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Milk processing quality of suckled/milked goats: effects of milk accumulation interval and milking regime

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Milk with a high concentration of fat and casein is required for cheese production, and these components have a major impact for both quality and yield of the curd. Recent observations have shown that suckling can elevate milk fat concentration in goats and our aim was therefore to check the hypothesis that animal welfare and cheese-processing properties of goat milk could be optimised by appropriate management of suckled/milked goats. Twelve Swedish dairy goats were kept together with one kid each in 4 different mixed management-systems (milking combined with partial suckling) in a cross-over design. Two milk accumulation intervals were tested; Short = dams and kids were together for 16 h (T16) and Long = ; dams and kids were together for 8 h (T8 h). In addition, two milking regimes were used; Suckled Before Milking = S and Milked Before Suckling = M. Milk accumulation interval referred to how long dams and kids were separated. The milk yield available for processing (milk offtake), was weighed and analysed from each milking occasion and the suckled milk yield was estimated by a weigh-suckle-weigh method (WSW) in combination with observing the suckling behaviour during the free suckling periods. Milking managements, such as 'suckling before milking (S)', increased milk fat concentration compared to milking before suckling (M) and 'Short accumulation treatments (T16)' gave higher milk fat, casein concentration and individual curd yield (%) compared to the 'Long accumulation treatment (T8)'. The total individual curd yield (g) was the same despite treatment, but the animal welfare was most likely higher in T16 where dams and kids spent more time together.

Keywords: Casein, Curd yield, Goats, Milk fat, Suckling.

Dairy goats can be kept in either intensive, semi intensive or extensive management systems (FAO, 2014). In intensive systems, which are most common in industrial countries, early weaning (within a few days) of the offspring is customary (Miranda-de la Lama & Mattiello, 2010). Intensification in the dairy sector gives less opportunity for animals to express natural behaviour and early separation of mother and offspring may compromise welfare (Miranda-de la Lama & Mattiello, 2010). In semi-intensive or extensive management systems, it is more common that dam and offspring are kept together for longer periods. In for example Sweden, where both intensive and semi intensive systems are practised, the separation of dams and kids ranges from a few days to several months (Brandt, 2009). It is of great importance to investigate how alternative managements systems, based on both milking and suckling (mixed managements) affects the milk production in dairy goats. It has for example been shown that partial suckling regimens, compared to milking only (no suckling), can increase the commercial milk yield during the entire lactation (Delgado- Pertínez et al. 2009). Also, dairy sheep in managements of partial suckling, yielded higher than those that were sucked exclusively (Knight et al. 1993).

On the other hand, it has been reported that ewes kept in mixed management systems produce milk with poor fat contents, which is explained by impaired milk ejections during milking (McKusick et al. 2002; Jaeggi et al. 2008). In ruminants, milk is stored in two udder fractions, the cisternal and the alveolar. The proportion of milk stored in the cisternal and the alveolar fractions varies according to species, breed, milking interval, and lactation stage (Marnet & Komara, 2008). Goats differ from dairy cattle because 70–90% of the milk can be stored in the gland cistern (Silanikove et al. 2010). In small ruminants, large volumes

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of milk can therefore be obtained without a milk ejection reflex, but milk from the gland cistern has then a low fat concentration (Marnet & McKusick, 2001). Fat globules (especially the largest ones) are stored in the alveolar fraction and do not pass freely to the gland cistern (McKusick et al. 2002). In response to oxytocin, myoepithelial cells contract and the alveolar milk is transported to the cisternal fraction (Bruckmaier et al., 1994).

We have previously observed that goat milk has relatively low contents of protein and casein (Högberg, 2011a, b) and it has been shown that 65% of the Swedish dairy goat population produces milk with low or no synthesis of α_{s1}-casein (Johansson et al. 2014), where some of the goats in the present study were included. The low production of α_{s1}-casein affects milk composition and thus the cheese making properties of milk negatively (Pirisi et al. 1994; Clark & Sherbon, 2000).

