Comparison of Milking Systems Based on Milk Quality and Milk Quantity

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Abstract

We analysed one Holstein- Friesian dairy farm using two types of milking technologies. One of them is a parallel milking parlour (2x8), where 200 cows are milked twice a day. The other part of the animals (500 cows) is milked with robotic milking machine. The average daily milking frequency is 2.8. We processed data from nearly 700 cows. Based on the two different milking technologies, we formed two groups for the calculations. We collected daily milk production (kg/day), milk protein (%/kg), milk fat (%/kg) and somatic cell count (SCC) (cell number/cm^3) data, based on a monthly test-day.

Each month, there was significantly more milk production for robotic milking (P<5%). In the 2nd month of lactation, at the time of peak production, the average milk production of the animals was 43 kg and 37 kg, respectively. The milk protein content was higher in conventional milking, because less milk is more concentrated. At months 2, 3, 4, and 11 of lactation, the difference was significant. In the month of peak production (month 2): 3.27 and 3.22 (milk protein %). Milk fat% was higher in conventional milking only in months 2 and 3 of lactation, however, this level was significantly higher in the second half of lactation in addition to robotic milking. The somatic cell count of milk was lower each month for robotic milking. This difference was significant for the first 11 months. At 3 months of lactation: 140,000 (AMS) and 220,000 (CMS) (number of cells/cm^3) (P<5%).

Based on our results, we can conclude that significantly more milk and milk fat can be produced and significantly less the SCC with the robot milking.

Keywords: milk fat, milk protein, milk yield, robot milking, somatic cell count

1. Introduction

The automatic milking system allows each cow to choose the time of milking, the time between two milkings during the day and during lactation [1]. During milking, the cow can see the herd, which reduces the stress associated with milking. As emphasized by many authors [2-4] it is important that animals have a positive experience at milking.

Somatic cell count

As a result of physiological factors, the somatic cell count of milk changes in a particular way. At the beginning and end of lactation, after calving, an increase in cell number can also be observed in healthy cows. The average somatic cell count increases in contrast to the decrease in the amount of milk [5-7]. As the number of lactations increases, the somatic cell count of raw milk also increases, which may be due to microtraumas to the udder [8]. There is no difference in the somatic cell count of the milk of cows milked once or twice a day, but the environmental effect is strong [9]. With robotic milking, the frequency of milking increases, therefore the milk yield also increases, so the reduction of SCC is a consequence of the dilution effect [10-11]. At the same time, it has been shown that more frequent milking reduces the possibility of bacteria adhering to the udder tissue [12]. The milking robot adjusts the ideal vacuum level every udder

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quarter, so there is less milking-related teat tip reaction and teat tip thickening [13]. As a result, fewer pathogens can enter the udder between the two milkings. However, Tse et al. study [14], producers reported an increase in milk yield, but milk quality was little affected by robotic milking.

Amount of milk

With the use of automatic milking machines (milking robots), the number of milkings increases, which is why the amount of milk increases. According to various studies, milking three times results in an increase of 1-25% compared to milking twice. In the case of cows with higher milk yield, milk production is 15-20% more and milk fat is 0.2% more when milking three times [15]. According to Amos et al., [16], multiple and first lactation cows, which were milked three times a day, produced 18.5 and 25.2% more milk. Sitkowska, et.al, [17] also reported an increase in milk yield when milking with milking robots was introduced. According to them, the optimal number of milkings per cow is between 2.6 and 2.8 milkings per day. Welper and Freeman [18] found the heritability of milk yield, milk protein, milk fat and milk sugar in the given order to be: h^2 = 0.30; 0.29; 0.27 and 0.26, which can be considered low.

