Ukrainian Journal of Ecology

*Ukrainian Journal of Ecology*, 2020, 10(4), 195-201, doi: 10.15421/2020_188

*ORIGINAL ARTICLE* *UDC 636.034;637.11*

# Assessment of cow lactation and milk parameters when applying various milking equipment

**A.P. Palii[1*], Yu.M. Handola[1], I.O. Shevchenko[1], A.O. Stotskyi[2], O.G. Stotskyi[2], A.I. Sereda[1], D.A. Levkin[1], L.G. Ulko[2], O.I. Shkromada[2], A.P. Paliy[3]**

*[1]Kharkiv Petro Vasylenko National Technical University of Agriculture*
*44 Alchevskih St., Kharkiv, 61002, Ukraine.*
*[2]Sumy National Agrarian University*
*160 Gerasim Kondratiev St., Sumy, 40000, Ukraine.*
*[3]National Scientific Center «Institute of Experimental and Clinical Veterinary Medicine»*
*83 Pushkinska St., Kharkiv, 61023, Ukraine.*
**Corresponding author E-mail: paliy.andriy@ukr.net*
***Received: 20.08.2020. Accepted 22.09.2020***

Improving the composition and quality of milk is ensured by a systematic monitoring the health of animals in the herd, feeding conditions and their maintenance, introduction of new technical means of production and effective methods of milking. Thus, we found that the rate of full lactation in cows during milking with the 'DeLaval' milking unit was 73.8%, while when milking at the installation ADM-8A it was 73.5%. Milking with the 'DeLaval' equipment with asynchronous milking mode had a positive effect on the quality of cow's milk: milk with a fat content of 4.17±0.01% was obtained, which is 0.27% more than when using ADM-8A (3.90±0.01%); a higher protein content in the milk of cows (3.32%) was detected, which is 0.09% higher than in milk obtained using a milking machine ADM-8A (3.23%); milk that contained more dry skim milk residue by 0.1% - 9.23% was obtained, against 9.13% obtained with the ADM-8A installation. A method for classifying the milk pipe-lines of milking parlors according to the destabilization of fat globules in milk at the level of <2%, 2-4%, 5-6% and >6% with the awarding of I, II, III and IV classes, respectively, has been developed.
**Keywords:** cow; lactation; milking process; milk quality; milking equipment; score

## Introduction

Dairy farming is a very important part of agricultural production in general. The results of its operation have a significant impact on the development of many branches of the agro-industrial subcomplex. It is possible to increase the efficiency of the manifestation of the genetic potential of dairy cows by ensuring a full-fledged secretion process of the udder and milk yield. The manufacturability of milking equipment is crucial. In recent years, the saturation of the market with a large variety of milking equipment, both domestic and foreign, makes it difficult to choose it for use in dairy farming. The information available in the literature on the testing of different milking parlors does not provide a comparative assessment of the use of previously and currently produced domestic and modern imported milking equipment (Dmytriv et al., 2018; Paliy et al., 2020).

Technological operation of a healthy lactating cow as a physiological machine for milk production requires special control of conditions for the full implementation of appropriate processes in the body to convert nutrients from the feed into the most perfect food for humans - milk (Paliy, 2016).

The biological potential of the animal provides the largest number of products and depends on the age of the animal, its breed, genetic potential, the degree of compliance of technical means of animal physiology, completeness of feeding and housing conditions, microclimate factors and inadequate influences (Ivanyos et al., 2020; Kitikov & Romaniuk, 2017; Palii et al., 2020a).

In order for machine milking not to have a negative effect on the animal's body, it is necessary to take into account the physiology of letting down of milk. Milk ejection from the udder during milking a cow is rather a complicated process. It involves the nervous system, endocrine glands and muscles. In order for them to interact, the cow must be prepared for milking: washed and massaged (Bondan et al., 2019; Paliy, 2019).

The correct implementation of the technological process of milking plays the leading role in obtaining high-quality milk. It depends on many factors (Odorcic et al., 2019; Palii & Palii, 2019; Silva et al., 2019). The main ones are: effective stimulation of milk production and complete letting down of milk from the cow's udder without manual addition; the effect on the cow's udder close to those natural actions of a calf during suckling; the ability to adjust the air vacuum, compression of the teat, the frequency of pulsations and the size of the teat rubber depending on the physiological state of the cow; milking machines and devices should not cause pathological irritation of teats and udders; elimination of the possibility of crawling milking cups during milking on the udder and squeezing the upper limb of the teat canal; automated shutdown of milking cups with complete milking of the cow and ensuring complete safety for animals in case of accidental overheating of milking cups on the teats of the udder; simplicity of design of milking installation, quietness of its work; good appearance of the installation; high operational reliability of milking installation and simplicity of its service.

