Figure 1. *Correlation matrix between indicators of somatic cell content and microbial contamination in combined milk samples*

Source: *compiled by the authors*

But indicators of bacterial contamination in milk from individual households did not fit into this system, so they were not taken into account when conducting correlation analysis. The microbiological indicators of milk samples from cows from private households exceeded the permissible norms by several times, despite the fact that this milk had the lowest indicators of the number of somatic cells. Their variability from sample to sample was also high. The coefficient of variation many times exceeded the values obtained for farms with an industrial type of milk production. Further analysis of the microbial contamination of milk from this category of farms also revealed a significant dependence of the fluctuation of the number of cone-forming microorganisms on the season of the year, while the seasonal fluctuations of this indicator in farms with industrial milk production technology were insignificant. Given that milk contains all nutrients in a form easily accessible to microorganisms and is a good nutrient medium, an important element of improving its safety is its further processing aimed at preventing rapid bacterial growth in it.

Therefore, in farms, freshly expressed milk is subjected to rapid cooling, which prevents the active development of microbiota, and this ensures compliance with the requirements of regulatory documents for the indicator of the number of colony-forming microorganisms in industrial milk production. At the same time, it is not possible to provide rapid cooling of a significant amount of milk in private households. Therefore, even some microorganisms that enter the milk during milking as a result of the exponential growth increase its quantity and thereby deteriorate the quality of milk raw materials. A significant seasonal variation in the bacterial contamination of milk sold on the market is also due to the increasing temperature of the environment in which transportation and its sale take place. To confirm this assumption, a microbiological study of milk was carried out, which was stored under different temperature conditions for 3, 12, and 24 hours. The results of the study are presented in Table 4.

Table 4. *Indicators of microbial contamination of raw milk during its storage under different temperature conditions (CFU, 10⁴)*

Temperature regime, °C	Milk storage time, hours			
	0	3	12	24
4±1	5.3	5.8	6.9	9.2

Table 4, Continued

Temperature regime, °C	Milk storage time, hours			
	0	3	12	24
10±1.5	5.3	7.4	21.3	83.2
18-20	5.3	8,9	49.3	208.8

Source: *compiled by the authors*

The results of the study shown in the table revealed a significant influence of the milk storage temperature on the number of microorganisms in it. This explains the increase in bacterial contamination of milk purchased on the agricultural market, with a few somatic cells in it. Therefore, in order to obtain high-quality milk according to safety indicators, it is necessary to strictly comply with all the requirements of the technological process of its production and primary processing, regardless of the method of keeping animals and the type of dairy equipment used.

DISCUSSION

The introduction of new safety criteria for milk and dairy products, as a step towards bringing domestic legislation into compliance with the requirements of the European Union, on the one hand, allowed to provide the population with high-quality food products, and to increase the export capacity of domestic goods. On the other hand, the introduction of stricter veterinary and sanitary requirements for the production and circulation of milk, aimed at improving the quality of milk raw materials at the expense of its safety indicators, reduced the profitability of the majority of farms due to a decrease in the marketability of milk and its price. Such a situation in the dairy business requires clear actions to find a quick solution for commodity farms and possible directions for further improvement of the state of dairy farming.

Solving the problems of improving the safety indicators of milk raw materials exclusively with the help of selection approaches did not have much success. After all, the level of somatic cells and microbial contamination of milk is a complex problem, which is affected by both genetic factors – the shape of the udder, the level of milk productivity, metabolism, the state of the immune system, and paratypical conditions – violations of the conditions of keeping and feeding animals, violations of milking technology and much more others This was confirmed in the works of domestic researchers – I.D. Filipenko *et al.* (2019), O.I. Shkromada *et al.* (2019a; 2019b), as well as foreign ones – S. Kaskous *et al.* (2023), D.S. Riveros-Galán and M. Obando-Chaves (2021), and others. Therefore, this work focused on certain technological aspects of milking and primary processing of milk.

The main reason for researching the level of somatic cells in milk raw materials is to determine the level of morbidity of herd animals for various forms of mastitis, since this indicator is the main indicator of the development of hidden inflammation in the mammary gland. This is indicated by the research of A. Egyedy *et al.* (2022) and R.M.C. Deshapriya *et al.* (2019). When analysing the situation in controlled farms, the increase in the number of somatic cells in the combined milk sample from the first farm with the number of detected cows with subclinical mastitis was monitored. Such studies were conducted only in one of the studied farms, so it can only be assumed that the reason for the increase in NSC in other farms was also the spread of cases of hidden mastitis in herds. But, taking into account that the composition of somatic cells, in addition to leukocytes that enter milk during the development of the inflammatory process, also includes other elements, in particular, cells of the epithelial tissue of the mammary gland, this assumption is no longer so unambiguous.

