

BRIEF COMMUNICATION: Composition of milk sampled from beef-cross-dairy cows unaccustomed to milking.

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Introduction

Growth of calves prior to weaning is dependent on energy intake from milk and pasture. Total pasture intake of a cow-calf pair can be estimated based on the growth rate and milk intake of the calf and the live weight and liveweight change of the cow. Estimates of the volume of milk consumed by the calf can be made using the weigh-suckle-weigh technique but estimates of volume alone do not indicate the energy content of the milk.

The present experiment is part of a larger project comparing the efficiency of cows of varying live weight and milk production (Hickson et al. 2014). The aim of this experiment was to determine the composition, and implied energy content, of milk consumed by calves reared on Angus (AA), Angus-cross-Holstein Friesian (AF), Angus-cross-Jersey (AJ) and Angus-cross-Kiwicross (AK) cows. It was hypothesised that Angus-cross-dairy breed cows would have greater concentration of fat and protein in their milk than AA cows.

Materials and methods

This experiment was conducted at Massey University's Tuapaka Farm, 15 km east of Palmerston North, with approval of the Massey University Animal Ethics Committee.

Animals

This experiment included fourth-lactation, five-year-old cows of four genotypes suckling Charolais-sired calves that were aged between 55 and 82 days at the time of sampling. Cows were as described previously (Hickson et al. 2014), and 12 cows from each genotype that had calved near the mid-point of calving for the herd were selected to minimise the variation in age of calves on the day of sampling. Milk intake of the calves of half of the cows from each genotype had been estimated using the weigh-suckle-weigh technique (Hickson et al. 2014) with a 16- to 20-hour separation six days prior to sampling.

Milking procedure

Milk samples were collected over two consecutive days, and half the cows from each genotype were sampled each day. On the afternoon prior to sampling, cows were separated from their calves at 1600 h. Cows were returned to pasture overnight, and yarded at 0800 h the next day. Milking of the first cow began at 0830 h and milking of the last cow ended around 1400 h.

Milking was conducted by restraining each cow in a head bale that had dual gates on both sides. The bottom gate was opened on the right side to allow access for the calf, and on the left side to allow access for the milker. In order to facilitate let-down, calves were allowed to suckle from three quarters while the most accessible quarter (usually the front left quarter) was hand milked. Milk was collected in 200-250 ml aliquots into 250 ml containers until no further milk could be stripped from the quarter. A rapid mastitis test was done on all four quarters prior to milking to identify any mastitis infection. Cows that became distressed during milking were released and excluded from the experiment (n=2 AA, n=1 AF, n=3 AJ, n=2 AK). Four cows (2 AA, 1 AF, 1 AK) were treated with 2 ml oxytocin by intramuscular injection in the rump but this practice resulted in unsettled cows that were difficult to milk and there was no detectable increase in let-down.

Selection and analysis of samples

Subsamples (30 ml per subsample) were selected for analysis of composition as follows. For cows that filled only one container, one subsample was taken from this container. For cows with two, three, or four containers in total, subsamples were taken from all aliquots and all milk from each cow was then pooled and a further subsample taken. For cows that filled five or more containers, subsamples were taken from the first and last aliquot from each cow, and from the aliquots that represented approximately one third and two thirds of the way through milking. All milk was then pooled and a final subsample taken for each cow. All milk to be subsampled was mixed prior to a subsample being extracted by dipping a small container into the milk.

Samples were stored at room temperature throughout milking and subsamples were placed on ice for transport to Fielding immediately after milking. Samples were transported to Hamilton in a refrigerated truck as per normal herd testing procedure (LIC, Hamilton). Samples were analysed by LIC using an infrared milk analyser (FT120, Foss Electric, Hillerød, Denmark) to determine fat, protein and lactose percentage. Net energy (NE) content of milk was calculated based on fat and protein percentage according to the equation from Holmes et al. (2002)

$$\text{NE (MJ/l)} = 0.376 \times \text{fat percentage} + 0.209 \times \text{protein percentage} + 0.976.$$

Data handling and statistical analysis

Fat, protein and lactose percentages for the four sequential samples were analysed using a mixed model allowing for repeated measures on each cow. The model included the fixed effects of genotype and sample and the

interaction between genotype and sample. Fat, protein and lactose percentage from the bulk milk sample and NE content were analysed using a mixed model that included the fixed effect of genotype.

Table 1 Least squares means (\pm SEM) for concentration (%) of fat, protein and lactose in milk and net energy content of milk (MJ/l) hand milked from a single quarter and range in volume of milk collected from that quarter and range in estimated volume of milk consumed by calves (from the whole udder) assessed using the weigh-suckle-weigh technique. Cows were Angus x Angus, Angus x Friesian, Angus x Jersey and Angus x Kiwicross.

	Angus x Angus	Angus x Friesian	Angus x Jersey	Angus x Kiwicross	P value
n	10	11	9	10	
Fat %	0.84 \pm 0.24	1.06 \pm 0.23	1.31 \pm 0.25	0.95 \pm 0.24	0.586
Protein %	3.44 \pm 0.07 ^a	3.58 \pm 0.07 ^{ab}	3.62 \pm 0.08 ^{ab}	3.76 \pm 0.07 ^b	0.038
Lactose %	5.40 \pm 0.14	5.55 \pm 0.13	5.48 \pm 0.14	5.17 \pm 0.14	0.218
Net energy (MJ/l)	2.01 \pm 0.09	2.12 \pm 0.09	2.22 \pm 0.10	2.12 \pm 0.09	0.485
Volume ¹ milked from one quarter (litres)	0.4–1.8	0.4–4.4	0.4–3.8	0.6–3.2	
n	5	6	4	5	
Milk consumed by calf (litres)	3.8–11.8	3.9–8.5	5.8–10.5	4.3–12.1	

^{ab} Values within row without letters in common differ among genotypes at the P<0.05 level

¹ Volume was approximate, determined based on the number of containers filled, not by weight.

