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ANIMAL SCIENCE

Comparative Analysis of Milking and Behavior Characteristics of Multiparous and Primiparous Cows in Robotic Systems

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Abstract: Robotic milking systems are successful innovations in the development of dairy cattle. The objective of this study was to analyse the milking characteristics and behavior of dairy cows of different calving orders in “milk first” robotic milking systems. The data were collected from a commercial herd located in the Midwest region of Minas Gerais (Brazil), which uses an automatic milking system (AMS ™, DeLaval). Were analysed 26,574 observations of 235 Holstein cows were available. Data were evaluated by multivariate analysis of variance and the Tukey test. - Tthe characteristics milk flow and milking efficiency were more favourable for multiparous cows ($p < 0.01$), while the time in the stall was more favourable for primiparous females ($p < 0.01$). The values of handling time were better in the primiparous cows ($p < 0.01$). Primiparous cows had higher amounts of kick-off ($p < 0.001$), and multiparous cows had higher incomplete milkings ($p < 0.001$). The number of incomplete milkings showed a higher ratio in terms of reduction in milk production in 26.6% in primiparous cows and 26.7% in multiparous cows ($p < 0.01$). Regarding the behavioral characteristics, primiparous cows had higher amounts of kickbacks, while multiparous cows had greater quantities of incomplete milkings.

Key words: dairy cows, milking efficiency, automatic milking system, livestock precision farming.

INTRODUCTION

The technological advances have driven dairy farming to increase production to meet the consumption needs of a growing population. Dairy activity in Brazil seeks to increase milk production in an innovative and competitive world market. Robotic milking systems, also known as the automatic milking system (AMS) or voluntary milking system (VMS), are successful innovations in the development of dairy cattle, automating complicated and repetitive milking activities. Its use offers an alternative option to produce milk. According to Salfer et al. (2019), there are approximately 35.000 robotic units in the world. Most are in North America and Europe (Utsumi & Insua 2019).

In Brazil, milking robots are a fairly recent novelty. The first one was installed in 2012 by the company DeLaval in a project in the state of Paraná. However, the use of AMS is a growing reality, especially because the -labor force in the country is increasingly expensive, poorly trained and difficult to – to retain on the farm (Simões Filho et al. 2020). However, investing in expensive equipment does not guarantee greater efficiency in milk production. The AMS provides a large amount of data which, according to King & Devries (2018), may overload thedairy farmers. Thus, the question arises of how to make the best use of these data to perform the selection of suitable cows for the equipment.

According to Simões Filho et al. (2020) and Maculan & Lopes (2016), in the Milk First system, the selection gate is positioned in front of the AMS and the cows have to cross the gate to reach the feeding area. The selection gate directs the cows to AMS or the feeding area, depending on whether they are allowed to milk or not. If the cow is allowed to be milked, she is directed to the waiting area in front of the AMS. Otherwise, if she is not allowed to milk, she will be directed directly to the feeding area. In the feeding area, cows have free access to the resting area through one-way gates

In robotic milking systems, it is possible to select cows with better milking performance conditions because the systems provide data on behaviors of the cows and several milking characteristics, like the evaluation of yield during milking, the milk flow rate, the time in the stall (Gäde et al. 2006) and milking efficiency (Vosman et al. 2018). A behavioral characteristic is handling time that includes the time from the cow entering the milking stall to the start of milking (time for teat detection, washing, stimulation and pre-milking) plus the time after milking until the entrance gate is opened to allow the next cow inlet (Carlström et al. 2016). Time in AMS before and after milking, in minutes (Wethal & Heringstad 2019), in milking, incomplete milking and kicking (Wethal & Heringstad 2019) are other parameters to consider.

Thus, more research that generates knowledge about the use of this technology is needed in Brazil. In particular, it is necessary to analyse the milking characteristics and behaviors of the cows that are more favourable during milking. Increasing the knowledge on the characteristics related to the animal, under Brazilian conditions, will provide information to producers and technicians interested in adopting this technology and, for those who already use it, suggestions on adjusting actions in herd management, which can improve the productivity and consequently the profitability of high investment.

The objective of this study was to analyse some milking and behavioral characteristics of dairy cows in voluntary milking systems

MATERIALS AND METHODS

A total of 26,574 daily milking data from 235 Holstein cows with various calving orders, grouped as primiparous or multiparous, were used. The farm, located in the Midwest region of Minas Gerais (Brazil), keeps the lactating cows in a compost bedded-pack barn, provided with four automatic milking systems (AMS TM, DeLaval, Tumba, Sweden). The data were collected from September 2019 to March 2020, rainy season of the year.

