FULL-LENGTH RESEARCH PAPER

FACTORS AFFECTING MILKING SPEED IN MURCIANO-GRANADINA BREED GOATS

Blasco

Dairy goats are selected for their main features of economic interest: milk production and composition. One way to further tighten the production cost is by cutting down the working hours in milking. It seems interesting to consider milking speed, both to increase and homogenize it among the animals, thereby optimizing milking parlor management and reducing the time spent on the platforms. Given the little information available in Murciano-Granadina goats, this study investigates which variation factors should be included in the models created to analyze these traits of interest.

FULL-LENGTH RESEARCH PAPER: **MILKING SPEED IN GOATS**

Factors Affecting Milking Speed in Murciano-Granadina Breed Goats

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ABSTRACT

Milk flow during the first minute of milking was analyzed using data from 1,132 Murciano–Granadina breed goats belonging to 17 herds. During the individual lactations, two test days were scheduled for recording several milk flow traits, total milk, milk composition (fat and protein percentages) and SCC. Average lag time from teatcup attachment to arrival of milk at the milk claw (T0) was 4.9 s and at the milk meter (T1) was 15.8 s. Average milk flow after 30 seconds (MF0.5) was 0.29 kg/min (0 to 1.1 kg/30") and milk flow at 60 seconds or milking speed (MF1) was 0.67 kg/min (0.1 to 2.1 kg/min). Repeatabilities of T0, T1, MF0.5 and MF1 were 0.45, 0.58, 0.62 and 0.68, respectively. MF1 showed high phenotypic correlation with T1 (-0.63) and MF0.5 (0.90), medium values with T0 (-0.42) and total milk (0.22), and very low values (-0.04 to -0.12) with fat, protein and SCC. There were no differences between flows during the first three lactations, with a reduction as the lactation number increased. Months in milk since parturition affected MF1, being highest in the first three months (0.67-0.71 kg/min) and decreasing until the end of lactation (0.58 kg/min). The effect of herd-test day was significant for all traits. Inclusion of all these effects for the analysis of milk flow traits is considered necessary.

Key words: milk flow, dairy goat, milking time, milk yield

INTRODUCTION

A large amount of working time on dairy goat farms is spent on milking the animals (up to 55% of the total time; Marnet et al., 2005). To this end, farmers express an interest in reducing the time given over to milking, which could then be spent on other activities, such as cheese manufacturing and distribution or increasing the herd size. The time spent on milking depends on the number of milking sessions daily (one or two in goats) and the hourly performance of milkers (goats milked/man and hour). In turn, this latter aspect is influenced by several factors related with the animals' ability for milking, the milking machine and parlor, the milking routine and skill of the operators (Manzur et al., 2012; Bueso-Ródenas et al., 2014; Fernández et al., 2015). The animal's milkability conditions the time spent extracting its milk from the udder, which in turn is related on one hand with those udder features affecting the speed at which the different milking operations are carried out (teatcup attachment, machine stripping and frequency of slipping or falling teatcups) and, on the other, the milk production and flow during machine milking. In this sense, milking speed is defined as the amount of milk produced by the animal in the first minute of milking (Ilahi et al., 1998). This trait is highly relevant and was found to be closely correlated with maximum milk flow (0.92), with average flow during milking (0.85) and with average flow during milk emission (0.85) in Alpine breed goats (Ilahi et al., 1999). In goat livestock, milk flow is considered to depend mainly upon anatomical and physiological teat characteristics (Marnet and McKusick, 2001; Marnet et al., 2005). Moreover, for the same animal, the milk flow tends to increase along with the quantity of milk present in the mammary gland (Peris et al., 1996; Komara and Marnet, 2009), due to the higher intra-mammary pressure. However, in small ruminants the presence of ejection reflex has no decisive effect on milk flow, unlike what occurs in dairy cattle (Bruckmaier et al., 1994; Marnet and McKusick, 2001).

