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Milk Losses during Control Milking of Jersey Cows and Sanitary Quality of Raw Products Obtained at Conveyor-type Milking Plant

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Abstract

The output growth of dairy products depends not only on the increase in the volume of milk preparations but also on its better use as a result of reducing losses to a minimum size. Any losses increase the cost of production, increase the contamination of wastewater, and the cost of their treatment. At the same time, the components of whole milk that pass into skimmed milk, buttermilk, and whey cannot be considered losses in the literal sense. Losses of raw materials and products can occur, among other things, as a result of overflow when filling flasks, containers; bottle fights; foaming during thickening, separation, bottling, spraying from bottles during bottling, as well as several other technological moments. The current norms of maximum permissible losses for each production type or its separate cycle consist mainly of irremediable losses. Losses exceeding the established norms are excessive. Thus, only those milk substances that are irretrievably loss in the production process are lost. These losses cannot be completely eliminated, but they must be reduced as much as possible since the economically justified functioning of the dairy industry requires increasing production efficiency.

Disciplinary: Veterinary, Zoology, Biotechnology, Food Production.

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1 Introduction

The use of artificial insemination in cattle breeding over the past decades has significantly increased the cows' genetic productivity potential. Moreover, if the herd's milk performance of the majority of commercial farms is at the level of 3.5-5.0 thousand kg of milk per year, then among bred livestock farms the cows' milk performance often reaches 6.5-9.0 thousand kg of milk per year. The main reason for the incomplete realization of the productivity potential lies in the cattle's under-feeding, as well as in feeding them biologically incomplete diets [1,2].

Health, productive longevity, animal fertility, product quality, and feed costs for its production should be considered as full-fledged feeding indicators. According to the ability to quickly and maximally process biological-based fodder into milk nutrients, the cow has no equal among pets. And if we take into account that the cow consumes most of the hay, silage, haylage, root crops, then it is quite obvious that it is an indispensable factory for processing the above-mentioned products of its diet into full-fledged nutrients of milk for humans [3-5].

2 Literature Review

The main condition for increasing the cow's milk performance is a high intensification of their feeding – this is the maximum use of fodder that meets the cattle's needs, according to their physiological state. When developing and designing milk production technologies, microclimate parameters, and fodder distribution facilities, the main link in milk production technology is often overlooked - this is full-fledged feed [6]. No matter what good premises we have, what kind of mechanization they are filled with, but if there is not enough full-fledged feed, the productivity of cattle will be low. To achieve high milk performance, specialists and service personnel should not be faced with the question of what to feed the cows [7,8]. The main task that they must solve is to prepare a sufficient amount of full-fledged feed and how to achieve maximum consumption in order to effectively convert it into milk. The output growth of dairy products depends not only on an increase in the quantity of milk harvesting but also on its better use as the result of reducing losses to a minimum size. Also as from reducing the waste of fat, protein, and other components into cream-free milk, buttermilk, and whey, as well as on timely and rational processing of the resulting secondary dairy raw products and intermediate products [9]. The components of full-fat milk that pass into cream-free milk, buttermilk, and whey cannot be considered as losses literally, because they are used for the production of other products. Losses are only those milk substances that are irretrievably lost in the production process (raw product residues on equipment, evaporation, analysis costs, etc.)[10]. These losses cannot be eliminated, but they must be reduced as much as possible.

Any losses increase the cost of production, increase the contamination of wastewater and the cost of their treatment. Milk losses can be divided into 2 categories: unavoidable and avoidable (wholly or partly). Unavoidable losses include milk residues on the filter, sticking and burning it in devices, etc., and avoidable losses include milk residues in containers, pipes, etc. Unavoidable losses should not exceed a certain minimum due to the appropriate organization of the technological process. Losses of raw products and products can occur as a result of wear of flow line and shut-off valves, leakage in valves, taps and dead ends of pipelines, welding irregularities, etc., emergencies (power outage, steam, water, failure of automatic control devices); overflow when filling flasks, containers; bottle fighting; foaming during thickening, separation, bottling, splashing from bottles during bottling. An important source of losses is flushing and cleaning of pipelines and technological equipment: removal of sludge from separators, replacement of the product in heat exchangers, vacuum evaporation plants, their shutdown, and washing. The current norms of maximum permissible losses for each type of production or its separate cycle consist mainly of unavoidable losses. Losses exceeding the established norms are excessive. Currently, existing methods for determining losses in the production of dairy products are used to analyze the production's condition [11].

