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Original article

Once-a-day milking of multiparous Holstein cows throughout the entire lactation: milk yield and composition, and nutritional status

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Abstract – **Once-a-day milking of multiparous Holstein cows throughout the entire lactation: milk yield and composition, and nutritional status.** Eighteen multiparous Holstein cows were distributed into two similar groups immediately after calving: the control group (M2) was milked twice a day throughout lactation whereas the other group (M1) was milked only once a day in the morning. During the indoor (winter) period, all animals received the same total mixed ration ad libitum. In the summer, they were turned to pasture at the same time. The seven cows of group M2 (2 cows were excluded) produced 7323 kg of milk on average in 305 days. The nine cows of group M1 produced 5114 kg of milk (–30%; $P < 0.01$) over an entire lactation that lasted 12 days less than the twice daily milked cows. Fat and protein concentrations were higher by 3.5 $g \cdot kg^{-1}$ ($P < 0.01$) and 2.1 $g \cdot kg^{-1}$ ($P = 0.06$), respectively, in the M1 group. Mean lactose contents (entire lactation) did not differ between groups ($P > 0.10$). Mean somatic cell count ($\log_{10} = 5.043$ per mL and 4.946 per mL in groups M1 and M2, respectively) did not differ between the groups despite the sharp increase noted in group M1 during the last third of lactation. Casein and whey protein contents also were not significantly different between the groups. Plasmin and lipoprotein lipase activities were unchanged although the plasminogen-derived activity tended to be higher in the milk from group M1. The dry matter (feed) mean intake amount of the first 14 weeks of lactation did not differ between the two groups although it gradually became higher in the M2 group. Group M1 cows' liveweight and body condition gradually improved over those of group M2, with a difference as high as 56 kg ($P < 0.01$) and 0.94 point on the body condition score ($P = 0.02$) on the 36th week of lactation. Eight of the nine M1 cows and four of the seven M2 cows were diagnosed as pregnant. The M1 cows did not show any specific sanitary disorder or abnormal behaviour throughout the lactation.

once-a-day milking / dairy cow / milk yield / milk composition / nutritional status

Résumé – **La traite une fois par jour de vaches laitières multipares Prim'holstein pendant toute la lactation : production laitière et état nutritionnel.** Dix-huit vaches Prim'Holstein multipares ont été réparties en deux lots semblables dès le vêlage : le lot témoin (2M) a été trait deux fois par

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jour durant toute la lactation, tandis que l'autre lot (1M) n'était trait que le matin. Au cours de la période de stabulation les animaux ont reçu, à volonté, la même ration complète. Pendant l'été, ils ont été conduits ensemble au pâturage. Les 7 vaches du lot 2M (2 vaches éliminées) ont produit en moyenne 7323 kg de lait en 305 jours. Les 9 vaches du lot 1M ont produit 5114 kg (–30 % ; $P <$ 0,01) au cours d'une lactation plus courte de 12 jours en moyenne. Les teneurs en matières grasses et en protéines ont été plus élevées de, respectivement, 3,5 $g \cdot kg^{-1}$ ($P <$ 0,01) et 2,1 $g \cdot kg^{-1}$ ($P =$ 0,06) dans le lot 1M. Les teneurs moyennes (sur la lactation) du lait en lactose n'ont pas été différentes entre les 2 lots ($P >$ 0,10). Il en est de même des concentrations des cellules somatiques ($\log_{10} =$ 5,043 par mL et 4,946 par mL pour les lots 1M et 2M), malgré la forte augmentation observée dans le lot 1M au cours du dernier tiers de la lactation. La concentration des caséines et des protéines solubles n'a pas été significativement différente entre les lots. Les activités de la plasmine et de la lipoprotéine lipase n'ont pas été modifiées, mais l'activité dérivée du plasminogène a eu tendance à être plus élevée dans le lait du lot 1M. La quantité de matière sèche ingérée au cours des 14 premières semaines de lactation n'a pas été, en moyenne, différente entre les 2 lots, mais elle est progressivement devenue plus élevée dans le lot 2M. Le poids vif des vaches du lot 1M et leur état corporel sont progressivement devenus plus élevés que ceux du lot 2M, la différence atteignant 56 kg à la 36^{e} semaine de lactation ($P <$ 0,01) et 0,94 point de note d'état corporel ($P =$ 0,02). Huit des neuf vaches du lot 1M et quatre des sept vaches du lot 2M ont été diagnostiquées fécondées. Les vaches du lot 1M n'ont présenté aucun trouble sanitaire particulier et aucun comportement anormal.