Milk fat, milk protein

The automatic milking system (AMS) significantly increased the daily milk yield compared to the traditional milking system [19]. There was no difference in milk fat and milk protein %. But milk fat and milk protein yields were significantly higher for AMS due to increased milk yield. According to Amos et al., [16], the frequency of milking did not affect the composition of the milk, however, the total milk fat was significantly higher in cows milked three times a day. In one study, milking frequency and milk yield of cows with CMS milking (conventional parlor milking system) were significantly (P<0.05) lower than those of AMS cows. There was a negative correlation between milking frequency and fat and protein content. Increasing the milking frequency increased the milk yield, although mainly in cows that calved more than in heifers [20]. Several experiments compared the milk of AMS and CMS cows of different herd sizes in different stages of lactation [20-23]. They found that the milking system did not significantly affect the fat, protein, casein, lactose, and fat-free dry matter content. Salovuo et al. [13], after the introduction of AMS, the average fat content increased from 3.85 to 4.20%. Contrary to the previously cited data, other researchers measured higher fat and protein content (P<0.01) in AMS milk than in CMS milk [17, 24]. In a large-scale study of 51 farms using AMS and 53 using CMS, Johansson et al. [10] found no difference in fat content between the 2 groups, while the protein content of AMS milk was lower (P=0.005). From the above studies, we can see that quite different results were obtained when comparing the milk fat and milk protein content of the milk of CMS and AMS cows.

2. Materials and methods

The examination were carried out on a Holstein-Friesian dairy farm, where two types of milking technology are used. One is a 2x8 parallel milking machine where 200 cows are milked twice a day. The other part of the animals is milked with milking robots. There are 2 barns, both with 3 milking robots for 500 cows. The average number of milkings per day: 2.8. We processed the data of nearly 700 cows from the database of the Riska program. Based on the two milking technologies, we formed two groups for the calculations. Within the groups, we sorted the animals according to the month of lactation and followed their lactation performance throughout (1-14 months) based on test day milkings. We collected data on daily milk production (kg milk/day), milk protein (%/kg milk), milk fat (%/kg milk) and somatic cell count (SCC), (cell count/cm3). Using the SPSS-26 program, we compared the results of the two groups with an independent T-test.

3. Results and discussion

Every month, **milk production** was significantly higher with robotic milking (P<5%) compared to traditional milking technology. In the 2nd month of lactation, i.e. at the time of peak production, the average daily milk production of the animals was 43 kg of milk and 37 kg of milk, the difference is 6 liters (Figure 1).

