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Herbage intake and milk production of late-lactation dairy cows offered a second-year chicory crop during summer

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ABSTRACT

Chicory (*Cichorum intybus* L.) is a summer-active forage herb which has been proposed as an option to increase summer feed supply, increase dry matter intake, nutrient intake, and milk yield from nonirrigated dairy production systems in southern Australia. Dry matter intake, nutrient intake, milk yield, and yield of milk fat and protein of predominantly Holstein-Friesian dairy cows in late lactation consuming 3 herbage-based diets (4 replicates per treatment) were measured. The 3 grazed herbages were second-year chicory (CHIC) and perennial ryegrass (*Lolium perenne* L.; PRG) monocultures and a mixed sward (~50:50) of chicory and perennial ryegrass (MIX). All diets (CHIC, PRG, and MIX) were supplemented with alfalfa (*Medicago sativa* L.) hay (5.5 kg of DM/cow per day) and an energy-based concentrate pellet (4.0 kg of DM/cow per day). There were no significant differences in milk yield (12.0 to 12.6 kg/d across the treatments) or the yield of milk fat (539 to 585 g/d) and milk protein (433 to 447 g/d) between the 3 herbage-based diets. No differences in DMI (17.9 to 19.2 kg/d) or estimated metabolizable energy intake (173 to 185 MJ/d) were noted between treatments. Estimated metabolizable energy concentrations in the forages on offer were lower in CHIC than PRG (7.6 vs. 8.2 MJ/kg of dry matter), but the concentration in consumed herbage was not different (9.1 vs. 9.2 MJ/kg of dry matter); as such, potential for increased milk yield in cows offered CHIC was limited. Increased concentration of polyunsaturated fatty acids was observed in chicory herbage compared with perennial ryegrass. This was associated with increased milk conjugated linoleic acid and milk polyunsaturated fatty acids when chicory formed part of the diet (CHIC compared to PRG and MIX). Chicory could be used as an alternative to perennial ryegrass in summer; however, the developmental stage of chicory will influence concentrations of metabolizable energy and neutral detergent fiber and, therefore, intake and milk production responses compared with perennial ryegrass.

Key words: chicory, perennial ryegrass, milk production, nutrient selection

INTRODUCTION

The feed base in temperate southern Australian and New Zealand dairy systems is dominated by perennial ryegrass pasture (*Lolium perenne* L.; Chapman et al., 2008; Muir et al., 2014). However, in these regions, perennial ryegrass exhibits a highly seasonal growth pattern, with spring dominance and low summer and autumn growth, which limits the utility of this species to increase homegrown forage supply in dry land systems in southern Australia (Chapman et al., 2006, 2008). Forage herbs, such as chicory (*Cichorum intybus* L.), provide an option to improve feed supply and nutrient intake from the homegrown feed base over late spring, summer, and autumn (Chapman et al., 2008; Muir et al., 2014). Chicory is a summer active forage with high DM yield potential and less variable ME and CP concentrations in its vegetative state than perennial ryegrass (Waugh et al., 1998).

Cows grazing chicory as a supplementary forage or mixed swards based on chicory may produce more milk or more milk solids (fat + protein) compared with those consuming perennial ryegrass-based swards during summer and autumn (Waugh et al., 1998; Li and Kemp, 2005; Chapman et al., 2008). However, Minnee et al. (2012) observed that milk yield and yields of milk fat and protein were increased above those in cows grazing perennial ryegrass only when the estimated ME concentration of the perennial ryegrass was low (9.6 MJ/kg of DM). When the estimated ME concentration of perennial ryegrass was moderate (10.5 MJ/kg of DM), cows supplemented with chicory had similar yields of milk and yields of milk constituents (fat + protein) to those fed perennial ryegrass pasture in both indoor and outdoor feeding experiments. This observation is consistent with the results of Muir et al. (2014), where cows consuming chicory or a mixed sward of

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chicory and perennial ryegrass had similar intakes and milk yield and concentrations of fat and protein to those grazing perennial ryegrass during spring. In that experiment, estimated herbage ME in the perennial ryegrass was 11.2 ± 0.20 MJ/kg of DM, compared with 11.3 ± 0.14 MJ/kg of DM for the chicory, resulting in similar estimates of ME intake from both forage types. Milk yield averaged 27.6 and 28.0 kg/cow per day for the perennial ryegrass- and chicory-based diets, respectively.

