Preliminary Results of a Field Study on Goats Milk Yield and Lactation Persistency as Affected by Automatic Cluster Removals

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Abstract
Automatic cluster removers (ACRs), although rarely adopted in goats milking, are available to remove milking equipment after milking. Main advantages of ACRs are overmilking reduction, improved teat condition, labour saving, improved milking routine. An innovative flow-based ACR for sheep and goats was coupled with an electronic milk meter was installed on the 16+16 parallel milking parlour with 32 milking units of the experimental goat farm associated with the University of Milan.
Two balanced groups of 12 Saanen goats each were selected according to parity and days in milking. Animals were milked twice a day., and the milking machine was set up to provide 90 pulsations/min in a 50:50 ratio with a vacuum level of 42 kPa. One group was milked with an ACR switch point of 70 g/min and a delay time of 10 s, while the reference one was milked disabling the ACRs. Reattachment of milking units to goats was discouraged. Individual milk yields were recorded at each milking session through electronic milk meters and the flock management software.
Milk yields recorded on the whole lactation were analyzed to evaluate the ACR effect on goats daily milk production, and by nonlinear regression, to determine Wood's lactation curves of the two groups. Results highlighted a higher mean milk daily production for the ACR group with 1.82 kg vs 1.68 kg of noACR group ($P < 0.001$). The results showed that ACR group reached significantly higher milk production with a significant better persistency during the whole lactation.

Keywords: ACR, dairy goats, peak of lactation, milking persistency

Introduction

Automatic cluster removers (ACRs) are available to remove milking equipment after milking in most of the new milking parlours for dairy cows. ACRs detach the milking units when the milk flow drops below a preset level (kg/min) and an additional delay time can usually be set to determine how long (s) the milking unit must remain attached to the udder after the flow level is reached. Main advantages of ACRs are overmilking reduction, improved teat condition, labour saving, improved milking routine, while disadvantages include cost, maintenance and reliability (Rasmussen, 1993).
Many studies were carried out to examine effects of ACRs settings on machine on-time, milk yield, and udder health in dairy cows. Traditionally cows have been regarded correctly milked when the milk flow rate drops below 200 g/min. A reduction in machine-on time without having a negative influence on milk yield was observed by Rasmussen (1993) with the 0.4 kg/min vs. 0.2 kg/min setting and by Stewart et al. (2002) who compared ACR settings of 0.5, 0.64, 0.73, and 0.82 kg/min. Magliaro and Kensiger (2005) reported a similar milk production for the 0.48 and 0.6 kg/min settings, but a reduction by 0.5 kg/milking for the 0.8 kg/min

setting. In their study an ACR setting of 0.6 kg/min resulted in faster milking times without sacrificing milk production.
Reduced machine-on time may also decrease the incidence or severity of teat-end lesions and potentially reduce the occurrence of mastitis providing health and economic benefits for the farmer (Neijenhuis *et al.*, 2000, 2001).
In dairy goats machine milking the adoption of ACRs is quite new and there are few reports on the effect of ACRs on milking performances in the scientific literature (Tangorra *et al.*, 2007, 2008).
Aim of the study was to evaluate the ACRs effects on milk yield and lactation persistency in goat lactation.

Materials and methods

An innovative flow-based ACR for sheep and goats developed by Guidobono Cavalchini *et al.* (2004) was coupled with an electronic milk meter (AfiFree™ S.A.E. AFIKIM). The system was installed on the 16+16 parallel milking parlour with 32 milking units of the "Gian Paolo Guidobono Cavalchini" experimental goat farm associated with the University of Milan, Italy. In detail, the system implemented (Figure 1) was constituted by:

- a telescopic bar, hinged just below the floor of each milking stall, with a special support to which is connected the milking unit. The bar allows to keep the milking unit steadily near the udder, working as a vertical stabilizer of the same milking unit. In this way a good coupling between the teats and the milking unit is ever guaranteed over the entire milking, avoiding that teats are folded and strained during the progressive udder emptying;
- an actuator of the bar, consisting of a small pneumatic piston, which allows to remove the milking unit from the udder at the end of milking;
- a high resolution free-flow milk meter to measure the milk yield and flow rates, enabling the detaching of the milking unit when the milk flow drops below a preset level.

From an available flock of Saanen goats, two balanced groups of 12 animals each were selected according to parity (1-3) and days in milking (10 ± 5). The two groups were housed separately in the same stall with external paddocks and received the same total mixed ration (TMR) as fed. The ration contained alfalfa hay, mixed hay, triticale silage, dried pulp, and concentrate (16.33% crude protein, 3.78% crude fat, 35.14% NSC, non-structural carbohydrates, and 38.66% NDF). Animals were milked twice a day at 5 a.m. and 5 p.m., and the milking machine was set up to provide 90 pulsations/min in a 50:50 ratio with a vacuum level of 42 kPa. Between February and October 2007, one group (ACR group) was milked with an ACR switch point of 70 g/min and a delay time of 10 s, while the other one (noACR group) was milked disabling the ACRs. Reattachment of milking units to goats was discouraged. Individual milk yields were recorded at each a.m. and p.m. milking session through electronic milk meters (AfiFree™ S.A.E. AFIKIM) and the flock management software (Afigoats™ S.A.E. AFIKIM).