traite une fois par jour / vache laitière / production laitière / composition du lait / état nutritionnel

1. INTRODUCTION

Standard, twice-a-day milking constitutes the most constraining task imposed on dairy producers because it has to be carried out routinely at morning and evening intervals. Milk producers have been attempting to lighten that burden, since it constitutes a main obstacle to improving their quality of life. Two broad solutions may be envisaged: either milking automation/robotisation, as is currently functional [3], or rescheduling to one daily milking, as commonly done by New Zealand farmers during the latter weeks of lactation. This practise is particularly suited to the milk production system operated in New Zealand which involves clustering of calvings and drying off.

The first-ever study conducted on once-a-day milking (ODM) more than 40 years ago [11] was practically never followed up until the late 1980s, since it reduced milk yield considerably (40 to 50 percent according to the authors). This precluded its implementation in the production context that prevailed a few decades ago: small farms, income directly linked to cows' productivity and a lower priority given to the quality of life in those days. ODM trials were resumed in the late 1980s, essentially in New Zealand where dairy farmers encouraged it (see review by Davis et al. [16]), and are ongoing in a few European countries such as Great Britain, Ireland and France. Also, a very small number of dairy farmers have been experimenting ODM in their own herds and their reports in the technical press have raised great interest on the part of many milk producers.

According to the literature data, the range of milk yield reduction associated with ODM is very wide. It varies from 10–20% [37, 39, 41] to 50% [11], because of the wide variability of experimental conditions (trial duration, cows' production level, lactation stage…). In most cases, losses appear to be higher at the beginning of lactation than at the end [7, 38], in primiparous than in multiparous cows [11, 43] and in breeds whose milk contains less dry matter than in those with higher DM contents [7]. The consequences of ODM increase in proportion with the duration of its application [11, 31]. Also, milk losses tend to be more noticeable when feeding levels are high than when they are low [1, 32], which enhances the potential interest of this technique in restricted dietary situations. Milk fat and protein contents are generally increased by ODM, whereas lactose content is reduced [16]. The effect of ODM on somatic cell count (SCC) is controversial. SCC is generally increased [1, 12, 18, 29], but not always [25, 33], possibly depending on the initial sanitary condition of the udder [12, 21]. The mechanisms that lead to milk yield reduction and milk compositional changes have also been investigated. Alveolar milk accumulation seems to be the triggering factor of a spate of physiological changes leading to milk yield reduction [16]. Inter-individual differences in milk loss, as frequently reported [6, 11, 18, 23], residual milk amounts [6, 7], udder storage capacity [23] or the kinetics of milk storage [15] have been mentioned as influencing factors.

However, most of these results were obtained during relatively short-term trials (a few days to a few weeks) and at the end of lactation, with grazing animals that were relatively low producers, i.e. under conditions very different to those that prevail in France. This trial was an attempt to assess the main modifications induced by ODM throughout lactation on milk yield and composition.

2. MATERIALS AND METHODS

2.1. Cows, husbandry and experimental protocol

Eighteen multiparous Holstein cows (mean lactation rank = 2.9) were used. Immediately after calving (which occurred between 04/12/2000 and 02/02/2001; mean = 01/01/2001), the cows were divided into two groups according to their lactation rank, liveweight, body condition score (as measured on 16 November 2000) and milk yield and composition (fat, protein and SCC), as recorded in weeks 4 to 16 of the previous lactation. One group was milked once a day from calving throughout lactation (group M1) and the other group was milked twice daily (group M2).