Milk with a high concentration of fat, total protein and casein is required for cheese production, and these components has a major impact for both quality and yield of the curd (Clark & Sherbon, 2000; Soryal et al. 2005; Damian et al. 2008). We have recently observed that partial suckling stimulates milk production and elevates the fat concentration of the milk (Högberg, 2011a), which suggests that milk production, milk composition and animal welfare could be improved by rearing goats and kids in mixed regimens.

In this study the hypothesis that the cheese-processing properties of goat milk could be optimised by appropriate management of suckled/milked goats was investigated. Two milk accumulation intervals (Short, Long) and two milking regimes (Suckled Before Milking = S, Milked Before Suckling = M) were tested. By definition, milk accumulation interval refers to the separation period. Milk yield available for processing (milk offtake), was weighed and analysed from each milking occasion. Also, the suckled milk yield had to be considered, which additionally was included in the Total Milk Production (milk offtake + suckled milk yield). The suckled milk yield was estimated by a weigh-suckle-weigh method (WSW) in combination with observing the suckling behaviour during the free suckling periods.

Materials and methods

Animals and housing

Twelve Swedish landrace dairy goats *(Capra hircus)* were kept together with one kid each in an indoor free range stall with straw and shavings as bedding material, at the Swedish University of Agricultural Sciences, Uppsala, Sweden. Three dams delivered twins, from which one of the kids was removed at birth. Hay, water and mineral licks were available *ad libitum* and large plastic boxes and tables served as enrichment items. A mixture of 930 g feed concentrate (50% Edel komet, Uppsala, Sweden) and 50% oat (Wollerts, Uppsala, Sweden) was offered at milking. Kids were offered concentrate once daily in the morning. The study was performed during lactation weeks 8 ± 2 to 11 ± 2 and dams were in their 1–6 lactation. Room temperature was kept at 17 ± 1 °C (range 15·8–18·5 °C) and relative humidity was kept between 41–54%. The experimental procedures were approved by the Local Ethical Committee, Uppsala, Sweden.

Experimental procedures

The study was performed during 4 weeks in a crossover design where goats and kids were kept in 4 different mixed systems (milking combined with suckling, Fig. 1). Dams were blocked by days in lactation and lactation number into the treatments, which each lasted for 1 week (Saturday to Friday), with 5 sampling days per week, Monday to Friday. During the first 2 d of each treatment (Saturday to Sunday), no data was collected.

Dams and kids kept together for 16 h night time (Short accumulation)

In the 'Short accumulation treatments', dams and kids were apart for 8 h daytime (8 h accumulation) and kept together for 16 h night time (T16, free suckling for 16 h, Fig. 1). Two milking regimes were applied; suckling before milking (S) and milking before suckling (M). In T16-S, kids were reunited with their dams and were allowed to suckle until satiation before milking. In T16-M, dams were milked directly (no suckling before milking). Dams were milked twice daily at 07·30 in the morning and at 15·30 in the afternoon, milk yield and composition were recorded. Directly after each morning milking, dams ($n = 6$) were moved to a free range pen in an adjacent room for 8 h while kids ($n = 6$) stayed in the home pen. Immediately after each afternoon milking, goats and kids in both treatments were reunited and spent the night together for 16 h.

Dams and kids together 8 h daytime (Long accumulation)

In the 'Long accumulation treatments', dams and kids were apart for 16 h night time (16 h accumulation) and kept together for 8 h daytime (T8, free suckling for 8 h, Fig. 1). Two milking regimes were applied; suckling before milking (S) and milking before suckling (M). In T8-S, kids were reunited with their dams and were allowed to suckle until satiation before milking. In T8-M, dams were milked directly (no suckling before milking). Dams were milked once daily at 07·30 in the morning, milk yield and composition were recorded. Immediately after milking, goats and kids in both treatments were reunited and spent the day together for 8 h.