The initial raw dataset was processed using DelProTM software (DeLaval, Tumba, Sweden). The selection of the data was made according to the methodology of Carlström et al. (2013). Information were collected on: a) identification of the cow: number, days in lactation, calving order (one calving, more than one), genetic group; b) milking data, such as date and time of entry (start time) and exit (end time) of each visit, milking time (minutes), milking interval and milking frequency; c) information on milk production (kg), mean milk flow rate (kg/min) and peak milk flow rate (kg/min) in each quarter of the udder; d) problems during milking, such as the number of incomplete milking, cow kick-off and missing teats.

The lactation period was considered to be between 5 and 305 days after calving. To group the production and milking speed data, the methodology of Wethal & Heringstad (2019) was used, which consider all records in which milk production was ≤50 kg in total per milking and ≤13 kg per quarter udder by milking, as well as the maximum mean milk flow was 3 kg milk/min and the maximum peak milk flow was 4 kg milk/min in any quarter of the udder.

The set of milking records was summarized in one observation per cow per day, considering the milking characteristics and behaviors such as the daily averages of time in the stall, milk flow, milking efficiency, handling time and milking intervals (Wethal & Heringstad 2019).

The following milking characteristics, obtained from AMS records, were analysed: a) average and peak milk flow rates. According to the method by Wethal & Heringstad (2019), the average and peak milk flow rates (kg of milk per minutes) were measured for each quarter of the udder in a milking. The mean values of mean milk flow and quarter peaks were used separately to obtain a single record by milking for each of these two characteristics. b) Time in the stall: the time, in min, from the time the cow entered the milking unit until its exit, according to the difference between the start and end times (Løvendahl et al. 2011). c) Milking efficiency, that is the milk production per unit of total time: the value was calculated with the total milk production (kg) of the four quarters in each milking divided by the time in the stall (min).

In addition, the milking time was analysed, defined as the longest milking time of the four quarters, that is, the time from the beginning of milking until the milk flow end, when the last teat cup was removed, with 30 seconds being added as a constant at the time of fixation according to the methodology of Carlström et al. (2013, 2016).

Three behavioral characteristics were analysed: a) handling time in milking: the difference between the time in the stall and the milking time (min), obtained from the longest time of the four quarters, to obtain a record for each milking (Carlström et al. 2013). b) Incomplete milking: the number of daily milking events with a minimum of one quarter recorded as incomplete milking. c) Kickbacks: the AMS sensors recorded the number of premature or unexpected removals of the liners from each quarter of the udder during milking (Carlström et al. 2016).

Regarding incomplete milking, the AMS DeLaval considers it when the current milk production is less than 70% of the expected production in any quarter of the udder based on the previous milking of the last 24 hours (Wethal & Heringstad 2019). According to Carlström et al. (2016), after the incomplete milkings were identified, those milkings with records of teats not found were included in the count, determined when the robot was unable to detect at least one teat of the four quarters. According to Carlström et al. (2013, 2016), even if the kickbacks resulted in incomplete milking, the incomplete milkings were kept separate from the kickbacks. Milking intervals between 5 and 30 hours were included. Next, the trait was defined and calculated as binary (0 or 1) by milking and summarized in all milkings per day. A cow with one or more incomplete milkings in each milking session and with three daily milkings was recorded as three incomplete milkings.

Kicking was considered for each milking and included at least one removal or fall of the liner from the ceiling of any quarter. The trait was defined as binary (0 or 1) by milking and summarized in all milkings per day. A cow that recorded at least one or more kicks in milking was assigned a kick record, and if it had three daily milkings and in all of them there was a kick record, three kicks/cow/day were recorded. However, due to the low frequency of milking with kick records and incomplete milking as a daily record, a second definition of analyses was created, summarized in percentages of the total milking days for each genetic group, calculated with the following formula:

Kicking (%) or incomplete milking (%) = Number of observations with kick-offor incomplete milking/Total observations per study.

The means of milking characteristics, behavior obtained from AMS were compared by calving order. Analysis of variance (ANOVA) was used, with analysis of univariate differences by the T test, For multivariate comparisons, Tukey's test was used, where the central limit theorem was assumed (Lopes 2014). Statistical analyses were performed using SPSS version 22.

