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RESEARCH REGARDING THE EFFECT OF THE NUMBER OF MILKINGS A DAY ON MILK PRODUCTION AT PRIMIPAROUS COWS

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Abstract

After the first 7 days, the primiparous cows milked three times a day achieved 20.00 kg milk postpartum, corrected at 3.5% fat, while the cows milked twice a day achieved an average production of 17.10 kg milk postpartum, corrected at 3.5% fat. There is an additional quantity of 2.9 kg milk at the primiparous cows milked three times a day (an increase of 16.9%). Statistically analysed, this increase is distinctly significant (P<0.01). After 21 days of experiments, the average milk production of the primiparous cows milked twice a day reaches 19.15 kg milk with 3.5% fat, and the average milk production of the ones milked three times a day reaches 20.50 kg milk with 3.5% fat; for the latter case, there is a decrease of production of 3.8% compared to the previous lapse of time, probably due to certain changes of the physiological status. After 28 days of experiments, the average production of the primiparous cows milked three times a day reached 22.80 kg milk with 3.55 fat, and the average production of the ones milked twice a day reached 18.85 kg milk with 3.5% fat, registering thus a difference of 2.95 kg milk (14.8%). Statistically analysed, this difference is distinctly significant (P<0.01).

Key words*: fat, milk corrected, primiparous.*

INTRODUCTION

Cows are generally milked twice (2x) a day. With the introduction of milking performed by milking robots it is necessary to know the productive effect of more than two milkings per day. Passing to more milkings a day often increases milk production by 10-20% (Erdman & Voiner, 1995; Rastani et al., 2007).

Although the udder is full and the milk pressure is high, milking is not possible, or it can only be done partially. For milking to be possible, the presence of a hormone, called oxytocin, is needed, which causes the contractile elements surrounding the alveoli to contract and the walls of the collecting ducts and the nipple sphincter muscle to relax. Under the action of oxytocin, the milk accumulated in the lumen of the alveoli is pressed to the milk tank from where it can be evacuated by milking.

Oxytocin is produced under the action of stimuli caused by the presence of the milkman, by the specific noises of milking, but the most important stimuli are washing with warm water, wiping and preparatory massage of the udder performed by the milkman. Under the action of stimuli, the secretion of oxytocin in the brain begins immediately, from where it reaches the udder through the blood, where it manifests effect in less than a minute.

It should be noted that of the total milk secreted between two milks only a part is stored in the milk tank, and the larger amount is accumulated in the alveoli and canals, an amount that can be extracted only under the action of oxytocin (Bar-Peled et al., 1995).

The effect of oxytocin is about 6-8 minutes, after which it disappears from the blood. Milking must be carried out during this time, because in the absence of oxytocin the milk can no longer be evacuated from the alveoli. The release of milk also stops when disturbances occur during milking, for example: hitting the cow, foreign noises, etc., which cause the appearance of another hormone in the body, adrenaline, which immediately annihilates the effect of oxytocin. The aim is to ensure normal conditions, without disturbances, and with the preparation of the animal for milking and the preparatory massage to ensure the normal secretion of oxytocin (Dahl et al., 2004)

The fact that the cow "does not give milk" in certain situations has a physiological explanation, and the culprit in most cases is the milkman and the stressors that occur during milking. The action of oxytocin has also been

demonstrated by experiments, when oxytocin was injected into a herd of cows immediately after the end of milking and milk quantities of between 0.5 and over 1 liter per cow could be milked. In reality we not talk about a complete milking, because in the udder there is always a quantity of milk, which is called residual milk, but this amount should not exceed 5-10% of the milk milk. A large amount of residue does not only mean economic loss, due to the high percentage of fat, but also an obstacle in the process of milk secretion, because the udder fills faster, increasing milk pressure, the secretion stops and the cow no longer produces, milking cannot be a routine activity that anyone can do at any time. Proper and complete milking requires proper preparation of the cows, a quiet, undisturbed atmosphere, milking at the same hours, and milking immediately after washing, wiping and massaging the udder, so that the effect of oxytocin is manifested throughout milking (Stelwagen, 2000).

