СІЛЬСЬКОГОСПОДАРСЬКІ НАУКИ

Laiter-Moskaliuk C. V.
Candidate of Veterinary Sciences,
Associate Professor at the Department of Animal Hygiene and Veterinary Support of the Cynological Service
of the National Police of Ukraine
Higher Educational Institution "Podillia State University"
Kamianets-Podilskyi, Ukraine
E-mail: *layter.moskalyuk1977@gmail.com*
ORCID: *0000-0001-5662-7636*

Tokarchuk T. S.
Candidate of Agricultural Sciences, Associate Professor,
Associate Professor at the Department of Animal Hygiene and Veterinary Support of the Cynological Service
of the National Police of Ukraine
Higher Educational Institution "Podillia State University"
Kamianets-Podilskyi, Ukraine
E-mail: *ttocarchuk@gmail.com*
ORCID: *0000-0001-6030-0572*

Dymchuk A. V.
Candidate of Agricultural Sciences, Associate Professor,
Associate Professor at the Department of Technology of Production and Processing of Livestock Products
Higher Education Institution "Podillia State University"
Kamianets-Podilskyi, Ukraine
E-mail: *scandinav.23@gmail.com*
ORCID: *0000-0002-7749-9327*

Mizyk V. P.
Assistant at the Department of Veterinary Obstetrics, Internal Pathology and Surgery,
Higher Educational Institution "Podillia State University"
Kamianets-Podilskyi, Ukraine
E-mail: *v.p.mizyk@gmail.com*
ORCID: *0000-0001-8962-8459*

Laiter V. V.
Postgraduate student at the Department of Technology of Production and Processing of Animal Husbandry Products
Higher Educational Institution "Podillia State University"
Kamianets-Podilskyi, Ukraine
E-mail: *laiterslavik@gmail.com*
ORCID: *0009-0002-9382-7383*

ASSESSMENT OF THE SAFETY AND QUALITY OF RAW MILK FOR THE IMPROVEMENT OF TECHNOLOGICAL PROCESSES OF PRIMARY MILK PROCESSING

Abstract

As you know, the quality of milk cannot be improved during its processing, therefore the milk quality management system at production facilities should be focused on high-tech processes of its production. It has been scientifically proven that the process of obtaining and collecting milk, its primary processing, storage and transportation are the least controlled production processes. Therefore, the study of the milking technology impact and primary processing on the quality of the obtained milk remains relevant. An analysis of production and primary processing of milk was carried out at the farm of "Lany Vinkovechchyny" LLC in Khmelnytskyi region, and in order to improve the quality of the obtained milk raw materials, it was proposed to optimize the technology of primary processing of milk, in particular, to supplement the traditional scheme of primary purification with a fine filter. It was established that there is a dependence between the quality of raw milk and the technology of primary processing, so with successive purification of milk with a filter of coarse and then fine purification, the number of mesophilic aerobic and facultatively anaerobic microorganisms (KMAFAnM) in milk was at the level of 228 thousand CFU /cm3, which corresponds to the highest grade, at the same time, during one-time filtration in a closed flow with a coarse filter, the milk contained 332 thousand CFU /cm3, which is according to DSTU 3662:2018. corresponds only to the first kind indicator. After double filtration, only 259,000/cm3 somatic cells were found in the milk samples, which is 27.6% less than in the milk samples that underwent single purification. The proposed measures to improve the quality and safety of raw milk through the consistent use of filters for coarse and fine primary cleaning made it possible to increase the quality of milk and increase financial income for the farm.

Key words: raw cow's milk, quality and safety, primary processing.

Milk is a unique food product that can provide the human body at any age with all the necessary nutrients and is the main part of the diet of most people. The high nutritional and biological value of milk is due to the protein presence, fat, carbohydrates, minerals and various vitamins in it [1, 6, 13]. However, the high quality of dairy products depends on the quality and safety of raw milk, as it is a good nutrient medium for various types of microorganisms [4, 6, 7]. However, raw cow's milk is suitable for processing only if it is obtained in accordance with sanitary and hygienic requirements and meets the indicators of DSTU 3662:2018 "Raw cow's milk" [12]. That is why chemically flawless milk obtained under unsatisfactory sanitary and hygienic conditions can quickly become unsuitable for processing and consumption or even harmful to human health [1, 13, 14]. Research by scientists [1, 3, 6, 7] confirms that the main hygienic parameters that most affect the quality and safety of raw milk when it is received at a processing plant include: excessive general bacterial insemination, excessive content of somatic cells, presence inhibitory substances, added water.