The economically reasonable functioning of the dairy industry requires an increase in production efficiency. First of all, this concerns resource-saving, since the cost of raw products is about 80 % of the cost of dairy products [12].

3 Method

Specialists of the control and assistant service of the regional selection and technological center conduct an accounting of cattle's dairy productivity.

During the control milking, the indicators such as the control milking date, which is the date of drawing up the relevant act, the nickname, the identification number of the cattle, a single milk yield for milking; the quality of milk are taken into account.

When determining the intensity of milk performance, the indicators such as the determining date the intensity of milk performance, which is the date of drawing up the relevant act, the nickname, the identification cattle's number, the current lactation's number, one-time milk yield for milking, the time spent on milking by the device for milking, the brand of the milking machine are taken into account.

The level of milk productivity and milk quality for lactation or a certain period of lactation of each cow is taken into account by summarizing the control milking results in accordance with the established procedure, according to the Procedure and conditions for breeding cattle valuation of dairy and dairy-meat directions of productivity (Order of the Ministry of Agriculture of the Russian Federation № 379 of October 28, 2010).

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Currently, dairy enterprises can be guided by the all-Union norms for the consumption of raw product for the production of dairy products developed in 1970-1990. At the same time, one of the major factors affecting the actual consumption of raw products is the equipment used in the technological process, the modernization and replacement of which has noticeably accelerated in recent years [13]. In this regard, almost all enterprises establish their own raw product consumption rates based on control workings, which, as a rule, constitute acommercial confidentiality.

During the various dairy products production, residues of raw products finished and by-products are retained on milk pipelines, in containers, apparatuses, and other equipment. Some of the raw products and products are spent on chemical analysis [14]. All these raw products' residues, finished products, and by-products constitute unavoidable technological losses.

To control production, loss standards have been developed that include only technological losses [15]. At the same time, non-production losses (losses from defects, equipment malfunctions, etc.) are not taken into account.

Standard losses are established on the experimental measurements basis of the residues of raw products and fat on the technological equipment.

The actual losses in production are calculated from the balance of fat or solid.

4 Result and Discussion

On the milking machine of the "merry-go-round" type, we observe the milking operation cyclicity. This unit has a cylindrical platform, the full rotation of which, with non-stop conveyor operation, occurs in 300 seconds (5 minutes). Thus, the throughput (the frequency of changing cows after the start of the cycle) of the conveyor is 300/40=7.5 seconds. For 1 merry-go-round's turn, 1 cow is milked, during which 16-20 liters of milk are milked, with a fat content of 7-9%. Each subsequent cow entering the milking unit section adds a time of 300/40 s. In case of emergencies, the time may increase to 10-15 minutes. The increase in milking time may be due to the entry into the milking cycle of cows with a low milk transfer rate. Then the cycle is delayed by the limiting time required to complete the work of the section in which such cattle are located and the amount of time spent on milking each of the cows following the cow with slow milk flow.

During the cows' control milking, we observed at least three moments during which there is a loss of milk associated with the human factor. The first is that due to the high-milk yielding capacity, the glass for sampling is overflowing. The volume of 400 ml can be exceeded by 10 percent and then when removing the glass, there is a loss of milk due to gravity. For every 400 ml, thus, there is a loss of 40 ml. In terms of 1200 milk cows, this is no less than 48,000 ml of milk with a fat content of 7%. If we take a full turn for 2π and divide the circle of the carousel into 4 parts, then we can see that part of the cows with fast milk production fills the control glass to the brim during the time during which the carousel makes $2\pi/4$ turns, part - during $\pi/1$, part $3/2\pi$, and part at the very end, that is, for 2π. During the non-stop operation of the conveyor, the operator of the control milking at the end of the turn, starting from $3/4\ \pi$ and until the completion of 2π, has to "catch up" with the sample "running away" from it with an angular velocity ω, and when the glass is separated from the vacuum system, there is a jerk-acceleration, which can be mathematically described by shifting the radius vector of the movement of the glass for control milking (Figure 1) and, accordingly, give a mathematical justification to the displacement factor and spilling of the accumulated precious liquid cow's milk.