Suckling behaviour

On day 4 of each week, 6 kids were continuously observed during 16 h of free suckling night time (T16) and the other 6

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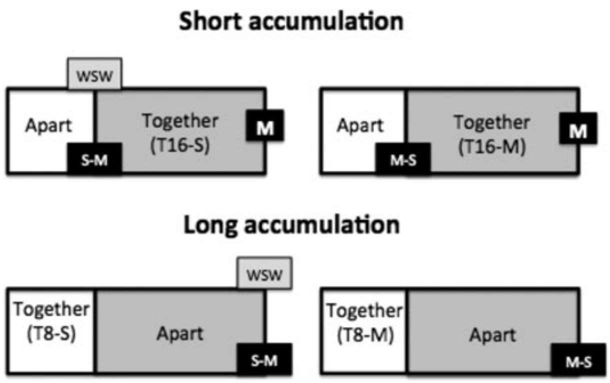

Fig. 1. Twelve goats were blocked by lactation number and days in lactation into 4 different treatments in a cross-over design. Each treatment lasted for 1 week (4 weeks in total, W1 – W4) with 5 sampling days per week. Dams were assigned into 4 treatments; 2 milk accumulation intervals (Short, Long) and 2 milking regimes (Suckled Before Milking, Milked Before Suckling). In the short accumulation treatments, dams and kids were kept together for 16h (T16) night time and in T16-S, dams were suckled before milking (S-M) and in T16-M, dams were milked before suckling (M-S). In the long accumulation treatments, dams and kids were kept together for 8h (T8) daytime and in T8-S, dams were suckled before milking (S-M) and in T8-M, dams were milked before suckling (M-S). In the short accumulation treatments, dams were milked twice daily (M and S-M or M-S) and in the short accumulation treatment, dams were milked once daily (S-M or M-S). In the S-M treatments, the suckled milk yield was estimated by a Weigh-Suckle-Weigh (WSW) method.

kids for 8 h during daytime (T8). Each time a kid suckled, the number of bouts was registered and the duration of each bout was clocked in seconds. The time recordings started when the kid had the teat in the mouth and tail flicked and stopped when the kid left the teat (or dam went away).The mean total suckling time for each treatment was calculated for all 12 kids.

Estimation of total suckled milk volume and milk production

When the kids were allowed to suckle before milking (T16-S and T8-S) the kids milk consumption was measured with a weigh suckle weigh method (WSW) for 5 consecutive days for both treatments. First, the kids were weighed; thereafter they were allowed to suckle to satiation. The time recordings started when the kid had the teat in the mouth and tail flicked and stopped when the kid left the teat (or dam went away). Finally, the kids were weighed again and both suckling duration (s) and weight gain of each kid (g) were recorded. The milk flow in g/s was calculated by dividing the kids body weight increase (g), with the time it took to suckle that amount (s).

WSW was measured in all kids for 5 consecutive days in each suckling before milking treatment (T16-S and T8-S). The milk flow was not significantly different, neither between days nor treatments and therefore, we assumed that the milk flow was similar at each suckling occasion for the individual kid. The total suckled milk volume was calculated by multiplying the total suckling duration (s) from the behavioural observations with the mean milk flow (g/s) from WSW for each kid.

Milk offtake and total production

The milk offtake (milk yield available for processing) was weighed (Mettler Toledo, 98 Stockholm, Sweden) and analysed during 5 consecutive days per treatment. Dams were either machine milked at a vacuum pressure of 42 kPa with a pulsation ratio of 90 pulses/min (De Laval International AB, Tumba, Sweden) or hand milked if low milk volume. The total milk yield (24 h) was determined as the sum of: milk offtake from milking, the estimated milk yield from WSW and from the suckled milk yield estimated from behavioural observations. Total milk yield (g) = WSW + milk offtake + estimated yield during suckling.

