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Oxytocin release and lactation performance in Syrian Shami cattle milked with and without suckling

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Oxytocin (OT) release and lactation performance in primiparous Syrian Shami cows were evaluated in response to two different machine milking regimes. Six cows were milked in the presence of the calves (PC) and subsequently suckled, whereas six cows were exclusively machine milked without the presence of their calves (WC) until day 91 *post partum*. Milk yield and milk constituents were determined weekly. The degree of udder evacuation was determined by the succeeding removal of residual milk. PC released OT during the milking process, whereas in WC no OT release was detected throughout the milking process. Consequently, the residual milk fraction was much lower in PC than in WC (11% *v.* 58%, $P<0{\cdot}05$) and daily milk yield until day 91 *post partum* was higher in PC than in WC ($12{\cdot}6\pm0{\cdot}3$ *v.* $7{\cdot}1\pm0{\cdot}4$ kg, $P<0{\cdot}05$). In conclusion, Syrian Shami cattle are not suitable to be exclusively machine milked without the presence of their calves.

Keywords: Oxytocin, suckling, Syrian Shami cattle.

Cattle husbandry plays a major role in supplying milk and meat for human consumption in Arabic countries such as Syria. About 50 years ago Shami was the predominant breed in Syria and the whole Middle East, the region where domestication of cattle started (Troy et al. 2001). In the meantime, most of the Shami cattle had been replaced by imported Holstein-Friesian, Friesian and Schwarzbuntes-Milchrind animals despite the local breeds being better adapted to the specific climatic conditions. However, it seems to be necessary, and it is traditionally practised, that Shami cows are milked in the presence of their calves to achieve adequate emptying of the udder. Because of lower yields and the higher work load due to the calf-handling during milking, Shami cattle are economically unattractive for dairy farmers.

The milk ejection reflex in dairy cows of high-yielding breeds like Holstein-Friesian or Brown Swiss is well investigated (Lefcourt & Akers, 1983; Bruckmaier & Blum, 1998). Tactile teat stimulation even at very low intensity induces sufficient release of oxytocin (OT) and ensures complete milk ejection and udder evacuation (Weiss et al. 2003b). Negrao & Marnet (2002) demonstrated that also in crossbreed cows (Holstein × Gyr) a stimulation only by the milking machine is sufficient to induce OT release and complete udder evacuation. However, in breeds not particularly bred for machine milking suitability such as Shami cattle, no data on OT release and machine milking behaviour are available.

In the present study the hypothesis was tested that the stimulatory effect of exclusive machine milking is sufficient to release OT during milking in Syrian Shami cattle. The aim was to establish OT profiles throughout the milking process and to determine lactation performance in primiparous Shami cows that were machine milked either with or without the presence of their calves.

Materials and Methods

Animals and their husbandry

The study was conducted at the Deir Al-Hajar Shami Cattle Research Station, Animal Wealth Research Administration close to Damascus. Twelve primiparous Shami cows that calved between 3 February and 9 March 2004 were used. Cows were kept in an open loose housing stall and fed

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twice daily at 09.00 and 16.00 with a restricted ration of wheat straw, green maize and alfalfa hay. Concentrate (barley, maize, bran, extracted cotton seed meal, minerals and vitamins) was provided according to individual production levels.

Experimental procedure

Cows were randomly selected either for machine milking without the presence of the calf (WC; $n=6$) or for machine milking in the presence of the calf and restricted suckling at the end of machine milking (PC; $n=6$). Both groups were machine milked twice daily at 6.00 and 18.00. WC calves were weaned at day 3 after parturition. PC calves were separated from their dams after day 3 and were kept separately throughout the day except for the time of milking. Except for suckling in PC, calves had no visual contact with their dams after day 3 after parturition. A bucket milking machine (DeLaval, Tumba, Sweden) was used. Milking was performed at a vacuum of 45 kPa, a pulsation rate of 60 cycles/min and a pulsation ratio of 70/30%. The milking routine was highly standardized and consisted of manual pre-stimulation and subsequent machine milking until milk flow ceased.

PC calves were moved to their dams immediately before milking. The calves had access to the udder for 5–10 s immediately before the start of manual pre-stimulation and were subsequently tethered close to their dams. A manual teat stimulation was performed until 1 min after the calf's first contact with the udder. Therefore total stimulation time before the start of milking (suckling and manual) was 1 min. Thereafter machine milking was performed on three teats. The calf was allowed to suck the remaining right front teat, which was not machine milked, after the end of milking for 5 min. The milk yield obtained during machine milking in PC was multiplied by 1·33 to estimate the total milk yield under the assumption that the milk production is evenly distributed between the four quarters. In WC 1 min of manual pre-stimulation was applied before the start of machine milking. Milk yield and milk composition were measured during two milkings (morning and evening) each week from day 7 until day 91 of lactation. To determine the degree of udder evacuation residual milk was extracted after one regular morning milking in 9 cows (5 WC, 4 PC) between days 50 and 60 of lactation by using an i.v. injection of 50 i.u. OT. Residual milk in WC was extracted before calves were allowed to suck. Milk composition was estimated using a MilkoScan analyser (Foss Electric, 3400 Hillerød, Denmark).