Both groups were identically managed and fed throughout the trial duration. The cows, which were at pasture for the summer period before the experimental lactation, were returned to free stabling cubicles no later than the 1st of November 2000. They were given a complete ration composed (on a dry matter basis) of 72% maize silage, 8% hay, 15% soyabean cake, and 5% concentrate, balanced for milk production, ad libitum, in individual troughs fitted with electronically controlled gates. This ration was calculated with the Inration software [20] based on the 1989 Inra feeding allowances [19]. Cows were turned to pasture on 2 May. During the grazing period, all the cows were given 2 kg·day^{-1} concentrate from 14/05/01 to 29/07/01, and from 17/09/01 to 11/11/01.

The cows were dried-off six weeks before their expected next calving date or whenever each of the two-week-average milk yields decreased to less than 6 kg·day^{-1}. They were inseminated from the 40th lactation day when observed to be in oestrus.

M2 cows were milked at 6.30 a.m. and 5 p.m. M1 cows were milked at 6.30 a.m. Milking was done in a 2 × 6 station milking parlour (Europarallèle, Alpha Laval) fitted with automatic cluster removers and milk meters (Alpro). When the cows were at pasture, they were all led twice daily to stables adjacent to the milking parlour. During both the stabling and the grazing periods, those cows that were to be milked in the evening (M2 group) were segregated a few minutes before milking.

2.2. Measurements

Milk yield was measured at each milking. Milk samples were taken from Tuesdays' and Wednesdays' milkings for protein, fat and lactose assays by infrared spectrophotometry (Foss Electric, Hillerod, Denmark) and for somatic cell count (Fossmatic 5000 automatic counter, Foss Electric, Hillerod, Denmark). During lactation weeks 10 and 28 (on average), milk samples were taken on a single day, at each milking, for specific dosages: total nitrogen, non-protein nitrogen and non-casein nitrogen were measured according to Rowland [34]; G1 immunoglobulins were assayed by radial immunodiffusion [27] and lipoprotein lipase (LPL) activity was measured using a radioactive substrate [17]; plasmin and plasminogen-derived activity were determined according to Bugaud et al.'s technique [4] and total calcium and phosphorus were determined by spectrometry. Residual milk amount following the morning milking was measured during lactation weeks 13 and 14 (two measurements per cow). Intramuscular injection of 50 UI oxytocin-S (Intervet) was performed immediately after the morning milking, in the milking parlour. The cluster was fitted four minutes after the injection, once the automatic removal device had been inactivated. All four udder quarters were manipulated in the course of milking to extract the maximum amount of milk. The clusters were removed manually whenever the milk flow from the udder was visually assessed as negligible. That measurement was repeated during the following week. Individual milk flow rates of 16 morning milkings were recorded between 05/03 and 21/03, i.e. in lactation week 10 on average.

Feed intake was measured on four days weekly during the stabling period. The cows were weighed between 1 p.m. and 2 p.m., twice during the first week after calving, then once every other week. Their body condition was assessed and rated 0 (very lean) to 5 (very fat) at calving, then monthly, according to Bazin [2].

Oestrus and insemination dates were recorded and pregnancy diagnosis was based on echographical examination. Health disorders were recorded.

2.3. Statistical analyses

Data statistical analysis was performed with the Proc GLM software [35], either by variance-covariance analysis (the covariates being the grouping parameters: milk, fat and protein contents, SCC during the previous lactation; liveweight and body condition score, as measured during the first week of the experimental lactation) or, in the absence of a covariate, by simple variance analysis (lactose…). Milk composition results from the two series of samples collected at mid-lactation and the results from residual milk measurements were subjected to repeated-datum analysis of variance (SAS). SCC was analysed on the basis of logarithmically transformed data.