Milk analyses

All milk samples were thoroughly mixed before 10 ml of milk was pipetted into plastic tubes. The tubes were heated in a water-bath to 40 °C and analysed for fat, total protein and lactose concentration with a mid-infrared spectroscopy (MIR) method (Miris AB, Uppsala, Sweden). The casein concentration and individual curd yield were measured by a rennet-coagulation method (adapted from Othmane et al. 2002), where 40 µl of Chy-Max Plus (190 IMCU/ml, Chr. Hansen A/S, Hørsholm, Denmark) was added to 10 ml of fresh milk (40 °C) and vortexed. The samples were set to coagulate for 30 min before the curd was vertically cut into four equally sized sections with a special four-edged knife, specially made to fit the tubes. After another 30 min of incubation, at 40 °C, the samples were centrifuged at 1650 × ***g*** for 20 min at 22 °C (Beckman Hettich Lab instrument, Stockholm, Sweden). The whey was expelled from the curd, and weighed in tared tubes. Only milk samples with a fat concentration below 5% were included because with higher milk fat the curd stayed in the upper part of the tubes and the whey could not be weighed. Curd yield was determined from the weight difference between the initial milk sample and the expelled whey and expressed as grams of curd per 100 g milk and presented in per cent. To determine the casein concentration the whey protein was analysed by MIR-technique. Total protein from the initial milk samples minus whey protein gave the casein concentration. The casein/total protein proportion is presented as casein number. The total individual curd yield in grams was calculated from individual curd yield (%) × the individual daily milk offtake (g).

Somatic cell count (SCC) was measured in fresh milk by fluoro-opto-electronic cell counting (Fossomatic 5000, Foss electric, Hillerød, Denmark). The milk pH was measured by a pH meter calibrated for goat milk (FiveGo™

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pH, Mettler Toledo, Stockholm, Sweden) in fresh milk directly after milking.

Statistical analysis

A mixed linear model for repeated measurements (SAS software 2011 v.9.3, SAS Institute Inc., Cary, NC, USA) was used to analyse the data. The statistical model included the fixed effects of treatments on suckling frequency, suckling duration, milk flow, estimated milk consumption, milk offtake, milk composition, somatic cell count and curd yield and the random effect of goat and experimental error. Pairwise comparisons of values between treatments were tested for significance. Results are presented as least square means (LSM) ± standard error of means (SEM) and range. The significance level was set at $P < 0{\cdot}05$.

Results

Suckling behaviour during 16 and 8 h of free suckling

The total number of suckling bouts was not affected by the time dam and kid spent together (15 ± 0·7 bouts for T16 (S and M) and 15 ± 0·7 bouts for T8 (S and M) treatments. However, the suckling frequency was therefore twice as high for T8 (1·6 ± 0·1 bouts/h) compared to T16 (0·9 ± 0·1 bouts/h, $P < 0{\cdot}01$). The number of suckling bouts varied greatly between animals, where the range between animals was between 8–29 bouts for T16 and 7–24 for T8 treatments. The total suckling duration was longer for T16 treatments (348 ± 24s) than for T8 (283 ± 24s, $P < 0{\cdot}01$), but the individual variation was large (T16 = 182 – 594s, T8 = 181 – 483s).

Weigh-suckle-weigh and daily weight gain in kids

When measuring milk intake by WSW, kids that had been separated for 16 h (T8-S), suckled for a longer time (51 ± 6s) compared to those that had been separated for 8 h (T16-S, 40 ± 6s). Also, T8-S consumed more milk; 509 ± 60 g, than T16-S (405 ± 60 g, $P < 0{\cdot}05$). The mean estimated milk flow was 9·3 ± 0·7 g/ for T16-S and 8·9 ± 0·6 g/s for T8-S. The daily weight gain was similar throughout the study, i.e. 217 ± 38 g/d when kids were together during 16 h night time (T16-S) and 215 ± 37 g/d when together during 8 h day time (T8-S).

Milk production

The milk offtake differed between all treatments, with the highest in the T8-M treatment and the lowest in the T16-S ($P < 0{\cdot}05$, Table 1). During the free suckling periods, the estimated milk consumption was on average higher ($P < 0{\cdot}05$) in T16-S treatment than in T8 (S and M), but not higher than in T16-M. There was no difference in total milk production (milk offtake + WSW + estimated milk consumption during free suckling) between the treatments. The individual variations were large within all treatments (Table 1).