In production farms, there are many routes of mechanical and bacterial contamination of milk, such as the hands and clothing of service personnel, the skin covering, the physiological condition of the cow's udder, the sanitary condition of milking and primary milk processing equipment, the quality of feed, bedding, indoor air, and animal diseases. Therefore, the main prerequisite for obtaining high-quality milk is compliance with sanitary and hygienic standards for keeping cows, feeding, milking and processing milk [14].

Milk is a product in which various microorganisms develop intensively. In order to keep it fresh and deliver it to the consumer, primary processing and processing of milk is carried out on livestock farms, complexes and farms [3, 6].

The purpose of the primary processing of milk is to preserve its primary beneficial properties before selling it to processing enterprises of the dairy industry. The process of primary processing of milk includes several stages, such as cleaning from mechanical impurities (filtering, separation), cooling and storage of milk, transportation and sale [5, 14].

Mechanical pollution (dust, feed particles, wool) has a significant negative impact on the quality of milk during its production. This pollution is also directly related to bacterial contamination of milk, which can lead to a significant deterioration of the technological and sanitary characteristics of milk, which becomes unfavorable for the production of high-quality dairy products. Thus, the main requirements for the primary processing of milk are its mechanical cleaning, including the removal of mechanical and partly bacteriological impurities, which contributes to improving the quality of milk and creating prerequisites for its long-term storage. In addition, it is important to ensure that the milk is cooled to a temperature of +4 to +6 °C and stored at this temperature until it is transported to the milk processing plant. This approach helps to maintain optimal conditions for storing milk before its further processing [2].

The purpose of the work was to conduct a comparative study of the safety and quality indicators of milk-raw material prepared by the traditionally operating technological process of primary processing and with the additional installation of a fine filter.

Presentation of the main research material. Determination of safety and quality indicators of raw milk was carried out at "Lany Vinkovechchyna" LLC of Khmelnytskyi region. The farm practices the stall method of keeping a dairy herd of cattle in typical two-row cowsheds. Cows are milked three times, carried out in the cowshed in the stalls with the help of the UDM 100 milking unit in the milk duct. Milk obtained from cows is sold at Vinkovetsky cheese factory LLC.

Primary processing of milk takes place in the milk block. The premises are divided into three departments: the milk room – where milk is received, filtered, cooled and temporarily stored, the laboratory – where the quality of the received milk is determined, and the washing room – the main purpose of which is the washing and disinfection of milking machines and milk utensils.

The technological process of the primary processing of milk on the farm of the farm takes place in the following sequence: after milking, the milk is transported through the milk pipeline to the dairy, undergoes primary cleaning (filtration in a closed flow under vacuum) and enters the tank of a milk cooler type (DeLaval DX/OC), where it is mixed and cooled up to a temperature of +40 +60 °C and stored for 8-12 hours, and then transported to Vinkovetski cheese plant LLC.

In the process of primary processing of milk, filtering is the first simplest, low-cost, but very necessary cleaning method. For filtering, coarse and fine milk filters are mainly used. Coarse cleaning filters do not ensure complete cleaning of milk from its mechanical impurities, as part of them dissolves and enters the milk together with microorganisms. Such milk quickly loses its bactericidal properties, is poorly stored and loses its quality. Fine filters are more effective in this regard. Their advantage is that they are able to retain small mechanical particles up to 15-20 microns in size. Filtering also reduces the dissolution of mechanical impurities and the washing of bacteria from them into milk.

Taking into account the production and technical data of the farm, in order to improve the primary purification of milk and increase the quality of milk raw materials, it was proposed to introduce a fine filter into the structure of milk primary processing operations (Manufacturer LLC "Agro-Frost", Sumy). The filter was installed after the coolant tank directly in the milk outlet hose immediately after the booster pump.

Organoleptic evaluation of selected milk samples was carried out in accordance with the requirements of DSTU 7357:2013. The analysis of quality parameters of raw milk and its physical and chemical composition, in particular, the fat content, protein, density, SZMZ, titrated acidity and temperature were determined using an ultrasonic milk analyzer EKOMILK M according to DSTU 7057:2009 [9]. The purity of raw milk was determined according to DSTU 6083:2009 [10]. Determination of the grade of raw cow's milk according to physico-chemical, sanitary-hygienic and microbiological quality indicators was carried out in accordance with DSTU 3662-2018 and DSTU 7089:2009. [8,12]. The number of somatic cells in milk was determined using the Prescott-Breed method according to DSTU ISO 13366-1/IDF 148-1:2014 [11].

