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UDDER TREATMENT AND EVALUATION ARE KEY ELEMENTS IN COW MILKING TECHNOLOGY

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One of the most pressing challenges in the field of agricultural science is the production of high-quality milk on industrial farms. In light of these conditions, there is an urgent need to ensure animal health and prevent mastitis. The generation of new ideas for improving current milk production technologies and technical solutions that ensure their high competitiveness should be a key priority in this process. Drawing on a wide range of information materials from both domestic and international databases in the field of intellectual property, the article contends that manufacturers currently offer a variety of devices for processing and evaluating cow udders. However, it is noted that not all of these devices are universally applicable and that there are some disadvantages associated with their use. The article presents the results of the development of devices for processing and evaluating the udder of cows. These were based on the results of a patent search and theoretical analysis of existing analogs and prototypes. As part of this work, the initial parameters, design features, and main advantages of the developed five devices for processing cow udders both before and after milking are substantiated. These devices are easy to use, provide optimal consumption of mammary gland treatment products, help reduce manual labor costs for machine milking operators, improve milk quality, and reduce the level of animal mastitis. A device for assessing certain properties of teats has been developed. The new technological devices differ from existing analogs not only in their simplified design, but also in being more technologically advanced and cost-effective. The results obtained from implementing the proposed devices in practice will allow us to offer new and effective programs for managing the processes of high-quality milk production in the functional system "man-machine". They will also contribute to the introduction of auxiliary biological tests and rational technological approaches to its evaluation shortly.

Keywords: cattle, udder, processing, device, scheme.



ОБРОБЛЕННЯ ТА ОЦІНЮВАННЯ ВИМЕНІ – КЛЮЧОВІ ЛАНКИ В ТЕХНОЛОГІЇ ДОЇННЯ КОРІВ

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Отримання високоякісного молока на фермах промислового типу є одним із актуальних завдань аграрної науки. За цих умов виникає нагальна необхідність в забезпеченні збереження здоров'я тварин та профілактики виникнення маститів. Чільне місце в цьому процесі має посісти питання генерування якісно нових ідей щодо удосконалення поточних технологій виробництва молока та технічних рішень, які забезпечують його високу конкурентоспроможність. За узагальнення інформаційних матеріалів вітчизняних та зарубіжних баз даних у сфері інтелектуальної власності аргументовано, що на сьогодні виробниками запропоновано цілу низку пристроїв для оброблення та оцінки вимені корів, проте не всі вони є універсальними та мають ряд недоліків за використання. У статті викладено результати щодо розробок пристроїв для оброблення та оцінки вимені корів, які виконували за наслідками патентного пошуку та теоретичного аналізу існуючих аналогів і прототипів. У рамках проведеної роботи обґрунтовано вихідні параметри, конструктивні особливості та основні переваги розроблених п'яти пристроїв для оброблення вимені корів як перед, так і після доїння, які прості у застосуванні, забезпечують оптимальну витрату засобів для оброблення молочної залози, сприяють зниженню витрат ручної праці операторів машинного доїння, дають змогу покращити якість молока та знизити рівень захворювання тварин на мастити. Розроблено пристрій для оцінювання окремих властивостей дійок. Нові технологічні пристрої вирізняються від існуючих аналогів не лише спрощеною конструкцією, але й є більш технологічними та економічно вигідними. Одержані результати щодо реалізації запропонованих пристроїв на практиці дадуть змогу запропонувати нові дієві програми управління процесами виробництва високоякісного молока у функціональній системі „людина–машина”, а також сприяли запровадженню допоміжних біологічних тестів і раціональних технологічних підходів щодо його оцінювання на найближчу перспективу.

Ключові слова: велика рогата худоба, вим'я, обробка, пристрій, схема.

Today, the problem of providing the population with high-quality and safe products of animal origin is reflected in the works of scientists (Nespolo N. M., 2021; Michalchenko S. A. et al., 2024). The complexity of solving this multifaceted problem implies compliance with high requirements, first of all, for the quality and safety of milk, as it is a unique and most popular human food product (Antunes I. C. et al., 2022). The



industrial realization of this problem is possible only if all sanitary and hygienic requirements are strictly observed during its production and processing (Hadzevych O. V. et al., 2019; Berge A. C. & Baars T., 2020). First of all, this concerns the increased bacterial contamination of milk as a result of non-compliance with the requirements of cow milking hygiene and the use of imperfect technologies and technical solutions.

