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Secretory Activity of The Mammary Gland of Holshtin Cows

Vasyl Ivanovych Kostenko*

Department of Milk and Meat Production Technologies, Doctor of Agricultural Sciences, National University of Bioresources and Nature Management of Ukraine, Ukraine

***Corresponding author:** Vasyl Ivanovych Kostenko, Department of Milk and Meat Production Technologies, Doctor of Agricultural Sciences, National University of Bioresources and Nature Management of Ukraine, Ukraine.

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Abstract

Evaluation of changes in the intensity of milk secretion under the conditions of "voluntary", physiologically motivated emptying of the mammary gland in Holstein cows of the 2nd, 3rd and 4th lactations showed that in cows of the 2nd lactation at the same level (about 1500 ml/hour) secretion was practically only in the first 3 months. During the 4th...8th, when compared with the 2nd, it decreased approximately by 19.7...36.1%, with a further decrease in the following months. Analyzing the secretory activity of the gland of a cow of the 3rd lactation, it was established that the intensity of secretion during the first 4 months was almost at the same level (about 1550 ml/hour), and then (the 5th and 6th) slightly decreased. In the future (7th...9th) - it was almost at the same level with a further gradual decrease in the following months. Evaluation of the nature of the secretion of the cow's gland of the 4th lactation showed that the secretory process was practically at the same level (more than 1750 ml/hour) only in the first two months. Subsequently, there was a sharp decrease in the intensity of secretion. Yes, in the 3rd...9th month, compared to the first, it was only 66.8%, 61.6%, 51.8%, 47.1, 42.9, 35.9 and 31.2 %, or was more than three times smaller. A peculiarity of the secretion of the gland of a cow of the 4th lactation is relatively high values of the maximum index of secretory activity, which during the first 4 months remained at a value of more than 2 liters per hour of the day.

Significant fluctuations in the intensity of secretion for individual milkings during each month of lactation have been established. Thus, the difference between its minimum and maximum values in a cow of the 2nd lactation was the largest in the 4th month of lactation and amounted to 3.1 times, and the smallest in the 5th - 1.08 times, in a cow of the 3rd, respectively on the 6th - 3.3 times and on the 8th - 1.48 times and on the 4th cow, where the specified difference for the 3rd month was the largest - almost 5.7 times, and the smallest - for the 2nd - 2.06 times. All this indicates that the feeding and housing conditions did not allow the animals to realize the functional capabilities of the secretory epithelium of the mammary gland to the maximum possible secretion for each day of lactation.

Keywords: Mammary gland; Intensity of secretion; "Voluntary" emptying, Holstein breed

Topicality

The secretory activity of the mammary gland, both in the intervals between milkings and during the entire lactation period, has its own patterns. Regarding the intensity of the secretory process, researchers have different views. Some believe that the secretion of milk occurs unevenly, it is higher immediately after

milking the udder, and as the interval between milkings increases, the intensity of the secretory process decreases. That is, in their opinion, the intensity of milk secretion has a curvilinear nature. Other researchers indicate that the secretory process in the mammary gland occurs constantly, evenly, and its intensity does not depend on the time intervals between udder milkings.



Hence the conclusion that the issue of regularities of milk secretion in the intervals between milkings and throughout lactation has not been sufficiently studied. In our opinion, this can be explained by different methodological approaches to the study of this issue, as well as problems caused by the morphological and functional features of the mammary gland. In addition, all studies known to date were performed under the conditions of regular milking, when a person established the intervals between milkings and on this basis appropriate conclusions were drawn. Unfortunately, it is not known to this day what the intensity of milk secretion will be under the conditions of "voluntary", physiologically motivated emptying of the mammary gland determined by the functional needs of the cow's body.

Analysis of recent research and publications

Studying the issue of the intensity of the secretory process in the mammary gland, scientists found in 1924 that milk secretion gradually decreases every hour after milking. This decrease is approximately 95% from the level of the previous hour. It has also been proven that milk secretion decreases with an increase in the interval between milkings. That is, these researchers recognize a gradual decrease in milk secretion in the intervals between milkings. They consider the main reason for this to be the increase in internal pressure in the udder as milk accumulates in it, since when the system was filled to 80...85%, the pressure in the mammary gland reached 25 mm. mercury column. According to them, as a result of this, the milk alveoli stretch, the glandular epithelium thickens, which creates unfavorable conditions for milk secretion. [1] are inclined to a similar conclusion, asserting that in only 4.0% of cow's secretory processes from milking to milking remain constant, while in others, especially with a daily milk yield of 35 kg or more, the processes secretions change.

