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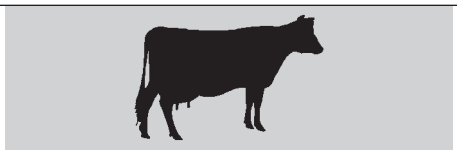

Chewing and ruminating with various forage qualities in nonlactating dairy cows

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ABSTRACT

This study investigated Italian typical dry forage diets used in the Parmigiano Reggiano PDO (protected designation of origin) area of Italy. The first cutting is typically a mixture of alfalfa and native wild grasses, resulting in a unique forage nutrient content. Alfalfa makes up less than 10% in the first cut because herbicides are not commonly used. Wild grasses are predominant in such conditions, whereas in the subsequent cuts alfalfa content increases as grasses decrease because of agronomical and climatic characteristics. Six multiparous, nonlactating Holstein cows were used in a replicated 3 × 3 Latin square to evaluate 3 different cuttings of alfalfa hay fed as the sole diet source. Eating and ruminating behavior were studied to investigate forage properties related to chewing activity. No differences were found in eating time; however, ruminating time per kilogram of physically effective NDF was greater when cows were fed first-cutting alfalfa than when they were fed the second or fifth cutting, despite similar digestibility and diet particle size of first- and fifth-cutting forage. In vivo digestibility of the diets revealed higher fecal NDF, ADF, and DM digestibility for first- and fifth-cutting hay. A similar trend was observed with the results of the in vitro data, with reduced digestibility for second-cutting forage.

Key words: eating behavior, forage digestibility, forage quality, ruminating

INTRODUCTION

Dairy cows require a minimum amount of dietary fiber with sufficient particle size to enhance digesta stratification in the reticulorumen. Chewing is strictly related to saliva production, which contains bicarbonate able to buffer rumen pH, preventing digestive disorders such as subacute ruminal acidosis (Owens et al., 1998; NRC, 2001). Mertens introduced the concept of physically effective NDF (**peNDF**) to better describe the fraction of dietary fiber implicated in the control of the subacute ruminal acidosis (Mertens, 1997).

Studies have shown that increasing peNDF increases chewing activity and ruminal pH (Krause et al., 2003), improves fiber digestion (Yang and Beauchemin, 2007b), and improves total digestibility (Kononoff and Heinrichs, 2003). A relationship between peNDF and milk fat content has also been reported (Yang et al., 2001; Kononoff and Heinrichs, 2003). Some studies have demonstrated increased chewing activity as a result of increased peNDF intake (Beauchemin, 1991; Krause et al., 2002; Yang and Beauchemin, 2007a), yet increased peNDF intake has shown less correlation to chewing in other studies (Kononoff et al., 2003b).

Several methods could provide an increase of peNDF in the diet and thus a possible increase in chewing activity. Total time spent chewing has been shown to increase as dietary NDF concentration increases (Beauchemin, 1991). This could be a useful mechanism to increase total chewing and thus alter rumen pH and milk fat production in diets with finely chopped forage. In the diets of cows producing milk for Parmigiano Reggiano cheese, only dry hay can be fed as forage; thus, making a TMR requires chopping the hay. The challenge in this situation is achieving a blended diet that also provides enough peNDF to allow adequate chewing and rumination. Therefore the objective of this study was to evaluate effects on eating, rumination, and apparent total-tract digestibility of 3 different chopped alfalfa hays, fed in a fixed amount to dry cows.