One of these requirements is to eliminate the possibility of bacterial contamination of the product at the milking stage. In other words, it is necessary to eliminate the possibility of microbial contamination of milk at the primary stage of its production - during the milking process of cows (Singh A. & Ramachandran A., 2020; Vargova M. et al., 2023). At the same time, the number of cases of bovine mastitis can easily be reduced by simple measures, such as treating the udder with antiseptics before and after milking. Pre-milking treatment helps to cleanse the teat skin of dirt and micro-organisms, preventing from entry of microorganisms into the freshly milked milk and transmitting mastitis pathogens from cow to cow via the milking equipment. The most important procedure in the technology for producing high-quality milk is the post-milking treatment of the cow's udder with antiseptics. This treatment reduces the level of pathogenic microflora on the teat skin. It prevents their penetration into the mammary gland by moisturizing the skin and maintaining it in a normal physiological state (Kukhtyn M. et al., 2021).

However, specialists are faced with the problem of choosing an antiseptic, which should be based on the proven effectiveness of its use. In particular, iodine, lactic acid, glycolic acid, and plant extracts are most commonly used to treat teats after milking (Zazharska N. V. & Biben I. A., 2023). The use of chemicals for teat treatment before and after milking can reduce bacterial contamination of teats and enable the production of high-quality milk (Fotina T. I. et al., 2015; Zazharska N. M. & Riaba A. O., 2016), but raises concerns about the risk of chemical residues in milk. Against the background of the use of chemicals for udder treatment, there are many different semiautomatic and automatic devices (Paladiychuk O. R., 2019), but their main disadvantages are complex design and inconvenience in use. Based on these conditions, the development of new technical means for the treatment of cows' udder teats emphasizes the undeniable scientific and practical basis of the problem, determines its relevance, and is the basis for in-depth scientific research.

The research aims to develop innovative devices for processing the teats of cow udders both before and after milking.

Materials and methods. The information base of the study was formed by domestic and foreign patents for inventions and utility models, scientific papers, and Internet resources. The methodological basis of the study was the methods of comparative analysis of existing analogues and prototypes on the studied issues, systematization, and generalization. The work was carried out at the production base of the National Scientific Center "Institute of Experimental and Clinical Veterinary Medicine" from 2018 to 2023.

Research results. As part of the research, several innovative devices have been developed for processing cow udders both before and after milking. The developments differ from existing analogs in their simplified design, are more technologically advanced, and cost-effective.

The innovation of the development lies in the fact that the device contains a container for the disinfectant solution, which is made of elastic transparent material and has a dipping glass with a handle, which is connected to the container by an adapter, while the glass in the upper part has rounded edges and a gutter that prevents overuse of the disinfectant (Fig. 1).

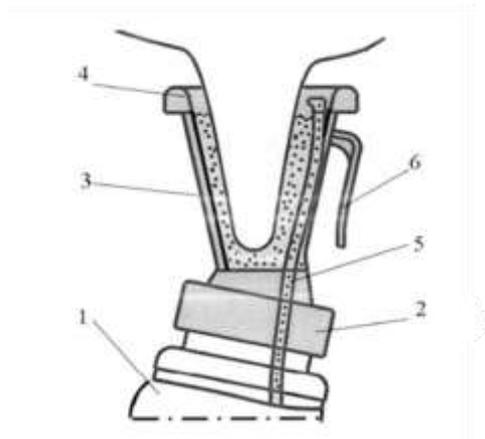


Fig. 1. Scheme of the device for processing cow udder teats

The device for treating cow udder teats consists of a container for disinfectant solution 1 made of elastic transparent material, an adapter 2 connecting the container 1 to a dipping glass 3, which has rounded edges 4 at the top to prevent injury to the udder teats during treatment and facilitate their quick entry into the glass, a gutter 5 that prevents overuse of the disinfectant, and a handle 6.