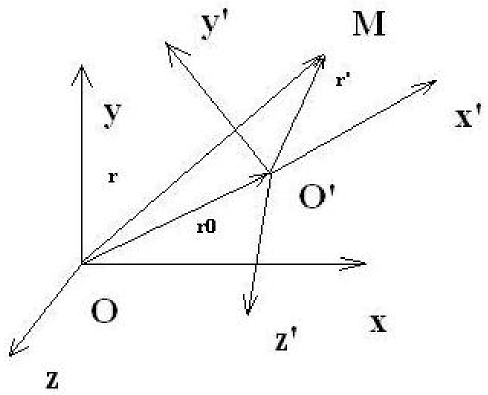

Figure 1. Graphical displacement description of the radius vector when disconnecting the glass for control milking.

To describe the relationship between the radius vectors r and r’, we present a projection relative to the stationary frame of reference with the origin O. Then in the dynamic system, we denote the beginning O'. Thus, we have two projections xyz and x'y'z', and when describing the displacement, we apply the orts of the projections and denote them a'b'c'. The losses in this case are described by the formulas of the absolute velocity of the point:

vaM(r)=dr/dt=dr0/dt+x'da'/dt+y'db'/dt+z'dc'/dt+(dx'/dt)a'+(dy'/dt)b' +(dz'/dt)c' (1).

If the direction of motion is constant, we can apply the formula to calculate the relative velocity:

vrM(r')=(dx'/dt)a'+(dy '/dt)b'+(dz '/dt)c'=đr'/dt (2),

where

đr'/dt – the relative time derivative for orts a'b'c'.

Thus, we apply the angular velocity formula ω for these orts:

da'/dt = [ω a'] (3),

db' /dt = [ω b'] (4),

dc'/dt=[ω c'] (5).

Then the absolute velocity and the associated losses will consist of the portable glass's velocity for control milking and the relative velocity:

va= vc+ vr (6)

va= v0+ [ωr']+vr (7)

where

v0= dr0/dt,

vc= v0+ [ωr']

When disconnecting the glass for control milking, there is also an acceleration - a jerk consisting of three types of acceleration: relative acceleration wr=đvr/dt = (d2x'/dt2)a'+(d2y'/dt2)b'+(d2z'/dt2)c', drag acceleration wc=w0 + [eg']+ [ω[ωr']], where w0= dv0/dt and rotational acceleration(Coriolis) wk=2[ωvr]. Thus, we calculate the absolute acceleration by adding the named acceleration types.

Prevention of milk loss because of splashing at the control glass time of separation can be achieved due to its incomplete filling. The maximum possible volume of milk in the glass, ensuring the absence of losses, can be determined based on the following reasoning.

When disconnecting the glass from the vacuum system, the control-milking operator tilts the glass by a certain angle α (Figure 2) and then follows an acceleration - a jerk, because of which there is an inertia force F_i, directed opposite to acceleration. Let us assume that the vector of the inertia force lies in the horizontal plane. As a result of the action of gravity F_t and inertia F_i on the milk particles, the liquid moves in the control glass: the free surface of the milk deviates from the horizon and is located, as is known, perpendicular to the resulting force ∑F.