The efficient milk ejection is one of the important points related to milking techniques and procedures. Effective milk ejection affects milk yield and milk composition, in particular fat content (Argov-Argaman, 2019; Couvreur & Hurtaud, 2017). The trends of strengthening the requirement for the quality of milk necessitate the improvement of the processes of its production and revision of a number of scientific provisions for the production of high quality products with a simultaneous transition to stricter regulations for determining its quality indicators (Nam, 2017). Thus, it turns out that modern milking equipment should eliminate the harmful effects of the machine on the animal's body, maximally promote the physiological processes of milk production and ensure high quality milk. Due to the growing requirements for milk quality (fat and protein content, purity, bacterial contamination, somatic cell count), the issue of modernization of milking equipment is currently of paramount importance.

Therefore, the issue of increasing the productivity of the dairy herd and milk quality through the use of modern, innovative high-tech conditions of keeping and milking, which will contribute to the development of the industry, its competitiveness in domestic and foreign markets has remained urgent.

## Materials and Methods

The research was carried out on the state experimental farm Gontarivka, IT NAAS of Kharkiv region. The material for the research was the data of primary zootechnical, veterinary and breeding records. In particular, we used the data of breeding records: cards of breeding cows and summary information. The evaluation of milk productivity of cows for a number of lactations using 'DeLaval' and ADM-8A milking equipment, the rate of lactation stability and the nature of lactation curves.

When tracing the lactation curve, milk yield for the first 305 days of lactation was used, not taking into account milk in the next period. The distribution of milk of daily milkings according to the months of lactation was taken as a basis. To study the milk productivity of cows in terms of lactation (first, third and highest), respectively (Ovsjannikov, 1976), two groups of analog pairs were formed. Each group included 97 cows, taking into account the linear affiliation, at the age of at least three lactations. Milking of cows in terms of lactation was analyzed for 305 days or for reduced lactation, but not less than for 240 days.

To study the quality of milk during milking cows on different milking equipment, two groups of cows of 17 heads each were formed. The groups were formed taking into account linear affiliation, milk productivity and age of calving, respectively (Ovsjannikov, 1976). To determine the quality of milk the 'Ecomilk' device KAM 98-2A № 271001/04 according to GOST 23453-90 and GOST 30518-97 was used. The amount of milk required for analysis was 25 $cm^3$. Milk samples from cows were taken in special cups monthly during control milkings during the year. Before checking the milk on the 'Ecomilk' analyzer, it was thoroughly mixed to distribute the fat evenly.

The results were presented like arithmetic mean (X), the deviation of the parameters from the arithmetic mean error ($S_X$) and the validility of the difference (P).

## Results and Discussion

Milk productivity of cows is characterized by the rate of the lactation curve, which graphically shows the nature of the distribution of milk by lactation months. Therefore, the work on the creation and improvement of breeds of cattle has always paid great attention to the uniformity of lactation. Uniform lactation indicates good development of the mammary gland in cows and its ability to produce a lot of milk. The nature of the lactation curve is a hereditary trait, but, according to some authors (Ignacio et al., 2018), it is prone to change as a result of various factors. The type of lactation curve, which is closely related to the milk productivity of cows, most fully reflects the nature of lactation. The authors (Gorbatenko & Gyl', 2006) identified four types of lactation curves: Type I - strong stable lactation activity with high milk yields; Type II - strong but unstable lactation activity, which decreases after obtaining a higher milk yield and rises again in the second half of lactation (two-peak lactation curve); Type III - high, but unstable, rapidly declining lactation; Type IV - stable low lactation.

Since the conditions of feeding and keeping cows were the same, the type of lactation curves when milking them at different milking parlors was identical (Type III - high, but unstable, rapidly declining lactation). The difference was in the level of milk productivity per lactation, which was higher when using 'DeLaval' milking equipment.

During the study, the indices of the shape of the lactation curve were calculated according to the empirical formula (Kramarenko, 2008). Thus, the parameters of completeness of lactation (ICL) were determined: the ratio of the average daily milk yield per lactation to the higher daily milk yield, multiplied by 100%.

The ICL for cows during milking with the 'DeLaval' milking plant was 73.8%, and during milking at the installation ADM-8A it was 73.5%, i.e. almost equal values. This is due to the fact that the conditions of feeding and keeping and the specifics of breeding work with the herd do not differ.