The device for treating cow's udder teats works as follows: the disinfectant solution container 1, made of elastic transparent material, is filled with disinfectant solution. A dip cup 3 is connected to it through an adapter 2. After milking, the cow's udder teats are treated by placing the teat in the dipping glass 3 and then squeezing the container 1 made of elastic transparent material. The rounded edges 4 facilitate quick and painless insertion and positioning of the teat in the inner part of the dipping glass 3. During manipulations, the excess disinfectant solution flows back into the container 1 through the gutter 5. In this way, the udder teats are processed quickly and efficiently, while preventing disinfectant loss and overspray. After use, the device can be placed on any surface of the machine equipment using the handle 6. The advantages of the proposed device are that it reduces the material costs of udder treatment and increases the productivity of the milking operators. The device is reliable and easy to use. The innovation is protected by a utility model patent*.

Another development has a container for a disinfectant solution made of elastic transparent material and a gradation, a body connected to the container at an angle of 5° and made in the shape of a hollow cone. The cone has a fleecy inner surface and a handle, which reduces material costs during processing, improves milk quality, and prevents microorganisms from entering the udder teats.

The design features of the developed device for pre-milking treatment of cow udder teats are shown in Fig. 2.

The device for pre-milking treatment of cow udder teats consists of a container for disinfectant solution 1 made of elastic transparent material and having a gradation 2, an adapter 3 that connects the container 1 to the body 4 at an angle of 5° , which is made in the form of a hollow cone, has a fleecy inner surface 5 and a handle 6.

* Utility model patent No. 133582 Ukraine, IPC A01J 7/00, A01J 7/04. Device for processing of udder teats of cows. Paliy A.P., Paliy A.P., Ishchenko K.V. - No. u 2018 11593; applied for on 26.11.2018; published on 10.04.2019; bulletin No. 7.

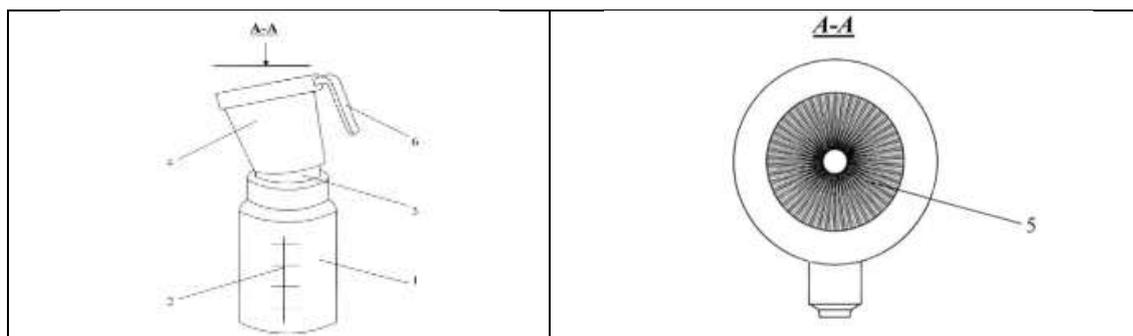


Fig. 2. Scheme of the device for pre-milking treatment of cow udder teats

The device for pre-milking treatment of a cow's udder teats works as follows: a container for disinfectant solution made of elastic transparent material 1 is filled with disinfectant solution according to the gradation 2. The body 4, which is presented in the form of a hollow cone, is connected to the filled container 1 through an adapter 3 at an angle of 5°. Before milking, each udder teat is treated separately by placing it in the inner hollow cone of the body 4, then squeezing the container made of elastic transparent material 1 and moving it around the udder teat. Due to the interaction of the udder teat with the fleecy inner surface 5 of the body 4, the udder teat is processed quickly and efficiently. After use, the device can be placed on any surface of the machine tool using the handle 6. The development is protected by a patent of Ukraine for a utility model**.

The next technological task was solved in the direction of creating a device for processing cow udders in milking parlors. The developed device has a vacuum pump (1), filter (2), fan (4), pressure (3) and distribution pipes (5) with nozzles (6) placed on the top along the technological trench and directing the flow of warm air to the animal's udder, which ensures high efficiency of the device. The device helps reduce manual labor costs for the milking operator, as it connects the milking machine to dry teats, which in turn prevents milk contamination. With dry teats, the milking cups at least go up the teats and compress the teat canal, which significantly reduces udder disease (Fig. 3).