In comparison to perennial ryegrass, when considered at the same ME and CP concentration, chicory typically has lower NDF concentrations (Waugh et al., 1998; Soder et al., 2006). It has been suggested that feeding large amounts of chicory may result in milk fat depression due to this low NDF concentration (Waugh et al., 1998; Soder et al., 2006). However, Muir et al. (2014) did not observe a depression in milk fat in cows consuming 12.5 to 14.9 kg of DM of chicory or a mixed sward of chicory and perennial ryegrass as the grazed forage source in the diet. Cows offered the chicory monoculture were also offered 2.2 kg of DM alfalfa (*Medicago sativa* L.) hay to maintain dietary NDF. Similarly, Minnee et al. (2012) fed diets of up to 60% chicory, without a negative effect on yield of milk fat and protein.

Altering the FA composition of milk has received considerable research attention with the aim of improving consumer health, particularly through increasing concentrations of essential FA, CLA, and increasing the concentration of unsaturated FA compared with SFA (Dewhurst et al., 2006; Elgersma et al., 2006). Feeding chicory has been associated with changes in the concentrations of beneficial FA, including CLA and PUFA (Muir et al., 2014). Concentrations of FA in milk are influenced by concentrations of FA in herbage (Dewhurst et al., 2006). During spring, chicory in a late vegetative or early reproductive phase (i.e., still leafy but with some stem elongation) contained greater concentrations of C18:2n-6, contributing to increased total PUFA in cows offered diets containing chicory (Muir et al., 2014). To our knowledge, no data exists on FA concentration or composition of chicory when fully reproductive and its subsequent effect on FA composition of milk. Marketing grass-fed milk with a more beneficial FA profile is already an option in the Netherlands (Elgersma et al., 2006), and with increasing consumer demand it may become an option for producers in other countries to add value to their production systems. Knowledge of the effect of alternative forages on the FA composition of milk will be increasingly important if producers intend to supply these markets. The hypotheses we tested were that feeding diets containing chicory during summer and in late lactation would increase DMI, nutrient selection, nutrient intake, and milk yield compared with a perennial ryegrass-based diet, and replacing perennial ryegrass with chicory in the diet would not affect milk fat concentration or milk protein yield but would increase the concentration of PUFA in milk during summer in late-lactation dairy cows.

MATERIALS AND METHODS

The experiment was conducted on a commercial dairy farm, DemoDAIRY (38°14′S, 142°55′E), in southwest Victoria, Australia, during summer (January 30 to February 26, 2013). All procedures were conducted in accordance with the Australian Code of Practice for the Care and Use of Animals for Scientific Purposes (National Health and Medical Research Council, 2004). Approval to proceed was obtained from the Department of Economic Development, Jobs, Transport and Resources (**DEDJTR**) Agricultural Research and Extension Animal Ethics Committee.

The experiment was conducted over 24 d, which included a 14-d adaptation period during which cows were progressively adapted to their respective herbage base by increasing the proportion of chicory in the diet (for those consuming chicory or the mixed sward). After the pre-experimental period, a 10-d measurement period occurred where DMI, nutrient concentrations in diet components, live weight, and milk production parameters were measured.

Experimental Design

The experiment was a randomized block design with 3 dietary treatments and 4 replicates or blocks. Thirty-six multiparous cows were used in the experiment, with 3 cows allocated to each replicate of a dietary treatment.

The dietary treatments were:

1. PRG: cows grazing a monoculture of perennial ryegrass supplemented with 5.5 kg of DM/d alfalfa plus energy-based pellets fed at 4 kg of DM/cow per day (fed in the parlor, 50% during each milking);
2. CHIC: cows grazing a monoculture of chicory supplemented with alfalfa hay and pellets, as above; and
3. MIX: cows grazing a mixed sward of perennial ryegrass and chicory (∼50:50 DM) supplemented with alfalfa hay and pellets, as above.