BRIEF COMMUNICATION: Effect of once daily milking on milk flavour chemistry

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INTRODUCTION

Indole and skatole have been associated with the "pastoral" flavour of New Zealand dairy products (Bendall, 2001). They occur at elevated levels in milk from pasture-fed cows in New Zealand, particularly in early to mid spring (Lane *et al.*, 2002). On-farm management approaches to control skatole levels in milk could provide benefits to the industry for particular products and markets sensitive to these compounds.

Appreciable diurnal differences in skatole levels occur in milk of cows grazing perennial ryegrass-based pastures. Mean concentrations of skatole in milk samples from an afternoon milking are typically two-fold higher than those in samples from a morning milking (Cosgrove *et al.,* 2006; Tavendale *et al.*, 2006). Indole and skatole are formed in the rumen from the degradation of tryptophan in forage protein (Schreurs *et al.,* 2007). Their concentration in the rumen of grazing cattle has been found to vary markedly during the day, rising from low initial levels after morning milking to peak in the middle of the day, but remaining elevated prior to afternoon milking (Tavendale *et al.*, 2006). However, these compounds can be rapidly eliminated from the animal by metabolism and urinary excretion (Schreurs *et al.,* 2007).

The time between peak feed intake and milking is likely to be a major factor in these observed diurnal differences. There is an appreciably shorter period prior to the afternoon than the morning milking for indole and skatole to be metabolised by the animal after feeding. Thus milking once daily might significantly reduce overall milk skatole levels, particularly if milking took place in the morning.

The effect of once-a-day (OAD) compared with twice-a-day (TAD) milking on the flavour chemistry of milk was examined in a farm systems trial conducted at the Waimate West Demonstration Farm (Dalley *et al*., 2008).

MATERIALS AND METHODS

Two groups of Jersey cows grazing nitrogen-fertilised perennial ryegrass-dominant pasture with supplementary silage early in the season, were milked either once-a-day in the morning (OAD: n = 101 cows) or twice-a-day until late January and then OAD for the rest of the season (TAD: n = 44 cows). Milk sampling occurred weekly from August 2006 to February 2007.

Bulk milk from the two groups was collected into separate vats, and weekly samples were taken after morning milking for both groups of cows (AM milk) on a day following tanker collection so that vats were empty prior to the sampled milking. In the afternoon a further sample was taken after milking for the TAD cows comprising milk pooled from both morning and afternoon milkings (PM milk). A purpose-constructed ladle was used to take representative samples from the vat following constant agitation for 5 minutes. Forage samples were collected for analysis from pastures assigned to each group prior to grazing and oven-dried at 60 °C for 48 hours prior to analysis. Forage composition was determined by near infrared spectroscopy (FeedTech, Palmerston North, New Zealand).

Milk samples were stored at -20 °C prior to analysis. Samples were thawed, the fat separated by centrifugation, and the concentration of indole and skatole in milk fat measured by partitioning and high performance liquid chromatography (Lane *et al.*, 2002).

Data were analysed using a general linear model (Minitab 15 Statistical Software, Minitab Inc.) which included effects of the periods Aug to Sept, Oct to Nov, Dec to Jan, and Feb; and milk collection procedures of OAD AM, TAD AM, TAD PM; and their interaction (period × milk collection).

RESULTS

Higher concentrations of indole and skatole occurred in milk-fat from the TAD-PM milking than from the TAD-AM and OAD milkings which were not significantly different (Table 1). While the difference was greatest in August-September when indole and skatole concentrations were highest, the trend was consistent throughout the trial.

The composition (Table 2) of the forage offered to the two groups of cows was similar and showed a pattern of increasing fibre content (ADF, acid-detergent fibre), decreasing crude protein (CP), and

TABLE 1: Mean (standard error of mean) concentration of indole and skatole in milk-fat from cows milked once (OAD) or twice daily (TAD) in the morning (AM) or afternoon (PM) after grazing ryegrass-dominant pasture between August 2006 and February 2007.

Period	Group	Milking	Number of milk samples	Indole (ng/g)	Skatole (ng/g)
Aug - Sept	OAD	AM	6	80 (6)^{a}	68 (14)^{a}
	TAD	AM	6	103 (13)^{a}	105 (34)^{a}
	TAD	PM	6	402 (51)^{b}	368 (64)^{b}
Oct - Nov	OAD	AM	6	67 (5)^{a}	39 (8)^{a}
	TAD	AM	6	72 (24)^{a}	89 (36)^{ab}
	TAD	PM	6	195 (48)^{b}	209 (49)^{b}
Dec - Jan	OAD	AM	7	49 (2)^{a}	20 (2)^{a}
	TAD	AM	6	52 (18)^{a}	63 (32)^{ab}
	TAD	PM	7	102 (23)^{a}	109 (26)^{b}
Feb	OAD	AM	4	43 (3)^{a}	22 (1)^{a}
	TAD	AM	4	50 (11)^{a}	58 (9)^{a}

Within period means with different superscripts differ significantly ($P < 0.05$)

TABLE 2: Mean (standard error of mean) concentrations of acid-detergent fibre (ADF), crude protein (CP) and soluble sugars and starch (SSS) in ryegrass-dominant pasture on offer to groups of dairy cows milked once (OAD) or twice daily (TAD) between August 2007 and February 2007.

