BRIEF COMMUNICATION

Effect of once daily milking and concurrent somatotropin (bST) on production and mammary tight junction permeability in cows

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Once daily milking (ODM) is well established among New Zealand dairy farmers as a management tool. There is, however, ample evidence that ODM decreases milk yields (Carruthers *et al.*, 1991 ; Holmes *et al.*, 1992). Earlier work has implicated break down of tight junctions (TJ) between adjacent mammary epithelial cells as a potential cause (Stelwagen *et al.*, 1994b). In comparison with twice daily milking (TDM), ODM significantly decreases the percentage of milk lactose (Carruthers *et al.*, 1991 ; Holmes *et al.*, 1992). Because lactose is the predominant osmoregulatory component in milk, a decrease in the percentage may indicate that lactose is leaking into the blood via disrupted TJ. When bST was used during ODM (Carruthers *et al.*, 1991), it not only increased milk yield, but also increased the percentage of milk lactose, suggesting that bST may be involved in TJ maintenance. The present study was undertaken to determine if bST can reverse the milk yield loss associated with ODM, and to examine the effect of ODM and bST on mammary TJ integrity.

Six pairs of late lactation, multiparous, monozygous, Friesian twin cows were used. During d 1 to 7 (period 1) all animals were on TDM, during d 8 to 13 (period 2) and d 14 to 21 (period 3) all cows were on ODM, and during d 22 to 28 (period 4) all animals were again on TDM. During period 3, one half of each twin pair was treated with bST (20 mg/d, i.m. ; Elanco, Auckland), while the other served as a control. Milk yields were recorded daily. Milk samples (TDM: am and pm, ODM: am) were taken twice weekly and analyzed for fat, protein, lactose, SCC, and serum albumin (BSA), as described by Stelwagen *et al.* (1994a). Blood samples were taken thrice weekly prior to the am milking and analyzed for lactose, according to Stelwagen *et al.* (1994a). Milk BSA and plasma lactose were used to assess TJ integrity. On d 30, functional mammary capacity (FMC) was determined following a 40-h milking interval (Stelwagen *et al.*, 1994a), at which time all cows were milked out with the aid 10 IU of oxytocin (i.v.). Data were analyzed using Minitab Release 8.21 (Minitab Inc., State College, PA), and differences between twin sisters and between periods within animal were evaluated by paired t-test.

Milk yield and composition are in Table 1. ODM reduced milk yield by 7.2%, but bST during ODM increased milk yield by 19.7%, thus confirming earlier data (Carruthers *et al.*, 1991). Measurements of FMC showed that gland capacity exceeded daily milk yields in period 3 (data not shown) ; hence, capacity was not limiting milk yields during bST treatment. The increase in milk protein during ODM is likely the result of an associated increase in BSA in milk (see below). In agreement with other studies (Carruthers *et al.*,

TABLE 1: Milk yield and composition per period and change in composition from one period to the next period of monozygous twin cows, during twice (TDM) and once (ODM) daily milking, and during bST treatment (n=6 per treatment group). Period 1, TDM (d 1 to 7); period 2, ODM (d 8 to 13); period 3, ODM with or without bST (d 14 to 21). Period 4, TDM (d 22 to 28).

	Period 1			Period 2			Period 3			Period 4		
	Control	bST	SED	Control	bST	SED	Control	bST	SED	Control	bST	SED
Milk (kg/d)	13.3	13.3	0.5	12.3	12.4	0.5	12.2	14.6	0.7b	12.4	13.3	0.5
Change[1] (%)	-	-	-	-7.5^{x}	-6.8^{x}	2.0	-1.3	18.1^{x}	1.8^{a}	2.3	-8.4^{y}	2.3^{a}
Fat (%)	4.57	4.44	0.07	4.81	4.86	0.08	4.93	5.02	0.11	4.88	5.13	0.05^{a}
Change (%)	-	-	-	5.3	9.3^{y}	2.3	2.4^{z}	3.5^{y}	2.1	-0.8	2.4	1.9
Protein (%)	3.36	3.37	0.04	3.54	3.6	0.06	3.69	3.65	0.05	3.55	3.70	0.06^{b}
Change (%)	-	-	-	5.5^{x}	6.7^{x}	2.1^{b}	4.1^{x}	1.7	0.8^{b}	-3.6^{x}	1.5	1.2^{a}
Lactose (%)	4.70	4.69	0.04	4.64	4.62	0.04	4.68	4.71	0.04	4.71	4.73	0.06
Change (%)	-	-	-	-1.2^{z}	-1.5^{z}	0.6	0.9	2.0^{x}	0.5^{c}	0.6	0.5	0.4
SCC (1000/ml)	75	113	95	97	249	220	136	103	58	95	68	53

^{a,b,c} Control and bST groups per row within a period differ, $P < 0.01$, $P < 0.05$ and $P < 0.10$, respectively.

[1] Change from one period to the next period.

$^{x\,y\,z}$ Control or bST groups within a row and between this and previous period differ, $P < 0.01$, $P < 0.05$ and $P < 0.10$, respectively.

1991 ; Holmes *et al.*, 1992) the lactose content of milk tended to decrease with ODM and increase with bST (period 2 *vs* period 3). The fact that the drop in lactose percentage was small, may be related to the relatively small drop in milk yield with ODM in the current study. Milk BSA and plasma lactose increased sharply (respectively: 40.0%, $P < 0.01$ and 468.5%, $P < 0.05$) immediately following the onset of ODM, indicating a significant loss of TJ integrity. While bST lowered milk BSA levels during ODM (218.1 *vs* 276.58 µg/ml, $P<0.01$), yield of BSA in milk (i.e., adjusted for milk volume) was not different ($P > 0.05$). Similarly, concentrations of lactose in plasma were not different (Control, 57.0 *vs* bST, 52.2 ± 9.0 µM ; $P > 0.05$) during bST treatment, implying that bST does not play a rôle in TJ maintenance. The increase in milk BSA with the onset of ODM remained significant (18-28%, $P < 0.01$) when BSA was expressed as yield, furthermore BSA yield in milk remained elevated throughout ODM. However, plasma lactose had returned to baseline levels within 2 d of the onset of ODM. These data suggest that the transition from TDM to ODM causes a transient permeability of TJ. This would further mean that high milk BSA levels must be maintained through a different mechanism. Because lymphocytes have been shown to produce and secrete BSA (Goussault *et al.*, 1976) it is tempting to speculate that an increase in SCC (Holmes *et al.*, 1992) during ODM, or a proportional change in the cell types that make up SCC, are involved. Alternatively, BSA could, together with immunoglobulins (Mepham, 1987), be invaginated on the basolateral side of the secretory cell and carried in intracellular vesicles to the apical side where it would be released by exocytosis. Consistent with this hypothesis, Bushe and Oliver (1987) showed that short-term ODM during late lactation increased concentrations of immunoglobulins in milk.

In conclusion, ODM reduces milk yield, relative to TDM, and causes a temporary disruption of TJ integrity. Although bST can override the production loss associated with ODM and increase the milk lactose percentage, the mechanism of action of bST in this context, is unlikely to be through its effects on TJ integrity.

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