Two M2 cows exhibited high SCC at the commencement of the experiment (782 000 per mL and 1 903 000 per mL during weeks 2 to 10, on average), markedly higher than those of other cows (18 000 per mL to 150 000 per mL, 37 000 per mL on average), reflecting udder subpathological condition in these two cows. In consideration of the importance of rigorous assessment of the impact of ODM on milk yield, and SCC in particular, the data of those two cows were excluded from the calculation of the results.

3. RESULTS

According to (unscheduled) observations reported by cow handlers, the M1 cows did not appear to be bothered by being milked only once a day. In particular, their segregation from the M2 cows before the latter's evening milking did not raise any difficulty and they did not try to go towards the milking parlour.

3.1. Milk yield

The milk yield curve of the M1 group revealed a production peak of 8 $kg \cdot day^{-1}$ lower than the M2 group ($P < 0.01$; Fig. 1), which occurred almost within the same time after calving for both groups (week 4.6 for M1 group vs. 5.6 for M2 group; $P > 0.10$) and a lactation shorter by 12 days than the

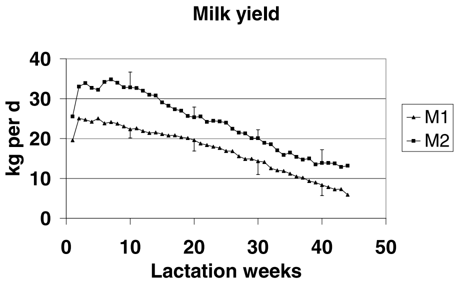

Figure 1. Evolution of milk yield (weekly mean, and standard deviation every ten weeks) during the first 44 lactation weeks in the groups of cows milked once-a-day (M1) or twice-a-day (M2).

305-day duration of reference. All M2 cows were dried off after the 305th day of lactation whereas four M1 cows were dried off earlier (on the 285th day on average). Nonetheless, the weekly persistence computed after the lactation peak was identical in both groups (98.1% and 98.2% in groups M1 and M2, respectively), making the lactation curves almost homothetical. The M1 cows produced 30.2% less milk than the M2 cows, on average, in 305 days (Tab. I). Milk flow rates at the morning milking were not significantly different between the two groups (4.05 kg·min^{-1} vs. 3.96 kg·min^{-1} in M1 and M2 groups, respectively; $P > 0.10$). The amount of residual milk at the morning milking was 38% lower in M1 cows than in M2 cows (1.5 kg vs. 2.4 kg; $P < 0.05$) although the former produced more milk (21.3 kg vs. 17.4 kg, respectively). The proportion of residual milk in relation to the total milking volume was about twice as low in the M1 group than in the M2 group (7% vs. 13%, $P < 0.01$).

3.2. Milk composition

Fat and protein contents (balanced means for the whole lactation) were significantly higher in the M1 group and regularly so throughout the lactation, by 3.5 g·kg^{-1} and 2.1 g·kg^{-1}, respectively (Tab. I and Fig. 2). Those higher contents only partially made up for the lower milk yield, so that the fat matter and protein amounts secreted by the M1 cows were 25% and 26% lower, respectively than those of the M2 cows. Mean lactose contents and SCC over the entire lactation did not significantly differ between the two groups. However, the lactose content difference gradually increased but never became significant (P within 0.10 and 0.18, for lactation weeks 30–40, with a mean lactose content difference of 2.7 g·kg^{-1}). Somatic cell count increased rapidly in M1 cows from lactation week 30. It was significantly higher in M1 ($0.05 < P < 0.10$) compared to M2 milk during 7 of the last 15 lactation weeks.

The arithmetically higher true protein (+1.9 g·L^{-1}), casein (+1.2 g·L^{-1}) and whey

Table I. Milk yield and composition of cows milked once-a-day (M1) or twice-a-day (M2).