In France, studies were carried out in Saanen and Alpine breeds on phenotypic variability and the estimation of genetic parameters for several milk flow-related traits (latency time, first minute milk flow, maximum and average machine milk flow and total milking time). Results showed that milk flow presents a high degree of variability in both breeds (Ilahi et al., 1999; Marnet et al., 2005) and that there may be a major gene affecting this trait (Ricordeau et al., 1990), which would explain up to 60% of the genetic variance (Ilahi et al., 2000). Furthermore, the estimated heritability (from 0.42 to 0.65; Ilahi et al., 1999, 2000; Palhière et al., 2014) and repeatability values (0.71-0.82; Ilahi et al., 1998; 1999) for milk flow in the first minute were high, indicating that this trait could be subject to direct selection. The aim would be to increase the animals' milk flow and try to ensure that it is as uniform as possible to facilitate the milking routine and avoid overmilking. Nevertheless, it is possible that excessively high flows may not be desirable, as studies in cattle have reported a positive relation with mastitis rates (Grindal and Hillerton, 1991) and somatic cell count (Rupp and Boichard, 1999).

Spain is the second European country in goat milk production (FAO, 2013), mainly obtained from local breeds. Among the Spanish dairy goat breeds, the Murciano-Granadina stands out as the largest on record (500,000 animals; MURCIGRAN, 2015). However, in this breed there is little information available on milking speed-related traits, nor have its genetic parameters been estimated. Only a few works are available, carried out on experimental farms using a small number of animals and, on occasion, with low production output at milking (Peris et al., 1996; Manzur et al., 2012). Therefore, to get a better estimate of the milk flow in the Murciano-Granadina goat population, it seems appropriate to record these variables in a sample that includes a large number of commercial farms and animals.

The aim of this paper is to describe several milking speed-related traits in the Murciano-Granadina goat breed in greater depth, as well as their relation with other important factors for milk payment (production, composition and somatic cell count).

MATERIALS AND METHODS

This work was carried out on 17 livestock farms of the Murciano-Granadina Goat Breed Livestock Farmers' Association of the Valencia Community (AMURVAL), where official milk recording took place every forty-two days. On the majority of farms (13) the system was intensive, with animals permanently stabled, whereas on the rest of the farms some livestock were let out to graze for a few hours a day.

Herd sizes varied from 100 to 2,000 goats, the average size being 390 animals.

All the farms practiced once daily machine milking, with similar milking parameters (vacuum level 40-42 kPa, pulsation rate 90 pulse/min and pulsation ratio of 60%) and the same milking routine (including machine stripping).

The experimental design proposed consisted of recording the milking speed traits twice in the same lactation. Monitoring was performed in females born by artificial insemination on the 17 farms cited, in their dams which had been inseminated and in their paternal grand dams (dams of sires from the Murciano-Granadina breed genetic improvement program insemination center). All animals were fitted with a plastic bracelet on the hind leg to simplify identification when making the records (at the same time as the official milk recording was carried out). In total, 2,146 records on 1,132 goats were obtained in the period from 2007 to 2014. The number of records sampled per farm varied from seven to 298.

Milking speed traits were recorded using a stopwatch and the milk meter used in the official milk recording (WB Mini-Test meter, Tru-Test®, 2015). The recorded traits were:

- **T0**: Time (s) from attachment of teatcups to arrival of milk at the milk claw.

- **T1**: Time (s) from attachment of teatcups to arrival of milk at the milk meter.
- **MF0.5**: Milk yield (kg) recorded in the milk meter 30 seconds after appearance of milk in the claw (T0)..
- **MF1**: Milk yield (kg) recorded in the milk meter 60 seconds after appearance of milk in the claw (T0).

Additionally, the total milk (**TM**, kg) in the milk meter was recorded. Once milking was completed, milk samples were taken from each animal. The samples were kept refrigerated for transport to the laboratory and 0.15 mL azidiol per sample was added as a preservative to prevent bacterial development. Milk composition (fat and protein percentages) was analyzed with a MilkoScan FT6000 (FossElectric®, Hillerød, Denmark) and the somatic cell count (**SCC**) was obtained using a Fossomatic 5000 (FossElectric®, Hillerød, Denmark).