The terms "frequency of milkings" and "interval between milkings" are often used. Reference frame time is 24 hours. When the number of milkings increases, the interval between milkings decreases and vice versa. Research has shown that the interval between two milkings must be less than 18 hours in order to avoid adverse effects on the product and quality of milk (Stelwagen et al., 1996, 1997). Milking twice a day has been a long practice in industrialized countries. In some countries milking passed to three or four times a day.

There are two physiological explanations for the impact of milking frequency on milk production (Stelwagen, 2001). The first explanation is the physical effect of the increase of intramammary pressure, which reduces the rate of milk synthesis in mammary epithelial cells.

The physical forces caused by the accumulation of milk in the mammary alveolus produce a compression of the secretory cells and thus reduces the metabolism of the cells and the synthesis of milk components. The rate of milk synthesis is the fastest immediately after milking, then with time it is reduced, and after 36 hours (if milking is not done) the milk synthesis stops (Cola & Cola, 2019). These phenomena, created by the increase of the intramammary pressure is avoided by increasing the number of milkings.

It has recently been observed that a hormone-like factor secreted by epithelial cells is involved in inhibiting milk synthesis. It has been called FIL; feedback inhibitor of lactation. As milk accumulates in the mammary gland between milkings, FIL inhibits the synthesis of milk components. By increasing the frequency of milking, this factor is removed from the mammary alveoli.

The general effect of milking frequency is also on secretion of prolactin. Circulating prolactin levels are highest immediately after each milking.

Research undertaken (Dahl et al., 2001) demonstrated that an increase of concentration of prolactin at the beginning of lactation can stimulate numerical growth of secretory cells in the mammary gland. Since milk production is a function of the number of secretory cells, starting milking with a larger number of secretory cells by default will increase production of milk. The important thing is that this increase will persist as cell loss is constant throughout the lactation. Prolactin has a stimulating effect on the development of breast cells and its higher concentrations large as response to increase of frequency of milking at the beginning of lactation explains the persistent effect of this practice on milk production.

The impact of milking 4x per day on milk components was studied by (Wiking et al., 2006), who found an increase in milk content in free fatty acids and fat globules with a larger diameter compared to milking 2x per day. Increasing the frequency of milking also causes a reduction in the number of somatic cells in milk (Dahl, 2004).

In the USA (Richard et al., 1994) were reported differences between milking three times a day (3x) and milking twice a day (2x) of 3.3 kg milk at primiparous cows and 3.5 kg at multiparous cows. Wall et al. (2007), in experiments on 1/2 udder with four milkings as compared to two find differences of 2.5 kg of milk at the beginning of lactation, the number of somatic cells, the percentage of fat and the percentage of protein being the same.

Van Baale et al. (2005) found no difference between milking six times a day and three

times a day. In an experiment with four milkings a day, they reported that after seven days the enzymatic activity of the secretory cells was not affected, but milk production was 18% higher than milking twice a day (Norgaard et al., 2005).
In a study using robotic milking in which cows have the freedom to be allowed to milk voluntarily, the average number of milkings was 3.9 times a day. It is considered that there is no biological advantage of increasing the frequency of milking more than four times a day (Ipema et al., 1987, quoted by Stelwagen, 2001).

MATERIALS AND METHODS

The aim of this research was to evaluate the effects of milking three times a day compared to milking twice a day in the first 28 days of lactation on total milk production.

Animals and feed rations

The experiment was carried out at S.C. FENOV SRL Dolj and included a total of 8 primiparous cows of Holstein Friesian breed (Table 1).

Table 1. Grouping of animals

Lactation	Daily milking frequency	No. of animals	Milking hours	Milking interval (hours)
1st Lactation	Group with 2 milkings	8	05:00 and 17:00	12
	Group with 3 milkings	8	06:00, 15:00 and 23:00	9 - 8 1/2 - 6 1/2
Total	Animals with 2 milkings	8	05:00 and 17:00	12
	Animals with 3 milkings	8	06:00, 15:00 and 23:00	9 - 8 1/2 - 6 1/2

The animals were kept "tied up" for 28 days, after which they were kept "free" in separate stalls. The feed ration was formulated according to NRC 2001 (Table 2), for cows of 600 kg live weight and production of 30 kg of milk per day with 3.60% fat and 3.35% protein. All feed ingredients were mixed once a day forming a total mixture ration and administered at discretion (Cola M., 2020), with a percentage of unconsumed residue of 5-7%.
Both primiparous and multiparous animals were randomly assigned to the two-milking and three-milking groups immediately after calving.