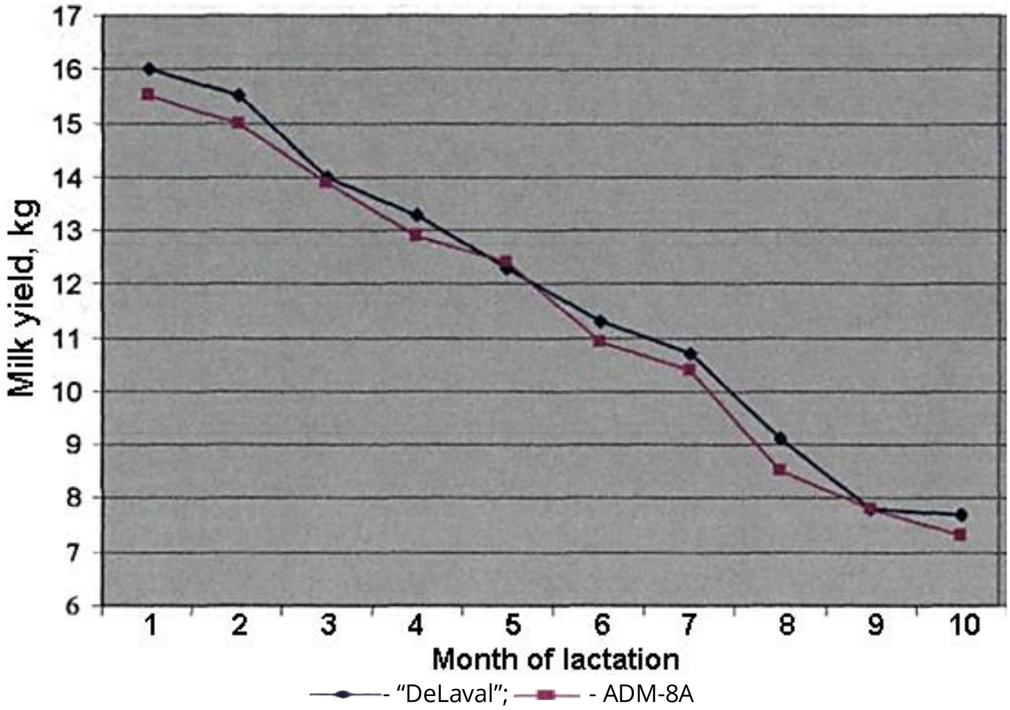


**Fig. 1.** Cows milk yeild obtained with various milking equipment.

To carry out the research on the quality of cow's milk during milking with different milking equipment, two groups of cows were formed by the method of analog pairs. The milk from each cow was examined monthly during the experimental period, then the average values were calculated (Table 1).

**Table 1.** Qualitative parameters of cow's milk when milking with various milking equipment.

| Milk parameters | ADM-8A | 'DeLaval' |
|---|---|---|
| Fat, % | 3.90±0.01 | 4.17±0.01*** |
| Protein, % | 3.23±0.02 | 3.32±0.02** |
| Skim solids, % | 9.13±0.05 | 9.23±0.03 |
| Density, °A | 31.31±0.17 | 31.36±0.15 |
| Freezing point, °C | -0.61±0.45 | -0.60±0.35 |

** - P<0,01; *** - P<0,001

The research revealed differences in the quality of cow's milk when using various milking equipment. The introduction of the 'DeLaval' milking parlors allowed to ensure proper completeness of milking and to obtain milk with a higher content of fat and protein. Analysis of the quality of the milk revealed an increased content of skim dried residues in the milk of cows that were milked on imported equipment.

During the experimental period it was found that: when milking cows at the 'DeLaval' milking plant milk with a fat content of 4.17±0.01% on average was received, while when milking with ADM-8A, fat content was 3.90±0.01%, i.e. 0.27 % (P<0.001) less. The content of dry skim milk residue in the milk of cows when using various milking equipment was 9.13% (ADM-8A) and 9.23% ('DeLaval'). The density of milk was almost the same (31.31°A when milking at the ADM-8A equipment, and 31.36°A when milking at the 'DeLaval' plant). The cows had a higher protein content in milk by 0.09% (P<0.01) during milking on the 'DeLaval' plant in comparison with domestic ADM-8A, 3.32% and 3.23%, respectively.

During the study, the milk of cows in both groups was tested for the presence of water at the freezing point. The freezing point of milk in groups of cows milked on a domestic installation was -0.605 and in those on imported 'DeLaval' plant it was -0.597. These figures in both cases are within normal limits. The freezing point of milk is the only reliable parameter for checking milk for dilution with water. In different cows, the freezing point of milk varies from -0.54 to -0.59.

Thus, the studies show higher milk yields of cows when using the 'DeLaval' milking equipment in comparison with the domestic installation ADM-8A. There is also an advantage in the fat content in milk when using the 'DeLaval' milking machine. The fat content in the milk of cows in the months of the first lactation when using different milking equipment is presented in Fig. 2.

It can be noted that the fat content in the milk of cows milked on different installations during the 1-2 months of the first lactation was almost the same. However, from the 3rd month of lactation due to more complete milking, a higher percentage of fat in the milk of cows during milking on the 'DeLaval' milking equipment was obtained. The same fat content during the 1-2 months of the first lactation is explained by the fact that cows after the first calving are milked in a separate group, where milking is made with the domestic installation ADM-8A.