Milking speed traits, total milk, fat and protein percentages and $\log_{10}$ SCC were statistically analyzed using a repeatability model. Goat permanent effect on the different records was considered as random. Farm-test day (142 levels, at least seven data for level), lactation number (LN, six levels: 1, 2, 3, 4, 5 ≥ 6) and lactation stage (LS, months in milk since parturition, eight levels) were included as fixed effects. Phenotypic correlations were estimated.

RESULTS

Table 1 shows descriptive analyses of studied variables. The average values (and SD in brackets) for T0 and T1 were 4.9 (4.0) and 15.8 (10.0) s, respectively, with minimum and maximum values separated by 48 and 88 seconds respectively.

Mean value for MF1 was 0.67 (0.33) kg/min, varying widely between 0.1 and 2.1 kg/min. Mean value for MF0.5 was lower at 0.29 (0.19) kg/30" and its frequency distribution was shifted to the left compared to MF1 (Figure 1, representing MF1 and 2*MF0.5). In this figure, we appreciate that 10% of the MF0.5 records had zero values, but this never occurred with MF1. This was because some goats did not produce any milk during the first 30 s after T0, but in all goats some milk was obtained during the first minute after T0. Figure 1 also shows that around 25% of the animals had very low milk flow (MF1 lower than 0.4 kg/min).

Mean values for total milk, fat and protein percentages were 1.97 (0.75) kg, 5.13 (1.14) % and 3.77 (0.54) %, respectively. Arithmetic and geometric mean of SCC were 1,246 $x10^3$ (2,403) and 505 $x10^3$ cells/mL, respectively. The 37.2% and 16.4% of the samples had SCC above 750,000 cells/mL and 1,750,000 cells/mL, values applied by De Crémoux and Poutrel (2001) to discriminate between uninfected animals and animals infected by minor pathogens (750,000 cells/mL) and infected by major pathogens (1,750,000 cells/mL).

Table 2 shows repeatabilities and phenotypic correlations between studied variables. Among milk flow traits, MF1 had the highest repeatability value (0.68), and the following value was MF0.5 (0.62). Repeatability of T0 and T1 were lower than the previous ones (0.45 and 0.58, respectively). Repeatability for TM and protein percentage were higher than fat percentage and $\log_{10}$ SCC. Phenotypic correlations of MF1 were very high and positive with MF0.5 (+0.90; $P < 0.001$), moderate and negative with T0 (-0.42; $P < 0.001$) and high and negative with T1 (-0.63; $P < 0.001$). Correlations between MF1 and economic traits were medium and positive for TM, very low and negative for protein percentage and close to 0 for fat percentage and $\log_{10}$ SCC variables. Phenotypic correlation between T0 and T1 was +0.75 ($P < 0.001$) and phenotypic correlations between the other milking variables (T0, T1 and MF0.5) with milk production and composition traits (TM, fat and protein percentages and $\log_{10}$ SCC) were very low (-0.10 to +0.16).

The statistical analysis results showed that the herd-day control effect was highly significant ($P < 0.001$) for all variables studied. Lactation number effect was also significant for all variables, except for T0 and protein percentage (Table 3). T1 increased significantly from first and second lactation (with 15.1 and 14.7 s) up to 19.4 s as of the sixth. MF0.5 tended to fall off as the lactation number increased, with differences in the first two lactations (0.31 kg/min) compared to the fifth and subsequent lactations (0.22-0.27 kg/min). MF1 also decreased as the lactation number increased, in such a way that the first two lactations (0.69-0.71 kg/min) presented differences compared to the fifth (0.63 kg/min), and even more so compared to the sixth and subsequent lactations (0.54 kg/min). As we expected, TM in primiparous goats (1.60 kg) was lower than that obtained in multiparous goats (2.07 to 2.20 kg). Fat percentage and $\log_{10}$ SCC increased significantly from first to third lactation, and did not vary significantly in subsequent lactations.

