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Effects of including alfalfa hay cut in the afternoon or morning at three stages of maturity in high concentrate rations on dairy cows performance, diet digestibility and feeding behavior

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ABSTRACT

Stage of maturity (SM) and cutting time (CT) are important factors affecting the feeding value of alfalfa hay in ruminants. No data is currently available about the effects of including alfalfa hay cut at different CT and SM in total mixed rations (TMR) containing high levels of concentrates on dairy cows performance. The objective of this study was to investigate the effects of including 200 g/kg dry matter (DM) alfalfa hay cut at two CT (18:00 and 06:00 h) and three SM (early bud, late bud and early flower) in a TMR with 650 g/kg DM concentrates and 150 g/kg DM barley silage on dairy cows performance, diet digestibility and feeding behavior. Eighteen cows were used in a cyclic change over design with six treatments (2 CT × 3 SM) in three 21 d periods. Leaf:stem ratio, crude protein (CP) and soluble carbohydrate (SC) concentration of alfalfa hay decreased with advancing maturity. Including alfalfa hay with advancing maturity in the TMR decreased CP intake (kg/d) and fecal N (g/100 g DM) concentration in dairy cows ($P<0.05$). Neutral detergent insoluble CP (NDICP) and acid detergent fiber (ADF) of alfalfa hay, mean particle size and physically effective factor of TMR and eating behavior (min/kg DMI) of dairy cows increased with advancing alfalfa hay maturity ($P<0.05$). Cutting alfalfa hay in the afternoon *vs.* morning increased leaf:stem ratio, leaf content and SC concentration ($P<0.05$). Feeding TMR with afternoon cut alfalfa hay to dairy cows increased apparent total tract digestibility of DM, organic matter (OM) and CP and serum total protein and decreased fecal nitrogen production (N; g/d), fecal N:milk N ratio ($P<0.05$) and tended to decrease fecal N concentration (g/100 g DM; $P<0.10$). At the early bud and early flower stage, afternoon cutting *vs.* morning cutting increased DM, OM and CP digestibility, serum total protein and decreased fecal nitrogen production (g/d) in dairy cows. At the late bud stage, afternoon cutting *vs.* morning cutting improved milk lactose and total solid non-fat yield (SNF; kg/d; $P<0.05$). In general, alfalfa hay CT at

Abbreviations: CT, cutting time; DM, dry matter; DMI, dry matter intake; SM, stage of maturity; TMR, total mixed ration.

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different SM had more effect on nutrient digestibility and N metabolism than on animal production. In conclusion, stage of maturity of alfalfa hay included in TMR did not greatly affect dairy cow performance when it was included at a rate of 200 g/kg DM. The TMRs with alfalfa hay cut in the afternoon improved N efficiency in dairy cows.

1. Introduction

Cultivated alfalfa (*Medicago sativa* L.) is the main, sometimes the only, forage ingredient in Iranian dairy cow rations (Yari et al., 2012a,b). The production of alfalfa hay during 2009–2010 was 5.7 million metric tons (Iranian Ministry of Agriculture, 2009–2010). To support a high milk production, forage in dairy rations has to be supplemented with high levels of concentrates (Oba and Allen, 2005). However, harvesting high quality forage minimizes the amount of concentrate supplementation required, increases dry matter intake (DMI) and milk production (Oba and Allen, 2005; Zebeli et al., 2010). This is especially important for high producing dairy cows in early lactation when nutrients demand is high and maximum feed intake not achieved because of physical rumen fill (Oba and Allen, 2005). Two main factors known to affect alfalfa hay quality are harvest stage of maturity (SM) and cutting time (CT) in the day (Fisher et al., 2002; Yu et al., 2003a,b; Burns et al., 2005; Brito et al., 2008, 2009; Yari et al., 2012a,b). Fiber content increases and protein content decreases with increasing maturity (Yu et al., 2003a,b; Yari et al., 2012a,b) and soluble carbohydrate (SC) concentration in alfalfa increases during the day (Yari et al., 2012a,b), which both have been found to improve dairy cow performance (Turnbull et al., 1982; Steacy et al., 1983; Shaver et al., 1988; Alhadharami and Huber, 1992; Brito et al., 2008, 2009).

However, the effectiveness of feeding forage with an improved quality on dairy cow performance is probably dependent on the level of concentrate inclusion in the ration (Zebeli et al., 2010). To the best of our knowledge, there is no published information about the effect of including alfalfa hay harvested at different CT and/or at different SM in total mixed rations (TMR) with a high level of concentrates on dairy cow performance.

The objective of this study was to determine the effects of including 200 g/kg DM of alfalfa hay cut in the afternoon or morning and at three stages of maturity in TMRs containing 650 g/kg DM concentrates on production performance, apparent total tract digestibility and intake behavior of high producing dairy cows. Our hypothesis was that alfalfa hay cut at an earlier stage of maturity and cut in the afternoon when included in the TMR of dairy cows improves DMI, digestibility, milk production and nitrogen efficiency.

2. Material and methods

2.1. Source of alfalfa hay

The third cut of alfalfa field (4 ha) seeded with *cv.* Ranger in 2010 at the Research Farm of Ferdowsi University of Mashhad (Mashhad, Iran; 36 17′52.8″ N, 59 36′20.52″ E) was used in this study. The whole field was harvested twice before commencing the experiment at April 6 and May 13, 2010. The field was irrigated every 10 d during the course of the experiment. The field was divided into three equal plots, which were cut at early bud, late bud and early flower. Each of three plots were sub-divided into two equal sections from which one section was cut in the afternoon at 18:00 h and the other half in the next morning at 06:00 h.

The SM was determined according the method of Kalu and Fick (1981). The DM of fresh alfalfa and leaf to stem (leaf:stem) ratio were determined as described in Yari et al. (2012a). Forage was cut using a conventional mower conditioner. The six alfalfa hay types (2CT × 3SM = 6) were wilted in the field for 3 d, baled in small square bales and stored in a cement building designed for the storage of hay. The six alfalfa hay types were chopped using an electrical hay chopper equipped with a 20 mm screen (Agri-Equip, Nasr Co., Isfahan, Iran) before feeding. Dates of alfalfa cutting and baling and weather condition during the experiment are shown in Table 1.

2.2. Experimental design, diets and dairy cow management

The experiment was carried out in a tie-stall facility at Ferdowsi University of Mashhad (Mashhad, Iran). Eighteen Holstein Frisian dairy cows, 12 multiparous and 6 primiparous, were used in a cyclic changeover design (Davis and Hall, 1969; Salawu et al., 2002; Krizsan et al., 2007) with three cows per treatment (CT × SM) and three periods of 21 d. At the beginning of the experiment, cows were blocked by parity and days in milk (DIM) and within block randomly allocated to one of the six dietary treatments. Multiparous cows were blocked in the first and second block. Before the beginning of experiment, the cows in the first block had a mean DIM of 48.7 ± 4.6 (±SEM) d and produced 44.6 ± 2.4 kg milk and cows in the second block had a mean DIM of 109 ± 4.6 d and produced 40.3 ± 2.4 kg milk. Primiparous cows were blocked in the third block and had a mean DIM of 49.0 ± 4.6 d and produced 41.3 ± 2.4 kg milk.

Cows were cared for according the guidelines of the Iranian Council of Animal Care (1995). The six experimental TMRs consisted of the same concentrates (650 g/kg DM) and barley silage (150 g/kg DM) and one of the six experimental alfalfa hay types (200 g/kg DM; Table 4). The TMRs were fed twice daily at 09:00 h and 17:00 h and were offered to permit for