In addition, in the studies of R. Rainard *et al.* (2018) noted that a low number of somatic cells in milk indicates the insufficiency of the body's protective mechanisms to resist pathogens and is a manifestation of immunodepression, which can also cause mastitis. Therefore, these studies require further study and monitoring of the state of the herd in all farms on the subject of cow disease due to hidden mastitis. An equally interesting direction of future research will be the application of a method that a number of scientists have recently begun to use to more clearly establish a diagnosis of mastitis. The method of differential determination of the number of somatic cells (DSCC) allows determining the contribution of individual categories of cells in NSC (Dal Prà *et al.,* 2022). This approach will be able to more objectively interpret the increase in somatic cells in the milk of animals and distinguish the inflammatory nature of the increase in leukocytes in milk from the increase in the number of epithelial cells in various technological disorders of the milking process. What will become no less important when studying the impact of individual technological methods of preparing animals for milking and processing the udder after it, to clarify the nature of the accumulation of somatic cells in milk and their processes that lie behind them.

The study of the influence of the technological process of obtaining milk raw materials on the bacterial contamination of milk became more predictable. The higher the culture of keeping animals in the farm and observing the rules of sanitary hygiene, the lower was the level of microbial insemination of raw materials.

In a farm with a milking parlour, lower indicators of the content of colony-forming microorganisms in milk were found in comparison with the use of other milking technologies. This fully agrees with the results of the study by O.V. Borodina and D.K. Nosevych (2017), which states that milking in milking parlours using the "Parallel", "Yalynka", "Carousel" type installations in comparison with milking in portable buckets or a milk pipe increases productivity labour of machine milking operators and contributes to the reduction of bacterial contamination of milk.

Moreover, each producer had its own microbiota in the obtained milk raw materials, which at the same time differed significantly in terms of signal microorganisms. Also, in these studies, the influence of procedures related to the preparation of teats and cleaning of milking equipment on the composition and amount of microbiota of raw milk was noted. It was indicated that the number of microorganisms depended precisely on these procedures, and only then on the type of milking system used. In controlled farms, a decrease in the number of microorganisms in the milk of cows whose udders were disinfected before milking in the first farm, and a significantly higher microbial contamination in the wet toilet of the mammary gland in other farms, was also found. Therefore, in order to increase the safety indicators of milk during its production, it is necessary to implement modern approaches to preparing animals for milking and processing the udder after it. The studies also revealed a direct correlational interdependence between the number of somatic cells and the level of microbial contamination of milk obtained by the industrial technology of its production. This fully agrees with the assumption that clinical and subclinical forms of mastitis of bacterial aetiology are the main cause of NSC growth.

Unfortunately, monitoring for hidden inflammation of the mammary gland among farm animals was practised in only one of the farms among which the research was conducted. But even these results confirm the assumptions about the need to control not only the cleanliness of the milking equipment, but also the constant check of the health of the mammary gland in productive cows and their timely treatment. They fully agree with the studies of El-Sh.-N. Mehany *et al.* (2021) and O. Olatoye *et al.* (2018), who also indicate the interdependence between indicators of the number of somatic cells and its bacterial contamination obtained as a result of conducting experiments.

The authors would also like to draw attention to the sphere of milk production in Azerbaijan. Intensive increase in the production and primary processing of milk in the Republic of Azerbaijan is considered one of the main priorities of the development of agriculture. After gaining independence, breeding heifers from foreign countries are imported to the republic annually to increase the production of livestock products, including milk. In order to develop livestock breeding by the order of the President of the Republic of Azerbaijan, funds are regularly allocated from the reserve fund of the President of the Republic of Azerbaijan to JSC "Agroleasing" (Abbasov, 2013). At the expense of these funds, 770 heads were purchased in 2009, 900 heads in 2010, 6630 heads in 2015, 5074 heads of breeding heifers in 2020 and leased to economic entities producing livestock products on 50% preferential terms. The provision of exemplary service to dairy-breeding heifers imported to the republic has a serious positive impact on the country's animal husbandry culture.

The registration of breeding animals with a breeding passport (certificate) is carried out by the State Statistics Committee of the Republic of Azerbaijan once a year. As a result of the stimulating measures implemented by the state for the development of the non-oil sector, in particular, the introduction of new rules for subsidizing livestock, at the expense of highly productive animal breeds imported from abroad, favorable conditions have been created for the operation and development of state breeding enterprises, as well as private dairy farms (Decree of the Cabinet..., 2008).

The main task of the country's meat and dairy enterprises in the modern era should be to ensure the demand of the population for this type of product at the expense of domestic products. The gross agricultural output of the Republic of Azerbaijan in 2021 increased by 6.41% compared to 2003 and amounted to 50.77% in the share of livestock products. In 2021, 37.4% of the total milk volume in the country was produced in the Karabakh, Central Aran and Milsko-Mugan economic regions, which is 832,178 thousand tons. Separately, the Baku Dairy Plant produces 80.4% of the total volume of low-fat dairy products (in terms of milk). The analysis shows that milk processing enterprises operate exclusively on the basis of a large-scale raw material base. Thus, facing milk processing enterprises were organized mainly in the centers of consumption in the east of the republic and near them, and creameries -in the western and mountainous regions -in the raw material zones (The State Statistical Committee of the Republic of Azerbaijan, 2023).