Month in milk did not affect T0, T1 and MF0.5, but did have a significant effect on the remaining variables (Table 4). MF1 was diminished throughout lactation, going from 0.67-0.71 kg/min in the first three months to 0.58-0.63 kg/min as of the seventh month. TM progressed as a lactation curve, with peak production values in the early months and a falloff from the fourth month until the end of lactation. As the lactation progressed, the composition variables varied inversely with production, with lows in the early months and peaks at the end of lactation. The $\log_{10}$ SCC also varied inversely in relation to production, with minimum values in the first three months and the highest values as of the fifth month (Table 4).

DISCUSSION

To compare the MF1 values with the literature, we must first specify the methodology. In our case, we began taking measurements from the moment the first streams of milk appeared in the claw (T0), whereas in other works measuring began immediately after the attachment of teatcups or when the first streams reached the meter (MF1r). From the mean value of MF1 in our experiment (0.67 kg/min) and the mean latency time values obtained (T0: 4.9 s; T1: 15.8 s), we can estimate an approximate MF1r of 0.8 kg/min. This latter value is similar to the

MF1r of 0.8-0.9 kg/min obtained with electronic meters by Fernández et al. (2015) in Murciano-Granadina goats from an experimental station, with 1 daily milking and a 2 L/d milk yield. In other research into this breed in experimental stations, notably lower MF1r values were obtained (0.44 kg/min, Peris et al., 1996; 0.61 kg/min, Manzur et al., 2012) possibly because the animals used presented a lower average milk production (0.5 L in the afternoon milking with two milkings daily and 1 L in single milking, respectively). The Murciano-Granadina breed could be considered to have a milk flow (in the first minute) similar to that of the Saanen breed (MF1r 0.72 kg/min, Marnet et al., 2005) and lower than those of the Alpine (MF1r 0.90 kg/min, Marnet et al., 2005) and Tinerfeña breeds (MF1r 1.06 kg/min, Capote et al., 2006).

The two latency time variables presented very different mean values (T0: 4.9 s; T1: 15.8 s), which can be explained because the milk meters used in the milking parlor were always located around 0.5 m above the animals standing level, regardless of whether the milk line was in low-level or in mid-level milking system. Thus, from T0 it was necessary for a certain quantity of milk to accumulate in the claw before gushing up through the long milk tube to reach the proportional milk meter. The fact that T1 was higher in mid-level (12 s) than in low-level (6 s) milking system was already demonstrated by Diaz et al. (2004) in an experimental farm. T0 and T1 values of our work are slightly higher than those reported by Ilahi et al. (1999) in Alpine breed (3.2 and 12.8 s, respectively).

In the absence of electronic milk meters, the three variables T0, T1 and MF0.5 are recorded more quickly and therefore at a lower time-cost than MF1. For this reason, in this work we studied these three variables as possible alternatives to characterize the milking speed in a goat population. T0 and T1 presented negative and moderate correlations with MF1 (-0.42 and -0.63, respectively), albeit slightly lower than those found by Ilahi et al. (1999; -0.45 and -0.75, respectively). This may be because our work was carried out in several commercial herds, whose machine milking conditions might have affected the milk flow traits, whereas the work by Ilahi et al. (1999) was performed in only one experimental herd. According to Marnet et al. (2005), these negative correlations suggest that there are common biological mechanisms that regulate the start of milk emission and subsequent milk flow. The anatomical and physiological teat characteristics (sphincter resistance) are crucial for milk emission kinetics (Marnet et al., 2005). However, the results achieved did not suggest that MF1 should be replaced by any of the previously described variables, as the correlations of T0 and T1 with MF1 were moderate and although MF0.5 had a high correlation with MF1 (0.90), it was handicapped by having zero value in 10% of the records, unlike MF1. Moreover, these three traits show lower repeatability than MF1.