The analysis of the conducted studies showed that the milk of the selected samples was white in color, with a barely noticeable yellowish tint, which is explained by the consumption of carotene-containing feed by the cows and the high content of milk fat. The milk of all samples had a pleasant milky aroma and smell, mostly sweet, occasionally a sweet-salty aftertaste. The consistency of milk in all samples was uniform, without the presence of extraneous impurities, mucus, flakes or sediment. Milk was not separated into fractions during mixing.

The values of density, protein mass fraction (MCHB), fat (MCH), mass fraction of dry matter (MCHSR) in all experimental samples were almost the same and corresponded to the requirements of the current standard. The index of titrated acidity was higher by 1.1 °T in milk, the primary purification of which was carried out only with a coarse filter, compared to milk with sequential filtration.

When evaluating the purity group, it was found that experimental milk samples taken during successive filtration (coarse filter and then fine filter) had no mechanical impurities. At the same time, there was a noticeable deposit of 1-2 mechanical impurities on the filters where the milk was passed after rough primary cleaning, which in general also corresponds to the 1st purity group.

It is known that not only the degree of purity, but also general microbiological contamination has a significant impact on the quality of milk. From the data in Table 1, it can be seen that during successive purification of milk with a filter of coarse and then fine purification, the number of mesophilic aerobic and facultatively anaerobic microorganisms (KMAFAnM) in milk was at the level of 228 thousand CFU /cm³, which corresponds to the highest grade, in the same time during one-time filtration in a closed flow with a coarse filter, the milk contained 332 thousand CFU/cm³, which is according to DSTU 3662:2018. corresponds only to the indicator of the first kind.

Table 1. Comparative assessment of the selected milk samples according to the main indicators and safety and quality according to DSTU 3662:2018

Indexes	Requirements according to DSTU 3662:2018		Milk for the period of sale	
			Traditionally operating technological process of primary milk purification	Primary cleaning with the sequential use of coarse and fine filters
1	2	3	4	5
Temperature, ºC	extra	6-8	6	6
	upper			
	first			
Density (t 20 °C), kg/m³ not less	extra	1028,0	1027,0±0,06	1027,7±0,06
	upper	1027,0		
	first	1027,0		
Titrated acidity, ºT	extra	16-17	17,8±0,35	16,7±0,05
	upper	16-18		
	first	16-19		

Continuation of Table 1

1	2	3	4	5
Purity group	1		1	1
MCHZH, %	3,4		3,6±0,07	3,6±0,15
MCHB, %	3,0		3,1±0,08	3,09±0,09
MCHSR, %	extra	12,0	11,7±0,087	11,8±0,092
	upper	11,8		
	first	11,5		
KMAFAnM for at a temperature of 30 °C), thousand CFU/cm³	extra	≤100	332±98	228±33
	upper	≤300		
	first	≤500		
Number of somatic cells in thousand/cm³	extra	≤400	358±83,21*	259,6±41,58
	upper	≤400		
	first	≤500		
Added water content, %	0		0	0

Notes: * − p ≤ 0,01; ** − P ≤ 0,001 − regarding farms

Analyzing the data of the conducted research, we can also note that after double filtration, only 259,000/cm³ somatic cells were found in the milk samples, which is 27.6% less than in the milk samples that underwent single purification.

In this way, the microbiological indicators obtained by us clearly show the direct dependence of the raw milk quality on primary processing, namely on the purification degree.

Conclusion. The farm does not have milk of the Extra class, defined in DSTU 3662:2018, according to which extra milk must have a total bacterial contamination of up to 100 thousand/cm³ and ≤400 thousand/cm³ somatic cells. Increasing the quality of milk from the first, higher grade to extra does not require significant costs for equipment or replacement of milking technology, primary processing. This indicator depends on the quality of compliance with hygienic standards in the process of animal care, milking and primary processing.