RESULTS AND DISCUSSION

The final set of data analysed had a total of 26.574 observations from 235 Holstein cows, with 10.759 and 15.815 of 118 primiparous cows and 117 multiparous cows, respectively.It Was observed statistical differences in most of the characteristics by lactation order groups. There were significant differences ($p <0.001$) in most characteristics between the two calving order groups, except for the average milking interval. Primiparous cows had a lower milking efficiency, a lower milk flow and a shorter stall time than multiparous cows, which produced 1.88 kg more milk ($p <0.001$) per milking (Table I).

When comparing the times in the stall, on average, the multiparous cows had 7.23 min/milking and the primiparous cows had 6.76 min/milking, a difference of 0.47 min/milking ($p <0.001$). Considering the average of 57 cows/AMS during the study period and the frequency of milkings/cow of 2.4, which represented 136 milkings/day (57 cows × 2.4 milkings), it can be inferred that with a total of 63.92 minutes (0.47 min x 136 milkings/day) saved in the group of primiparous cows, it would have been possible to milk 8.8 multiparous cows or 9.4 primiparous cows more, without decreasing the robot's idle or inactivity time or the frequency of milking, thus optimizing its use. This fact is interesting because, according to Castro et al. (2012), increasing an average of 60 cows per AMS without compromising milking performance, maximizing 2.6 milkings per cow, can increase the amount of milk obtained annually per robot. Therefore, the selection of cows with faster milking speeds is an important factor in balancing milk production and increasing the number of cows per robot.

According to Tremblay et al. (2016), the time in the stall and the frequency of milking are associated with increased milk production by AMS, but they rarely increase simultaneously. They reported an average stall time of 6.84 min/milking in 2.91 milkings/cow and 50.5 cows/AMS or 147 milkings/day (50.5 cows × 2.9 milkings). This was observed in the present study; on average, the milking intervals were similar between the two groups of calving order, 9.54 and 9.56 hours in primiparous and multiparous cows, respectively ($p <0.001$) (Table I). However the highest frequency of milking and the shortest time in the stall were obtained with the primiparous cows, which indicated that animal traffic may increase because more cows could be milked by AMS. This fact, according to Tremblay et al. (2016), allows the grouping of cows with high milking speeds, which take less time in the stall or require less milking during the day.

In the present study, the average production was 32 kg of milk/cow/day, with a production of 1.824 kg per AMS/day. Tremblay et al. (2016), in 635 American herds, with an average of 50 cows

Table I. Effect of calving order on the characteristics of cows milked by automatic systems (AMS) with guided milk-first traffic in a commercial herd (Minas Gerais).

Characteristics	Order of delivery												p *value*
	Primiparous						Multiparous						
	Mean*	Standard deviation	Minimum	Maximum	Variance	Coefficient of variation	Mean*	Standard deviation	Minimum	Maximum	Variance	Coefficient of variation	
Milking													
Time in the stall (min)	6.76	1.89	3.73	16.27	3.58	0.28	7.23	1.85	3.55	19.93	3.43	0.26	<0.001
Milking efficiency (kg/min)	1.91	0.61	0.01	4.83	0.37	0.31	2.03	0.60	0.03	4.82	0.36	0.29	<0.001
Milk flow (kg/min/udder)	2.82	1.42	0.00	9.57	2.02	0.34	2.99	1.19	0.60	8.64	1.43	0.26	<0.001
Behavior													
Handling time (min)	2.40	1.03	0.31	13.17	1.06	0.43	2.49	1.05	0.30	14.04	1.10	0.42	<0.001
Incomplete milkings (number/cow/day)	0.09	0.35	0.00	4.00	0.12	4.05	0.14	0.45	0.00	4.00	0.20	3.27	<0.001
Milking with kicking (number/cow/day)	0.17	0.53	0.00	4.00	0.29	3.13	0.05	0.23	0.00	3.00	0.05	4.80	<0.001
Other													
Milk production/milking (kg)	12.34	3.38	0.13	26.65	11.45	0.27	14.22	4.02	0.40	33.16	16.13	0.28	<0.001
Average milking interval (hour)	9.54	2.55	5.02	23.99	6.52	0.27	9.56	2.64	5.01	23.99	6.98	0.28	0.582
Milking frequency (number)	2.49	0.73	1.00	5.00	0.53	0.29	2.41	0.73	1.00	5.00	0.53	0.30	<0.001
Milking time (min)	4.37	1.49	0.76	11.32	2.21	0.34	4.75	1.62	0.90	11.74	2.62	0.34	<0.001

***Means analyzed by the t-test at 5% significance.**

producing 31 kg of milk per day, obtained a value of 1.626 kg/AMS. Manufacturers and distributors suggest that 2.000 kg/AMS of 60 cows producing 33 kg/day is a reasonable target for confined herds (Rodenburg 2017). This value is similar to that obtained in this study.