Milk production correlations with the flow variables (MF0.5 and MF1) were positive, indicating that more productive animals tended to have higher milk flows. However, these correlations were very low (0.16 and 0.22) and many of the animals had very low milk flows (less than 0.4 kg/min), while at the same time presenting high milk production. These animals would be most problematic, as they take a long time to milk, but at the same time farmers are reluctant to remove them from the herd due to their high milk production output. These correlations presented values between 0.10 (Ilahi et al., 2000) and 0.25, estimated by Peris et al. (1996) and Ilahi et al. (1999)

On the other hand, animals with a high milking speed might also be troublesome, as works in cattle have described how excessively high milk flows may increase mastitis rates and SCC (Grindal and Hillerton, 1991; Mielke, 1994; Rupp and Boichard, 1999) and, moreover, estimated genetic correlations between milk flows and SCC in Alpine and Saanen goats were positive (+0,63 and +0.39, respectively; Palhière et al., 2014). However, we found virtually no phenotypic correlation between milk flow and $\log_{10}$ SCC, in accordance with the low phenotypic correlation (0.11, not significantly different from zero) reported by Marnet et al.

(2005) in goats. It is possible that our result was due to several reasons: a) the small number of animals showing very high flows (fewer than 2.5% of records with flows over 1.4 kg/min); b) the existence of factors affecting the recording of milk flow from the same animal (for example, milking conditions or the amount of milk present in the udder during milking); c) several other factors influencing SCC in dairy goats , such as age, days in milk, estrus, time of infection or the pathogenic agent (Mehdid et al., 2013; Jiménez-Granado et al., 2014; Paterna et al., 2014). In any case, the existence of a positive genetic correlation between milk flow and SCC in high yielding goats (Palhière et al., 2014) would indicate that the selection of animals with high flows would lead to deterioration in the health status of the udders. So, selection should not be done on high milk flow animals but to eliminate animals whose milking flows are too low, which would reduce variability of this trait in herds.

The effect of lactation number and month in milk on milk flow found in this work is similar to that described in other studies (Ilahi et al., 1999; Marnet et al., 2005). In principle, these changes could be associated with variation in milk production and hence in intramammary pressure, or with changes in the anatomical and physiological characteristics of the teats. In the case of month in milk, the tendency to reduce milk flow as the months elapsed postpartum could be explained mainly by the reduction in intramammary pressure, as Le Du et al. (1993) found that the teat sphincter resistance (vacuum needed for opening) scarcely varies throughout lactation, which would also explain why in our experiment we found that this had no significant effect on latency times. In the case of lactation number, the tendency to diminish milk flow and increase T1 as of the third or fourth parity cannot be explained by changes in milk production, which scarcely varied among these goats. Thus, the trend may be due to changes in the teat wall and muscle tonicity throughout the productive life of the dairy goat (Chastin et al., 2003).

CONCLUSIONS

Results showed that MF1 was the trait of choice for estimating milk flow during milking because the other traits (T0, T1 and MF0.5), easily recorded, have lower repeatability than MF1 (0.45, 0.58 and 0.62, respectively versus 0.68). For this reason, we considered that MF1 should continue to be used to estimate milk flow machine. First minute milk flow in Murciano Granadina is intermediate, at 0.67 kg/min, with a difference of more than 2 kg/min between the fastest and slowest.

Milking speed analysis models in goats must include the herd, control day, lactation number and lactation stage. It is necessary to characterize these traits economically and genetically and study their inclusion in dairy goat breeding programs. Currently, only milk production and composition traits are concerned. The aim is to try to reduce the variance in individual milking times and optimize work and energy saving.