Figure 1. The innovative flow-based ACR installed on the milking parlour of the experimental farm of the University of Milan

The ANOVA of the individual milk traits was performed using the GLM procedure of SAS (SAS, 2008). The model contained the effects of treatment (presence or absence of automatic cluster removal), days in milking, number of lactation, and their interactions, random effect of goats nested within treatment, and residual error. Significance was declared at $P \leq 0.05$ and values are presented as least square means with pooled standard errors.
Milk yields recorded on 210 d of lactation were analyzed by nonlinear regression P-NLIN (Marquardt method) procedure of SAS (SAS, 2001) to determine lactation curves of each individual goat. Parameters were calculated utilizing the Wood's equation (Wood, 1967):

$$Y(n) = an^{b}e^{(-cn)}$$

where:
Y = milk production;
n = time interval;
a = a scaling factor to represent yield at the beginning of lactation;
b = slope of the ascending phase to the peak (index of the animal's capacity to use energy for production);
c = slope of the descending phase to the peak (decay rate).

The DIM at peak yield (Y_{max}) was defined as b/c, and Y_{max} was calculated as $a(b/c)^{b}e^{-b}$. The coefficient of determination was used as an index to assess the goodness of fit.

Results

Results highlighted a higher mean milk daily production for the ACR group with 1.82 kg of milk vs. 1.68 kg for the noACR group ($P < 0.001$), revealing a positive effect of ACR on milk yield. The lactation curves of ACR and noACR groups are shown in Figure 2.

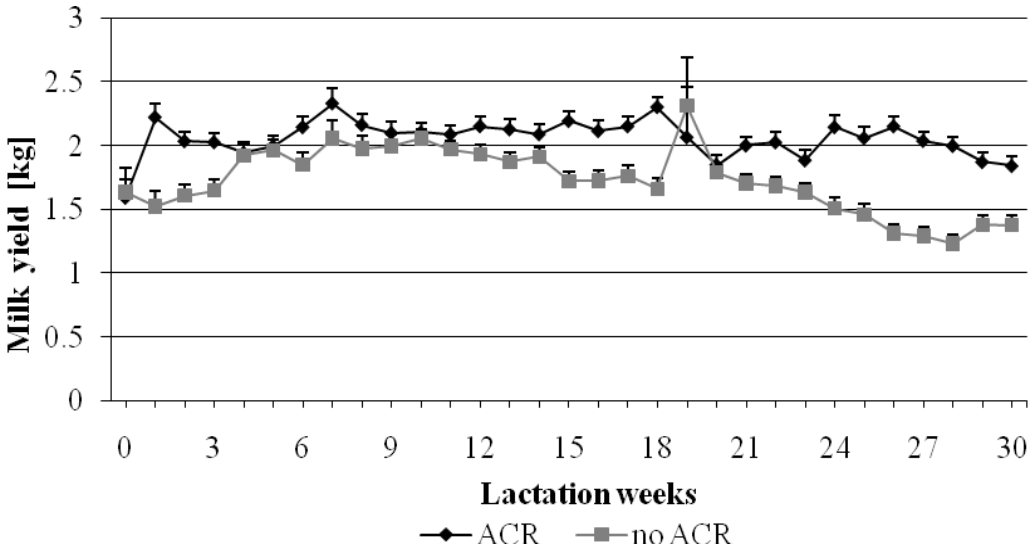

Figure 2. Lactation curves of the two groups involved in the field study

The two curves determined by Wood's equation (Figure 2) were both characterized by a good coefficient of determination (R^2). The curve describing the lactation of the ACR group showed a higher R^2 (84%) in comparison with the R^2 of the noACR group (60%), highlighting a greater uniformity of the ACR group in milk production throughout the whole lactation, also confirmed by the lower SEMs reported near the values for the lactation curve traits (Table 1).