However, [2] found in his research that the internal pressure in the udder during the first 9 hours after milking does not change. This is due to the fact that during the accumulation of milk in the udder, the tone of its muscle elements reflexively decreases, as a result, its capacity increases, and therefore the pressure does not increase. In research [3] it was established that the highest intensity of milk secretion after "complete emptying" of the alveoli of the mammary gland was observed during the first hour. Then, during the 2nd to 5th hour, the intensity of the secretory process decreased somewhat. When the interval between udder emptyings increased to 8-12 hours, the intensity of secretion decreased sharply, but not in direct proportion to the duration of the interval. According to other researchers [4], about 20% of single breast milk is generally synthesized during the emptying of the mammary gland.

It is known that in the regulation of secretion of the mammary gland, different, closely connected, regulatory mechanisms of the animal's body are involved. Regulation of the activity of the glandular epithelium is provided by the nervous system, hormones and mediators. Various external and internal (mechano-, thermo-, baro-, chemo-) receptors are well represented in the mammary gland to ensure communication with these mechanisms. Further studies [5-7] proved that stimulation of these receptors during

sucking or milking has a decisive effect on the intensification of the secretory process in mammary gland.

According to (Velytok I.G., 1974), the intensity of milk secretion is influenced by two factors - time and space. The time factor that affects the intensity of secretion is the duration of the interval between emptying's of the mammary gland, and the space factor is the capacity of the udder. At the same time, the physiological mechanisms that regulate the intensity of secretion in the gaps between udder emptying's begin to act long before the udder cavity is completely filled. To solve this issue [8] proposed a mathematical model of milk accumulation in the udder of a cow, which describes the dynamics of the metabolic process of its synthesis depending on the values of the time interval that has passed since the end of the last milking. The purpose of the study is to study the dynamics of the intensity of milk secretion by a cow during the day, month and lactation under the conditions of "voluntary", physiologically motivated emptying of the mammary gland.

Research materials and Methods

The study of the dynamics of the intensity of milk secretion under the conditions of "voluntary" emptying of the mammary gland in Holstein cows of the second, third and fourth lactations with a level of milk productivity of at least 7000 kg of milk was performed using the automatic milking control system, which is installed and functions in the VMS milking plant - 2012. The automated information storage system of the facility provides the following data: identification of the animal's personal number, date and time of milking, mass of milk obtained for each milking, duration of milking and many other lactation and physiological parameters of each cow. These data are accumulated in the computer memory, which allows you to use them for operational management of milking. To evaluate the dynamics of the intensity of milk secretion, we used the daily materials of this system, namely the date and time of each milking and the mass of milk obtained. After that, we calculated the difference in time (hours) between each two adjacent milkings and, dividing the obtained hope by the calculated time, determined the intensity of the secretory process in the mammary gland for the specified period of time. The obtained materials were processed by the methods of variational statistics.

Research results and their discussion

In studies [9] on goats and cows, it was established that systematic injections of oxytocin along with thorough milking stimulate milk secretion and do not negatively affect the functional state of the mammary gland. However, it is desirable to know how this process is regulated under the conditions when the emptying of the mammary gland occurs under the influence of factors of the internal environment of the body (mammary gland). In addition, it is not known how the secretory process changes in the mammary gland of such a cow during lactation. Evaluating the intensity of milk secretion in a second-lactation cow with a productivity of more than 9.7 thousand liters (Table 1), it should be noted that the secretory process was practically at the same level only in the first three months

Table 1: The intensity of the secretory process in the mammary gland of a second-lactation cow with a yield of 9750.8 kg of milk.