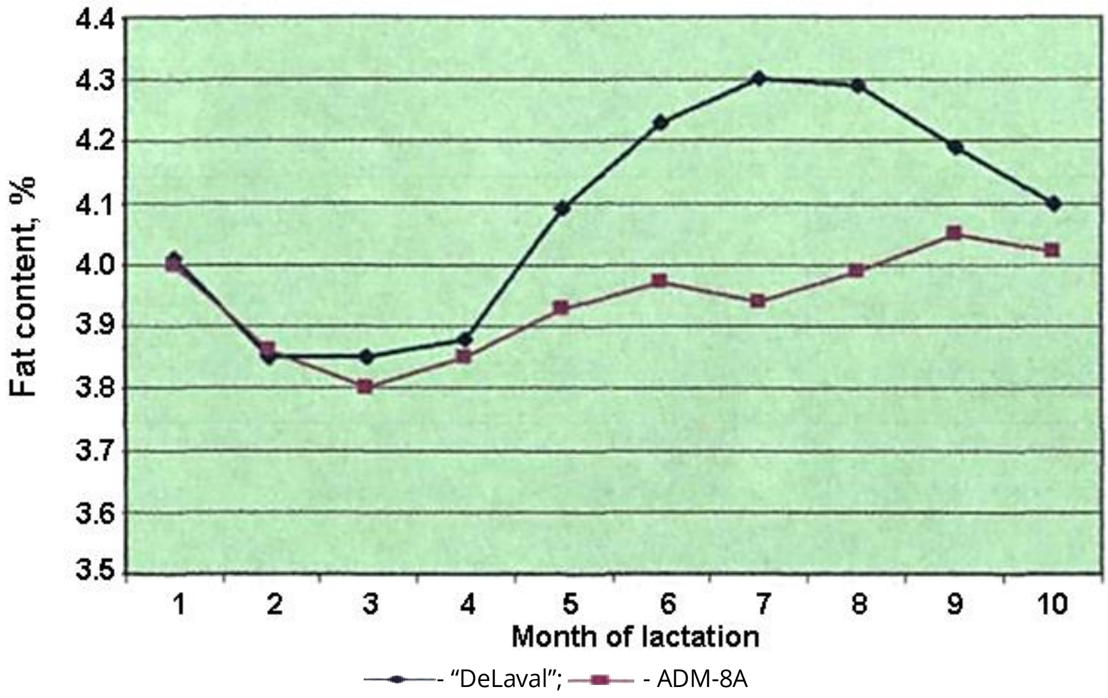


**Fig. 2.** Milk fat content during the first lactaion, %.

When milking cows with the 'DeLaval' milking plant for almost all months of the first lactation more milk fat was received than when using ADM-8A. In our opinion, it is necessary to detail milking machines with a milk pipe-line with the characteristics of the effect on the quality of milk of its individual components on the basis of new innovative techniques in order to improve the quality of milk. Milk pipe-lines are used to transport milk, they are made of different materials, they also have different lengths and inner diameter and surface profile.

To classify the milk pip-lines of milking parlors, a method has been developed, which is carried out as follows: milking cows is provided with a milking machine, which is equipped with an individual meter with a beaker. These meters are installed at the level of the milk pipe-line. The meters have a graduated beaker, where milk is directed, which moves in a stream from the collector of the device to the milk pipe-line, in strict proportion to its quantity, forming an average milk sample by the end of milking.

At the end of the milking process, milk, which characterizes its quantity and average composition, is accumulated in the beaker. Next, from the meter, the product is transported directly during milking through the milk pipe-line through its communications into the cooling tank. Milk samples are collected from the beakers of individual meters from all milking cows into one container, mixed and the average milk sample is taken before moving it along the milk pipe-line. Subsequent transportation of milk is performed on the milk pipe-line of the milking parlor into the cooling tank, from which a milk sample is also taken, but only after passing through the milk pipe-line. Then the mass fraction of fat in milk samples is determined before transportation ($F^{BT}$) and after transportation ($F^{AT}$) on the milk pipe-line of the milking parlor and taking into account these parameters calculate the destabilization index of fat particles in milk ($D$) according to which the milk line is classified. The interpretation of the obtained data is carried out according to Table 2.

**Table 2.** Classification of pipe-lines on milking pants.

| Class of milking pipe-line | Index of destabilization of fat globules in milk (D), % |
|---|---|
| I - excellent | <2 |
| II - good | 2-4 |
| III - satisfactory | 5-6 |
| IV - unsatisfactory | >6 |

Provided that the index of destabilization of fat globules ($D$) is <2%, the milk line is classified as Class I (excellent) - the highest preservation of fat content. If the destabilization index of fat globules ($D$) is 2-4%, the milk line is classified as class II (good) - high fat content. If the destabilization index of fat globules ($D$) is 5-6%, the milk line is assigned class III (satisfactory) - the average preservation of fat content. If the destabilization index of fat globules ($D$) is > 6%, the milk line is assigned to class IV (unsatisfactory) - low fat content. In addition, a high positive correlation (r = +0.998) was found between the class of the milk pipe-line and the index of destabilization of fat globules in milk. As a result, a 4-point classification of the milk pipe-lines of milking plants according to the index of fat ball destabilization was developed.