The biggest surprise was the results of research on milk samples from the market, where products from private households were sold. There has always been a stereotype that milk from this category of farms was significantly inferior in quality to milk raw materials obtained from farms with industrial production technology (Maslak *et al.,* 2020). But the conducted studies, on the contrary, revealed that the lowest level of somatic cells was observed in milk from private farms of the population. And this is despite the least technological solutions when obtaining milk. Probably, this is connected with the constant control of the animal owners by the physiological and clinical condition of the animals, as well as regular monitoring of the main

infectious diseases by the state veterinary services. The increase in the level of bacteriological pollution is associated with non-compliance with the temperature regime during the storage and transportation of milk to the places of its sale, which is fully consistent with the reports of K.K. Dash *et al.* (2022). Therefore, taking into account the difficult situation with milk raw materials necessary to ensure the industrial capacity of milk processing farms, milk from this category of farms is quite suitable for further technological processing. It is only required to ensure the conditions for the primary processing of such raw materials.

CONCLUSIONS

As a result of the conducted research and based on the results of previous works of other researchers regarding the study of the influence of a number of technological approaches to the production and primary processing of dairy raw materials on its safety indicators, a number of the following conclusions can be drawn:

In the conditions of industrial milk production, the number of somatic cells, as one of the indicators of the safety of milk raw materials, has a significant impact on technological approaches to the organization of the processes of preparation and milking of cows. The level of somatic cells depends on compliance with the regulations of these procedures, as an indirect indicator of the incidence of hidden forms of mastitis in herd animals. Bacterial contamination of milk, determined by the number of mesophyllic aerobic and facultatively anaerobic microorganisms (NMAFAnM), in all farms that used industrial milk production technology was insignificant and did not exceed normative indicators in any of the seasons of the year. The detected seasonal fluctuations of milk safety indicators were characterized by an increase in the levels of both indicators in the summer period and a decrease in the winter.

A high correlation coefficient was found between the level of microbial contamination of milk and the number of somatic cells in it, with a high probability ($P<0.001$), which indicates a high dependence of safety indicators and their interrelationship. Therefore, measures aimed at improving one of them will be positively noted at the level of another indicator. Milk from private farms of the population had the best safety indicators in terms of somatic cells, but the violation of the requirements of the technology of primary processing of milk (lack of cooling) led to the subsequent growth of microbial cells in it. Therefore, ensuring a stable temperature of milk in the range of +4-+6°C during storage and transportation will allow increasing the amount of high-quality milk raw materials to ensure the capacity of milk processing enterprises.

In the following studies, it is planned to continue the study of the influence of the technological processes of preparing animals for milking and processing the udder after it on the level of somatic cells according to their differential content.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

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Технологія виробництва та первинної переробки молока в умовах фермерського господарства

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Анотація. Запровадження на законодавчому рівні нових критеріїв безпечності молочної сировини, з одного боку, дозволило покращити забезпечення населення якісними продуктами харчування, а з іншого - спричинило зниження прибутковості господарств через погіршення товарності молока та його ціни. Така ситуація в молочному бізнесі вимагає пошуку рішень для товарних господарств щодо можливих шляхів якнайшвидшого покращення показників безпечності молока з метою уникнення подальшого скорочення поголів'я молочної худоби в Україні. Метою досліджень було вивчення технології отримання та окремих елементів первинної переробки молока на кількість соматичних клітин та рівень мікробного обсіменіння молочної сировини. У роботі використовували загальнонаукові методи, арбітражний метод та метод варіаційної статистики. Для цього щоквартально протягом одного року досліджували об'єднані зразки молока з 3 фермерських господарств, які використовували різні підходи до утримання тварин і технології отримання молока від них, та низки особистих господарств населення з метою вивчення динаміки та взаємозв'язків між показниками безпечності сировини. Виявлено значний вплив паратипових факторів на кількість соматичних клітин у молоці, таких як: технологія виробництва молока, сезонність виробництва та рівень захворюваності тварин на приховані форми маститу. При цьому встановлено прямий кореляційний зв'язок між показниками кількості соматичних клітин та мікробного обсіменіння молока на рівні 0,91 ($P<0,001$), що свідчить про те, що заходи, спрямовані на покращення одного з них, автоматично сприятимуть покращенню іншого. Порушення вимог первинної обробки молока спричинило значне зростання мікробного навантаження. Усунення виявлених технологічних недоліків сприятиме збільшенню сировини на молокопереробних підприємствах

Ключові слова: кількість соматичних клітин; сире молоко; мікробне обсіменіння молока; кількість колонієутворюючих одиниць; кореляція