Milk composition and milk pH

The milk fat concentration differed between all treatments, with the highest in T16-S ($P < 0{\cdot}05$, Table 2). Both milking regime and milk accumulation interval affected the milk fat concentration, as was higher when dams were suckled before milking (T16-S and T8-S) compared to when they were milked before suckling (T16-M and T8-M). Also, longer time together T16-S and T16-M, gave a higher fat concentration compared to T8-S and T8-M ($P < 0{\cdot}05$). Between individuals, the variation was large as is illustrated by the range in Table 2.

The total protein concentration was lower in T8-S than in both T16-S and T16-M treatments ($P < 0{\cdot}05$, Table 2). The casein concentration was significantly higher ($P < 0{\cdot}001$) when dams and kids were together for a longer time (T16) than when they were together shorter (T8), which also resulted in a higher casein number (casein/total protein) in T16 and compared to T8 ($P < 0{\cdot}05$, Table 2).

Somatic cell count and milk pH

SCC was higher in both the T8 treatments than in the T16 treatments ($P < 0{\cdot}001$) and T8-S had even higher SCC than T8-M ($P < 0{\cdot}05$; Table 2. The milk pH was lower in T16-M compared to all other treatments ($P < 0{\cdot}05$; Table 2). The variation in SCC was large between individuals (Table 2).

Individual curd yield

The individual curd yield in per cent was higher in T16 compared to the T8 treatments ($P < 0{\cdot}001$; Fig. 2; left). Between suckling (S) and milking (M) managements, the curd yield was higher in T8-S than in T8-M and tended to be higher in T16-S than in T16-M ($P = 0{\cdot}07$). There was no difference in the total individual curd yield (yield % × milk offtake) between the treatments (Fig. 2; right).

Discussion

In the present study, suckling before milking increased both milk fat concentration and curd yield, which demonstrates that suckling improves the neuroendocrine milk ejection reflex (Marnet & Negrao, 2000; Olsson & Högberg, 2009) by releasing the alveolar milk rich in fat into the cistern (Högberg et al. 2014). It was further shown that the more time dam and kid spent together (T16), higher concentrations of both fat and casein were received at milking. The efficiency of transferring the fat rich milk from the alveolar fraction into the cisterns is related to plasma levels of oxytocin, and for a complete emptying of that milk, plasma oxytocin concentration must reach a certain level, otherwise some milk remains in the alveoli (Shams et al. 1984;

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Table 1. The total milk production is presented as the sum of milk offtake from milkings (milk yield available for processing) + the suckled milk yield estimated during weigh suckle weigh WSW + during the free suckling periods.

Treatment	M. offtake (g)	Range	Suckling (g)	Range	Tot. milk prod. (g)
T16-S	$1071^{d} \pm 176$	401–2803	$3535^{a} \pm 272$	2309–4400	4551 ± 278
T16-M	$1264^{c} \pm 176$	616–2733	$3256^{ab} \pm 272$	1972–5322	4475 ± 278
T8-S	$1505^{b} \pm 176$	350–2694	$2786^{b} \pm 272$	1005–3896	4254 ± 278
T8-M	$1820^{a} \pm 176$	1131–3157	$2956^{b} \pm 272$	1084–4443	4739 ± 278

Dams were assigned into 4 treatments; 2 milk accumulation intervals (Short, Long) and 2 milking regimes (Suckled Before Milking = S, Milked Before Suckling = M). In the short accumulation treatments, dams and kids were separated for 8 h daytime and together during 16 h night time (T16). In the Long accumulation, dams and kids were separated for 16 h night time and together during 8 h day time (T8)
Different superscript letters between treatments differ at $P < 0{\cdot}05$. Significance level was set at $P < 0{\cdot}05$
Values are presented as least square means (LSM) and standard error of means (SEM). Individual variations are presented as range

Table 2. Milk compositions, casein number (Cn nr, casein/total protein), somatic cell count (SCC × 10^3 cells/ml) and milk pH from Swedish dairy goats kept in 4 different management systems (cross-over design).

