Meal pattern analysis for effects of compound feed formulation in mid/late lactating dairy cows fed hay and compound feed both *ad libitum*

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Introduction

A primary limitation on milk yield in high producing dairy cows is net energy intake. The dietary energy density and the dry matter intake (**DMI**) are, therefore, critical factors to achieve high milk production. Kempen System (KS) (Nutreco, Boxmeer, The Netherlands) is a dairy feeding system allowing *ad libitum* access to dry hay and pelleted compound feed (CF). KS results in high daily DMI (up to 30 kg DM, 80% CF). Earlier references on meal pattern analysis for dairy cows describe TMR diets therefore feeding behaviour in KS deserves specific attention. Smaller and more frequent CF meals in KS have shown to reduce negative fluctuations of rumen pH. Moreover, ruminal propionate affects short term intake regulation. Out of economic and physiological concerns it would be ideal if the DMI of hay could be increased without compromising milk yield. Meal pattern analysis was done to study effects on meal size and frequency of two different CF, formulated to produce different propionate signals.

Materials & Methods

A 4 x 4 latin square experiment was conducted in a free-stall barn using 20 primi-and multiparous Holstein-Friesian cows (203± 35.4 DIM). Grass hay was fed ad libitum with one of two different CF also offered ad libitum. The two isonitrogenous CF (Starch vs. Fibre) had equal calculated Net Energy Value according to the Dutch VEM system (1140 vs. 1139) and differed in neutral detergent fibre (NDF) (170 vs. 231 g/kg DM), acid detergent fibre (ADF) (96 vs. 149 g/kg DM)) and starch (309 vs. 204 g/kg DM) . Meal criteria (MC), being the shortest non-feeding interval between feeding events that separates two consecutive meals, were used to cluster feeding events into separate meals. Per experimental cow, MC were determined by fitting the log10 transformed feeding intervals to Gaussian-Gaussian probability density functions. These were used to calculate feed intake behaviour variables; meal size, frequency and meal duration. Variables were statistically evaluated using a model including the fixed effects of CF formulation, experimental block, experimental period and the random effect of cow.

Results

Meal criteria did not differ between treatments ($P \leq 0.773$) and were unaffected by animal ($P=0.114$) and period ($P=0.223$) Meal criteria ranged from 46 to 98 min and averaged 54 ± 5.3 min. Daily DMI of CF (Starch 18.1 vs. Fibre 18.8 ± 0.54 kg) tended ($P=0.094$) to be greater for the Fibre CF. Daily DMI of hay was unaffected ($P=0.231$) by CF formulation (Starch 5.0 vs. Fibre 4.7 ± 0.29 kg). CF meal size did not differ ($P=0.258$) between treatments (Starch 2.9 vs. Fibre 3.0 ± 0.10 kg). Cows under different treatments showed similar ($P=0.870$) meal numbers (Starch 6.3 vs. Fibre 6.4 ± 0.22). Meal durations did not differ ($P=0.873$) between treatment groups. (Starch 65 vs. Fibre 63 ± 3.5 min).

Discussion

The Meal Criteria Calculator, used in this experiment, did not allow fitting the Gaussian-Gaussian-Weibull model (Yeates et al., 2001; Melin et al., 2005 and Abrahamse et al., 2008). Accuracy of MC estimation might be greater with this model. In the current experiment, the Gaussian-Gaussian model

was used following DeVries et al. (2003) instead of the Gaussian-Weibull model (Melin et al., 2005). Weibull distributions are thought to be in better agreement with the concept of satiety. There is no literature on MC estimation for dairy cows in feeding systems similar to the KS. Estimated MC in TMR systems are 44.7 min (Tolkamp et al., 2000), 26.4 to 63.7 min (Yeates et al., 2001) and 27.74 min (DeVries et al., 2003). We thus found a considerably higher meal criterion for the cows in the KS; because we estimated MC on pooled data of hay and CF consumption. Greter et al. (2012) estimated MC for cows fed on a TMR (33.3 min) and wheat straw (132.4 min) and suggested that the difference in chemical and physical properties of the feeds provoked a different method of consumption and thus a different meal criterion. In the current experiment, the cows were fed two feed stuffs varying considerably in chemical and physical properties and thus consumed them in a different way. The range of number of meals per day (6.30 to 6.40) corresponds to the range (5.8 to 6.7) found by Tolkamp et al. (2000) and the numbers 6.4 and 6.7 reported by Tolkamp et al. (2002), but are lower than the range (7.2 to 7.7) found by Abrahamse et al. (2008). However, meal durations for the cows in the current experiment (63 to 65 min) were much higher than the range (33.8 to 39.3 min) found by Tolkamp et al. (2000) and values 31.3 and 41.4 min reported by Tolkamp et al. (2002). This difference stems from the larger meal criterion found in the current study. Cows in the KS have longer within-meal intervals, which prolong the duration of a meal considerably. Meal pattern variables, consisting of meal frequency, meal size, hay consumption and CF consumption per meal, visits to feeders, eating times and meal duration, were not affected by CF formulation. The hypothesis that meal patterns could be altered through differences in CF formulations was not demonstrated with the formulations used in this trial. Miron et al. (2004) fed 75% of a TMR and 25% of pelleted concentrate either high in starch (barley and corn) or composed of soy hulls and corn gluten feed (SHCG). Cows fed the latter concentrate had higher daily DMI, higher meal frequency, longer daily meal time, with smaller meal size and lower intake rates. The authors found a higher extent and rate of NDF digestion with the SHCG pellets that might speed up the passage from the rumen and stimulate DMI (Miron et al., 2004). In accordance with the hepatic oxidation theory (Allen et al., 2009), the authors also suggest that the diet with the starchy pellets supplies more metabolites to the blood of the animal. This increases satiety and thus reduces meal frequency and total daily meal time, resulting in lower DMI. Considering these findings we assume that the contrast in starch level and type of the CF in the current experiment was not big enough to provoke altered meal patterns.

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