	Group of cows		RSD	Treatment effect (P)
	M1	M2		
Duration of lactation (d)	293	305		
Milk (kg in 305 d)	5114	7323	674	<0.01
Fat (kg in 305 d)	236	315	27	<0.01
Proteins (true) (kg in 305 d)	167	225	21	<0.01
Fat content (g·kg^{-1})	47.5	44.0	2.4	0.01
Protein (true) content (g·kg^{-1})	33.5	31.4	2.1	0.062
Lactose content (g·kg^{-1})	45.8	46.7	1.8	0.331
Somatic cell count ($\log_{10}$·mL^{-1})	5.043	4.946	0.255	0.461

RSD: residual standard deviation.

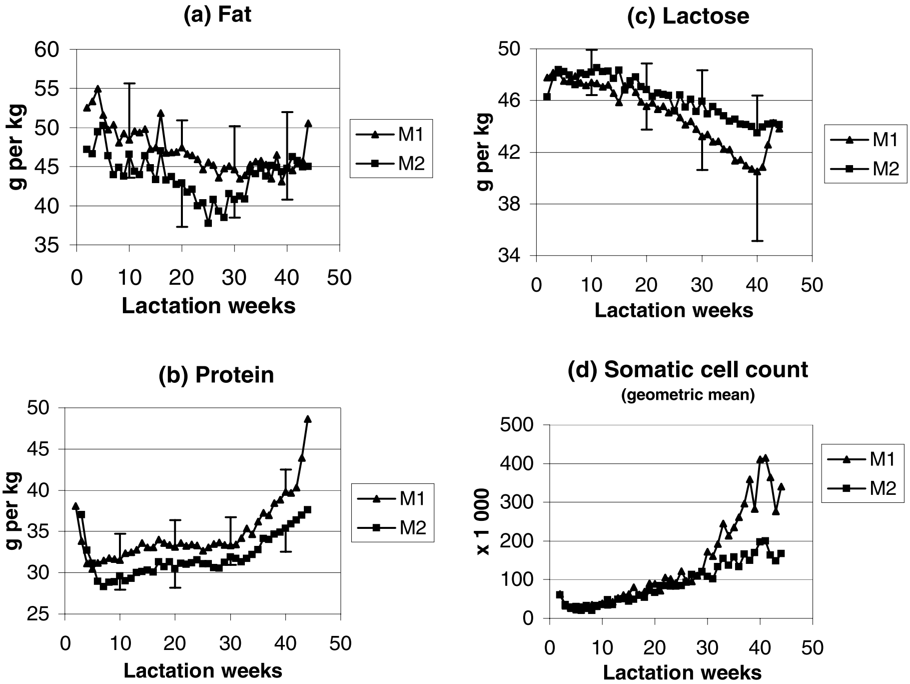

Figure 2. Evolution (weekly mean, and standard deviation every ten weeks) of the fat (a), protein (b), and lactose (c) contents and somatic cell count (geometric mean; d) throughout lactation in the groups of cows milked once-a-day (M1) or twice-a-day (M2).

Table II. Protein, calcium and phosphorus contents of milk from cows milked once-a-day (M1) or twice-a-day (M2).

	Group of cows			Period	Treatment
	M1	M2	RSD	effect (*P*)	effect (*P*)
Proteins (true) ($g \cdot kg^{-1}$)	33.0	31.1	3.6	<0.01	0.17
Caseins ($g \cdot kg^{-1}$)	26.7	25.5	3.2	<0.01	0.30
Whey proteins ($g \cdot kg^{-1}$)	6.2	5.6	1.2	0.05	0.14
Caseins/proteins	0.81	0.82	0.03	0.75	0.37
IgG1 ($g \cdot kg^{-1}$)	0.48	0.46	0.18	0.20	0.73
Calcium (total) ($g \cdot kg^{-1}$)	1.24	1.23	0.11	<0.01	0.82
Phosphorus (total) ($g \cdot kg^{-1}$)	0.93	0.91	0.11	<0.01	0.65

RSD: residual standard deviation.
Analyses of milk samples taken in lactation weeks 10 and 28 (see Materials and Methods) according to the repeated measurement model.
The interaction group × week of sampling was not consistent for any of the constituents.

protein (+0.6 $g \cdot L^{-1}$) contents measured in the M1 milk samples collected in lactation weeks 10 and 28 were not significantly different from those of the M2 samples (Tab. II). The increase in milk proteins noted in the M1 samples was largely due to

Table III. Protease and lipase activities in the milk of cows milked once-a-day (M1) or twice-a-day (M2).

