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Influence of the frequency of feeding hay to grass on chewing activity and ruminal pH-fluctuation in dairy cows

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ABSTRACT

Six ruminally cannulated cows were used in a double 3×3 Latin square design to investigate the influence of the frequency of hay feeding to a grass diet on chewing activity and ruminal pH fluctuation. Feeding hay for three times instead of all at once did not influence chewing activity but there was a trend towards a more stabilising effect concerning ruminal pH fluctuation. As no reduction in milk fat and no disorders of rumen function were observed, it seems not to be necessary to supplement a pure grass diet with hay to improve its physical fibrousness.

KEY WORDS: chewing activity, dairy cow, feeding frequency, grass, hay, ruminal pH fluctuation

INTRODUCTION

In cost-efficient grazing systems, grass is rich in energy and protein in order to cover the requirements of higher yielding dairy cows. However, this type of grass may reduce chewing activity, modify rumen fermentation and decrease ruminal pH because of low contents of components characterized by the physical property of fibrousness. On the other hand, hay unless mechanically treated seems to have sufficient physical fibrousness when evaluated by chewing activity (Balch, 1971). By contrast in a previous study, Graf et al. (2003) observed that compared to full time grazing, part-time grazing with additional hay supply during the night lowered ruminal pH at daytime. Therefore, the aim of the present study was to

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investigate whether the frequency of hay supplementation to a grass-based diet influences chewing activity and ruminal pH fluctuation in dairy cows.

MATERIAL AND METHODS

Six multiparous ruminally cannulated cows with a milk yield of 32.9 (± 3.7) kg were used in a study designed as a double 3×3 Latin square. In treatment G cows received a fresh young legume-grass mixture *ad libitum* and 300 g/d of a mineral mix. In the other treatments, cows were fed with 6.0 kg/d hay which was either offered only at 18.00 h for 3 h (H1) or divided into three equal portions and fed at 07.00, 13.00 and 17.00 h and offered for 1 h each (H3). During hay feeding cows had no access to grass. The nutrient content (g/kg dry matter (DM)) of the legume-grass mixture was 153±9 crude protein, 343±14 NDF and 226±40 ADF. The crude protein, NDF and ADF concentrations (g/kg DM) of the hay were 115±6, 464±10 and 285± 0, respectively. The study comprised three consecutive periods consisting of 14-d adaptation and 7-d sample and data collection sub-periods each. Cows were tethered in individual stalls and were milked twice daily. Throughout the collection periods feed intake and milk yield was recorded daily. In the milk samples collected at every milking, fat, protein, and lactose contents were determined. Ruminal pH fluctuations were measured continuously over 22 h. The self-manifactured device consisted of a pH electrode placed into the rumen fluid through the cannula and a data-recording unit, which was integrated in the cover of the cannula. Individual datasets per cow were summarized separately for daytime and night as mean, maximum, minimum pH and time period when pH was below 5.8. Rumen fluid was sampled via the device described directly through the cannula on days 3 to 5 at 08.00, 14.00 and 18.00 h and was analysed for volatile fatty acids (VFA) and ammonia. In addition, bicarbonate was determined in the morning samples. In order to examine periods of eating and ruminating, the chewing activity was recorded continuously for 23 h/d with IGER Behaviour Recorders developed by Rutter et al. (1997) and were extrapolated to 24 h. Data were analysed with the general linear model (GLM) procedure of SAS (version 8.00, SAS Institute Inc., Cary, NC, USA). Rumen fluid VFA and ammonia data across sample times were treated as repeated measurements.

RESULTS

Grass intake was highest in Group G (17.7 kg DM) and different ($P<0.01$) from groups H1 and H3 (13.0 kg DM). Intake of hay DM tended to be higher ($P=0.07$) in group H3 (5.3 kg) than in group H1 (5.1 kg) but the total DM intake was similar for all groups (18.3 kg on average). Dietary treatments did not affect milk yield (24.5 kg) as well as milk fat (3.68%), protein (2.92%) and lactose percentages (4.84%).