Registration of milk production and sample analysis

The animals were milked at the milking parlor, and milk production was recorded daily at each milking starting with the 3rd day of milking until the 7th day postpartum, after which, weekly, until the 28th day of lactation and every 13 weeks, until the end of lactation. After 28 days of lactation, from three milkings a day it was returned to two milkings a day, until the end of lactation.

Table 2. Ration ingredients and chemical analysis

Ingredients	Feed ration
Concentrate mixture	47,00
Corn silo	24,80
Alfalfa hay	20,20
Brewers grains	4,00
Soya beans	2,00
Vitamin-mineral premix	2,00
Chemical composition:	
Crude protein	17,00
Neutral detergent fiber	36,20

Milk samples were collected from each animal and each milking. Cows with decreased milk production on the control day (animals in rut), at one or more milkings, were excluded from the evaluations and introduced in the following weeks. The milk samples were kept in the refrigerator and analyzed within a maximum of 24 hours. On the day of the analyzes, the milk samples from each milking, both from cows milked twice a day and from those milked three times a day, were mixed in equal proportions, with only one sample per day. The fat and protein content of milk was determined in the animal husbandry laboratory of the Faculty of Agronomy in Craiova with the Ecomilk ultrasonic Milk Analyzers.

Statistical analyses

Milk production and fat and protein content were statistically analyzed. Statistical differences were recorded when the value $p \leq 0.05$.

RESULTS AND DISCUSSIONS

a) Milk production of primiparous animals

Table 3 shows the milk production of primiparous animals made after 28 days of experimentation. The average milk production at the end of the first 28 days of experiments

was 19.85 kg for primiparous milked twice times a day and 22.80 kg for those milked three times a day (Table 3). The difference between the two productions is 2.95 kg, a distinctly significant difference. The average milk production of primiparous milked three times a day was after 28 days 14.8% higher than the production of primiparous milked twice a day. The evolution of average productions after 7, 14, 21 and 28 days postpartum is shown in Figure 1.

Table 3. Milk production of primiparous cows

Milking frequency		Average milk production after:			
		7 days p.p. * (kg milk with 3.5% fat)	14 days p.p. (kg milk with 3.5% fat)	21 days p.p. (kg milk with 3.5% fat)	28 days p.p. (kg milk with 3.5% fat)
2x (two milkings)		17.10	18.50	19.15	19.85
3x (three milkings)		20.00	21.30	20.50	22.80
Difference : 2X-3X	kg	2.90	2.80	1.35	2.95
	%	+16.9	15.1	7.0	14.8
Statistical significance of differences		Significantly distinct p<0.01	Significantly distinct p<0.01	Insignificant p> 0.05	Significantly distinct p<0.01

*p.p. = postpartum

After the first 7 days, primiparous cows milked three times a day achieved an average of 20.00 kg of milk corrected to 3.5% fat, while those milked twice a day achieved an average production of 17.10 kg milk corrected to 3.5% fat. There is an increase of 2.9 kg of milk in primiparous cows milked three times a day (an increase of 16.9%). Statistically analyzed, this increase is distinctly significant (P<0.01).

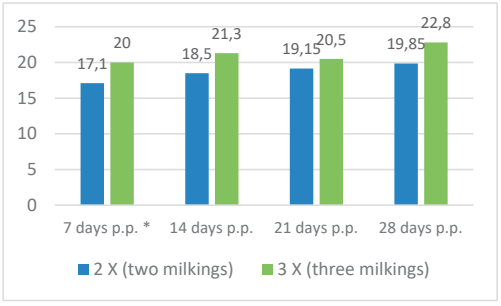

Figure 1. Milk production of primiparous cows

After 14 days, the primiparous cows milked three times a day achieved an average of 21.3 kg of milk corrected to 3.5% fat, and those milked twice a day produced an average of 18.50 kg of milk corrected to 3.5% fat while maintaining an increase of 2.8 kg of milk (15.1%) between the two groups.

After 21 days of experimentation, the average milk production of primiparous cows milked twice a day reaches 19.15 kg of milk with 3.5% fat, and of those milked three times a day at 20.50 kg of milk with 3,5% fat, with a decrease in production compared to the previous period by 3.8%, probably due to changes in genetic status.