References

1. Bukalova, N.V., Prylipko, T.M., Bohatko, N.M., Liasota, V.P., Dzhmil, V.I., Utechenko, M.V., & Bohatko, L.M. (2022). Sanitarno-hihiienichnyi kontrol vyrobnytstva moloka-syrovyny koroviachoho ta yoho mikrobiolohichnyi analiz. *Tavriiskyi naukovyi visnyk. Seriia: tekhnichni nauky,* (3), 119–127. https://doi.org/10.32851/tnv-tech.2022.3.13 [in Ukrainian].

2. Danylenko, I. (2000). Teoriia i praktyka okholodzhennia moloka. *Veterynarna medytsyna Ukrainy,* 10, 26–27 [in Ukrainian].

3. Hryshchuk, A.V. (2011). Pro kontrol vyrobnytstva ta zahotivli bezpechnoho ta yakisnoho moloka. *Veterynarna medytsyna Ukrainy,* 8, 32–33 [in Ukrainian].

4. Kasianchuk, V.V., Berhilevych, O.M., Kryzhanivskyi, Ya.Y., & Kukhtyn, M.D. (2006). Orhanizatsiia veterynarno-sanitarnoho kontroliu yakosti ta bezpeky moloka koroviachoho na molochnykh fermakh u vidpovidnosti do pryntsypiv NASSR. *Zbirnyk naukovykh prats Luhanskoho natsionalnoho universytetu.* Luhansk. 65 (68), 96–100 [in Ukrainian].

5. Kozenko, O.V., & Sverhun, Zh.H. (2011). Peredumovy stvorennia systemy nalezhnoi hihiienichnoi praktyky v hospodarstvakh-vyrobnykakh moloka koroviachoho syroho. *Naukovyi visnyk Lvivskoho natsionalnoho universytetu veterynarnoi medytsyny ta biotekhnolohii im. Gzhytskoho.* T. 13, 2 (2), 234–240 [in Ukrainian].

6. Kukhtin, M., Layter-Moskalyuk, S., Tyutyun, A., & Kosyanchuk, N. (2019). Safety and quality of crude cow milk, which made by collective farms. *Ukrainian journal of veterinary sciences*, 10(3), 11–12. https://doi.org/10.31548/ujvs2019.03.010 [in Ukrainian].

7. Kukhtyn, M.D. (2008). Mikrobiolohichni normatyvy efektyvnosti tekhnolohii oderzhannia moloka syroho ekstra-gatunku. *Veterynarna medytsyna Ukrainy*, 2, 45–46 [in Ukrainian].

8. Moloko i molochni produkty. Metodyka pidrakhovuvannia kilkosti mezofilnykh aerobnykh ta fakultatyvno-anaerobnykh mikroorhanizmiv, drizhdzhiv i plisenevykh hrybiv za dopomohoiu plastyn (2010). *DSTU 7089:2009* [Chynnyi vid 2009−10−27]. Kyiv: Derzhspozhyvstandart Ukraine [in Ukrainian].

9. Moloko koroviache syre. Vyznachennia hustyny, masovoi chastky zhyru, bilka, sukhoi rechovyny ta laktozy ultrazvukovym metodom. (2009). *DSTU 7057:2009* [Chynnyi vid 2010−01−01]. K.: Derzhspozhyvstandart Ukrainy, (Natsionalnyi standart Ukrainy) [in Ukrainian].

10. Moloko. Metod vyznachennia chystoty. (2009). *DSTU 6083:2009*. [Chynnyi vid 2009−07−01]. K.: Derzhspozhyvstandart Ukrainy, (Natsionalnyi standart Ukrainy) [in Ukrainian].

11. Moloko. Pidrakhuvannia somatychnykh klityn. Chastyna 1. Mikroskopichnyi (kontrolnyi) metod. (2015). *DSTU ISO 13366-1/IDF 148-1:2014* [Chynnyi vid 2015−07−01]. K.: Minekonomrozvytku Ukrainy, (Natsionalnyi standart Ukrainy) [in Ukrainian].

12. Moloko-syrovyna koroviache. Tekhnichni umovy. (2019). *DSTU 3662–2018* [Chynnyi vid 2019−01−01]. Kyiv: Derzhspozhyvstandart Ukraine [in Ukrainian].

13. Ntuli, V., Sibanda, T., Elegbeleye, J. A., Mugadza, D. T., Seifu, E., & Buys, E. M. (2023). Dairy production: microbial safety of raw milk and processed milk products. *V Present Knowledge in Food Safety* (p. 439–454). Elsevier. https://doi.org/10.1016/b978-0-12-819470-6.00076-7 [in Ukrainian].