Blood samples to determine OT concentrations were taken during two milkings (morning and evening) in each individual cow between days 43 and 65 of lactation. Cows were catheterized in one jugular vein for blood sampling on the day before the first experimental milking (Certofix Mono S 430, Braun, 34212 Melsungen, Germany). Sampling was performed at −5, −1, 0, 0·5, 1, 1·5, 2, 2·5, 3, 3·5, 4, 4·5, 5 min relative to the start of milking and at

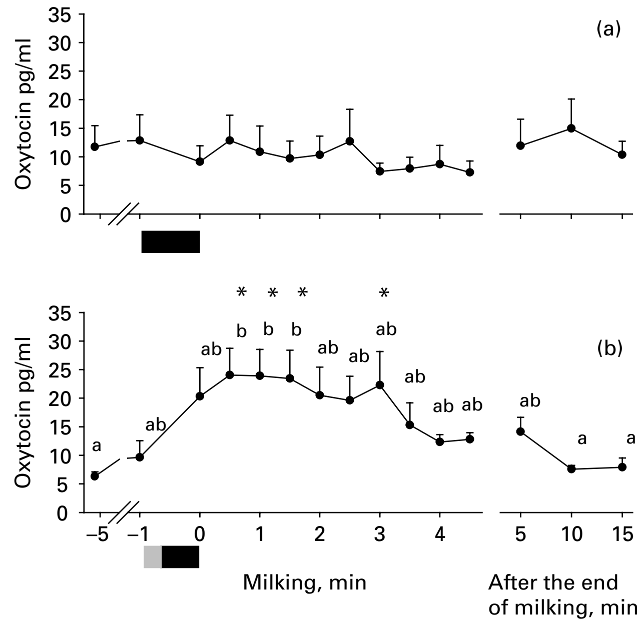

Fig. 1. Oxytocin concentration before, during and after milking without the presence of the calf (a, WC), and with the presence of the calf (b, PC). The black bar indicates manual pre-stimulation of the teat, the grey bar indicates stimulation by the calf. *indicates significant differences between treatments, means without common letters within treatments differ significantly ($P<0·05$). Error bars are SEM.

5, 10 and 15 min after the end of milking. Blood samples were anticoagulated with EDTA, cooled on ice, centrifuged at 4 °C and 3000 ***g*** for 15 min. Plasma was separated and stored at −20 °C until analysis. OT concentrations were measured according to Schams (1983).

Statistical analysis

Results are presented as means ± SEM. The statistical analysis were performed using the MIXED procedure of SAS (SAS 1999). The model used to analyse OT measurements was:

$$Y_{ijkl} = \mu + T_i + S_j + P_k + C_l(T_m) + \varepsilon_{ijklm}$$

where:
Y_{ijklm} = Oxytocin concentrations in blood plasma (pg/ml)
μ = overall mean
T_i = effect of the treatment (i = 1, 2)
S_j = effect of time of sampling (j = −5 to 21)
P_k = effect of the sampling period (k = 1 morning, 2 evening)
$C_l(T_m)$ = repeated effect of the cow (l = 1 to 12) within treatment (m = 1 to 2)
ε_{ijklm} = residual error

The model used to analyse milk yield and composition was:

$$Y_{ijkl} = \mu + T_i + P_j + C_k(T_1) + \varepsilon_{ijkl}$$

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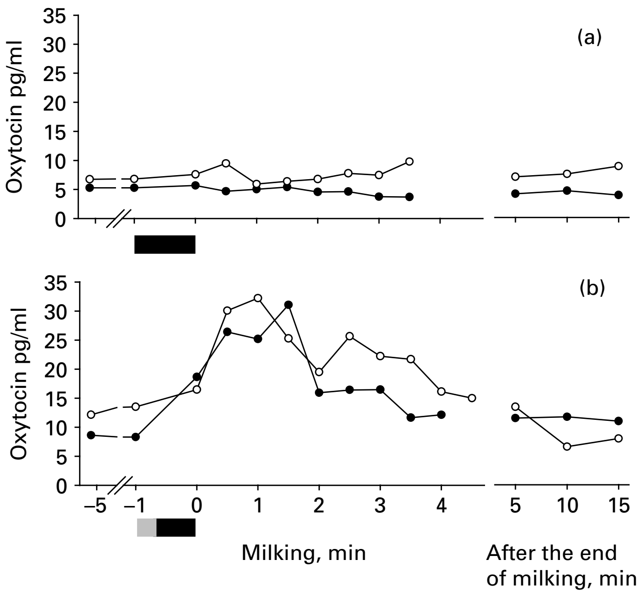

Fig. 2. Oxytocin profiles during morning (open circles) and evening milking (closed circles) of two representative cows either without (a, WC) or with the presence of the calf (b, PC). The black bar indicates manual pre-stimulation of the teats, the grey bar indicates stimulation by the calf. Error bars are SEM.