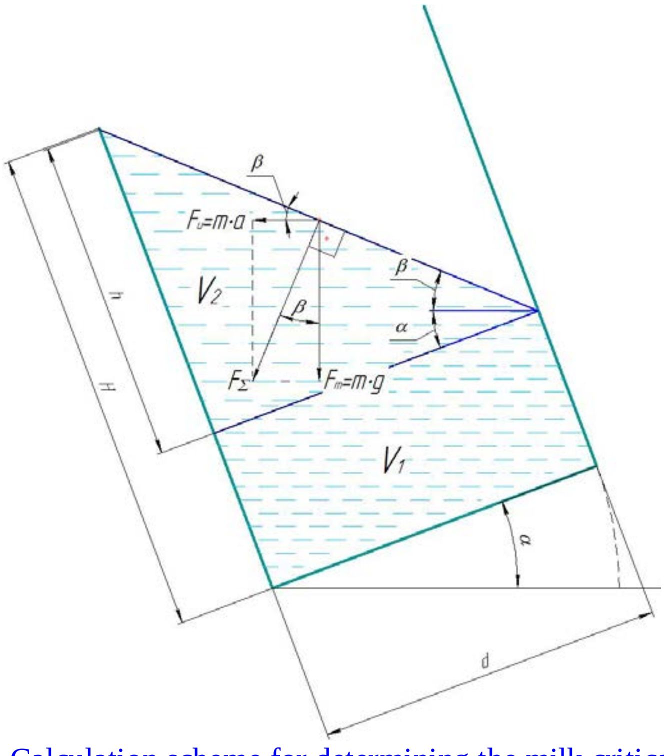

Figure 2: Calculation scheme for determining the milk critical volume

Depending on the volume, in an emergency, the surface of the milk will deviate from the horizontal position so much that it will reach the edge of the glass and splashing will occur. Accordingly, the critical volume of the V_{CR}, taking into account certain assumptions, can be found geometrically:

$$V_{cr} = V_1 + V_2 = \frac{\pi \cdot d^2}{4}(H - h) + \frac{1}{2} \cdot \frac{\pi \cdot d^2}{4} \cdot h \quad (8).$$

After conducting auxiliary constructions and determining the missing angles, we get:

$$h = d \cdot tg(\alpha + \beta) \quad (9),$$

and accordingly

$$V_{cr} = \frac{\pi \cdot d^2}{4}\left(H - \frac{d \cdot tg(\alpha+\beta)}{2}\right) \quad (10),$$

where

d and H – the control glass's dimensions (diameter and height),

α – the angle of inclination of the glass at the disconnection time from the system,

β –the angle of free surface inclination of the milk relative to the horizon.

The angle β can be found from the expression

$$tg\beta = \frac{F_i}{F_t} = \frac{m \cdot a}{m \cdot g} = \frac{a}{g} \quad (11)$$

where

a– the absolute acceleration (defined above),

g –the acceleration of gravity.

Thus, the critical volume of milk in the control glass, if exceeded, spilling is guaranteed to occur at the time of disconnection from the vacuum system, depending on the angle of glass inclination and the jerk - acceleration. To reduce the milk loss, it can be recommended to take samples and empty the control glass when filling it with an amount of milk not exceeding V_{cr}.

The study of the raw milk viscosity dependence on temperature revealed the following dependence (Table1).

Table 1.The viscosity of raw cow's milk depending on the temperature

Temperature, °C	10	20	30	40	50	60	70	80
Viscosity, mPa/s	2.47	1.79	1.33	1.04	0.85	0.71	0.62	0.57

With the revealed dependence of acceleration, as well as the viscosity of raw milk on temperature, losses during control milking at a temperature in the range from 20 to 30 degrees Celsius, on average reach 10% or 40 ml per cow. After the control glass is separated, a sample is carefully poured from it into a test tube for sending to the laboratory, the rest is drained into the tank. There may be several tanks around the perimeter of the merry-go-round in such cases. If the diameter of the tank is small, then part of the jet from the control glass may miss the target when draining, or when the tank overflows, the milk may spill, and thus about 10% of each sample of the control glass may be lost. Thus, knowing which cows are milked at what speed, it is possible to predict in which quarter of the merry-go-round's turn the control glass will be filled and prevent the milk loss, in a total volume of 120 ml in three factors of milk loss of 40 ml from each cow.

5 Conclusion

The presented material clearly illustrates that in the process of control milking there is an irreversible loss of a certain amount of raw materials-milk, which can be mathematically described, which can be used in the further development of algorithms and automation of the process, and as a result - forecasting losses.

6 Availability of Data And Material

Data can be made available by contacting the corresponding author.

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8 References

[1] Trukhachev V.I., Oleinik S.A., Zlydnev N.Z., MorozovV.Yu. Adaptation of the recommendations of the international committee for animal recording (ICAR) in evaluating the quality of milk. Research Journal of Pharmaceutical, Biological and Chemical Sciences. 2015; 6(6):1317-1320.