Therefore, in order to improve the quality and efficiency of milk production, it is necessary to classify milk pipe-lines of milking parlors with a milk line according to the developed method, which afford ground for the reconstruction of milk lines and raising their class to I.

The degree of hydromechanical effect on such important parameters of milk quality as the dispersed composition and structure of fat globules depends on the speed and acceleration of the flow, configuration and condition of the surface of communications. The hydromechanical effect on fat globules in the flow of moving milk is due to the shear stress caused by the action of vortices in the turbulent flow. Since the composition of milk is a complex dispersed system, the components of which have different properties, under the influence of significant inertial forces characteristic of the unstable flow regime, there is an intensification of mutual collisions of air bubbles in fresh milk and fat particles of different size. During transportation, the milk-air mixture is subjected to intense mechanical shocks, mixing and is accompanied by foaming.

The combined effect of these factors changes the dispersed state of the fat phase, forming milk grains and pieces of fat that settle on the inner surfaces of the pipes. When milking a group of cows of 80 heads on the ADM-8A unit, the fat content of the average sample milk, which was taken from the collection tank from all individual milk meters before transportation through the milk pipe-line ($F^{BT}$), was 4.0%. The fat content of the milk sample, which was taken from the milk tank after transportation along the milk line of the milking parlor ($F^{AT}$), was 3.9%.

The destabilization index of fat particles ($D$), according to the developed method, is calculated according to the formula:

$$D = \frac{F^{BT} - F^{AT}}{F^{BT}} \times 100\%$$

The destabilization index of fat globules $D$ is 2.6%. It is more than the standard for class I. Therefore, the milk transporting pipe system of the milking plant ADM-8A has a good degree of preservation of milk fat in the product and it corresponds to class II.

When milking a group of cows of 80 heads into the milk pipe-line of the 'DeLaval' plant, the fat content of average milk sample, which was taken from the collecting tank before the transportation through the milk pipe-line from all individual milk meters ($F^{BT}$) was 4.25%. The fat content of the milk sample after transportation through the milk pipe-line of the milking parlor ($F^{AT}$) was at the level of 4.17%. Thus, the index of destabilization of fat globules is equal to 1.9%, which corresponds to the standard of class I (<2%). Therefore, the milk system provides a high degree of preservation of milk fat in the product.

Studies have shown that milking parlors used for milking cows in the basic farm have an excellent and good degree of preservation of milk fat in milk, which fully meets the requirements of regulatory documents for technical systems in dairy farming.

Some authors (Nanka et al., 2018; Paliy et al., 2018) note a change in the composition of milk when using different milking parlors. Research data (Tyapugin et al., 2015) confirm that the technique of milking cows affects the composition and properties of milk. If all the rules and modes of milking are observed, taking into account the physiology of milk letting down, the content of skim milk dry residue, fat and protein in milk significantly increase. It is important for machine milking that the conditioned and unconditioned factors that cause the lactation reflex are interrelated and they ensure its full manifestation only when present all together (Palii et al., 2020d). Therefore, the design of milking parlors, devices and milking technology should provide maximum stimulation of conditioned and unconditioned reflexes of milk letting down in cows. With such functioning of physiological processes, the animal can fully realize its genetic potential. Thus, the quality of cow's milk depends on the milking equipment used. The introduction of the 'DeLaval' milking parlor made it possible to obtain cow's milk with a higher fat content. The fat content in the milk of cows increases due to the completeness of milking cows, due to additional udder massage (asynchronous milking) and due to fewer connections in the milk pipe-line which has an internal polishing and a larger diameter.

The generalized indicator that characterizes the milk productivity of animals according to the basic criteria is determined by the factors of realization of the biopotential of the animal for production and use of energy resources (Habtamu et al., 2018; Palii et al., 2020b).

Therefore, taking into account the importance of state variables in achieving the required quantity and quality of products, information on the characteristics of mechanization, physiological growth of animals, generalized parameters characterizing the quality of products and milk productivity of animals will be of key importance.

Milk, as a food product and raw material for dairy production, is valuable only if it is fresh and of high quality. The quality of milk largely depends on strict compliance with technological requirements throughout the chain of production processes, from animal husbandry to the sale of finished products - delivery to the consumer (Mishra et al., 2020; Palii et al., 2019b). Achieving high results in improving the composition and quality of milk is provided by an end-to-end solution. This includes the account of hereditary factors (breed structure), systematic monitoring the state of health of animals in the herd, conditions of feeding and their keeping, introduction of new technical means into the technology of production, effective milking methods, primary processing, transportation of milk, sanitary and hygienic service of milking and dairy equipment, as well as advanced training of employees of complexes (Palii et al., 2020c; Shtepa et al., 2020).