The device works as follows: the vacuum pump 1, which draws air from the vacuum system of the milking machine, delivers it to the pressure pipe 3. Passing through filter 2, the warm air is cleaned, picked up by fan 4, creating a slight vacuum in the pressure pipe 3, and fed to the distribution pipe 5 of the warm air flow with nozzles 6, which are located at the top along the technological trench.

The nozzles are designed in such a way that the warm air coming out of them creates a directed movement of streams on the animal's udder from both sides, drying it. The advantages of the proposed device are that it is easy to use, reduces the cost of manual labor of the milking operator during milking, improves the quality of milk and reduces the incidence of udder diseases in cows. The development is protected by utility model patent of Ukraine***.

**Utility model patent No. 134677 Ukraine, IPC A01J 7/00, A01J 7/04. Device for pre-milking treatment of cattle udder teats. Paliy A.P., Paliy A.P., Petrov A.M. No. u 2019 00307; applied for on 26.02.2019; published on 27.05.2019; bulletin No. 10

***Utility model patent No. 151014 Ukraine, IPC A01J 7/00. Device for processing cow udders in milking parlors. Rodionova K.O., Paliy A.P., Khimych M.S., Paliy A.P., Dubin R.A. No. u 2021 06282; applied for on 08.11.2021; published on 25.05.2022; bulletin No. 21.

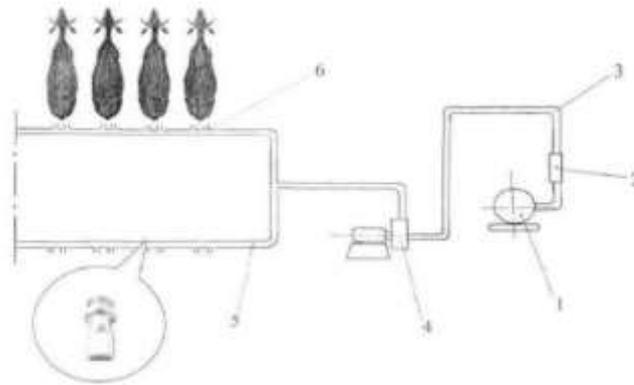


Fig. 3. Device for treating cow udders in milking parlors

The following technological solution for the pre-milking treatment of the cow's udder was set as a task, which was solved by designing a device consisting of a body (1), two brushes (2) rotating towards each other, a drive (3), a handle (4) and a wire (5). The proposed device reduces material costs for udder treatment, improves milk quality, prevents microorganisms from entering the udder teats, and reduces the workload of the milking operator (Fig. 4).

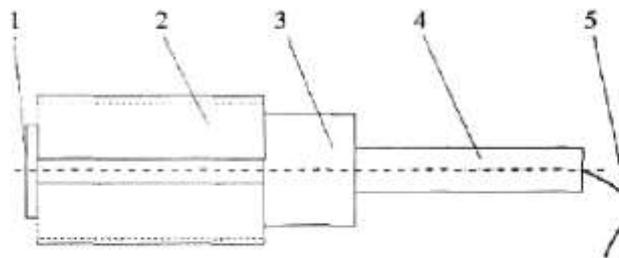


Fig. 4. Device for pre-milking treatment of the cow udder

The device operates as follows: after the cow has taken a suitable place in the milking parlor, the body (1), on the axes of which two brushes (2) are fixed, is brought to the base of the animal's udder with the help of the handle (4). The body (1) is placed in such a way that the two teats of the udder are between the brushes (2). At the next stage, the drive (3) of the brushes (2) is turned on and they begin to rotate toward each other, performing the function of removing the first lumps of milk, cleaning, disinfecting, and massaging. The significant advantages of the proposed device are that it is easy to use, reduces material costs for pre-milking udder treatment, improves milk quality and prevents microorganisms from entering the udder teats, reduces the workload of the milking operator, and speeds up preparatory operations. The development is protected by the utility model patent of Ukraine****.

The next technological solution was based on the task of developing a stationary device for processing cows' udders in milking parlors. The task was solved by the fact that this device consists of a platform 1, a base plate 2, a switching device 3, a pump 4, a disinfectant container 5, a piping system 6, and nozzles 7.