	Treatment					
	T16-S	T16-M	T8-S	T8-M	SEM	Range
Fat (%)	$4{\cdot}50^{a}$	$4{\cdot}07^{b}$	$3{\cdot}07^{c}$	$2{\cdot}25^{d}$	0·19	1·3–6·1
Protein (%)	$2{\cdot}98^{a}$	$2{\cdot}99^{a}$	$2{\cdot}94^{b}$	$2{\cdot}97^{ab}$	0·05	2·7–3·5
Casein (%)	$2{\cdot}13^{a}$	$2{\cdot}13^{a}$	$2{\cdot}06^{b}$	$2{\cdot}08^{b}$	0·05	1·8–2·6
Cn nr (%)	$71{\cdot}47^{a}$	$71{\cdot}26^{a}$	$70{\cdot}04^{b}$	$70{\cdot}00^{b}$	0·57	66–73
SCC	377^{a}	416^{ab}	1009^{a}	691^{b}	306	18–6052
Milk pH	$6{\cdot}49^{a}$	$6{\cdot}42^{b}$	$6{\cdot}49^{a}$	$6{\cdot}49^{a}$	0·02	6·2–6·7

Different superscript letters between treatments within a row differ at $P < 0{\cdot}05$
Values are presented as least square means (LSM) and standard error of means (SEM)
Individual variations are presented as range
For information of treatment, see legend to Table 1

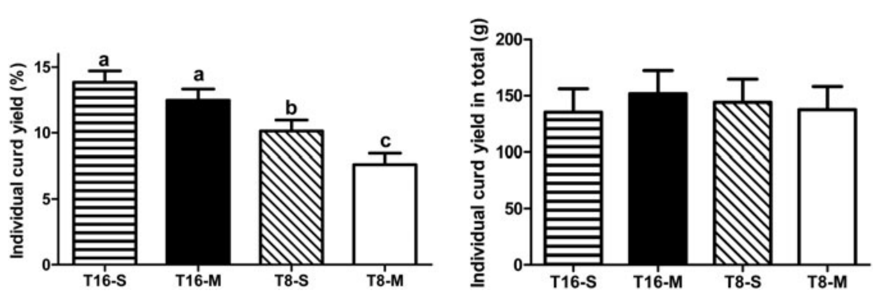

Fig. 2. Individual curd yield per day and goat in percent (left) and the total individual curd yield presented in grams (milk offtake × %, right). Values are presented as LSM ± SEM. Different superscript letters differ at $P < 0{\cdot}05$. For information of treatment, see legend to Table 2.

Bruckmaier et al. 1994). Keeping dams and kids together could therefore improve milk removal from the alveoli by a more regular oxytocin release. More frequent emptying of mammary epithelial cells might thereby stimulate intracellular transport of proteins and newly synthesised caseins (Lollivier et al. 2006), which might explain the higher casein concentration in the T16 treatments compared with T8.

The significant reduction of milk fat in the T8-M treatment confirms that cisternal milk mostly was received during these milkings (McKusick et al. 2002; Högberg et al. 2014). Comparable findings have been observed in dairy ewes kept in mixed management systems (McKusick et al. 2001, 2002; Jaeggi et al. 2008; Tzamaolukas et al. 2015), explained by impaired milk ejections during milking caused by partial contact between dam and lamb (McKusick et al. 2002). In the present study, the milk fat concentration was higher when dam was suckled before milked (S) compared to milked before suckling (M) and when dam and kid spend 16 h together instead of 8 h, which clearly shows that management systems had a major impact upon the milk fat concentration. The management design for T8-M and the studies by McKusick et al. (2002) and Jaeggi et al. (2008) were similar. Dams and offspring were separated for 14 to 16 h during night and milked once daily without udder stimulation by the offspring before milking, which explains the low fat concentration. Therefore, we assume that suckling before milking and shorter separation between dam and kid is to be recommended when rearing dams and offspring in mixed management systems.

