J. Dairy Sci. 98:1–10
http://dx.doi.org/10.3168/jds.2015-9427

Feeding preferences and voluntary feed intake of dairy cows: Effect of conservation and harvest time of birdsfoot trefoil and chicory

D. Lombardi,* E. Vasseur,* R. Berthiaume,† T. J. DeVries,‡ and R. Bergeron*[1]
*Organic Dairy Research Centre, Université de Guelph, Campus d'Alfred, Alfred, ON, K0B 1A0 Canada
†Valacta, Ste-Anne-de-Bellevue, QC, H9X 3R4 Canada
‡Department of Animal and Poultry Science, University of Guelph, Kemptville Campus, Kemptville, ON, K0G 1J0 Canada

ABSTRACT

Bioactive forages contain compounds, such as tannins, that are active against pathogens. They have been successfully used in ruminants to control parasite infections. Because cattle may find bioactive forages unpalatable, it is of interest to know if an afternoon harvest time, which has been shown to increase the percentage of nonstructural carbohydrates (NSC), hence palatability, may mitigate this. The objectives of this study were to quantify voluntary intake and preference of dairy cows for 2 bioactive forages, harvested in the morning and evening, in addition to determining their time spent grazing on each forage species. The forage species evaluated were fresh chicory harvested at 0700 h (FCAM) and 1800 h (FCPM), fresh birdsfoot trefoil harvested at 0700 h (FBAM) and 1800 h (FBPM), birdsfoot trefoil baleage harvested the previous summer at 0700 h (BBAM) and at 1800 h (BBPM), and third-cut alfalfa baleage harvested the previous summer and used as control (CON). Single forages were offered ad libitum in 30-min tests to 14 dairy cows to determine intake in a 7 × 7 Latin square (experiment 1). Every possible pair of forages (21 pairs) was then presented for a 30-min test to 8 different dairy cows, and feed intake was measured (experiment 2). Finally, time spent grazing on chicory and birdsfoot trefoil was measured on 12 dairy cows (experiment 3). The tests consisted of 2 d of restriction on 1 of the 2 fields for 1 h, and 2 d of free-choice sessions (1 h) between the 2 fields adjacent to each other. Grazing time and location of the animals on the field was assessed through 2-min scan sampling. In experiment 1, the highest voluntary intakes were for CON, BBPM, and BBAM. In experiment 2, BBPM was preferentially consumed over all other forages followed by CON and BBAM. Multidimensional scaling showed that preference for BBPM, CON, and BBAM in dimension 1 was positively associated with dry matter and nitrogen content, and negatively associated with hemicellulose and soluble N/total N. No relationships between dimension coordinates and any of the measured chemical composition variables could be found for the other 2 dimensions. In experiment 3, cows spent 71% of their time grazing in the birdsfoot trefoil field and 23% in the chicory field during the free-choice sessions. In conclusion, cows in the present experiments showed an overall preference toward baled forages compared with fresh forages, most notably toward birdsfoot trefoil baleage. Cow preference did not appear to be linked to harvest time (a.m. vs. p.m.).
Key words: feed preference, bioactive forage, chicory, birdsfoot trefoil, dairy cow

INTRODUCTION

Gastrointestinal infections are very common in dairy cows, and parasite burden typically increases with exposure to pasture (Vanderstichel et al., 2012). In dairy heifers, infection has been shown to reduce growth rate and delay sexual maturity (Mejía et al., 1999, 2009). Even though it is generally assumed that dairy cows can better deal with parasites than younger animals (Perri et al., 2011), infected and untreated animals have shown a reduced milk yield (Forbes et al., 2004).

Livestock producers rely on the routine use of anthelmintics to maintain animal health and productivity (Marley et al., 2006). Given the emergence of genetically resistant parasites to conventional anthelmintic treatments (Gilleard and Beech, 2007), and the restrictions imposed by organic dairy production standards on their use (Canadian General Standards Board, 2011), scientific evaluation of sustainable alternative treatments is needed for both conventional and organic pastured cows and heifers.

Bioactive forages, which contain secondary compounds that are active against pathogens (Athanasiadou and Kyriazakis, 2004), have been successfully used in ruminants to control parasite infections (Min et

Received February 5, 2015.
Accepted June 25, 2015.
[1]Corresponding author: rbergero@uoguelph.ca

al., 2003). Dosing nematode-infested sheep with plant secondary compounds, such as condensed tannins, has been shown to reduce their fecal egg count (Athanasiadou et al., 2000), and grazing lambs on birdsfoot trefoil and chicory, forages rich in tannins, resulted in a reduced level of helminth parasites (Marley et al., 2003). In their review of temperate forages containing secondary compounds, Ramirez-Restrepo and Barry (2005) concluded that birdsfoot trefoil and chicory were among the most promising alternatives. More recently, we reported that heifers receiving a daily allowance of birdsfoot trefoil as a supplement to pasture did not show an increase over time in their fecal egg count, compared with heifers that did not receive a supplement (Shepley et al., 2015). Although it has been suggested that condensed tannins are the active compounds behind the anthelmintic effect of these alternative forages, other factors may be involved (Athanasiadou and Kyriazakis, 2004).