****Utility model patent No. 151015 Ukraine, IPC A01J 7/00. Device for pre-milking treatment of cattle udder. Paliy A.P., Rodionova K.O., Rodionova K.O., Khymych M.S., Paliy A.P., Anfiorova M.V. - No. u 2021 06294; applied for on 08.11.2021; published 25.05.2022; bulletin No. 21.



A comparative analysis of the developed device and the closest analog allows us to conclude that it differs from the closest analog in that it uses a platform, a base plate, an automatic switching device, a pump, a disinfectant tank, a piping system, and nozzles to treat cows' udders in milking parlors. This helps to reduce the manual labor costs of the milking operator in milking cows by saving time in preparation operations, ensuring optimal consumption of udder treatment products, and improving the quality of the milk produced (Fig. 5).

The device is mounted in the milking parlor under the place where the cow is placed during milking, and it works as follows: the cow enters the milking parlor and is placed on the platform 1. After that, the platform 1 acts on the base plate 2, which starts the pump 4 through the automatic switching device 3.

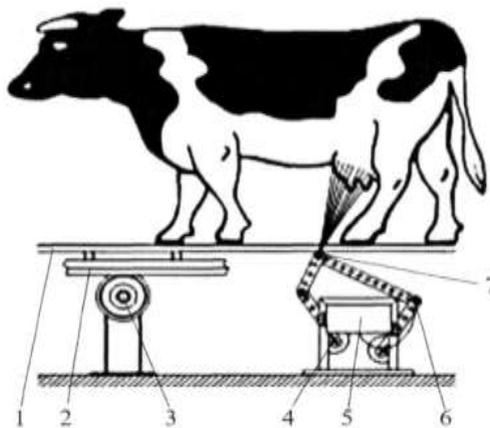


Fig. 5. Stationary device for processing cow udders in milking parlors

After the pump 4 is started, the disinfectant is supplied from the disinfectant container 5. The disinfectant is delivered through the pipeline system 6 to the nozzles 7, through which the udder is treated. The advantages of the device are that it is easy to use, provides optimal consumption of products for treating cow udders, reduces manual labor costs for milking operators, improves milk quality, and reduces udder diseases. The development is protected by the utility model patent of Ukraine****.

The lack of proper equipment for assessing the condition of cows' udder teats causes serious problems for their health and productivity, which requires more thorough research. This technological problem has been solved by developing a device for determining the elastic properties of cows' udder teats. The development is protected by a patent of Ukraine for a utility model*****. The main physical and mechanical properties of cow's udder teats, which are necessary for the development of physiologically adapted equipment, include the characteristics of elastic properties: the coefficient of transverse deformation of the teat and, accordingly, the variable modulus of its elasticity (Fig. 6).

****Patent for utility model No. 153790 Ukraine, IPC A01J 7/00. Stationary device for processing cow udders in milking parlors. Paliy A.P., Naumenko A.O., Naumenko O.A., Paliy A.P., Petrov A.M. - No. u 2022 04586; applied for on 05.12.2022; published 30.08.2023; bulletin No. 35.

*****Patent for utility model No. 146403 Ukraine, IPC A01J 7/00. Device for determining the elastic properties of cow udder teats. Paliy A.P., Naumenko A.O., Paliy A.P. - No. u 2020 06386; applied for on 02.10.2020; published 02.17.2021; bulletin No. 7.

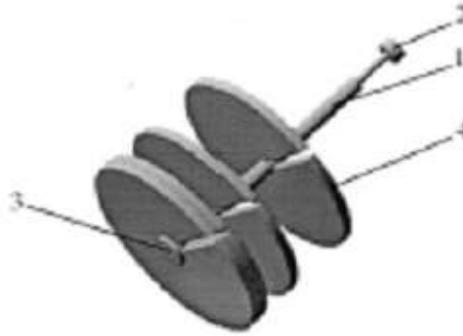


Fig. 6. Device for determining the elastic properties of cow udder teats

The device consists of a metal rod-body 1, at the upper end of which is mounted to the udder teat 2, and in the lower part - a disc lock-limiter 3 and metal discs with slots 4. The device works as follows: at the beginning of use, horizontal parallel lines are applied to the middle part of the teat with a marker. Then, a metal rod-body 1 is attached to the teat using a mount 2. Subsequently, a load is gradually and consistently applied to the teat by installing the required number of metal discs with slots 4 on the metal rod-body 1. The metal discs with slots 4 are held on the rod-body 1 through a disc lock-limiter 3. At the end, the determination is fixed, and this is done with each subsequent load. To determine the scale, a ruler is used, which is placed directly near the teat in the required plane. To determine the elastic properties, the load on the udder teat varies from 0.135 kg to 0.675 kg.