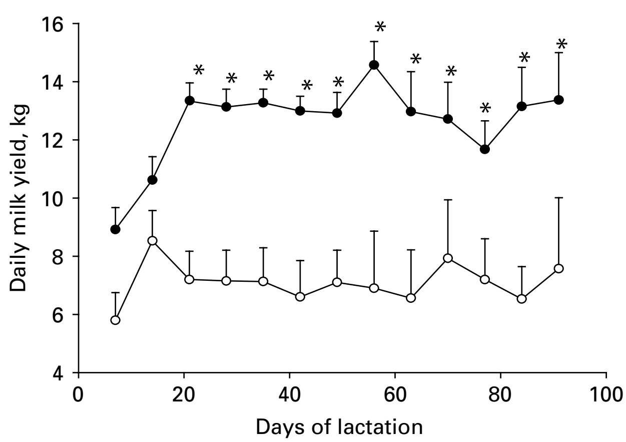

Fig. 3. Daily milk yield throughout the experimental period (until day 91 *post partum*). Open circles indicate cows that were milked without the presence of their calves (WC). Closed circles indicate cows that were milked in the presence of their calves (PC). *indicates significant differences between treatments ($P<0{\cdot}05$). Error bars are SEM.

where:
Y_{ijkl} = milk yield or milk composition
μ = overall mean
T_i = effect of the treatment (i = 1, 2)
P_j = effect of the sampling period (k = 1 morning, 2 evening)
$C_k(T_l)$ = repeated effect of the cow (k = 1 to 12) within treatment (l = 1 to 2)
ε_{ijkl} = residual error

Table 1. Daily milk yield and milk constituents during the experimental period of the first 91 d *post partum*

		Milking in the presence of the calves (PC)	Milking without the presence of the calves (WC)
Milk yield	kg/d	$12{\cdot}6 \pm 0{\cdot}3^{a}$	$7{\cdot}1 \pm 0{\cdot}4^{b}$
Fat	g/l	$33{\cdot}9 \pm 0{\cdot}7^{a}$	$42{\cdot}0 \pm 1{\cdot}4^{b}$
	g/d	439 ± 14^{a}	301 ± 20^{b}
Protein	g/l	$37{\cdot}2 \pm 0{\cdot}3$	$36{\cdot}8 \pm 0{\cdot}4$
	g/d	464 ± 10^{a}	256 ± 13^{b}
Lactose	g/l	$48{\cdot}6 \pm 0{\cdot}2^{a}$	$45{\cdot}2 \pm 0{\cdot}3^{b}$
	g/d	613 ± 15^{a}	324 ± 18^{b}

$^{a,\,b}$: means within a row without common superscript letters differ significantly ($P<0{\cdot}05$).

Results

Oxytocin concentrations

For both PC and WC, OT concentrations were low before the start of milking (Fig. 1). OT concentrations increased after the start of stimulation in PC, whereas in WC, OT concentrations remained at the baseline level throughout the course of milking. In PC, OT concentrations peaked 1·5–2 min after the start of stimulation and decreased to basal level until 10 min after the end of milking. Patterns of OT release did not differ between morning and evening milkings (Fig. 2). WC did not release OT either during morning milking or during evening milking.

Milk yields and constituents

During the first 2 weeks of lactation milk yields in PC and WC did not differ significantly. However, after the second week milk yields in PC increased whereas yields in WC remained unchanged (Fig. 3). Throughout the experimental period of 91 d *post partum*, milk yields in WC were about 56% of the milk yields in PC (Table 1). Fat, protein and lactose yields were significantly reduced in WC compared with PC, although relative fat content was higher in WC than in PC. The residual fraction in PC was about 11% of the totally stored milk, whereas in WC the residual fraction accounted for about 58% of the totally stored milk (Table 2). Consequently, residual milk fractions of fat, protein and lactose were dramatically increased in WC compared with PC.