Condensed tannins also have the potential to prevent bloat and increase nitrogen utilization in ruminants (McMahon et al., 2000; Mueller-Harvey, 2006). However, high levels of condensed tannins in ruminant diets (Min et al., 2003) can have some disadvantages such as impairing rumen metabolism by affecting the mucosa in the digestive tract, and reducing the absorption and digestibility of fiber (Reed, 1995; Barry and McNabb, 1999). Additionally, condensed tannins are associated with a bitter taste (McMahon et al., 2000), which may serve as a warning to the animal on the potential negative effects of the forage (Marten, 1978).

As stated by Scharenberg et al. (2007), a high palatability of anthelmintic forages is necessary when offered from mixed grasslands, together with other forages, and even alone, to ensure a sufficient intake and rapid adaptation period. Most research on bioactive forages has focused on small ruminants (Min et al., 2003) that can tolerate higher bitterness than cattle (Bell, 1959). Because cattle may find bioactive forages unpalatable, it is of interest to determine if other plant characteristics may mitigate this. Forage total NSC are strongly correlated with palatability (Smit et al., 2006) and could possibly counteract the bitterness caused by condensed tannins. Timing of harvest or access to pasture is an important factor affecting forage NSC, as forages harvested in the later part of the day have a higher concentration of NSC than those harvested early in the morning (Morin et al., 2011, 2012). This occurs as a result of accumulation of NSC throughout the day, as the rate of photosynthesis exceeds the rate of respiration and carbon fixation (Burns et al., 2007). These diurnal variations in herbage chemical composition have been shown to cause changes in feeding behavior and DMI (Gregorini et al., 2008; Raggio et al., 2010).

The objectives of the present study were to (1) assess the voluntary intake and feeding rate of dairy cows for chicory and birdsfoot trefoil harvested in the morning and in the evening, (2) assess the preference or aversion of dairy cows for chicory and birdsfoot trefoil harvested in the morning and in the evening, as well as the relationship between the forage constituents and cow preference, and (3) determine time spent grazing on chicory or birdsfoot trefoil.

MATERIALS AND METHODS

Three experiments were conducted at the Organic Dairy Research Centre of the Université de Guelph–Campus d'Alfred (Alfred, ON, Canada), following a protocol in agreement with the guidelines of the Canadian Council on Animal Care (CCAC, 2009), and approved by the University of Guelph Animal Care Committee. In experiment (**Exp.**) 1, voluntary intake for 7 forages were evaluated; in Exp. 2, the 7 forages were provided in pairs to assess cow preferences; and in Exp. 3, the time spent grazing on 2 forages was evaluated. For all experiments, cows were kept outdoors grazing and were brought in twice daily (approximately 0700 and 1700 h) to a freestall barn to be milked. The experiments took place after morning milking and after cows received their daily ration of concentrate in the barn (ground wheat, micronized soybeans, salt, and minerals).

Voluntary Intake (Exp. 1) and Preference (Exp. 2): Forages

Seven forages were tested: fresh chicory (*Cichorium intybus* L.) cultivar Puna harvested at 0700 h (**FCAM**) and at 1800 h (**FCPM**), fresh birdsfoot trefoil (*Lotus corniculatus* L.) cultivar Bull harvested at 0700 h (**FBAM**) and at 1800 h (**FBPM**), birdsfoot trefoil baleage harvested at 0700 h (**BBAM**) and harvested at 1800 h in the summer of 2011 (**BBPM**), and baleage of third-cut alfalfa (*Medicago sativa* L.) cultivar Pickseed 2065MF harvested in the summer of 2011 (**CON**). All forages were grown at the same site. Chicory and birdsfoot trefoil were seeded in the summer of 2010, and alfalfa in 2008.

Fresh forage (FCAM, FCPM, FBAM, and FBPM) was harvested from fields that had been cut the previous summer. It was cut daily the day before serving with a sicklebar mower (John Deere 350, Moline, IL) to a stubble height between 2 to 5 cm, and was manually collected into paper biodegradable bags (8 kg, Canadian Tire Co., Toronto, Ontario, Canada), which were stored in a refrigerator at 1°C overnight to preserve freshness. One bale of each birdsfoot trefoil baleage (BBAM and BBPM) and alfalfa baleage (CON) was used per week.