The nutritive value of pasture ingested by dairy cows varies within a herd

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ABSTRACT

Dairy cows progressively deplete a pasture sward in successive layers, and these layers vary in their chemical composition. As the milking order of dairy cows is relatively consistent, the objective of this study was to determine the effects of milking order on the quality and quantity of pasture accessed by dairy cows. Two experiments were conducted. The association between milking order and time of paddock access was evaluated in the first experiment whilst the second experiment determined the association between the order in which cows entered the paddock (paddock access order) and the quality and quantity of kikuyu pasture (*Pennisetum clandestinum*) ingested by cows after milking. Milking order was strongly associated with timing of paddock entry (R^2 = 0.92). Over the duration of paddock entry, 70% of pasture (relative to post-grazing mass) was consumed before the last cow entered the paddock. Cows that arrived first to the paddock ingested pasture with approximately 21% greater ($p<0.01$) CP (19% vs 15%) and 15% lower ($p<0.01$) ADF (26% vs 30%) than those arriving last. Cows that accessed pasture last had greater (P=0.03) rumination than those accessing pasture first (567 and 544 minutes/cow/day, respectively. These data highlight the variability in nutritive value ingested by cows within a herd and the requirement for future research to evaluate the impact of such findings on milk (solids) yield and the ability to capitalise on this through differential feeding.

Keywords: Milking order; pasture; nutritive value

INTRODUCTION

The depletion of sward canopy by cattle typically occurs in successive layers (Wade & Carvalho, 2000; Jouven, 2006). The chemical composition of a sward varies between these layers, with the greater end of the fraction typically containing more CP and less NDF than lower fractions (Delagarde et. al, 2000). As there is a relatively consistent milking order for cows both within and between days (Botheras, 2006), the last cows being milked may be consistently arriving to a paddock later and accessing pasture of differing nutritive value compared to those consistently arriving to a paddock first after milking.

Our hypotheses were that milking order would be positively associated with paddock access order and that cows early in the milking order would ingest pasture of greater CP and reduced fibre as compared with those accessing pasture last. Thus, our objectives were to determine the association between milking order and paddock access order, the change in the quantity and nutritive value of pasture accessed by dairy cows over the time of paddock access and the impact of paddock access timing on dairy cow daily rumination time.

MATERIALS AND METHODS

The research was conducted at Corstorphine dairy farm, University of Sydney, Camden. Ethics approval (Project: 569) was granted through the University of Sydney Animal Ethics Committee.

Over the 9 day experimental period, all cows within the milking herd were offered grain-based concentrate (7 kg/cow/d), a mixed crop of sorghum (*Sorghum bicolor*) and millet (*Echinochloa utilis*) after the morning (AM) milking, and kikuyu pasture (*Pennisetum clandestinum*) supplemented with oaten silage after the afternoon (PM) milking. A sub-set of this herd (*n*=46) were fitted with SCR heat and rumination long distance tags (Hi Tag, SCR Engineers Ltd., Netanya, Israel). These sensors consist of an accelerometer to quantify activity and a microphone to monitor rumination, as validated by (Schirmann *et al.* 2009). The SCR tags were fitted to the first 21 cows and last 25 cows based on average milking order rank taken as an average of order during the 60 days period leading up to the experimental period.

The time of cow entry to each paddock was manually recorded and collated against the milking order recorded automatically at the dairy each day.

Pre-grazing extended tiller height was measured across each paddock with a ruler. Tiller height measurements across the paddock (50counts; base to highest leaf) were repeated every 15 minutes from time the first to the last cow entered the paddock to determine pasture depletion across the paddock. To determine the relationship between extended tiller height and pasture mass (kg DM/ha), nine 50 × 50cm quadrats of the 3 different average tiller heights within the paddock were selected; low (L) (~20-30

cm), medium (M) (~30-45 cm) and high (H) (>50 cm) resulting in 3 replicates of each of height. These data were also used to determine the variance in nutritive value down the tillers. In each quadrat, the tiller height was randomly measured 6 times with the ruler. The tillers within the quadrat were cut as close to ground level as possible with a cordless grass shearer (Ozito HTL-072). The tillers were removed to maintain the vertical structure of the sward, labelled and taken for chemical composition analysis. The remaining stubble heights were randomly measured at 6 points and all stubble was then removed for chemical composition analysis. All samples were weighed and then pooled based on L, M and H tiller heights and cut into 5 cm fractions (5-10, 10-15, 15-20 cm from ground level). The fractions were weighed (fresh weight) and then dried at 60°C for 48 hours. Samples were ground to ~1mm and then analysed for crude protein (CP, FP628 Food/Protein Analyzer, LECO, Michigan, USA). Neutral detergent fibre (NDF) and acid detergent fibre (ADF) were analysed using ANKOM^{200} Fibre Analyzer (ANKOM, New York, USA).

Linear regression was used to determine the association between milking order and paddock access order. Pasture sward data were fitted with linear mixed models and all parameters were estimated using the Restricted Maximal Likelihoods (REML) procedure (Genstat, v.14; VSN International Ltd, Hemel Hempstead, Hertfordshire, UK). To determine the changes in CP, NDF and ADF for height of sward above ground level within L, M and H tiller heights, fraction height above ground (in 5cm increments) and treatment were fixed effects, and day was a random effect. To determine the changes in CP, NDF and ADF ingested by cows across time, sward height taken as a mean of each 15 minute period post the first cow accessing the sward was a fixed effect and day a random effect. To determine the change in pasture mass overtime, time post the first cow entering the sward and day were fixed effects.