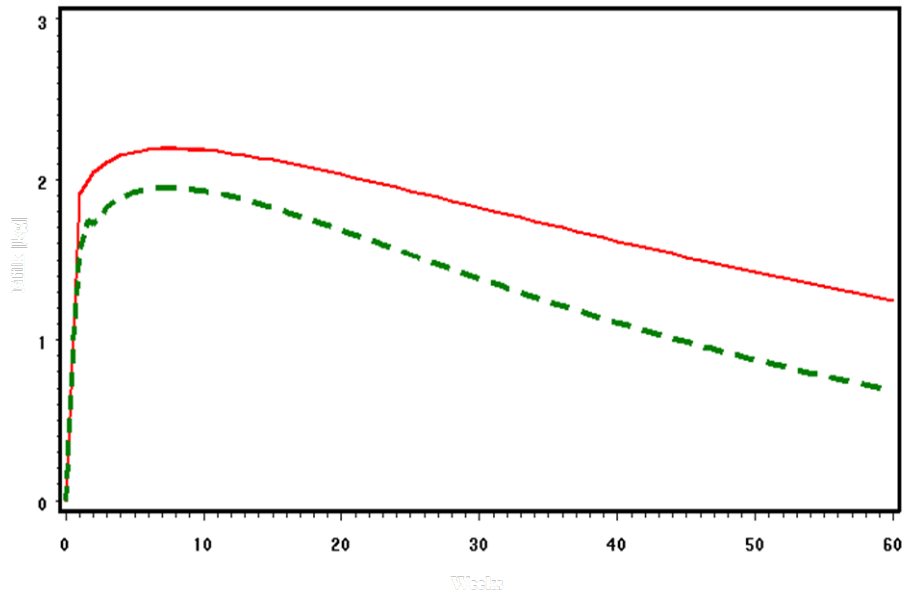

Figure 2. Milk yield lactation curve in ACR (solid line) and noACR (dashed line) groups performed through non linear regression of Wood equation.

Table 1. LS means and coefficient of determination of noACR and ACR groups for lactation curve traits

	Lactation curve[1] traits						
	a		b		c		
	Mean	SEM	Mean	SEM	Mean	SEM	R^2
noACR[2]	1.579[A]	0.092	0.210	0.037	0.028	0.003	60 %
ACR[2]	1.939[B]	0.053	0.119	0.018	0.013	0.001	84 %

[A,B] Means with different superscripts differ significantly ($P < 0.001$)
[1] "a" is a scaling factor to represent yield at the beginning of lactation, and "b" and "c" are factors associated witrh the inclining and declining slope of the lactation curve
[2] n = 12

The shape of the curves (Figure 2) determined by Wood's equation showed that the ACR group reached a higher lactation peak about two weeks later than the noACR group (9.2 vs. 7.5 weeks of lactation), but maintained a higher production throughout lactation.
Average peak production, calculated by Wood's curve parameters, was 2.24 kg/day for ACR group and 1.95 kg/day for noACR group ($P < 0.001$).
A higher value of parameter ***a***, which represents milk yield at the beginning of lactation, was recorded for ACR group (1.939 vs. 1.579; $P < 0.001$). Consequently at a higher ***a*** value, a lower value of parameter ***b*** was associated, which stands for the inclining slope of lactation. The declining slope of the lactation curve, decay rate ***c,*** higher for noACR group (0.028 vs. 0.013), was not significantly different between treated and control animals during the rest of lactation.
Mean 210-d actual milk yield was 434.84 ± 10.44 kg for ACR group and 362.017 ± 13.03 kg for noACR group. The higher SEM associated to the lower mean milk yield for the untreated goats confirmed further the higher variability of the daily milk production for the animals with manual removing of the milking unit at the end of milking.
The higher milk production registered for ACR group could be mainly due to the better coupling between the teats and the milking unit guaranteed over the entire milking by the innovative ACR system developed. It is reasonable to think that this system, working as a vertical stabilizer of the milking unit, avoided the folding and the straining of the teats during the progressive udder emptying, allowing to collect completely the cisternal fraction of milk. This hypothesis seems supported by the fact that oxytocin release in goats occurs immediately after the start of stimulation, causing a tendency for immediate decrease in milk flow rate after unit attachment (Bruckmaier *et al.*, 1994) and that, in contrast with cows in which less than 30% of the total milk yield volume is stored in the cistern within a normal milking interval (Ayadi et *al.*, 2003), in dairy goats the cisternal fraction accounts for up to 75% (Marnet and McKusic, 2001).
Another factor, though not investigated in this study, which may have contributed to increased milk production in goats managed by ACRs is the overmilking reduction. On the contrary, the extension of milking in the absence of milk flow, which typically occurs when milkers remove the milking units late, causes teat tissue congestion and injury (Isaksson and Lind, 1992). Overmilking for a long period has been shown to increase the incidence of intramammary infection (IMI) in dairy cows (Mein *et al.*, 1986) by compromising the teat end's ability to resist bacterial penetration to the mammary gland (Peterson, 1964), resulting in decreased milk production.

Conclusions

This study attempted to evaluate the ACRs effects on milk yield and lactation persistency in goat lactation.
A higher milk peak and a better persistency in milk yield was observed in goats subjected to the automatic cluster removal at a preset milk flow level in comparison with goats subjected to the manual removal of the milking group at the end of milking.
The better coupling between the teats and the milking unit guaranteed over the entire milking by the innovative ACR system developed and a potential overmilking reduction seem to be the key factors.

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