The chemical composition of cow's milk is not constant and depends on a number of factors: lactation period, breed, age, feeding ration, housing and milking conditions, animal health, etc. Under the influence of these factors, the physicochemical, organoleptic, and technological properties of milk change (Paliy, 2016). Thus, the largest share (more than 85%) of milk is water, and other components (proteins, lipids, carbohydrates, minerals, etc.), which are part of the dry matter, account for only 11- 13%. The content of the main components of milk solids is interrelated.

At the current stage of operation of dairy complexes there are high requirements for milk production of proper quality, which requires farms to constantly improve facilities, timely replacement and modernization of obsolete and physically worn equipment, introduction of new technologies, integration of production processes, training, etc. (Silva et al., 2016). The introduction of advanced equipment allows to fully realize the genetic potential of animals, maintain the health of the cow and obtain high quality milk. The most promising areas in the mechanization of milking cows are automation of the milking plant modes with maximum consideration of animal physiology, improvement of milking plants and stabilization of the vacuum in milking parlors (Ferneborg et al., 2016; Jacobs & Siegford, 2012).

One of the main tasks of increasing the milk productivity of cows is to create optimal conditions for their maintenance, which increase the use of genetic potential of animals based on the implementation of engineering solutions (Shortall et al., 2016). When choosing the technology and technical means to increase the milk productivity of animals, it is advisable to realize their biopotential with limited energy consumption and minimal impact on the finished product (Fischer et al., 2015; Guarin & Ruegg, 2016; Palii et al., 2019a).

Modern crisis phenomena in domestic dairy farming have led to a decrease in production and decrease of product quality. The problem of sanitary quality of milk has become especially urgent right now due to the relatively high profitability of dairy production, which requires milk with high technological performance (Shkromada et al., 2019). Thus, the priority task for the specialists and scientists engaged in the dairy industry for the stable supply of dairy products to the population is to create specialized dairy complexes for milk production, where the technology of its production, machinery and equipment would meet modern European standards and ensure high quality and profitable milk.

## Conclusion

The introduction of modern milking equipment did not affect the nature of lactation of cows. The rate of completeness of lactation in cows during milking at the 'DeLaval' milking plant was 73.8% and during milking at the installation ADM-8A it was73.5%. Milking with the 'DeLaval' equipment had a positive effect on the quality of cow's milk: milk with a fat content of 4.17±0.01% was obtained, which is 0.27% ($P<0.001$) more than when using ADM-8A (3.90±0.01%); a higher protein content in the milk of cows (3.32%) was detected, which is 0.09% ($P<0.05$) higher than in milk obtained using a milking machine ADM-8A (3.23%); milk that contained more dry skim milk residue by 0.1% - 9.23% was obtained, against 9.13% obtained with the ADM- 8A installation. A method for classifying the milk line of milking parlors according to the destabilization of fat globules in milk at the level of <2%, 2-4%, 5-6% and >6% with the awarding of I, II, III and IV classes, respectively, has been developed.

## References


Argov-Argaman, N. (2019). Symposium review: Milk fat globule size: Practical implications and metabolic regulation. Journal of Dairy Science, 102(3), 2783-2795. https://doi.org/10.3168/jds.2018-15240

Bondan, C., Folchini, J. A., Noro, M., Machado, K. M., Muhls, E., & González, F. H. D. (2019). Variation of cow's milk composition across different daily milking sessions and feasibility of using a composite sampling. Ciancia Rural, 49(6), e20181004. https://doi.org/10.1590/0103-8478cr20181004

Couvreur, S., & Hurtaud, C. (2017). Relationships between milks differentiated on native milk fat globule characteristics and fat, protein and calcium compositions. Animal, 11(3), 507-518. doi:10.1017/S1751731116001646

Dmytriv, V., Dmytriv, I., Lavryk, Y., & Horodeckyy, I. (2018). Models of adaptation of the milking machines systems. BIO Web of Conferences, 10(9), 02004. doi:10.1051/bioconf/20181002004

Ferneborg, S., Stadtmüller, L., Pickova, J., Wiking, L., & Svennersten-Sjaunja, K. (2016). Effects of automatic cluster removal and feeding during milking on milking efficiency, milk yield and milk fat quality. Journal of Dairy Research, 83(2), 180-187. doi:10.1017/S0022029916000170

Fischer, W. J., Schilter, B., Tritscher, A. M., & Stadler, R. H. (2015). Contaminants of Milk and Dairy Products: Contamination Resulting from Farm and Dairy Practices. Reference Module in Food Sciences. Elsevir, 1-13. http://dx.doi.org/10.1016/B978-0-08-100596-5.00698-3

