Effect of low vacuum on sheep milking

Caria M., Murgia L., Pazzona A.
Dipartimento di Ingegneria del Territorio, University of Sassari, Viale Italia, 39 – 07100 Sassari, Italy. Telephone number: +39079/229375, Fax number: +39079/229285, mariac@uniss.it.

Abstract

The level of the vacuum in machine milking is one of the principal parameters which influence the integrity of the tissues and the milk quality. Many studies have shown that while raising the level of the vacuum increases the speed of milk emission, it can also generate congestion in the teat, formation of oedema, increase in residual milk and in the number of somatic cells. Thus milking should be performed with the lowest possible level of vacuum which is compatible with not excessively prolonging milking time. In Italy the vacuum level is unjustifiably high - on average 42 - 46 kPa- while in other European countries the usually level is 4-5 kPa lower.

In order to define the milking techniques which best satisfy the physiological needs of dairy sheep, we have compared milking performances at a low vacuum level (28 kPa) and at a standard level (42 kPa). The effects of the working conditions were evaluated by analyzing the milk emission curves and the vacuum fluctuations registered in the milkline and in the short milk tube.

Results showed that using a vacuum of 28 kPa increased the latency time, reduced both average and peak milk flow, and increased the average milking time per head by 17%.

The reduction of vacuum did not produce significant variations in vacuum fluctuations in the short milk tube (10.4 kPa at 28 kPa and 9.0 kPa at 42 kPa) and also in the milkline where the vacuum fluctuations were less than 2 kPa.

Keywords: small ruminant, working vacuum, milking time.

Introduction

The different adjustments of milking machine can modify the milk flow characteristics. Each species of animal has to be milked with suitable operative parameters. However, the level of working vacuum is still very changeable and it depends principally on the country and area.

The level of working vacuum used in Sardinia ranges on average from 41 to 44 kPa, with a maximum level of 50 kPa (Pazzona and Murgia, 2003), while in other countries there has been a tendency to reduce it, operating at about 34 - 36 kPa (Billon, 1999).

High vacuum levels can cause many inconveniences in cows, such as an increase in hyperkeratosis at the apex of the teat (Mein et al., 2003), an increase in stripping milk (Reinemann et al., 2001a), reduction of the machine milk fraction (Mein, 1992) and udder damage (Hamann et al., 1993). Similar negative effects have also been found for small ruminants. High vacuum levels have been associated with an increase in the somatic cell count (Sinapis and I. Vlachos, 1999; Le Du, 1983; 1985; Pazzona and Murgia, 1993) which is also linked to low pulsation frequency (Fernandez et al., 1999). By contrast Peris et al. (2003) reported that in the short term neither somatic cell count of the milk nor teat thickness changes were affected by variations in vacuum level (36 vs. 42 kPa). It is well-known that the application of the vacuum slows down blood circulation in the teat tissue thus influencing its temperature. Recent studies (Stelletta et al., 2007) have shown that the teat returns to its normal physiological temperature more rapidly if the milking vacuum is reduced. The increase in milking time and the increased frequency of the teat cups falling off are the principal negative factors which have up to now discouraged the use of low vacuum (Spencer and Rogers, 1991).

In line with the current interest in animal welfare in animal husbandry and in order to define milking techniques which best satisfy the physiological needs of dairy sheep, the goal of this study was to evaluate the effects of mechanical milking of dairy sheep at the vacuum of 28 kPa.

Materials and Methods

The milking system used

A prototype milking system specifically designed for low vacuum milking was used in the experiment.

The milking parlour prototype was 24 sequentially gated stalls, with 12 milking units in a low line system. The exit phase occurred simultaneously from the front, with the swing over arms assisting in the rapid evacuation of the milking session. The technical innovation of the prototype was the volume of the milk line. This had an external diameter of 76 mm, so that the volume was more than double that of the 50 mm line normally used for sheep.

The greater volume of the milk line, with the resulting improvement in transport capacity of air and milk, optimised the flow conditions even when air suddenly enters, a very common event during sheep milking due to the short milking time for this species. Stabilising the vacuum in the milk system minimised the possibility of the clusters falling off.

The vacuum regulator was servo-controlled. The sensor is positioned on the main airline near the sanitary trap, in order to guarantee an immediate response when air enters. There was a liquid-ring vacuum pump, with a capacity of 1200 l/min at nominal vacuum. The milking units were assembled from different types of components, chosen from among those most frequently used in sheep milking. When choosing the type of cluster assembly we took into consideration both the suitability of the teatcups for the flock and the weight of the equipment. This was 490 g, the average weight for clusters commonly used in sheep milking which vary between 390-640 g in weight. The cylindrical liners were made of rubber, with an internal diameter of 20 mm and 10.4 cm long. The short milk tube was 8 mm in diameter and the claw capacity was 120 cc. To help the flow of the milk, the long milk tubes (14 mm in diameter) were shortened and mounted with a constant slope towards the milk line. This avoided curves and roses in the tube which could have caused high fluctuations in the vacuum, due to slugs of milk.