Discussion

The aim of the present study was to evaluate the OT release and the lactation performance in primiparous Syrian Shami cows in response to different machine milking regimes. The results clearly indicate that machine milking without suckling or at least the presence of the calf (WC) did not induce a sufficient OT release during the milking process to cause complete alveolar milk ejection

Table 2. Milk yield and milk constituents in main and residual milk during one morning milking between days 50 and 60 of lactation

		Main milk	Residual milk	Residual yield relative to total yield, %
Milking in the presence of the calves (PC, $n=4$)				
Milk yield	kg/milking	$5{\cdot}8 \pm 0{\cdot}5^{a}$	$0{\cdot}76 \pm 0{\cdot}3^{a}$	11
Fat	g/l	$32{\cdot}0 \pm 5{\cdot}8$	$117{\cdot}3 \pm 7{\cdot}4^{a}$	
	g/milking	187 ± 4^{a}	88 ± 3^{a}	32
Protein	g/l	$35{\cdot}7 \pm 2{\cdot}1$	$30{\cdot}7 \pm 2{\cdot}1$	
	g/milking	209 ± 3^{a}	24 ± 2^{a}	10
Lactose	g/l	$50{\cdot}0 \pm 1{\cdot}5^{a}$	$45{\cdot}2 \pm 1{\cdot}9$	
	g/milking	294 ± 3^{a}	35 ± 2^{a}	11
Milking without the presence of the calves (WC, $n=5$)				
Milk yield	kg/milking	$1{\cdot}4 \pm 0{\cdot}5^{b}$	$1{\cdot}9 \pm 0{\cdot}6^{b}$	58
Fat	g/l	$37{\cdot}9 \pm 7{\cdot}9$	$63{\cdot}9 \pm 7{\cdot}3^{b}$	
	g/milking	46 ± 3^{b}	117 ± 5^{b}	72
Protein	g/l	$34{\cdot}9 \pm 3{\cdot}2$	$36{\cdot}7 \pm 2{\cdot}3$	
	g/milking	49 ± 3^{b}	69 ± 3^{b}	59
Lactose	g/l	$41{\cdot}6 \pm 3{\cdot}5^{b}$	$42{\cdot}6 \pm 3{\cdot}5$	
	g/milking	60 ± 3^{b}	84 ± 4^{b}	58

[a, b]: treatment means without common letters differ significantly ($P<0{\cdot}05$)

(Bruckmaier et al. 1996; Macuhova et al. 2002). In contrast, machine milking in the presence of the calves (PC) resulted in increased OT levels throughout the milking process, similarly to previous findings in high yielding dairy cow breeds like Holstein and Brown Swiss (Bruckmaier & Blum, 1998, 1996). Therefore, the degree of udder evacuation in PC was similar to previous reports in modern dairy cows (Brandsma, 1978; Weiss et al. 2003a). The amount of residual milk in WC was dramatically increased, comparable to situations of disturbed milk ejection (Bruckmaier et al. 1996; Macuhova et al. 2002). Since a significant amount of milk remaining in the udder causes reduced milk secretion and increased apoptosis of the mammary secretory tissue by local autocrine regulation, the reduced lactation performance in WC was obviously a long-term result of the incomplete udder evacuation due to the reduced or even lacking OT release during the milking process (Peaker & Wilde 1996; Stefanon et al. 2002).

The present results indicate clearly that the presence of the calf during machine milking and suckling after machine milking increased milk production in Shami cows. Restricted suckling causes increased milk production and therefore does not reduce the milk available for human consumption as might be assumed due to the milk consumption by the calf (Alvarez et al. 1980; Teeluck et al. 1981; Little et al. 1991; Coulibaly & Nialibouly, 1998; Sandoval-Castro et al. 2000; Combellas & Tesorero, 2003). The present results show the crucial role of OT release in milking performance.

In crossbred Gyr × Holstein cows, Negrao & Marnet (2002) demonstrated similar OT release and similar milk yields in exclusively machine milked cows compared with a combined suckling and milking regime, whereas Murugaiyah et al. (2001) reported reduced milk yields and increased apoptotic activity in exclusively machine milked crossbred Sahiwal × Holstein cows. However, increased OT release and milk yields due to suckling even in high-yielding Holstein cows that are adapted to machine milking demonstrate the crucial role of suckling in stimulating OT release (Bar-Peled et al. 1995; Krohn, 2001). The modern type of dairy cow seems to be selected for readiness of milk release without contact with the calf, whereas in less-selected breeds the mixed management systems are dominant and therefore machine milking has not been the central goal of breeding strategies. These results correspond to dairy species like sheep and goats, where the adaptation to exclusive machine milking is very variable between breeds (Bruckmaier & Blum, 1998).

In conclusion, the present results indicate that Shami cattle are not adapted to machine milking without the presence of the calf. Therefore early weaning is not suitable to increase milk production in Shami cattle. Further studies are necessary to develop production systems taking into account the need for increased milk production and, simultaneously, the preservation of genetic resources.

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