14. Ostapiuk, M.P., Kasianchuk, V.V., & Berhilevych, O.M. (2010). Vyvchennia sanitarno-hihiienichnykh umov vyrobnytstva moloka na molochnykh fermakh dlia zabezpechennia umov nalezhnoi hihiieny pratsi. *Naukovyi visnyk LNUVMBT imeni S.Z. Gzhytskoho,* 12, 3(45), 243–248 [in Ukrainian].

15. Varpikhovskyi, R.L. (2019). Mekhanichne zabrudnennia domishkamy moloka yoho bakterialne obsimeninnia ta shliakhy pokrashchennia yakosti moloka. *Ahrarna nauka. Suchasni problemy selektsii ta kharchovi tekhnolohii rozvedennia ta hihiieny tvaryn,* 3 (106), 193–100 [in Ukrainian].

Лайтер-Москалюк С. В.
кандидат ветеринарних наук, доцент,
доцент кафедри гігієни тварин та ветеринарного забезпечення кінологічної служби
Національної поліції України
Заклад вищої освіти «Подільський державний університет»
Кам’янець-Подільський, Україна
E-mail: *layter.moskalyuk1977@gmail.com*
ORCID: *0000-0001-5662-7636*

Токарчук Т. С.
кандидат сільськогосподарських наук, доцент,
доцент кафедри гігієни тварин та ветеринарного забезпечення кінологічної служби
Національної поліції України
Заклад вищої освіти «Подільський державний університет»
Кам’янець-Подільський, Україна
E-mail: *ttocarchuk@gmail.com*
ORCID: *0000-0001-6030-0572*

Димчук А. В.
кандидат сільськогосподарських наук, доцент,
доцент кафедри технології виробництва і переробки продукції тваринництва
Заклад вищої освіти «Подільський державний університет»
Кам’янець-Подільський, Україна
E-mail: *scandinav.23@gmail.com*
ORCID: *0000-0002-7749-9327*

Мізик В. П.
асистент кафедри ветеринарного акушерства, внутрішньої патології та хірургії,
Заклад вищої освіти «Подільський державний університет»
Кам’янець-Подільський, Україна
E-mail: *v.p.mizyk@gmail.com*
ORCID: *0000-0001-8962-8459*

Лайтер В. В.
аспірант кафедри технології виробництва і переробки продукції тваринництва,
Заклад вищої освіти «Подільський державний університет»
Кам’янець-Подільський, Україна
E-mail: *laiterslavik@gmail.com*
ORCID: *0009-0002-9382-7383*

ОЦІНКА БЕЗПЕЧНОСТІ ТА ЯКОСТІ МОЛОКА-СИРОВИНИ ЗА УДОСКОНАЛЕННЯ ТЕХНОЛОГІЧНИХ ПРОЦЕСІВ ПЕРВИННОЇ ОБРОБКИ МОЛОКА

Анотація

Як відомо, якість молока не можна підвищити в процесі його переробки, тому система управління якістю молока на виробничих потужностях повинна бути орієнтована на високотехнологічні процеси його виробництва. Науково доведено, що процес отримання, збору молока, його первинна обробка, зберігання і транспортування є найменш контрольованими виробничими процесами. Тому дослідження впливу технології доїння й первинної обробки на якість отриманого молока залишається актуальним. В господарстві ТОВ "Лани Віньковеччини" Хмельницької області було проведено аналіз виробництва та первинної обробки молока і з метою підвищення якості отриманої молочної сировини запропоновано оптимізувати технологію первинної обробки молока, зокрема, традиційну схему первинної очистки доповнити фільтром тонкої очистки. Уста-

14   *Випуск 1 (42) 2024*
Сільськогосподарські науки   *Issue 1 (42) 2024*
Agricultural sciences

новлено, що існує залежність між якістю сирого молока й технологією первинної обробки. Так при послідовному очищенні молока фільтром грубої, а потім тонкої очистки кількість мезофільних аеробних і факультативно-анаеробних мікроорганізмів (КМАФАнМ) у молоці була на рівні 228 тис. КУО /см³, що відповідає вищому ґатунку, в той же час при разовій фільтрації у закритому потоці фільтром грубої очистки молоко містило 332 тис. КУО /см³, що, згідно з ДСТУ 3662:2018, відповідає лише показнику першого ґатунку. Після подвійної фільтрації у пробах молока було виявлено всього 259 тис./см³ соматичних клітин, що на 27,6 % менше, ніж у пробах молока, яке пройшло разову очистку. Запропоновані заходи щодо підвищення якості та безпечності молока-сировини шляхом послідовного використання фільтрів грубої та тонкої первинної очистки дозволили підвищити ґатунок молока та збільшити фінансові надходження для господарства.