Experimental design, equipment used and variables measured

This work was carried out on 48 pluriparous Sarda breed sheep. The animals were randomly divided into two groups of 24, and one group was assigned the working vacuum of 28 kPa (LV) while the other was assigned the 42 kPa (SV). Milking was performed twice daily at 6.00 a.m., and 6.00 p.m.; for the trial the data was recorded one time a day for three months, at the afternoon milking. During milking, ewes received concentrates ad libitum.

Milking routine consisted of attachment of teatcups without previous touching of the udder, and detachment of the cluster without machine stripping. When needed the hook was used in order to have teats at the lowest position.

For the period of the experiment, the milk flow and milk yield data collected with the milk flow apparatus (LactoCorder®, WMB AG, Balgach, Switzerland) included: maximum milk flow rate; average milk flow rate (machine milk yield/milk flow time); latency time (the time it takes for milk to begin flowing after the teat cups have been placed on the ewe); milk flow time (milking time – latency time); machine milk yield and milking time (the amount of milk obtained by the machine from time 0 to when milk flow rate fell below 70 ml/min);

Vacuum fluctuations and average vacuum during milking were continuously monitored by a sensor which was directly connected to the milk line and two sensors connected to the short milk tubes of the two different clusters. A computer–based data acquisition system (DAS-M, Star Ecotronics – Milano), equipped with three pressure transducers (Trafag, Mod. 8891.23.3317) with a maximum sampling rate of 100 kHz, was used.

Statistical analysis was carried out by comparing the LV and SV for the milk flow characteristics, using a Mann-Whitney *U* test from the SPSS 15.0 program.

Results and discussion

<u>*Analysis of the milk emission curves recorded at low and standard vacuum.*</u>

Sample statistics of milk flow, milk yield, milking time in Sarda breed ewes are summarized in table 1.

Table 1. Sample statistics (1) of milk flow, milk yield, milking time in Sarda breed ewes

Trait	LV			SV		
	mean ± stdev	range		mean ± stdev	range	
		min	max		min	max
Maximum milk flow rate (kg/min)	1.07 ± 0.45^{a}	0.20	2.17	1.47 ± 0.44^{b}	0.69	2.51
Average milk flow rate (2) (kg/min)	0.55 ± 0.20^{a}	0.24	1.14	0.64 ± 0.19^{b}	0.30	1.08
Latency time (s)	12.03 ± 6.05^{c}	0	28	9.95 ± 5.99^{d}	0	26
Milk flow time (s)	53.22 ± 15.17^{a}	25	97	45.85 ± 13.20^{b}	23	97
Milking time (s)	65.25 ± 16.83^{a}	33	108	55.79 ± 12.67^{b}	27	113
Machine milk yield (kg)	0.49 ± 0.16	0.20	0.89	0.49 ± 0.15	0.22	0.88

(1) The average of three months evening milkings
(2) Average milk flow rate = machine milk yield/milk flow time.
^{a,b} Within a trait, means with different superscripts differ ($P < .001$)
^{c,d} Within a trait, means with different superscripts differ ($P < .005$)

The representative's flock during an evening milking gave on average 0.49 kg of milk in 55.79 s using an operative vacuum of 42 kPa and a time increased of 17% (9.46 s) using an operative vacuum of 28 kPa ($P < 0.001$). The milking time was divided into latency time and milk flow time. The data obtained showed that both traits were affected by the vacuum. Latency time resulted 12.03 s for the LV test and 9.95 s for the SV test ($P < 0.005$), thought both always in a common value remaining (Marie-Etnacelin et al., 2002). The milk flow time was 7.37 s longer for LV ($P < 0.001$), with an average value of 53.22 s. As a consequence of the results obtained on milking times, the average milk flow rate and the maximum milk flow rate resulted higher with the standard vacuum (0.64 and 1.47 kg/min) compared with the values recorded at low operative vacuum (0.58 and 1.07 kg/min).

The delay of the milking time for one ewe obtained using the vacuum of 28 kPa should not show so high considering the session milking time. In fact, allowing for milking routine the time that the milker, operating on 6 milking units, needs to execute the movements sequences during mechanical milking of sheep is almost the delay obtained using the low vacuum.