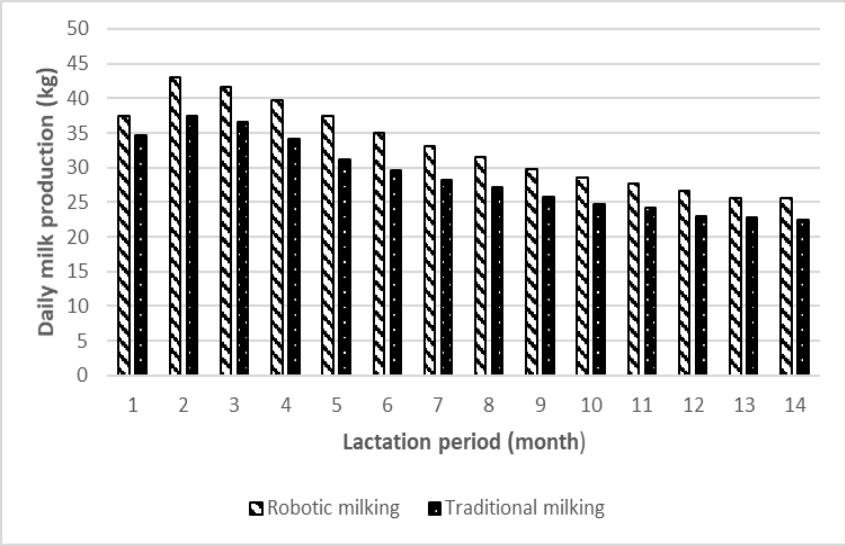

Figure 1. Daily milk volume during lactation based on milking systems

Towards the end of lactation (months 11-14), with the decrease in milk production, the difference also decreased to 3 liters (25.5 and 22.4 liters in the 14th month, respectively). Ki et al., [12], Hogenboom.et al, [20] also report a significant increase in milk yield with robotic milking, which is caused by the increased number of milkings. As the udder becomes saturated, the produced milk puts more and more pressure on the milk-producing cells and to the pressure-sensing nerve endings in the walls of the milk ducts. Thus, partly as a result of the pressure of the milk, partly due to nervous and hormonal effects, the secretion of milk decreases and then ceases; it can only start again when the milk is emptied from the milk ducts and the pressure on the milk-producing cells ceases [25]. With repeated milking, the udder is emptied several times, enabling more intense milk production.

The **milk protein** content was higher in the case of traditional milking (Figure 2). The difference was significant in the 2nd, 3rd, 4th and 11th months of lactation. In the month of peak production (month 2): 3.27 and 3.22 (milk protein%). Our result is the same as Hogenboom.et al, [20] and Johansson et al. [10], who describe that increasing milking frequency, higher milk yield and the accompanying thinner milk caused the decrease in milk protein in the case of robotic milking.

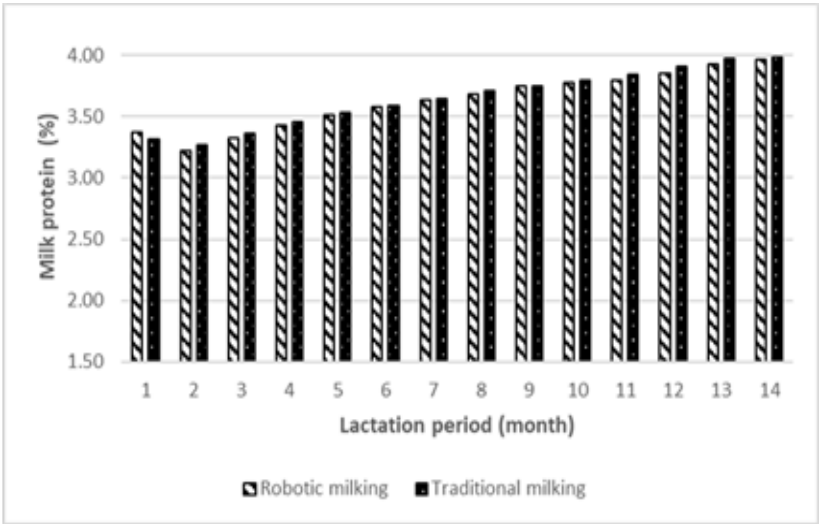

Figure 2. Changes in milk protein % during lactation based on milking systems

At the same time, many authors report different results when examining the effect of traditional and automatic milking systems on milk protein. They showed that there was no difference in milk protein %, and the frequency of milking did not affect the composition of the milk either [16, 19-23]. In contrast, other researchers measured higher protein content during robotic milking [17, 24].

The **milk fat%** was higher in the 2nd and 3rd months of lactation, i.e. at the time of peak production, in the case of traditional milking (CMS). This is the period when the difference in milk production is the biggest when comparing the two milking technologies. With robotic milking (AMS), the average daily milk production is 6 liters more, which results in thinner milk. In the second half of lactation, with the decrease in milk production, the milk fat% was higher, with a significant difference in the 7th, 9th, 10th, 11th, and 13th months with robotic milking.