[2] Siddiqui, S.A., Blinov, A.V., Serov, A.V., Gvozdenko, A.A., Kravtsov, A.A.; Nagdalian, A.A.; Raffa, V.V., Maglakelidze, D.G., Blinova, A.A., Kobina, A.V., et al. Effect of Selenium Nanoparticles on Germination of HordéumVulgáre Barley Seeds. Coatings 2021, 11, 862. https://doi.org/10.3390/coatings11070862

[3] Omarov, R. S. Rastovarov E. I., Alexandrova T. S., Nesterenko A. A., Shlykov S. N. Estimation the grass-feeding influence on cattle productivity and meat quality. Research Journal of Pharmaceutical, Biological and Chemical Sciences, 2018; 9 (2): 907-912

[4] Rzhepakovsky I., SiddiquiS.A., AvanesyanS., BenlidayiM., DhingraK., DolgalevA., EnukashvilyN., FritschT., HeinzV., KocherginS., NagdalianA., SizonenkoM., TimchenkoL., VukovicM., PiskovS., GrimmW-D. Anti-arthritic effect of chicken embryo tissue hydrolyzate against adjuvant arthritis in rats (X-ray microtomographic and histopathological analysis). Food Science & Nutrition 2021, 00:1-22. https://doi.org/10.1002/fsn3.2529

[5] Zimmerman T, Siddiqui SA, Bischoff W, Ibrahim SA. Tackling Airborne Virus Threats in the Food Industry: A Proactive Approach. International Journal of Environmental Research and Public Health. 2021; 18(8):4335. https://doi.org/10.3390/ijerph18084335

[6] Blinov AV, Siddiqui SA, Nagdalian AA, Blinova AA, Gvozdenko AA, Raffa VV, et al. Investigation of the influence of Zinc-containing compounds on the components of the colloidal phase of milk. Arab J Chem. 2021;14(7):103229

[7] Osipchuk G. V., Povetkin S. N., Simonov A. N., Verevkina M. N., Karatunov V.A., Yakovets M. G. On the Issue of Non-Hormonal Stimulation of the Reproductive Function of Rams, Pharmacophore, 2020;11(2), 73-76

[8] Cheboi PK, Siddiqui SA, Onyando J, Kiptum CK, Heinz V. Effect of Ploughing Techniques on Water Use and Yield of Rice in Maugo Small-Holder Irrigation Scheme, Kenya. AgriEngineering. 2021; 3(1):110-117. https://doi.org/10.3390/agriengineering3010007

[9] Khramtsov, A.G.; Blinov, A.V.; Blinova, A.A.; Serov, A.V.; Blinova, A.A. Influence of the whey type on composition and properties of its mineralizates. Foods Raw Mater. 2017; 5, 30–40

[10] Nesterenko, A., Koshchaev, A., Kenijz, N., Luneva, A., and Varivoda, A. Biomodification of raw meat in order to obtain functional products enriched with beneficial microflora. Indo-Americanjournalofpharmaceuticalsciences, 2019; 6(3), 6347-6353

[11] Nagdalian, A. A.; Rzhepakovsky, I. V; Siddiqui, S. A.; Piskov, S. I.; Oboturova, N. P.; Timchenko, L. D.; Lodygin, A. D.; Blinov, A. V; Ibrahim, S. A. Analysis of the Content of Mechanically Separated Poultry Meat in Sausage Using Computing Microtomography. J. Food Compos. Anal., 2021;100,103918. https://doi.org/https://doi.org/10.1016/j.jfca.2021.103918

[12] Trukhachev V.I., Oleinik S.A., Zlydnev N.Z. Daily dynamics of milk quality indicators. Rural development 2017 Bioeconomy Challenges. 2017:158-161

[13] Salins SS, Siddiqui SA, Reddy SVK, Kumar S. Experimental investigation on the performance parameters of a helical coil dehumidifier test rig. Energy Sources, Part A: Recovery, Utilization, and Environmental Effects. 2021; 43(1):35-53

[14] Nesterenko, A., Koshchaev, A., Kenijz, N., Luneva, A., and Varivoda, A. Biomodification of raw meat in order to obtain functional products enriched with beneficial microflora. Indo-American journal of pharmaceutical sciences, 2019; 6(3), 6347-6353

[15] Siddiqui SA, Ahmad A. Implementation of Newton's Algorithm Using FORTRAN. SN Comp. Sci. 2020;1(6): 1-8.

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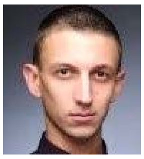

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