	Week	Group of cows M1	Group of cows M2	RSD	Treatment effect
Plasmin (1)	10	4.9	4.3	1.4	0.98
($dA_{405}\cdot dt^{-1} \times 10^4$)	28	6.4	7.0		
Plasminogen (2)	10	34.4	30.2	7.3	0.27
($dA_{405}\cdot dt^{-1} \times 10^4$)	28	45.4	34.6	6.7	< 0.01
(1)/(2)	10	0.17	0.15	0.05	0.61
	28	0.15	0.21		
Lipoprotein-lipase	10	449	525	142	0.21
($nmol\cdot mn^{-1}\cdot mL^{-1}$)	28	439	623		

RSD: residual standard deviation.
Milk samples: see Table II. Statistical analyses according to the repeated measurement model when the group × week of sampling interaction was not significant. Otherwise, variance analysis per week.

caseins (66%). The casein/protein ratio was not significantly affected. IgG, calcium and phosphorus concentrations did not differ between the two groups (Tab. II).

Plasmin activity was similar in both cow groups but that derived from plasminogen was significantly higher in M1 milk at the second sampling (Tab. III). Lipoprotein lipase activity did not differ significantly between the two groups.

3.3. Nutritional indices, reproduction and pathology

Daily feed intake amounts (dry matter), as computed with week 1 bodyweight as a covariate, were identical during lactation weeks 2 to 6 (means 19.3 kg and 19.5 kg in M1 and M2 groups, respectively; $P = 0.88$). They were higher in the M2 group from week 7 (by 1.3 kg in weeks 7 to 14; $P = 0.14$) and the difference reached 2 kg ($P = 0.09$) in week 14. M1 cows' liveweight decreased less and for a shorter period at the beginning of lactation than that of M2 cows (Fig. 3). Adjusted liveweight differences between the two groups gradually increased in the course of lactation, from 16 kg in week 5 ($P = 0.31$) to 56 kg in week 36 ($P < 0.01$). Body condition scores evolved in parallel with liveweight (Fig. 3). Score differences between the two groups went from 0.28 points in week 5 ($P = 0.22$) to 0.94 points ($P = 0.02$) in week 36.

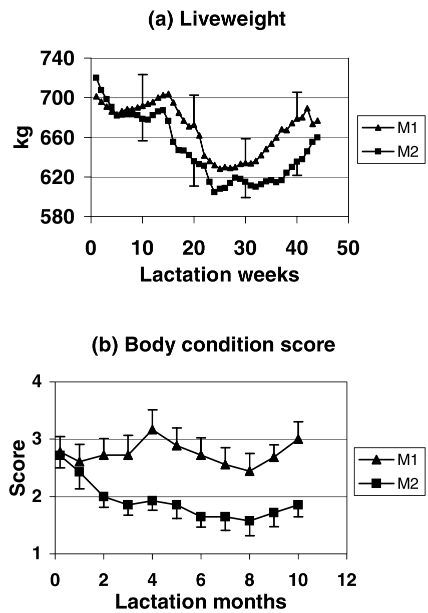

Figure 3. Evolution (mean and standard error) of the liveweight (a) and body condition score (b) throughout lactation in the groups of cows milked once-a-day (M1) or twice-a-day (M2).

Eight of the nine M1 cows were diagnosed as pregnant 102 days on average after calving, whereas only four of the seven M2 cows were diagnosed as pregnant, three of which calved again and one had to undergo termination.

Considering the entire lactation, four cows in each group presented with limb disorders (lameness, footrot) and two mastitis cases (one in each group) were detected and managed.