Short milk tube

The results concerning short milk tube fluctuations did not show important differences between the milking at 28 kPa and at 42 kPa (tab. 2), in accord with Murgia and Pazzona (1999). The fluctuations of 9.2 - 9.8 kPa recorded in the short milk tube, with internal diameter of 8 mm, resulted overall lower than the values found in the laboratory with the short milk tube of peer diameter with constant flows of 1.5 l/min (12.9 - 16.6 kPa) (Murgia, Pazzona, 2001).

Table 2 – Average and standard deviation of vacuum level and fluctuations in short milk tube and in milkline during milking

	SHORT MILK TUBE		MILKLINE	
	Vacuum (kPa)	Fluctuation (kPa)	Vacuum (kPa)	Fluctuation (kPa)
LV (28 kPa)	29.1 ± 0.65	9.2 ± 2.03	28.2 ± 0.39	1.0 ± 0.30
SV (42 kPa)	41.8 ± 0.87	9.8 ± 2.35	41.5 ± 0.30	1.4 ± 0.23

Milkline

Testing the milk pipeline during milking, provides valuable information on the technical condition of the milking machine (tab. 2 and fig. 1). According to the technical standards, the milking machine performances are defined in terms of vacuum stability during the milking. The average vacuum fluctuations of 1.0 kPa for the low vacuum system and 1.4 kPa for the standard vacuum system, resulted lower than 2.0 kPa prescribed by the standards, it can be asserted that the milkline of 76 mm guarantees an optimal flow conditions. The best vacuum stability recorded working to low vacuum was mainly due to the speed reduction of the air that entered inside the milking system. However, to evaluate these results it is necessary to consider that the differences in vacuum fluctuations would be accentuated if the milking at 42 kPa was with the traditional milkline (50 mm diameter) instead of the 76 mm diameter.

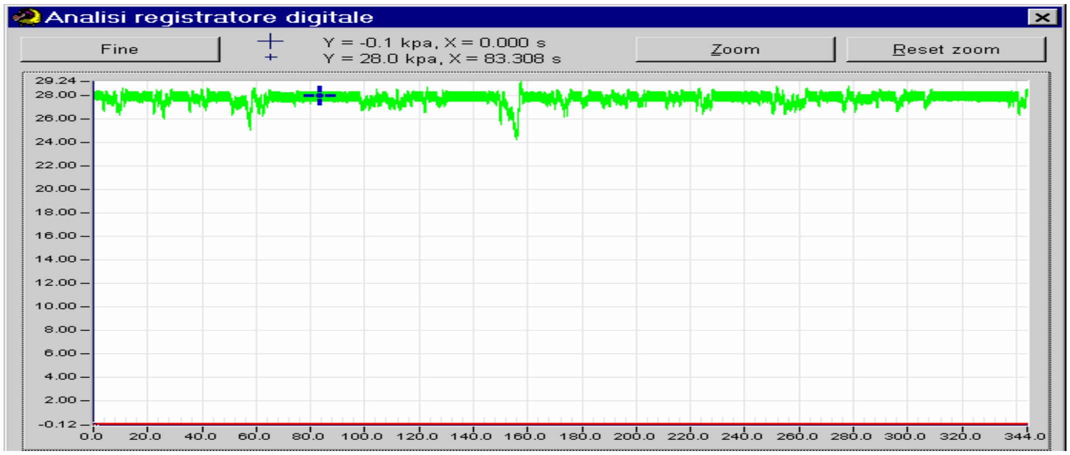

Figure 1. Vacuum dynamics of the milkline 76 cm diameter, during a session sheep milking at 28 kPa

Conclusions

The results of the study clearly showed that the low vacuum level, modified significantly the kinetics of the milk ejection. Working at 28 kPa increased the latency time for the first milk emission, it reduced the average milk flow rate and the maximum milk flow rate and, consequently, it prolonged of about 17% the milking time for the milking of the single ewe. Nevertheless, considering the times of milking routine where the milkers operate contemporarily 6 milking units each one, the milker productivity is reduced in a small degree.

The reduction of the vacuum from 42 to 28 kPa did not produce appreciable variations about vacuum fluctuations in the short milk tube (9,2 kPa for the low vacuum and 9,8 kPa for the standard vacuum). Analogous considerations can make for the milkline where the vacuum fluctuation was on average 1,0 kPa for the low vacuum and 1,4 kPa for the standard vacuum.

The good vacuum stability in the milk system, due to the milk pipeline of 76 cm diameter, positively influenced the milking routine that was not interrupted by liner slips or milking units fall-off.

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