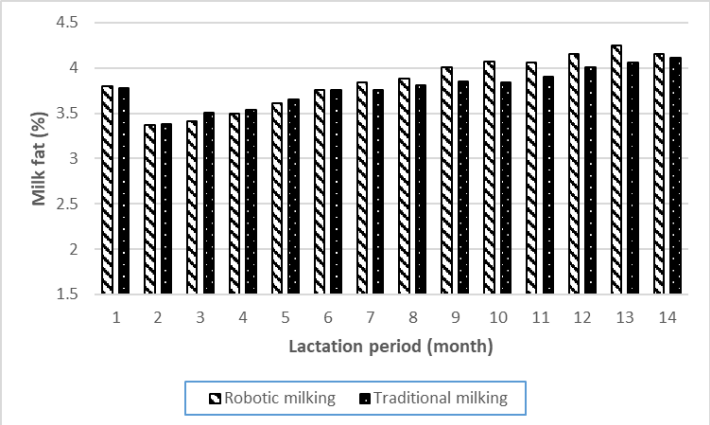

Figure 3. Changes in milk fat % during lactation based on milking systems

According to some opinions, the two milking systems (AMS and CMS) do not significantly affect milk fat [20-23]. At the same time, others described that there was no difference in milk yield, and milking frequency did not affect the composition of the milk [16, 19]. Although the lactation fat yield was significantly increased by the robotic milking due to the increased milk yield. However, Salovuo et al. [13], milk fat % also increased with AMS milking.

The **number of somatic cells** (SCC) in the milk was lower in every month of lactation with robotic milking. This difference was significant in the first 11 months. In the 2nd month of lactation, the number of cells/cm^3 (P<5%) in milk was 140,000 and 220,000, respectively, for AMS and CMS (Figure 4). In case of traditional milking, SCC changed rhapsodically during lactation. In case of conventional milking, SCC changed rhapsodically during lactation. In the case of AMS, in the first month of lactation and at the end, an increase in the number of cells can be observed even in healthy cows.

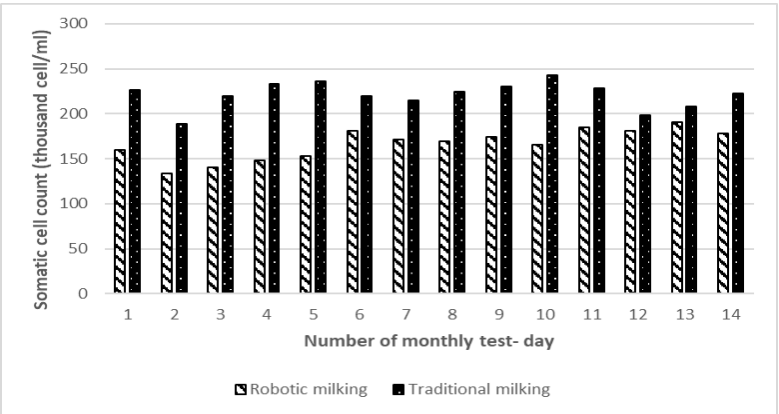

Figure 4. Changes in the somatic cell count (SCC) during lactation based on milking systems

Examining the relationship between the amount of milk during lactation and the somatic cell count, it can be concluded that the somatic cell count increases in contrast to the decrease in the amount of milk. This finding agrees with the results of Gulyás [6]. Berglund et al. al, [26], who also compared the two milking systems, describe that in the case of an automatic milking system, the SCC was significantly ($P<0.05$) less when the milk was examined per udder quarter, while in the mixed milk, the type of milking was not effect. In the results of Gere [9], there was no difference in SCC either. However, other authors reported a decrease in SCC when using robotic milking [10-12].

4. Conclusions

Based on our results, we can conclude that with robotic milking, significantly more milk can be produced during the entire duration of lactation compared to traditional milking technology. With this technology, the average number of milkings per day is 2.8, compared to the traditional milking twice a day. The udder is emptied several times, which stimulates the udder to produce more milk. The somatic cell count values are significantly lower in robotic milking. In the case of traditional milking, the milk protein content is significantly higher in the months of peak lactation production, as the less milk is more concentrated. The milk fat content in the second half of lactation is significantly higher with robotic milking. This can also be explained by repeated milking, as the fat content of the milk is higher at the end of the milking.

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