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Table 1. Number of records (n), mean value (M), standard deviation (SD), minimum (MIN) and maximum value (MAX) of the variables T0[1], T1, MF0.5, MF1, TM, Fat, Protein, SCC and $\log_{10}$ SCC

Variables	Statistics				
	n	M	SD	MIN	MAX
T0 (s)	2081	4.9	4.0	1	49
T1 (s)	2057	15.8	10.0	2	90
MF0.5 (kg/min)	2089	0.29	0.19	0	1.1
MF1 (kg/min)	2136	0.67	0.33	0.1	2.1
TM (kg)	2106	1.97	0.75	0.4	5.5
Fat (% g/100g)	1963	5.13	1.14	2.11	9.16
Protein (% g/100g)	1966	3.77	0.54	2.38	6.26
SCC (10^3 cells/ml)	1699	1246	2403	11	24466
$\log_{10}$ SCC	1699	5.70	0.56	4.04	7.39

[1]Variables: T0 = Time (seconds) from the attachment of teatcups to arrival of milk at the milk claw. T1 = Time (seconds) from attachment of teatcups to arrival of milk at the milk jar. MF0.5 = Milk yield (kg) recorded in the milk meter 30 seconds after appearance of milk in the claw (T0). MF1 = Milk yield (kg) recorded in the milk meter 60 seconds after appearance of milk in the claw (T0). TM = Total Milk (kg) in the milk meter (machine milk plus machine stripping milk). Fat = Fat percentage (%). Protein = Protein percentage (%).

Table 2. Repeatability (r, and SE in brackets) and phenotypic correlations (below diagonal) between the variables T0[1], T1, MF0.5, MF1, TM, Fat, Protein and $\log_{10}$ SCC

Variables	r	T0	T1	MF0.5	MF1	TM	Fat	Protein
T0	0.45 (0.03)	--						
T1	0.58 (0.02)	0.75***	--					
MF0,5	0.62 (0.02)	-0.43***	-0.64***	--				
MF1	0.68 (0.02)	-0.42***	-0.63***	0.90***	--			
TM	0.60 (0.02)	-0.05*	-0.08***	0.16***	0.22***	--		
Fat	0.31 (0.03)	0.03	0.01	-0.02	-0.04	-0.26***	--	
Protein	0.62 (0.02)	0.07**	0.08***	-0.10***	-0.12***	-0.40***	0.50***	--
$\log_{10}$SCC	0.34 (0.03)	0.00	0.02	-0.01	-0.02	-0.14***	0.16***	0.21***

[1]Variables: T0 = Time (s) from the attachment of teatcups to arrival of milk at the milk claw; T1 = Time (s) from the attachment of teatcups to arrival of milk at the milk jar; MF0.5 = Milk yield (kg) recorded in the milk meter 30 seconds after appearance of milk in the claw (T0); MF1 = Milk yield (kg) recorded in the milk meter 60 seconds after appearance of milk in the claw (T0); TM = Total Milk (kg) in the milk meter (machine milk and machine stripping milk); Fat = Fat percentage (%); Protein = Protein percentage (%).

* $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$

Table 3. Least square means (and SE in brackets) of the variables T0[1], T1, EMF1, MF1, TM, Fat, Protein and $\log_{10}$ SCC by lactation number level (LN)