Gorbatenko, I. Ju., & Gyl', M. I. (2006). Biologija produktyvnosti sil's'kogospodars'kyh tvaryn. Navchal'nyj posibnyk. Mykolai'v. ISBN 966-8205-35-9. (In Ukrainian)

Guarin, J. F. & Ruegg, P. L. (2016). Short communication: Pre- and postmilking anatomical characteristics of teats and their associations with risk of clinical mastitis in dairy cows. Journal of Dairy Science, 99, 8323-8329. doi:10.3168/jds.2015-10093

Habtamu, L. D., Ashenafi, M., Taddese, K., & Berhanu, K. (2018). Improving milk safety at farm-level in an intensive dairy production system: relevance to smallholder dairy producers. Food Quality and Safety, 2(3), 135-143. https://doi.org/10.1093/fqsafe/fyy009

Ignacio, M. L., Isabel-Maria, O. R., & Carmelo, R. T. (2018). A study of lactation curves in dairy cattle using the optimal design of experiments methodology. Italian Journal of Animal Science, 18(1), 594-600. doi:10.1080/1828051X.2018.1548913

Ivanyos, D., Monostori, A., Németh, C., Fodor, I., & Ózsvári, L. (2020). Associations between milking technology, herd size and milk production parameters on commercial dairy cattle farms. Mljekarstvo, 70(2), 103-111. doi:10.15567/mljekarstvo.2020.0204

Jacobs, J. A., & Siegford, J. M. (2012). Invited review: The impact of automatic milking systems on dairy cow management, behavior, health, and welfare. Journal of Dairy Science, 95(5), 2227-2247. https://doi.org/10.3168/jds.2011-4943

Kitikov, V., & Romaniuk, W. (2017). The influence natural and industrial factors on the efficiency of the dairy industry. De Gruyter open. Agricultural Engineering, 21(2), 91-100. doi:10.1515/agriceng-2017-0019

Kramarenko, S. S. (2008). Vykorystannja matematychnoi' modeli Vuda dlja ocinky laktacijnyh kryvyh koriv riznyh ekogenotypiv. Tavrijs'kyj naukovyj visnyk, 58, 237-243. (In Ukrainian)

Mishra, A., Khatri, S., Jha, S., & Ansari, S. (2020). Effects of Milking Methods on Milk Yield, Milk Flow Rate, and Milk Composition in Cow. International Journal of Scientific and Research Publications (IJSRP), 10(1), 9765. doi:10.29322/IJSRP.10.01.2020.p9765

Nam, I. (2017). Effects of HACCP System Implementation on Reproduction, Milk Quality, and Milk Sanitation on Dairy Farms in Korea. Emirates Journal of Food and Agriculture, 29(9), 685-689. doi:https://doi.org/10.9755/ejfa.2017.v29.i9.98

Nanka, O., Shigimaga, V., Paliy, A., Sementsov, V., & Paliy, A. (2018). Development of the system to control milk acidity in the milk pipeline of a milking robot. Eastern-European Journal of Enterprise Technologies, 3/9(93), 27-33. doi:10.15587/1729-4061.2018.133159

Odorcic, M., Rasmussen, M., Paulrud, C., & Bruckmaier, R. (2019). Review: Milking machine settings, teat condition and milking efficiency in dairy cows. Animal, 13(S1), 94-99. doi:10.1017/S1751731119000417

Ovsjannikov, A. I. (1976). Osnovy opytnogo dela v zhivotnovodstve. Moskva: Kolos. (In Russian)

Palii, A. P., Admina, N. G., Mihalchenko, S. A., Lukyanov, I. M., Denicenko, S. A., Gurskyi, P. V., Paliy, A. P., Kovalchuk, Y. O., Kovalchuk, V. A., Kuznietsov, O. L., Gembaruk, A. S., & Solodchuk, A. V. (2020a). Evaluation of slaughter cattle grades and standards of cull cows. Ukrainian Journal of Ecology, 10(1), 162-167. doi:10.15421/2020_26

Palii, A. P., Holovatiuk, A. A., Pushka, O. S., Pushka, I. M., Oliadnichuk, R. V., Kravchenko, V. V., & Voitik, A. V. (2019a). Biotechnical aspects of the feeding heifer full-purpose courses of different granulometric composition. Ukrainian Journal of Ecology, 9(2), 81-90

Palii, A. P., Mihalchenko, S. A., Chechui, H. F., Reshetnichenko, A. P., Rozum, Y. E., Bredykhin, V. V., Bogomolov, O. V., Denicenko, S. A., Mitiashkina, T. Y., Sychov, A. I., Savchenko, V. B., Levkin, D. A., & Paliy, A. P. (2020b). Milking and udder health assessment in industrial farming. Ukrainian Journal of Ecology, 10 (2), 375-381. doi:10.15421/2020_112

Palii, A. P., Nanka, O. V., Naumenko, O. A., Prudnikov, V. G., & Paliy, A. P. (2019b). Preconditions for eco-friendly milk production on the modern dairy complexes. Ukrainian Journal of Ecology, 9(1), 56-62.