Months of lactation	Intensity of secretion on average per hour of the day, ml, M±m	The minimum value of the secretion indicator per hour of the day, ml	The maximum value of the secretion indicator per hour of the day, ml	Actual average daily hope, kg	Possible forecasted hope per day, kg
1	1492,3±32,12	1124,4	2073,3	34,4	49,8
2	1599,4±9,52	1232,4	1787,3	38,4	42,9
3	1506,5±17,03	1055,6	2228,4	36,2	53,5
4	1336,6±22,92	664,0	2086,4	31,4	50,1
5	1287,4±13,15	1120,5	2214,1	30,7	53,1
6	1236,5±13,32	900,8	1668,8	29,4	40,0
7	1295,6±10,92	992,4	1584,0	30,7	38,0
8	1175,4±14,24	914,1	1785,7	28,8	42,8
9	984,3±9,01	762,1	1181,0	23,6	28,3
10	975,3±9,93	503,8	1213,7	23,3	29,1
11	858,3±13,25	673,9	1128,6	20,4	27,1

lactation from the fourth to the eighth, when compared with the second, it decreased approximately by 19.7...36.1%. In the following months of lactation, there was a further decrease in the intensity of secretion. Thus, during the ninth to eleventh months of lactation, compared to the second, it decreased by 62.5...86.3%, or almost twice. That is, the intensity of the secretory activity of the mammary gland even under the condition of "voluntary" emptying in cows of the second lactation decreases as its duration increases.

As with first-born cows [10], significant fluctuations in the intensity of secretory activity were also observed here over the course of a month and even a day. Thus, the difference between the maximum and minimum values of the intensity of secretion per hour of the day in the first month of lactation was: 1.8 times, in the second – 1.4, in the third – 2.1, in the fourth – 3.1, in the fifth – 1.9.

sixth – 1.8, seventh – 1.6, eighth – 1.9, ninth – 1.5, tenth – 2.4 and eleventh – 1.7 times. Such a difference shows that the conditions for the optimal functioning of the organism were not created even for the cow of the second lactation, and therefore the secretory activity of the mammary gland could not be fully realized.

Under optimal conditions of the body's functioning, the average daily hope for the first month of lactation should be 44.8% higher and, accordingly, for the remaining months, it should be higher by: 11.7%; 47.8; 59.6; 73.0; 36.6; 23.8; 48.6; 19.9; 24.9 and 32.8%. All this shows that the secretory activity of the mammary gland is not fully realized in most cases, even with the condition of its "voluntary" emptying. At the same time, it should be noted that the intensity of the secretory process in the cow of the second lactation was significantly higher in comparison with the first-born.

Table 2: The intensity of the secretory process in the mammary gland of a cow in the third lactation with a yield of 11211.9 kg of milk.

Months of lactation	Intensity of secretion on average per hour of the day, ml, M±m	The minimum value of the secretion indicator per hour of the day, ml	The maximum value of the secretion indicator per hour of the day, ml	Actual average daily hope for the month, kg	Possible forecasted hope per day, kg
1	1387,1±19,1	955,5	1752,7	33,1	42,1
2	1551,5±21,0	1304,1	2200,0	36,6	52,8
3	1597,6±79,4	1180,2	3078,9	36,4	73,9
4	1550,6±20,6	1028,4	2088,8	36,7	50,1
5	1455,8±19,3	1035,7	1991,9	34,6	47,8
6	1358,3±32,0	1047,0	3462,5	31,6	83,1
7	1241,7±12,2	981,0	1474,2	19,2	35,4
8	1216,1±8,9	1021,8	1516,8	29,2	36,4
9	1209,2±100,1	702,2	1752,9	26,4	42,1
10	1035,9±9,2	664,3	1255,6	24,6	30,1
11	903,3±9,6	735,2	1334,8	21,4	32,0
12	899,3±8,9	719,2	1072,7	21,6	25,7
13	786,4±11,8	527,3	1034,3	18,5	24,8

Evaluating the nature of the secretory activity of the mammary gland of a cow in the third lactation (Table 2), we found that under the conditions of "voluntary" emptying, the intensity of the secretory process during the first four months is practically at the same level, and then (the 5th and 6th months) decreases somewhat. In the future (7th...9th month) - it was almost at the same level, and in the following months it gradually decreased. Thus, in the second month of lactation, compared to the first, it was 111.8%, in the third - 115.2%, in the fourth - 111.8%, in the fifth - 105.0%, in the sixth - 97.9%, the seventh - 89.5%, the eighth - 87.7%, the ninth - 87.2%, the tenth - 74.7%, the eleventh - 65.1%, the twelfth - 64.8% and in the thirteenth - only 56, 7% of the indicator of the first month of lactation.