Period	Group	Number of samples	ADF (g/kg DM)	CP (g/kg DM)	SSS (g/kg DM)
Aug-Sep	OAD	6	196 (4)^{a}	297 (6)^{a}	105 (6)^{a}
Aug-Sep	TAD	6	196 (3)^{a}	291 (7)^{ab}	95 (7)^{a}
Oct-Nov	OAD	9	220 (3)^{abc}	259 (7)^{bcd}	120 (8)^{ab}
Oct-Nov	TAD	13	217 (3)^{ab}	267 (8)^{abc}	127 (10)^{ab}
Dec-Jan	OAD	6	226 (8)^{bcd}	243 (5)^{cde}	140 (10)^{ab}
Dec-Jan	TAD	9	240 (9)^{cd}	230 (7)^{def}	152 (7)^{b}
Feb	OAD	3	253 (7)^{d}	210 (9)^{ef}	135 (21)^{ab}
Feb	TAD	1	271^{d}	172^{f}	156^{ab}

Within column means with different superscripts differ significantly ($P < 0.05$)

increasing soluble carbohydrate content (SSS, soluble sugars and starch) ($P < 0.001$ in each case) as the season progressed from spring to mid summer.

Production and other data from this trial are presented elsewhere (Dalley *et al*., 2008).

DISCUSSION

As the TAD-PM milk samples are composites of morning and afternoon milk, the data for these samples are the mean daily concentrations for cows milked TAD and should be representative of standard dairy production. The seasonal pattern of high levels of indole and skatole in early spring declining to moderate levels in summer was similar to that reported by Lane *et al.* (2002) for cows grazing forage, although the concentrations were somewhat higher. By contrast the mean daily concentrations of indole and skatole in milk from the cows milked OAD did not exhibit the same early season peak. Thus it appears that the "pastoral" flavour effects of indole and skatole in early season milk may be able to be avoided with OAD milking.

In this trial, the difference in concentration of indole and skatole between the PM and AM milk for the TAD group in August-September was very marked, exceeding the differences reported previously for cows grazing the same pasture type day and night (Cosgrove *et al.,* 2006; Tavendale *et al.*, 2006). In these other studies the PM milk values represent milk collected solely at the afternoon milking, rather than a daily mean.

Investigation of additional data from this trial is in progress to elucidate the cause of the difference in flavour chemistry reported here between cows milked OAD and TAD.

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REFERENCES

Bendall. J.G. 2001: Aroma compounds of fresh milk from New Zealand cows fed different diets. *Journal of agricultural and food chemistry* **49**: 4825-4832.

Cosgrove, G.P.; Burke, J.L.; Death, A.F.; Lane, G.A.; Fraser, K.; Pacheco, D.; Parsons, A.J. 2006: Clover-rich diets and production, behaviour and nutrient use by cows in late lactation. *Proceedings of the New Zealand Society of Animal Production* **66**: 42-49.

Dalley, D.E.; Clough, J.W.; Hofmann, L.A.; Phyn, C.V.C.; Clark D.A. 2008: Jersey cows milked once-a-day can produce 1200 kg milksolids per hectare. *Proceedings of the New Zealand Society of Animal Production* **68**: 96-97.

Lane, G.A.; Fraser, K.; Kolver, E.S.; Rowan, D.D.; Allen, J.M.; Mills, O.E.; Abraham, A.S.; Olney, S.D. 2002: Effect of a total mixed ration diet on the concentration of amino acid-derived volatiles in milk. *Proceedings of the New Zealand Society of Animal Production* **62**: 242-245.

Schreurs, N.M.; Marotti, D.M.; Tavendale, M.H.; Lane, G.A.; Barry, T.N.; Lopez-Villalobos, N.; McNabb, W.C. 2007: Concentration of indoles and other rumen metabolites in sheep after a meal of fresh white clover, perennial ryegrass or Lotus corniculatus and the appearance of indoles in the blood. *Journal of the science of food and agriculture* **87**: 1042-1051.

Tavendale, M. H.; Lane, G.A.; Cosgrove, G.P.; Pacheco, D.; Fraser, K.; Burke, J.L. 2006: Diurnal ruminal responses to grazing ryegrass varieties and consequences on milk production and flavour chemistry. *Proceedings of the New Zealand Grassland Association* **68**: 261-265.