Palii, A. P., & Palii, A. P. (2019). Technical and technological innovations in dairy cattle. Monograph. Kharkiv: Mis'kdruk. ISBN 978-617-619-207-7 (In Ukrainian)

Palii, A. P., Paliy, A. P., Rodionova, K. O., Zolotaryova, S. A., Kushch, L. L., Borovkova, V. M., Kazakov, M. V., Pavlenko, I. S., Kovalchuk, Y. O., Kalabska, V. S., Kovalenko, O. V., Pobirchenko, O. M., & Umrihina, O. S. (2020c). Microbial contamination of cow's milk and operator hygiene. Ukrainian Journal of Ecology, 10(2), 382-387. doi:10.15421/2020_113

Palii, A. P., Shkromada, O. I., Todorov, N. I., Grebenik, N. P., Lazorenko, A. B., Bondarenko, I. V., Boyko, Y. A., Brit, O. V., Osipenko, T. L., Halay, O. Yu., & Paliy, A. P. (2020d). Effect of linear traits in dairy cows on herd disposal. Ukrainian Journal of Ecology, 10(3), 88-94. doi:10.15421/2020_138

Paliy, A., Nanka, A., Marchenko, M., Bredykhin, V., Paliy, A., Negreba, J., Lazorenko, L., Panasenko, A., Rybachuk, Z., & Musiienko, O. (2020). Establishing changes in the technical parameters of nipple rubber for milking machines and their impact on operational characteristics. Eastern-European Journal of Enterprise Technologies, 2/1(104), 78-87. https://doi.org/10.15587/1729-4061.2020.200635

Paliy, A. P. (2016). Innovative foundations for the production of high-quality milk. Monograph. Kharkiv: Mis'kdruk. ISBN 978-617-619-188-9 (In Ukrainian)

Paliy, A. P., Nanka, O. V., Lutcenko, M. M., Naumenko, O. A., & Paliy, A. P. (2018). Influence of dust content in milking rooms on operation modes of milking machine pulsators. Ukrainian Journal of Ecology, 8(3), 66-70.

Paliy, A. P. (2019). Research of technological methods for preparing highly productive cows for milking. Scientific and Technical Bulletin, 121, 181-190. https://doi.org/10.32900/2312-8402-2019-121-181-190

Shkromada, O., Skliar, O., Paliy, A., Ulko, L., Gerun, I., Naumenko, O., Ishchenko, K., Kysterna, O., Musiienko, O., & Paliy, A. (2019). Development of measures to improve milk quality and safety during production. Eastern-European Journal of Enterprise technologies (Technology and equipment of food production), 3/11(99), 30-39. doi:https://doi.org/10.15587/1729-4061.2019.168762

Shortall, J., Shalloo, L., Foley, C., Sleator, R. D., & O'Brien, B. (2016). Investment appraisal of automatic milking and conventional milking technologies in a pasture-based dairy system. Journal of Dairy Science, 99(9), 7700-7713. doi:10.3168/jds.2016-11256

Shtepa, V., Plyatsuk, L., Ablieieva, I., Hurets, L., Sherstyuk, M., & Ponomarenko, R. (2020). Substantiation of the environmental and energy approach of improvement of technological regulations of water treatment systems. Technology audit and production reserves, 1/3(51), 11-17. doi:10.15587/2312-8372.2020.196948

Silva, B. P., Reinemann, D. J., & Upton, J. (2019). Effect of teatcup removal settings on milking efficiency and milk quality in a pasture-based automatic milking system. Journal of Dairy Science, 102(9), 8423-8430. https://doi.org/10.3168/jds.2018-15839

Silva, S. D., Kanugala, K., & Weerakkody, N. (2016). Microbiological quality of raw milk and effect on quality by implementing good management practices. International Conference of Sabaragamuwa University of Sri Lanka, 92-96. doi:10.1016/j.profoo.2016.02.019

Tyapugin, E. A., Tyapugin, S. E., Simonov, G. A., Uglin, V. K., Nikiforov, V. E., & Serebrova, I. S. (2015). Comparative evaluation of technological factors affecting milk production and quality with various milking technologies. Russian Agricultural Sciences, 41(4), 266-270. https://doi.org/10.3103/S1068367415040199

*Citation:*
Palii, A.P., Handola, Yu.M., Shevchenko, I.O., Stotskyi, A.O., Stotskyi, O.G., Sereda, A.I., Levkin, D.A., Ulko, L.G., Shkromada, O.I., Paliy, A.P. (2020). Assessment of cow lactation and milk parameters when applying various milking equipment. *Ukrainian Journal of Ecology, 10*(4), 195-201.