The significantly higher fat and casein concentration from the T16 treatments resulted in a higher curd yield compared to the T8 treatments. That high fat content increase curd yield has also been found by others (Soryal et al. 2005; Jaeggi et al. 2008). The individual curd yield was only 7·5% in T8-M, compared to about 14% in milk from T16-S and -M treatments. The cheese yield from Swedish dairy goats is in general 10–12% (10 l of milk to produce 1 kg of cheese; personal communication, Lipage M), which is similar to the curd yield in the T8-S treatment. It has to be mentioned that milk samples with a fat concentration higher than 5% were excluded from the analysis of individual curd yield due to missing values. The individual curd yield was therefore underestimated and higher values would have been obtained if all samples from the T16 treatments had been included. When comparing the total individual curd yield in grams (% × milk offtake), there was no difference between treatments. This confirms that the milk composition has a greater impact than the yield itself when milk is aimed to be used for cheese production.

The rise in SCC during T8 (S, M) treatments may be explained by the abrupt changes from 8 to 16 h of free suckling, since when udders undergo less frequent emptying the SCC tend to rise (McKusick et al. 2001). This increase in SCC was most apparent in dams with generally higher SSC values. In dams with lower SCC, only small or no changes were observed. One individual differed greatly from others with SCC >1000×10^3 cells/ml (thereby the high range), but no bacterial infection, diverged milk composition or milk pH was found in that goat. However, the SCC in T16 (S, M) was lower in comparison to other breeds (Paape et al. 2007), and surprisingly much lower than the closely related Norwegian dairy breed, which have >1000×10^3 cells per ml in normal milk (Skeie, 2014). The present low SCC values might explain that Swedish landrace goats have a good udder health status in general (Persson & Olofsson, 2011), or that suckling might have beneficial effects upon udder health (Fröberg et al. 2008). Others have reported that ewes reared in mixed management systems have lower SCC levels than dams milked only (|McKusick et al. 2001, 2002; Rassu et al. 2015; Tzamaolukas et al. 2015).

Even if the total time for free suckling was twice as long (16 h) for T16 than for T8, there was no difference in the total number of suckling bouts between the treatments. The suckling frequency was thereby doubled in T8 treatments, compared to T16, which shows that the kids compensated their milk intake during the shorter period together. The suckling behaviour appeared to vary greatly between individuals (Delgadillo, 1997; Cameron, 1998), even within the same treatment. Dams and kids seemed to adapt to the treatments differently, where only 5 of 12 kids suckled more times during 16 h compared to 8 h, while the rest (7/12 kids) suckled more or equal times during shorter period together (T8), compared to T16.

More frequent milking has been shown to increases the milk yield in goats (Henderson et al. 1985; Wilde et al. 1987; Knight & Wilde, 1993). Further, Wilde et al. (1987) suggested that suckling plus frequent milking during early lactation could improve both proliferation and differentiation of mammary cells of goats. In our experiments there was no difference in the total milk production (milk offtake + WSW + suckled yield) between the treatments, but the individual variation was large between animals. Some goats had both a high milk offtake and fat concentration, which is in agreement with earlier studies by us (Högberg, 2011a), that Swedish goats kept in mixed management systems were able to produce 3–4 kg daily, at the same time as the fat concentration was around 5%. The individual variation between goats thus shows that high yielding goats (high milk offtake) are more appropriate for mixed management systems than low yielding ones. Furthermore, when keeping dairy goats in mixed regimens, cisternal capacity might influence both milk yield (Salama et al. 2004) and fat concentration. Goats with great cisternal capacity could thereby store large volumes of fat rich alveolar milk, once ejected by suckling.

Conclusions

The present study shows that both milking regime and milk accumulation interval influenced the cheese processing properties of goat milk when dams and kids were kept together in mixed management. Milking management, such as 'suckling before milking (S)', increased milk fat concentration compared to 'milking before suckling (M)'. Also, 'longer time together with their kids (T16, 'Short accumulation treatments') gave higher milk fat, casein concentration and individual curd yield (%) compared to the 'Long accumulation treatment' (T8; shorter time together with their kids). The total individual curd yield (g) was the same despite treatment, but the animal welfare was most likely higher in T16 where dams and kids spent more time together. However, individual variations in suckling behaviour, milk yield and composition should be considered when using mixed regimes, i.e. high yielding goats should be more appropriate for mixed managements than low yielding ones.

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