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MATERIALS AND METHODS

This experiment was conducted at the Faculty of Veterinary Medicine of the University of Bologna following approval by the university animal care and use committee. This study was designed to investigate Italian typical dry forage diets used in the Parmigiano Reggiano PDO (protected designation of origin) area of Italy, using the typical forage management system. Forages were all harvested from the same small farm in Medicina (near Bologna, in northern Italy) in 2008: first cut on April 27, second on June 9, and fifth on September 20 (27 d after the fourth). The first cutting is typically a mixture of alfalfa and native wild grasses, resulting in a unique forage nutrient content. Alfalfa makes up less than 10% in the first cut because herbicides are not commonly used in this region of the country. Wild grasses are predominant in such conditions during the early rainy season, whereas in the subsequent cuttings alfalfa content increases as grasses decrease because of hot and dry climatic characteristics of summer. Forages were harvested and then dried in the field, and the moisture was approximately 10% before baling (New Holland BR 7060, New Holland, PA). Hays were chopped using a Zago TMR mixer (Padova, Italy) and offered twice a day at 10 kg/d (approximately 90% of ad libitum intake based on 1-wk pretrial measurements). Six nonlactating cows were housed in a naturally ventilated tie stall facility using a replicated 3 × 3 Latin square design with 18-d periods with 14 d of adaptation. The cows were nonlactating Holsteins averaging 719 ± 66 kg of BW and 46 ± 8 mo of age. Cows were only fed the forage in question during the study, covering the maintenance requirement without gaining BW according to NRC requirements (NRC, 2001). Cows were also allowed free-choice water. Eating and ruminating activities were recorded on d 14 through 18 of each period (two 24-h periods/cow) using the Institute of Grassland and Environmental Research Behavior Recorders and Graze Jaw Movement Analysis Software (Ultra Sound Advice, London, UK) and validated for use in this type of situation (Kononoff et al., 2002). Total feces were collected on d 16 and 17 of each period. Feed samples were collected daily and composited for analysis; there were no refusals. Samples were then placed in a forced-air oven at 65°C for 48 h to determine DM. Samples were ground through a 1-mm-screen Wiley Mill (Arthur H. Thomas, Swedesboro, NJ) and analyzed for residue DM, ash (AOAC, 1990), and ADF and

Table 1. Nutrient composition and particle size analysis of alfalfa hay used in the study

	1st Cutting		2nd Cutting		5th Cutting	
Item	Mean	SD	Mean	SD	Mean	SD
DM, %	90.95	0.04	90.52	0.48	91.60	0.20
CP, % DM	15.56	0.06	13.90	0.20	22.26	0.09
Ash, % DM	9.45	0.11	7.91	0.12	9.19	0.19
NDF, % DM	47.85	0.67	52.66	3.61	41.62	1.53
ADF, % DM	33.89	0.83	38.82	3.51	32.12	1.63
ADL, % DM	6.29	0.07	8.42	0.65	6.70	0.54
Ca, % DM	1.40	0.06	1.70	0.07	1.43	0.04
P, % DM	0.31	0.03	0.18	0.02	0.37	0.05
24-h NDF digestibility, %	50.44	0.52	39.00	0.43	48.38	0.56
Particles >1.18 mm,[1] % DM	43.75	4.32	58.25	3.19	49.73	2.29
NDF, % DM	58.25	0.25	57.56	0.35	60.16	0.14
ADF, % DM	41.65	0.37	45.36	0.37	48.45	0.48
ADL, % DM	8.32	0.28	10.31	0.15	10.79	0.35
24-h NDF digestibility, %	43.05	0.32	35.00	0.26	35.03	0.16
K_d[2]	6.63	0.06	5.20	0.12	7.47	0.08
Particle size analysis[3]						
>19 mm, %	14.9	4.7	24.1	7.3	12.5	7.2
19 to 8 mm, %	28.5	3.2	24.0	2.2	26.1	5.3
8 to 1.18 mm, %	30.9	2.4	33.2	2.2	28.3	1.7
<1.18 mm, %	25.7	2.5	18.7	5.3	33.0	12.0
Mean particle size, mm	4.9	3.5	6.3	3.4	4.3	3.5
% >1.18 mm	74	—	81	—	67	—
% >8 mm	43	—	44	—	39	—

[1]Particles >1.18 mm determined by Ro-Tap separator.

[2]Digestibility rate.

[3]Determined by Penn State Particle Separator, DM basis.