Ключові слова: *молоко коров'яче сире, якість та безпечність, первинна обробка.*

Список використаних джерел

1. Санітарно-гігієнічний контроль виробництва молока-сировини коров'ячого та його мікробіологічний аналіз / Н. В. Букалова та ін. *Таврійський науковий вісник. Серія: технічні науки.* 2022. № 3. С. 119–127. https://doi.org/10.32851/tnv-tech.2022.3.13127. https://doi.org/10.32851/tnv-tech.2022.3.13.

2. Даниленко І. Теорія і практика охолодження молока. *Ветеринарна медицина України.* 2000. № 10. С. 26−27.

3. Грищук А. В. Про контроль виробництва та заготівлі безпечного та якісного молока. *Ветеринарна медицина України.* 2011. № 8. С. 32−33.

4. Організація ветеринарно-санітарного контролю якості та безпеки молока коров'ячого на молочних фермах у відповідності до принципів НАССР. / В. В. Касянчук та ін. *Збірник наукових праць Луганського національного університету.* Луганськ. 2006. № 65 (68) С. 96–100.

5. Козенко О. В., Свергун Ж. Г.. Передумови створення системи належної гігієнічної практики в господарствах-виробниках молока коров'ячого сирого. *Науковий вісник Львівського національного університету ветеринарної медицини та біотехнологій ім. Ґжицького.* 2011. Т. 13, № 2(2). С. 234–240.

6. Safety and quality of crude cow milk, which made by collective farms / M. Kukhtin et al. *Ukrainian journal of veterinary sciences.* 2019. Vol. 10, no. 3. P. 11–12. https://doi.org/10.31548/ujvs2019.03.010.

7. Кухтин М. Д. Мікробіологічні нормативи ефективності технологій одержання молока сирого екстра-ґатунку. *Ветеринарна медицина України.* 2008. № 2. С. 45–46.

8. ДСТУ 7089:2009. Молоко і молочні продукти. Методика підраховування кількості мезофільних аеробних та факультативно-анаеробних мікроорганізмів, дріжджів і плісеневих грибів за допомогою пластин. [Чинний від 2009–10–27]. Вид. офіц. Київ, 2010. 27 с.

9. ДСТУ 7057:2009. Молоко коров'яче сире. Визначення густини, масової частки жиру, білка, сухої речовини та лактози ультразвуковим методом:. – [Чинний від 2010–01–01]. К.: Держспоживстандарт України, 2009. 11 с. (Національний стандарт України).

10. ДСТУ 6083:2009. Молоко. Метод визначення чистоти: [Чинний від 2009−07−01]. К.: Держспоживстандарт України, 2009. 9 с. (Національний стандарт України).

11. ДСТУ ISO 13366-1/IDF 148-1:2014. Молоко. Підрахування соматичних клітин. Частина 1. Мікроскопічний (контрольний) метод: [Чинний від 2015−07−01]. К.: Мінекономрозвитку України, 2015. 18 с. (Національний стандарт України).

12. ДСТУ 3662–2018. Молоко-сировина коров'яче. Технічні умови. Чинний від 2019–01–01. Вид. офіц. Київ, 2019. 22 с.

13. Dairy production: microbial safety of raw milk and processed milk products / V. Ntuli. et al. У Present Knowledge in Food Safety. 2023. P. 439–454. Elsevier. https://doi.org/10.1016/b978-0-12-819470-6.00076-7.

14. Остапюк М. П., Касянчук В. В., Бергілевич О. М. Вивчення санітарно-гігієнічних умов виробництва молока на молочних фермах для забезпечення умов належної гігієни праці. *Науковий вісник ЛНУВМБТ імені С.З. Ґжицького.* Том 12 № 3(45) Частина 4, 2010. С 243–248.

15. Варпіховський Р. Л. Механічне забруднення домішками молока його бактеріальне обсіменіння та шляхи покращення якості молока. *Аграрна наука. Сучасні проблеми селекції та харчові технології розведення та гігієни тварин.* Випуск 3 (106). 2019. С. 193–100.