This fact is extremely interesting because what is desired, in practice, at the end of the day, is to obtain the largest amount of milk production possible (Lopes et al. 2019). When the frequency of daily milking increases from two to three times, milk production increases, on average, by 14.76% (Lopes et al. 2012). To increase the economic viability of the AMS, the frequency of daily milking should be maximized (Bach & Cabrera 2017). This fact depends on the cows voluntarily visiting the milking stall (Maculan & Lopes 2016), which will increase the use efficiency (Castro et al. 2012) and maximize the daily occupancy rate of the AMS (Steeneveld et al. 2012).

The milking efficiency, on average, was 1.91 and 2.03 kg of milk/min ($p < 0.001$) for primiparous and multiparous cows, respectively, with a difference of 0.13 kg/min. The difference can be attributed to higher production and high milk flows in multiparous cows. The results were similar to those reported by Wethal & Heringstad (2019) and Løvendahl et al. (2014), which stated that the primiparous cows showed an efficiency below 1.50 kg/min throughout the lactation curve.

The primiparous cows had lower milk production per milking and lower milk flow than the multiparous cows ($p < 0.001$). The results were similar to those obtained by

Siewert et al. (2019) in guided flow systems. The primiparous cows had biologically normal lactation curves, with a lower production peak and greater persistence than the multiparous cows. However, other factors can cause differences in milk flow. According to Norman et al. (1988), the anatomical characteristics of dairy cattle are not the same for all breeds, and the udder and teat morphology may favour the performance of certain breeds. According to Santos et al. (2018), the time in the stall and the milk flow are influenced by the pressure and morphology of the udder. Long milking intervals lead to udder distension (Hogeveen et al. 2001); moreover, shorter teat lengths increase milk flow (Porcionato et al. 2010).

The time in the stall is directly related to the capacity of cows per robot (Carlström et al. 2013). The shorter time improves the traffic of cows through it (King et al. 2018). However, milking efficiency is an alternative feature that reflects the economic efficiency of using SMA (Wethal & Heringstad 2019). Thus, an AMS-efficient dairy cow is one that provides more milk per minute in the milking stall (Løvendahl et al. 2011). This characteristic is highly correlated with the milk flow velocity (Wethal & Heringstad 2019) and is subjective and somewhat vague, given that the milking time becomes dependent on the ease of cow management in milking (Jacobs & Siegford 2012b).

Multiparous cows had longer milking times and higher milk production ($p < 0.001$). Carlström et al. (2013) reported shorter milking times in primiparous cows (4.58 min) and longer milking times in multiparous cows (4.97 min), with average milk production per milking of 12.06 to 14.92 kg, respectively. Such times were similar to those observed in the present study. The increased milk flow in the multiparous group ($p < 0.001$) may be related to the anatomical conditions of the teats, with shorter lengths and longer intervals between milking. According to Norman et al.(1988), the anatomical characteristics of dairy cattle are not the same for all the breeds, and the udder and teat morphology may favour the performance of certain breeds.

It was observed statistical differences in most of the behavioral characteristics by lactation order groups. Primiparous cows had higher numbers of observations with kicks, while the number of incomplete milkings was higher in multiparous milking. In primiparous cows, milk production by milking decreased by 3.2% ($p < 0.001$) as the record of milking with kicks increased, while in multiparous cows, it decreased by 2.0% ($p < 0.05$). The number of incomplete milkings was found to be higher in terms of reduced production in 26.6% of primiparous cows and 26.7% of multiparous cows ($p < 0.001$) (Table II). These results demonstrate, as reported by Carlström et al. (2014) and Wethal & Heringstad (2019), that problems of fixing the liners due to kicking or incomplete milking are undesirable characteristics reducing the efficiency of the use of AMS. Kicking during milking is more frequent in nervous and anxious cows, regardless of breed (Metz-Stefanowska et al. 1992), while the characteristic of incomplete milking is related to the effects associated with udder morphology or positioning of the teats with time in the stall, considering that the robotic arm takes longer to find the teats in morphologically incorrect udders (Carlström et al. 2016).