As we can see, the average value of the intensity of milk secretion per hour of the day was quite close during the second to fourth months, and only starting from the fifth, it decreases by 6.1% compared to the fourth, and by as much as 76.4% in the thirteenth compared to the first month of lactation. At the same time, there are significant fluctuations in the intensity of milk secretion for individual milkings during each month of lactation. Thus, the difference between the minimum and maximum values of the intensity of milk secretion by the mammary gland in the first month of lactation was 1.76 times, in the second - 1.69, in the third - 2.61, in the fourth - 2.03, in the fifth - 1.92, sixth - 3.31, seventh - 1.50, eighth - 1.48, ninth - 2.50, tenth - 1.89, eleventh - 1.82, twelfth - 1.49 and thirteenth - 1.96 times. The indicated difference shows that the intensity of milk secretion even under the conditions of "voluntary" emptying of the mammary gland is significantly influenced by factors of the internal and external environment and, above all, the conditions of nutrition, maintenance and operation. This did not allow the animal to realize the functional capabilities of the mammary gland to the maximum possible secretory process

for each day of lactation. So, under relatively optimal conditions of nutrition, maintenance and operation, the average daily yield in the first month of lactation should be more than 54.0 kg of milk, while the actual yield is 33.1 kg, or 1.63 times more. We observe a similar pattern during all months of lactation, where this difference varied from 1.47 to almost 3.40 times.

Analyzing the intensity of the secretory process in the mammary gland of a cow in the fourth lactation with a productivity of more than 7.1 thousand liters (Table 3), it is necessary to note that the secretory process was practically at the same level only in the first two months of lactation. During the third and fourth, compared to the first, the intensity of secretion was only 66.8% and 61.6%, respectively. In the following months of lactation, there was a further sharp decrease in the intensity of secretion. Thus, in the fifth to ninth months of lactation, compared to the first, it was 51.8%, 47.1, 42.9, 35.9 and 31.2%, or more than three times less. That is, the intensity of the secretory activity of the mammary gland in a cow of the fourth lactation, under the conditions of "voluntary" emptying, significantly decreased. A characteristic feature of the secretion of the mammary gland of a cow of the fourth lactation is relatively high values of the maximum index of secretory activity, which for four months remained at a value of more than 2 liters per hour of the day. All this testifies to the huge possibilities of realizing the genetically determined level of milk productivity of the animal under the conditions of the appropriate level of nutrition, maintenance and operation. Creating optimal living conditions for such a cow would make it possible to have almost one and a half times more daily milk compared to what was received. It should also be noted that with age in lactation, the intensity of the secretory process per hour of the day increases. This indicates that the total mass of glandular tissue in the mammary gland probably increases with age.

Table 3: The intensity of the secretory process in the mammary gland of a cow in the fourth lactation with a yield of 7111.5 kg of milk.

Months of lactation	Intensity of secretion on average per hour of the day, ml, M±m	The minimum value of the secretion indicator per hour of the day, ml	The maximum value of the secretion indicator per hour of the day, ml	Actual average daily hope for the month, kg	Possible forecasted hope per day, kg
1	1907,8±19,41	1290,4	2658,6	44,4	63,8
2	1759,8±24,02	1115,2	2332,1	41,7	56,0
3	1275,3±44,45	364,6	2070,0	28,9	49,7
4	1175,7±30,37	550,4	1935,6	27,7	46,4
5	988,3±19,43	453,4	1578,3	23,4	37,9
6	898,0±13,22	580,8	1323,1	21,2	31,8
7	818,2±17,45	385,4	1262,8	18,9	30,3
8	685,5±17,93	384,1	1386,4	16,2	33,3
9	596,0±23,86	338,6	959,1	13,5	23,0

Conclusions and perspectives

The results of the conducted research allow us to state that the assessment of the intensity of the secretory process in the mammary gland under the conditions of "voluntary" milking can serve as a

reliable criterion for determining the genetic potential of cows' milk productivity and the optimality of their feeding, maintenance and operation conditions. For more fundamental conclusions, further studies of changes in the intensity of the secretory process with age in lactations and in larger herds are needed.

Acknowledgement

None.

Conflict of Interest

None.

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