LN	**n**	**T0** (s)	**T1** (s)	**MF0.5** (kg/30")	**MF1** (kg/min)	**TM** (kg)	**F** (% w/w)	**P** (% w/w)	$\log_{10}$ **SCC**
1	818	5.0 (0.19)	15.1 (0.46)^{c}	0.31 (0.008)^{a}	0.69 (0.014)^{ab}	1.60 (0.030)^{c}	5.16 (0.046)^{b}	3.78 (0.020)	5.49 (0.029)^{c}
2	461	4.5 (0.21)	14.7 (0.50)^{c}	0.31 (0.009)^{a}	0.71 (0.015)^{a}	2.07 (0.033)^{b}	5.18 (0.052)^{b}	3.76 (0.022)	5.67 (0.032)^{b}
3	301	5.0 (0.27)	16.0 (0.64)^{bc}	0.30 (0.011)^{ab}	0.69 (0.020)^{abc}	2.13 (0.042)^{ab}	5.41 (0.066)^{a}	3.83 (0.028)	5.89 (0.039)^{a}
4	223	4.9 (0.30)	16.4 (0.72)^{b}	0.28 (0.013)^{ab}	0.65 (0.022)^{bc}	2.20 (0.047)^{a}	5.26 (0.074)^{ab}	3.76 (0.032)	5.95 (0.045)^{a}
5	165	5.1 (0.33)	16.2 (0.80)^{b}	0.27 (0.015)^{b}	0.63 (0.025)^{c}	2.20 (0.053)^{a}	5.30 (0.085)^{ab}	3.78 (0.037)	5.91 (0.050)^{a}
6	176	5.6 (0.34)	19.4 (0.84)^{a}	0.22 (0.015)^{c}	0.54 (0.027)^{d}	2.12 (0.056)^{ab}	5.42 (0.086)^{a}	3.76 (0.039)	5.95 (0.051)^{a}

$^{a\text{-}d}$Least square means in the same column which don't share a superscript are different ($P < 0.05$).

[1]Variables: T0 = Time (s) from the attachment of teatcups to arrival of milk at the milk claw; T1 = Time (s) from the attachment of teatcups to arrival of milk at the milk jar; MF0.5 = Milk yield (kg) recorded in the milk meter 30 seconds after appearance of milk in the claw (T0), times two; MF1 = Milk yield (kg) recorded in the milk meter 60 seconds after appearance of milk in the claw (T0); TM = Total Milk (kg) in the milk meter (machine milk and machine stripping milk); F = Fat percentage (%); P = Protein percentage (%).

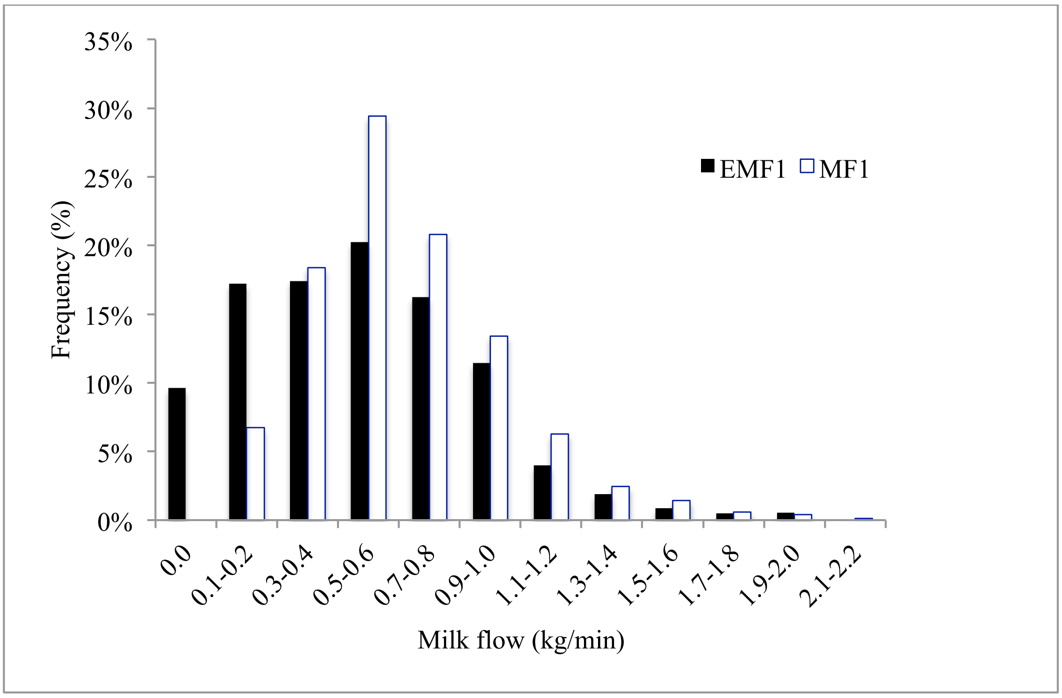
Table 4. Least square means (and SE in brackets) of the variables T0[1], T1, EMF1, MF1, DMY, Fat, Protein and $\log_{10}$ SCC, by month in milk level (LS).