4. DISCUSSION

This trial differed from most other published reports on three points: (1) it involved the entire lactation, (2) it was carried out with high producing and sustainably well-fed cows and (3) the udders of the experimental cows were all in good healthy condition at the beginning of the trial.

4.1. Milk yield

The results of the current study confirmed earlier reports: ODM was accompanied by a slight shortening of lactation (already noted by Claesson et al. [11] and similar to that described by Cooper [12], i.e., 14 days) and by a 30% decrease in milk yield, close to that recorded by Holmes et al. [18] and by Cooper [12] (35% and 31%, respectively) throughout entire lactations. The 50% and 40% milk yield reductions reported by Claesson [11] in primiparous and multiparous cows, respectively, may have been due to the use of lower producing cows which, in addition, were less selected for milking than they are now, both characteristics being likely to reinforce the negative impact of ODM on milk secretion [33]. The similarity of the milk rate decline throughout lactation in both groups may come as a surprise for 2 reasons: 1/ it is contrary to the observations of Claesson et al. [11] (increasing difference between the yields of milk by once and twice daily milked cows up to mid-lactation) and Carruthers et al. [7] (nevertheless, Cooper [12] observed a similar rate of decline of the secretion of milk solids by once and twice daily milked cows); 2/ it seems hardly compatible with the increased rate of cellular death of udder alveoli (hypothesised by Davis et al. [16] as a consequence of ODM) that should induce a higher rate of decline of milk secretion [42]. Nevertheless those authors [42], in their modelling approach, also showed that the shape of the curve of lactation could be largely influenced by the level of nutrition of the cows, and Stelwagen [36] expressed that the relationship between milking frequency and lactational persistency is not apparent. In the current trial, the nutrient supply was more in excess over needs in the M1 group than in the M2 group, as shown by the evolution of liveweight and body condition score in both groups. That could have limited the potential detrimental effect of ODM on the persistency of lactation. The lower amount of residual milk (as kg or %) recorded in this study in M1 cows confirmed the tendency observed by Carruthers et al. [8] (1.1 kg and 8.1% in cows milked once daily versus 1.4 kg and 12.8% in cows milked twice daily) which was ascribed to a low effectiveness of oxytocin (5 UI IV injection after normal milking) secondary to reduced blood irrigation following 24-h milk accumulation in the udder. In this trial, the higher oxytocin level (50 UI IM injection) and the 4-minute lag phase between injection and the beginning of the second milking did not alter the results. It may therefore be that ODM would induce a reduction of residual milk via a mechanism yet to be defined. This result could also contribute to explain the normal persistency of milk yield in the M1 group, since a high level of residual milk has been shown to be associated with a high milk loss on ODM [7].

4.2. Milk composition

The milk composition changes induced by ODM in this trial were consistent with earlier reports [16, 31–33]. The lack of statistical significance of the difference in lactose content between groups was surprising because a decrease in milk lactose content is classically the most consistent change induced by ODM [16]. Introducing the lactose contents recorded in early lactation (when they were similar for both groups) as a covariate in the mathematical model of analysis of the lactose contents recorded in late lactation (when they were increasingly different) did not make that difference more significant. The (non-significantly) higher casein and soluble protein contents of M1 cows' milk noted in this trial, by comparison with M2 cows' milk, were consistent with previously reported results [11, 26, 29]. They probably were caused by a better fulfilment of the cows' energy requirements [13] that did not modify the casein/protein ratio [14], and also by increased permeability of the mammary epithelium tight junctions [39], at least with whey proteins. However, the absence of modifications in SCC, IgG concentration, plasmin and lipoprotein lipase activity and the limited increase in plasminogen-derived activity and lower lactose concentration indicate that the increase in tight junction permeability must have been restricted. As suggested earlier [32], implementing ODM at calving may have trained the udder to gradually adapt to the lower milking frequency, and hence limited the milk composition changes described as marked in the literature, after a sudden switch from two to one-only milking per day in the course of lactation.