Among treatments, ruminal pH variables did not significantly differ. At daytime the mean pH was 6.45; the minimum pH 5.91 and the maximum pH 6.84. In treatments G and H1 the time period when the pH was below 5.8 was numerically twice as long as in treatment H3 (35 min vs 18 min). In group H1 compared to groups G and H3, the nocturnal mean pH (6.27 vs 6.44) was numerically lower and the time period when the pH was below 5.8 (125 vs 46 min) was numerically longer. The nocturnal minimum and the maximum pH were 5.78 and 6.85, respectively, on average of all three groups.

The concentrations of ammonia and total VFA as well as the molar percentages of individual VFA were influenced by sampling time ($P<0.01$, for each variable), but there were no interactions between treatment and time. The ammonia concentration was higher ($P<0.01$) in group H1 (8.01 mmol/L) than in group G (6.49 mmol/L) whereas group H3 took an intermediate position (7.32 mmol/L). No treatment differences were observed for total VFA concentration (125 mmol/L). The molar percentage of butyrate was higher ($P<0.001$) in group G (9.00%) than in group H3 (7.88), whereas the molar percentage of valerate was higher ($P<0.05$) in group H1 (0.815%) than in group H3 (0.701%). The molar percentage of acetate was higher ($P=0.05$) in group H3 (71.7%) compared to groups G and H1 (70.7%). The concentration of bicarbonate in the rumen fluid was not affected by treatment (33.7 mmol/L).

Cows in group G spent more time eating per day (+59 min (11.4%)) and per kg of NDF (+18.9 min (22.0%)) compared to cows in groups H1 and H3 ($P<0.05$) whereas eating time per kg of DM was not significantly different among the three groups (27.8 min). Time spent ruminating (492 min) as well as rumination per kg DM (28.4 min) and per kg NDF (75 min) was not influenced by treatment.

DISCUSSION

The frequency of feeding can influence rumen fermentation. However, most of the studies focusing on this subject were carried out with concentrate or TMR but not with hay. Le Liboux and Peyraud (1999) observed increased feed intake with more frequent feed supply with TMR which supports the observed trend to higher hay intake with feeding three times instead of one time. In accordance with the present results, Kaufmann (1976) found that a higher feeding frequency stabilizes ruminal pH and supports acetate production.

Contrary to taking several spot samples to assess the mean pH in the rumen, continuous measurements with indwelling electrodes are more precise to identify fluctuations in ruminal pH. In line with results of Graf et al. (2003), grass feeding alone did not clearly negatively affect ruminal pH and fermentation. Although Balch (1971) assumed a reduction in milk fat percentage due to a lack of physical fibrousness, neither Graf et al. (2003) nor the present study showed such an effect.

Moreover, the shorter eating and rumination time per kg DM with dried grass compared to hay as an indicator for insufficient physical fibrousness (Balch, 1971) were in contrast to the equally long chewing time per kg DM with fresh grass or supplemented with hay. Balch (1971) suggested to use the total time spent chewing per kg DM (eating plus ruminating) as an index of the physical property of fibrousness. However, during rumination more saliva is produced and consequently more bicarbonate enters the rumen and helps to stabilize ruminal pH. In the present study bicarbonate concentrations were in line with those (34.7 mmol/L) observed by Tafaj et al. (1999) 3 h after feeding hay with particle sizes between 28.7 and 9.2 mm. In contrast, bicarbonate concentrations reported by Graf et al. (2003) were nearly three times higher determined in the morning 2 h before the start of grazing and probably after a longer period of ruminating. This discrepancy in the results between studies could be caused by sampling time.

CONCLUSIONS

The study showed that more frequent supply of hay caused lower fluctuations of ruminal pH compared to a one-time supply. However, from the present results a supplementation with hay of grass of the type investigated seems not to be necessary in order to improve the diet's physical fibrousness.

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