Table 2 Least squares means (\pm SEM) for concentration of fat, protein and lactose in milk samples taken from the first 200 ml (sample 1), the last 200 ml (sample 4), and two in-between samples of milk (samples 2 and 3) from Angus x Angus, Angus x Friesian, Angus x Jersey and Angus x Kiwicross cows.

	Angus x Angus	Angus x Friesian	Angus x Jersey	Angus x Kiwicross	All genotypes
n					
Sample 1	10	11	9	10	40
Sample 2	8	9	8	10	35
Sample 3	6	8	8	9	31
Sample 4	10	10	9	10	39
Fat %					
Sample 1	0.51 \pm 0.12 ^d	0.52 \pm 0.11 ^d	0.46 \pm 0.13 ^d	0.34 \pm 0.12 ^d	0.46 \pm 0.06 ^d
Sample 2	0.86 \pm 0.28 ^{de}	1.02 \pm 0.26 ^{de}	0.73 \pm 0.28 ^{de}	0.61 \pm 0.25 ^{de}	0.81 \pm 0.13 ^e
Sample 3	0.95 \pm 0.45 ^{de}	1.24 \pm 0.39 ^{de}	1.63 \pm 0.39 ^e	1.18 \pm 0.37 ^{ef}	1.25 \pm 0.20 ^e
Sample 4	1.49 \pm 0.45 ^{ae}	1.70 \pm 0.45 ^{abe}	2.97 \pm 0.47 ^{bf}	2.01 \pm 0.45 ^{abf}	2.04 \pm 0.23 ^f
P values	Breed 0.200	Sample <0.001	Breed*sample 0.544		
Protein %					
Sample 1	3.46 \pm 0.08 ^a	3.61 \pm 0.08 ^{ab}	3.64 \pm 0.09 ^{ab}	3.78 \pm 0.08 ^b	3.62 \pm 0.04
Sample 2	3.44 \pm 0.09 ^a	3.60 \pm 0.09 ^{ab}	3.62 \pm 0.09 ^{ab}	3.77 \pm 0.08 ^b	3.61 \pm 0.04
Sample 3	3.31 \pm 0.10 ^a	3.65 \pm 0.09 ^b	3.60 \pm 0.09 ^b	3.72 \pm 0.08 ^b	3.57 \pm 0.04
Sample 4	3.45 \pm 0.08 ^a	3.61 \pm 0.08 ^{ab}	3.60 \pm 0.09 ^{ab}	3.74 \pm 0.08 ^b	3.60 \pm 0.04
P values	Breed <0.001	Sample 0.853	Breed*sample 0.994		
Lactose %					
Sample 1	5.48 \pm 0.15	5.55 \pm 0.15	5.56 \pm 0.16	5.17 \pm 0.15	5.44 \pm 0.08
Sample 2	5.44 \pm 0.18	5.57 \pm 0.17	5.58 \pm 0.18	5.18 \pm 0.16	5.44 \pm 0.08
Sample 3	5.28 \pm 0.15	5.52 \pm 0.13	5.46 \pm 0.13	5.41 \pm 0.12	5.41 \pm 0.07
Sample 4	5.27 \pm 0.16	5.42 \pm 0.16	5.18 \pm 0.17	5.04 \pm 0.16	5.23 \pm 0.08
P values	Breed 0.029	Sample 0.178	Breed*sample 0.870		

^{ab} Values within row without letters in common differ among genotypes at the P<0.05 level.

^{def} Values within column within milk component without letters in common differ among samples at the P<0.05 level.

Results and discussion

Protein concentration in the bulk milk sample was greater ($P < 0.05$) for AK cows than for AA cows, whilst AF and AJ cows were not different to either AA or AK cows ($P > 0.05$; Table 1). Lactose and fat concentration was similar amongst genotypes, but fat concentration was less than expected for all genotypes. Fat percentages were less than previous reports of 3.2–5.65% for bulk milk (Nicol 1976, Peterson et al. 2010, LIC & DairyNZ 2013).

It is well documented that milk-fat concentration is least in cisternal milk and increases throughout milking (Ontsouka et al 2003; Nielsen et al. 2005). This pattern was repeated in the current experiment (Table 2). It would appear that incomplete or disrupted milk let-down occurred in many of the cows (Tančin & Bruckmaier 2001), resulting in collection of cisternal milk only. There was no difference between the fat percentages of milk from the four cows treated with intramuscular oxytocin compared with those not treated (data not shown). Suckling and the presence of the cow's calf are an effective stimulant of release of alveolar milk (Combellas et al 2003), however, this was not successful in this experiment, perhaps because the head bale restraint of the cow interfered with her ability to interact with the calf.

Cisternal milk is held in the gland cistern, which has 0.19–2.09 litre capacity (Caja et al., 2004). Ayadi et al. (2003) reported that the proportion of cisternal milk increased with interval since last milking up to 40% of total volume after 20 hours. Cows in the current experiment were separated from their calves for 16–22 hours, thus the cisternal capacity of a single quarter may have been around 10% of total milk volume. For some cows, this was approximately the volume collected (Table 1).

This experiment highlights the difficulties associated with determining milk composition of cows that are unaccustomed to machine milking. The fat percentage was low and most of the milk sampled appeared to be cisternal milk. Alternative milking strategies would be required to better investigate differences in fat concentration. Nevertheless, in contrast to the original hypothesis, the results indicate that despite the greater protein percentage, milk composition of Angus and Angus-cross-dairy cows was not different enough to result in a difference in NE content of the milk.

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