During the measurement and determination of the indicators, the distance between the horizontal parallel lines on the teats and, accordingly, the diameter of the mammary gland after each subsequent load are measured. The device provides rapid receipt of reliable data, allows arguing the mechanism of interaction of the teat liner and the teat, and on this basis, to justify the amount of teat liner tension.

Discussion. The increase in milk production is based on the intensive development of the industry, the introduction of innovative technologies and technological solutions, and the improvement of the organization and management of production processes. The corresponding growth rates of milk production make us pay special attention to improving its quality. Ensuring high quality and safety of dairy raw materials for dairy products is a fundamental component of public health protection and, of course, one of the priority challenges of the Ukrainian agro-industrial complex.

As the demand for higher milk yields and improved milking efficiency increases, there is a growing focus on the productive capacity of dairy cows to meet the needs of a growing global population (Neculai-Valeanu A. S. & Ariton A. M., 2022). In this context, the findings from various studies align with previous research (O'Rourke D., 2009; Williamson J. H. & Lacy-Hulbert S. J., 2013; Barkema H. W. et al., 2015), highlighting that proper udder care is crucial not only for preventing mastitis but also for reducing its incidence, particularly after milking. Mastitis can be transmitted during the milking process or through the milking machine. Additionally, other studies have demonstrated a direct link between udder care procedures and the technical and technological parameters of milking cows (Aliiev E. et al., 2022).

To treat udder teats, it is suggested to use special cups with an antiseptic preparation, followed by wiping with reusable napkins (Miseikiene R. et al., 2015; Paladiychuk O. R., 2019), which is emphasized in our work. However, other scientists have reported that pre-milking udder treatment does not ensure sufficient teat cleanliness. Pathogenic organisms remain afterwards and can accumulate in the teat dipping caps



(Borodina O. V. & Nosevych D. K., 2017). Instead, (Paliy A. et al., 2021) demonstrated the high efficiency of udder teat treatment with special brushes, the use of which significantly improved milking hygiene.

The quality of udder treatment is directly related to the antiseptic used on a particular farm. However, it is important to consider the methods used. The use of liquid products, which is the vast majority, requires the use of appropriate containers and equipment. Based on the results of the research, many innovative equipment has been offered to the industry, which is import substitution.

High efficiency of using high-yielding cows, increasing their productivity and milk quality can be ensured only if the animals comply with the rules of machine milking, which requires the introduction of innovative technological solutions based on the latest animal care technologies and rational organization of production processes (Boltianska N. & Zabolotko O., 2020). However, all this is possible with a scientifically based assessment of the suitability of cows for automated milking, taking into account their physiological characteristics (Hovinen M. & Pyörälä S., 2011). Our research complements the existing system for evaluating dairy cows for milking by developing a device for evaluating individual teat characteristics.

Conclusions:

1. The quality and safety of cow milk directly depends on the hygiene of milking. Udder treatment is a key element in milking technology and a preventive measure to reduce the incidence of milk contamination with microorganisms.

2. Five devices have been developed for processing cow udders both before and after milking, as well as a device for determining the elastic properties of teats, which should be used at milk production complexes.

3. The advantage of the developed devices is their ease of use; they provide optimal consumption of means for processing and evaluating the udder of cows, help reduce the cost of manual labor of milking operators, improve milk quality, and reduce cow mastitis. They are more technologically advanced and cost-effective.

4. The results obtained on the implementation of the proposed devices in practice will allow us to offer new effective programs for managing the processes of high-quality milk production in the functional man-machine system, and also contribute to the introduction of auxiliary biological tests and rational technological approaches to its evaluation shortly.

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