RESULTS

Milking order was associated ($p<0.001$; $R^2 = 0.92$) with the order that cows accessed the paddock. Pasture mass availability (kg DM/ha) was associated with the time of paddock entry ($P<0.001$). Cows that entered the paddock earlier had greater pasture availability than those that entered last (Figure 1).

70% of pasture mass above post-grazing mass had been depleted over the duration of cow access into the paddock. The rate of cow access to the paddock was relatively constant as per the linear increase in the number of cows in the paddock across time (Figure 1).

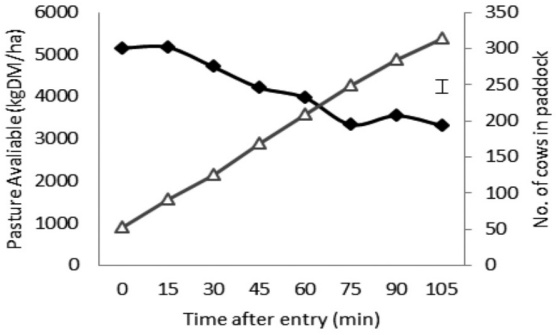

Figure 1: Depletion of pasture (kgDM/ha;◆) and the number of cows in the paddock (Δ) against time after entry. The error bar indicates the average standard error of the difference for kg DM/ha.

There was an effect ($P<0.001$) of L, M and H tiller heights on CP (Figure 2a) and ADF (Figure 2b) but NDF levels remained similar across the fractions of the tiller above ground level. The highest fractions contained approximately double the crude protein and two thirds the ADF as compared with the lowest fractions above ground level.

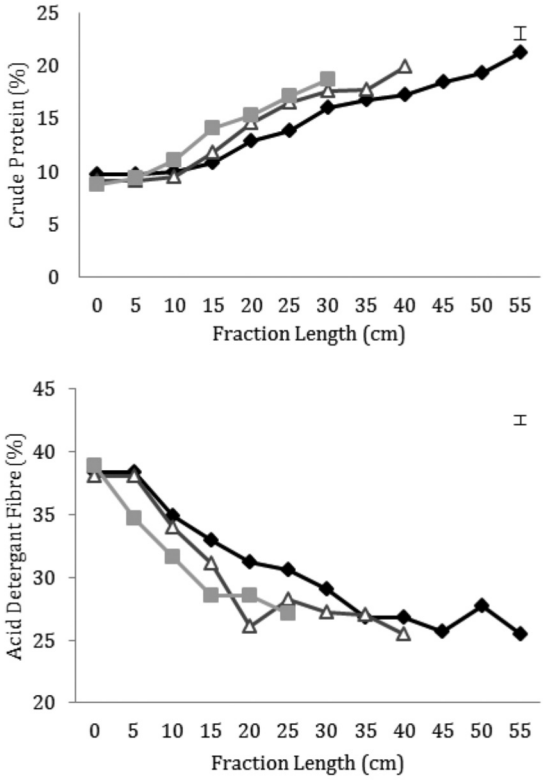

Figure 2: a) Variation in crude protein (%)and b) ADF (%)for each pasture level: H (diamond), M (triangle) and L (square) in relation to fraction of the sward canopy layer. The error bar indicates the average standard error of the difference.

The average CP ingested from the sward decreased by 21% ($P<0.01$) over the duration of

cow access, whilst the average NDF and ADF content increased 8% ($p<0.05$) and 15% ($p<0.01$), respectively (Table 1).

Rumination differed by day ($P<0.01$) and milking order group ($P=0.02$). Cows that accessed pasture last had a greater ($P=0.03$) rumination duration than those accessing pasture first (567 and 544 minutes/cow/day, respectively).

Table 1: The nutritive value of pasture ingested (CP, NDF and ADF, % in DM) and sward height (cm) over the time of paddock access.

Time of access (min)	CP (%)	NDF (%)	ADF (%)	Sward height (cm)
0	19	60	26	42
15	19	60	26	42
30	18	62	27	37
45	17	63	28	34
60	16	64	29	31
75	15	65	30	27
90	15	65	29	28
105	15	65	30	26
SED	1	3	2	2

DISCUSSION AND CONCLUSION

Our work is the first to report on the substantial variation in the quantity and quality of pasture ingested by individual dairy cows associated with the timing of paddock access after milking. Pasture was depleted by 36% to ground level, and 70% to post-grazing pasture mass during the duration between the first and last cow accessing pasture. These findings show that cows accessing pasture late in the order have a vastly reduced mass to select from (Figure 1).

Throughout the period of pasture access, the nutritive value of kikuyu herbage ingested decreased markedly (Table 1), presumably due to the preference of leaf versus stem (Chacon and Stobbs, 1976) for those cows arriving early in the order and the difference in nutritive value that are apparent between sward fractions (Chapman *et al.* 2012) . In line with these findings, those cows accessing pasture later in the order had greater rumination levels, presumably due to the greater proportion of fibre on offer in the pasture and associated increased requirement for rumination to break down particle size (Adin *et al.* 2009).

This work presents a new insight into the amount of pasture on offer to, and the nutritive value of this pasture ingested by, cows when pasture is offered immediately after milking. With the intensification of dairy systems in both New Zealand and Australia, these preliminary findings highlight the opportunity to better formulate supplementary feeding strategies to account for differences in the nutritive value and amount of feed offered to individual cows. Alternatively, new systems to help reduce this variability could be designed. Before such changes are considered, further work should be conducted to determine the nutritive value, and quantity of pasture, ingested for differing pasture species such as ryegrass and the impact this has, if any, on milk (solids) yield for individual animals within a herd.

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