The very low SCC of both milk groups during the first 30 weeks of lactation suggests that ODM did not affect that parameter during that period. Although most authors, working in conditions different from ours (trial duration…) observed increased SCC [18, 22, 28], other authors did not note any significant effect of ODM, especially in cows whose udders were free of bacteria or whose milk exhibited low SCC [1 and 25 in restricted cows; 12, 29], as was observed in this trial. The increase in SCC during the last third of lactation was

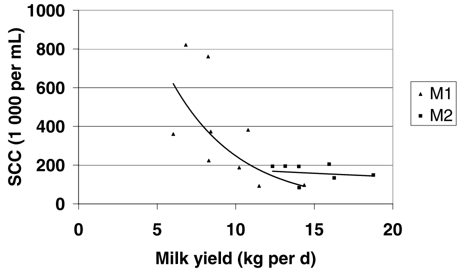

Figure 4. Relationship between milk yield in late lactation (mean of weeks 31 to 41) and somatic cell count during the same period in the groups of cows milked once-a-day (M1) or twice-a-day (M2).

unexpected. The higher proportion of pregnant cows in the M1 group (8 of 9) than in the M2 group (4 of 7) as well as the lower milk yield in the M1 group at the end of lactation could partly account for these different SCC results (Fig. 4).

The lack of effect of ODM on plasmin activity and the increase in plasminogen-derived activity noted in this trial had already been observed [24, 29, 32, 40]. The lack of effect of ODM on lipoprotein lipase (LPL) activity or even its slightly reducing effect, was consistent with the decrease in LPL activity noted in two further trials where the reduction of milking frequency was studied at earlier stages of lactation [32, Chilliard et al., unpublished results]. In addition, this result was consistent with the mid-lactation reduction in free fatty acid concentration in the milk of cows milked on a once daily basis [33]. However, since LPL measurements in this trial were performed at earlier lactation stages (weeks 10 to 28) than in other trials (weeks 30 to 40) where sharp increases in SCC and protein content and lower lactose content were noted, it would be worth verifying the lipolytic system responses to milking frequency at late lactation/pregnancy stages, the latter being known as one of the main factors influencing milk lipolysis levels at the end of lactation [9].

4.3. Nutritional state

In this trial, as in previous studies [31, 32], ODM did not affect food intake in the early weeks of lactation, or in the first weeks of its application. In another husbandry situation (omission of the dry period in late pregnancy) that also led to a large reduction of milk yield (–7.6 $kg \cdot day^{-1}$ for the first 12 weeks of lactation), we did not either observe any difference in the feed intake of previously dried or not-dried cows, for the first 3 months of lactation [30]. Conversely, injections of recombinant bovine somatotropin were shown to augment milk yield within a few days, but food intake only increased after a lag-time of about 6 weeks [10]. In those situations where the yield of milk is modified by management practices (milking frequency, omission of the dry period, administration of somatotropin…), cows seem to progressively adapt their intake to their modified milk yield, after a lag-time of several weeks. As a consequence, our results did not contradict Holmes et al.'s data [18] that reported, in late lactation, a lower grass intake by cows milked once daily than by control cows. Delayed adaptation of intake levels to lower production requirements accounts for the lesser degradation of body condition and reduction of liveweight at the beginning of lactation and the maintenance of, or increase in, that difference throughout the remainder of lactation. Further studies [11, 12, 18, 31] recorded reduced losses and/or slight increases in liveweight and body condition score, in early lactation. These results reflect the better nutritional condition of the cows, also manifested by higher glycemia [1, 18]. This better nutritional condition was consistent [5] with the higher number of pregnant cows in the M1 group.

5. CONCLUSION

ODM of high producing dairy cows does not appear to raise any specific husbandry problem or definitive modifications of milk chemical composition. However, certain authors have expressed their fears that milk issued from ODM may be less suitable for processing. This issue, as well as the impact of ODM in primiparous cows and over several consecutive lactations, would be worth exploring.

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