LS	n	T0 (s)	T1 (s)	MF0.5 (kg/30")	MF1 (kg/min)	TM (kg)	F (% w/w)	P (% w/w)	$\log_{10}$ SCC
1	105	5.0 (0.43)	14.5 (0.98)	0.31 (0.018)	0.71 (0.029)^{a}	2.32 (0.065)^{ab}	5.18 (0.110)^{cd}	3.56 (0.043)^{ef}	5.57 (0.067)^{c}
2	243	4.8 (0.29)	16.3 (0.68)	0.29 (0.012)	0.68 (0.020)^{ab}	2.40 (0.044)^{a}	4.97 (0.075)^{d}	3.50 (0.030)^{f}	5.63 (0.044)^{c}
3	361	4.8 (0.24)	15.8 (0.55)	0.29 (0.010)	0.67 (0.016)^{ab}	2.27 (0.036)^{b}	5.07 (0.061)^{d}	3.63 (0.024)^{e}	5.69 (0.036)^{c}
4	421	4.9 (0.22)	16.6 (0.51)	0.27 (0.009)	0.64 (0.015)^{b}	2.19 (0.033)^{c}	5.08 (0.056)^{d}	3.74 (0.023)^{d}	5.84 (0.032)^{b}
5	361	5.0 (0.23)	16.7 (0.54)	0.28 (0.010)	0.65 (0.016)^{ab}	2.03 (0.035)^{d}	5.29 (0.060)^{c}	3.86 (0.024)^{c}	5.94 (0.036)^{a}
6	282	4.8 (0.27)	16.3 (0.62)	0.29 (0.011)	0.65 (0.019)^{ab}	1.90 (0.041)^{e}	5.40 (0.072)^{bc}	3.87 (0.029)^{bc}	5.95 (0.044)^{a}
7	187	5.4 (0.34)	17.2 (0.77)	0.27 (0.014)	0.63 (0.023)^{bc}	1.77 (0.052)^{f}	5.51 (0.096)^{b}	3.95 (0.037)^{b}	5.89 (0.057)^{ab}
8	184	5.5 (0.33)	17.0 (0.76)	0.27 (0.014)	0.58 (0.023)^{c}	1.54 (0.054)^{g}	5.78 (0.090)^{a}	4.13 (0.037)^{a}	5.98 (0.052)^{a}

[a-e]Least square means in the same column which don't share a superscript are different ($P < 0.05$).

[1]Variables: T0 = Time (s) from the attachment of teatcups to arrival of milk at the milk claw; T1 = Time (s) from the attachment of teatcups to arrival of milk at the milk meter; MF0.5 = Milk yield (kg) recorded in the milk meter 30 seconds after appearance of milk in the claw (T0), times two; MF1 = Milk yield (kg) recorded in the milk meter 60 seconds after appearance of milk in the claw (T0); TM = Total Milk (kg) in the milk meter (machine milk and machine stripping milk); F = Fat percentage (%); P = Protein percentage (%).

Blasco1



35%
30%
25%
20%
15%
10%
5%
0%
Frequency (%)
EMF1
MF1
0.0
0.1-0.2
0.3-0.4
0.5-0.6
0.7-0.8
0.9-1.0
1.1-1.2
1.3-1.4
1.5-1.6
1.7-1.8
1.9-2.0
2.1-2.2
Milk flow (kg/min)

Figure 1. Frequency distribution of milk flow in first minute (MF1, kg/min; n = 2,497) and estimated milk flow in first minute (EMF1 = 2 *MF0.5; being MF0.5 the milk flow over 30 seconds; kg/min; n = 2,438)