The greatest number of failures in the fixation of the liners (incomplete milking or kicking) was related to a 26% decrease in milk production during the next milking, and the recovery to the previous milk production level occurred only after seven milkings (Bach & Busto 2005). Therefore, incomplete emptying of the udder promotes the development of pathological conditions such as mastitis (Bobić et al. 2011).

Table II. Effect of calving order on behavioral characteristics of dairy cows milked in automated systems (AMS) with guided milk-first traffic in a commercial herd (Minas Gerais).

Order of delivery	Number of obs.	obs.	MP[1]	Standard deviation	Coefficient of variation	Number of obs.	obs.	MP[1]	Standard deviation	Coefficient of variation	*p* value
	Milking without kicking [2]					**Milking with kicking [3]**					
Primiparous	9.510	88.4	12.3a	3.40	0.27	1.249	11.6	11.9b	3.17	0.27	<0.001
Multiparous	15.114	95.6	14.5a	4.04	0.28	701	4.4	14.2b	3.45	0.24	0.041
	Milking complete [2]					Incomplete milkings [3]					
Primiparous	10.029	93.2	12.5a	3.26	0.25	730	6.8	9.17b	3.43	0.37	<0.001
Multiparous	14.185	89.7	14.6a	3.81	0.26	1.630	10.3	10.7b	4.12	0.38	<0.001

[1] MP: Average milk/milking production (kg); *Means in the same row followed by the same letters do not differ by *the t test* at 5% significance; [2] No record of milking with kicks/day or no record of incomplete milking/day; [3] With one or more milking with kicking/day or with one or more incomplete milking/day.

Mastitis causes considerable economic losses, such as reduced milk production, milk disposal, cost of treating clinical cases, increased labour costs, decreased milk sales price and animal disposal (Halasa et al. 2007). Several of these losses were quantified by Lopes et al. (2012) and Demeu et al. (2015).

Removal of the couplers may be caused by a combination of factors, such as arm malfunction (Carlström et al. 2014), discomfort resulting from decreased milk flow and pressure from the vacuum system at the end of milking (Cerqueira et al. 2012), or sore teats due to mastitis or increased frequency of milking (Rodenburg 2013). In addition, the accumulation of dirt on the teats and in the chamber of the robotic arm, dark teats and excess hair on the udder can be causes of incomplete milking (Svennersten-Sjaunja & Pettersson 2008, Salfer et al. 2013).

Based on these assumptions, in the present study, it is possible that the presentation of kicks during milking caused a greater reduction in milk production in primiparous cows, which already had lower milk production. However, in multiparous individuals with higher yield, perhaps kick-off does not represent a behavior associated with stress that affects production and is an involuntary reflex. It is known that the training of the animals in the AMS has positive results in the milking intervals and visits to the feeding area, resulting in greater milk production (Widegren 2014). Most likely, in primiparous cows in the postpartum period, hormonal changes and the act of waiting in line to enter the robot are factors that can be stressful until they become familiar with the system. Because postpartum multiparous cows have more experience in the use of AMS as consequence of previous lactations, they become calmer at the time of milking. In addition, milk yield and behavior during milking may be associated with the amount of feed and the conditions of body condition and health. Therefore, these hypotheses need future studies to evaluate, in greater depth, the behavior of multiparous cows.

The primiparous cows took less time in the stall than the multiparous cows (p <0.001) (Table I). This may be due to the shorter milking time resulting from the lower milk production and milk flow, in addition to the shorter handling time. The results are similar to those reported by Carlström et al. (2013), who showed that primiparous cows spent less time in the stall than did multiparous Swedish Holstein and Swedish Red cows. They reported a similar handling time between 2.57 and 2.62 min for the two calving order groups, which could be a reason for the shorter time in the stall.

In contrast, Wethal & Heringstad (2019) found a longer handling time, with an average of 3.14 min, which was relatively similar among the calving orders, with longer handling times at the beginning and end of the lactation curve, except in primiparous cows, which showed lower values at the end of lactation. The difference in the shorter handling time in the present study can be attributed to the fact that they added a constant (1.5) to the logarithm of the statistical model after the record of the longest milking time was calculated for each quarter of the udder. It is known that more docile cows have less time in the stall, which is associated with a shorter handling time (Carlström et al. 2016). According to Wethal & Heringstad (2019), factors such as temperament and udder conformation have a positive correlation with the handling time in milking.