After 28 days of experimentation, the average production of primiparous cows milked three times a day reached 22.80 kg of milk with 3.55% fat, and of those milked twice a day, 18.85 kg of milk with 3,5% fat, with a difference of 2.95 kg of milk (14.8%).

Statistically analyzed, this difference is distinctly significant (P<0.01).

After 119 days of lactation, the difference between the average milk production of primiparous cows milked three times a day (between 3 and 28 days of lactation) and the milk production of primiparous cows milked twice a day was 2.00 kg of milk with 3.5% fat (9.5%) (Figures 2 and 3).

Table 4. Average milk production of primiparous cows after 119, 210 and 301 days of lactation

Milking frequency		Average milk production after:			Milk production per 301 days of lactation	
		119 days p.p. * (kg milk with 3.5% fat)	210 days p.p. (kg milk with 3.5% fat)	301 days p.p. (kg milk with 3.5% fat)	Physically Kg	Maturity equivalent Kg
Two milkings a day (2X)		22.10	20.50	19.50	5869	7336
Three milkings a day (3X)		24.10	22.50	21.30	6411	8014
Differences 2X-3X	kg ±	+1.90	+1.80	542	678	678
	%	9.5	9.2	9.2	9.2	9.2
Statistical significance		Significant p <0.05	Significant p <0.05	Significant p <0.05	Significant P <0.05	Significant p <0.05

At 210 days, there was a difference of 1.9 kg of milk with 3.5% fat (9.2%), and at 301 days of lactation, the difference in production between the two primiparous groups was 1.8 kg of milk

with 3.5% fat (an increase of 9.2% in favour of primiparous cows milked three times a day during 3-28 days of lactation - Table 4).

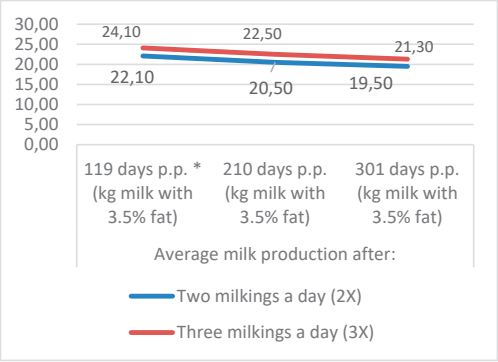

Figure 2. Average milk production of primiparous cows after 119, 210 and 301 days of lactation

Physical milk production per 301 days of lactation was 542 kg higher at 3 milks per day compared to 2 milks per days which means 9.2% (Figure 3)

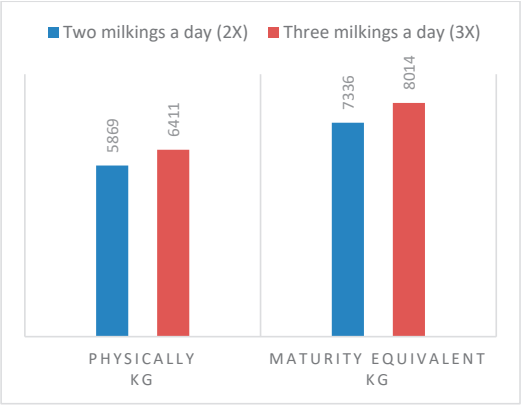

Figure 3. Milk production per 301 days of lactation

CONCLUSIONS

Milking the animals three times a day had the effect, in this experiment, of an increase in milk production both in the first 28 days of lactation and during 301 days of lactation.

The mammary gland of dairy cows has the ability to respond positively to the demands of milking three times a day.

Increasing milk production per cow increases the efficiency of milk production.

The milk production of a cow is determined by the number of secretory cells of the mammary gland and their metabolic activity.

The cows' response to milking 3 times a day takes place in stages, each stage reflecting different mechanisms.

In stage I, the increase in milk production occurs immediately due to the more frequent removal of the lactation inhibitory factor.

In stage II, the increase in milk production takes place in the short term (from a few days to one week), due to the stimulation of secretory cell differentiation.

In stage III, the increase of milk production takes place on a long-term basis (from a few weeks to a few months) due to the stimulation of the proliferation of secretory cells.

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