According to Stephansen et al. (2018), the handling time is associated more with udder conformation and not as much with temperament. In the present study, a higher number of incomplete milkings and a longer handling time were observed in the multiparous cows ($p < 0.001$), which could be related to the longer time needed to find the udder caps when the cows were morphologically incorrect. Although primiparous cows had more kicks, they had a shorter handling time ($p < 0.001$) (Table I). Future studies could relate the temperament in more detail by analysing the number of kicks per milking for each quarter of the udder and the number of attempts to fix the liners by the robotic arm.

Siewert et al. (2019) found 0.067 more failures in liner fixation per day in primiparous cows than in multiparous cows during the first seven days of lactation. However, these failures decreased with advancement in the lactation period (between 0.003 and 0.039). Jacobs & Siegford (2012b) observed, in primiparous cows in the first 30 days of transition between conventional and robotic milking, a greater number of kicks (15.6) after fixation of the liners than in multiparous cows (13.3) ($p < 0.05$).

According to Siewert et al. (2019), the differences between birth orders of liner fixation failures during milking, which could lead to apparent results of lower liner fixation failures and good behavior in multiparous cows, were attributed to a combination of factors: primiparous cows learning how to interact with the AMS; robot learning the positioning of teats by changes in udder conformation during lactation; discards in the first lactation or in the early stages of lactation based on criteria such as udder conformation, temperament or other problems. According to Jacobs & Siegford (2012a, b), a possible explanation for the greater number of failures in the fixation of liners during milking in primiparous cows is attributed to the smaller body size, leaving cows more space to move around in the milking stall. Thus, it may be considered, in future studies, to analyse the presentation of kickbacks in the different stages of lactation, aiming at the voluntary culling related to the performance criteria of the cows in the AMS.

Practices for training the robot can be implemented. According to Jacobs & Siegford (2012b), new cows will learn from cows already accustomed to the system, reducing the work in this adaptation period. Thus, according to Jago & Kerrisk (2011), teaching 3 to 5 days prior to the movements of the robotic arm and the characteristic noises inside the milking stall are associated with increased ease of entry into the AMS after the first milking (Jago & Kerrisk 2011). In the present study, it may be that primiparous cows without training before having their first postpartum visit in the AMS may be more anxious during milking and need more time to become familiar with the -system.

The primiparous cows had higher milking frequencies than the multiparous cows ($p < 0.001$), while the milking interval was similar ($p = 0.582$). Siewert et al. (2019), in guided traffic systems, obtained lower milking frequencies in primiparous cows, especially in the early stages of lactation, compared to multiparous cows. In contrast, Penry et al. (2018) found shorter milking intervals, especially in the early stage of lactation, in primiparous cows (7.8 hours) than in multiparous cows (8.7 hours). However, Munksgaard et al. (2011) did not find notable differences in the frequency of milking between calving orders. This difference among the three studies in guided flow traffic systems can be attributed to the number of cows per unit of the AMS and the strategy of grouping primiparous cows.

The increase in milking frequency has clear positive effects on milk production. It is known that in conventional milking systems, frequent milking (3 times/day) starting from the first or fourth day until 21 to 28 days brings benefits in milk production and has lasting effects during the remainder of lactation (Hale et al. 2003, Patton et al. 2006). It is known that there are important factors to consider, such as feeding and behavior, that can potentially affect milking frequency and affect production (Bach & Cabrera 2017).

CONCLUSIONS

Multiparous cows have more favourable milking characteristics in relation to milk flow and milking efficiency, as well as a higher milk production per milking, while primiparous cows spend less time in the stall in robotic milking systems.

Regarding the behavioral characteristics, primiparous cows have more kickbacks, while multiparous cows have more incomplete milkings.

However, as observed in the present study, primiparous cows may be the most affected after the first milking event in the AMS, which is associated with the lack of initial adaptation, which seems to hinder their potential for productive performance in milking. Thus, the training of primiparous cows may be necessary, as their lack could be associated with undesirable behavioral results when they are milked for the first time in the AMS. Additional research to improve the adaptation of primiparous cows to AMS is necessary.

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