J. Dairy Sci. 98:1–16
http://dx.doi.org/10.3168/jds.2014-9016

The effect of high and low levels of supplementation on milk production, nitrogen utilization efficiency, and milk protein fractions in late-lactation dairy cows

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ABSTRACT

To fill the feed deficit in the autumn/late lactation period in a seasonal grazing system, supplementation is required. This study aimed to investigate the use of baled grass silage or concentrate as supplementation to grazing dairy cows in late lactation. Eighty-four grass-based spring-calving dairy cows, averaging 212 d in milk, were allocated to 1 of 6 treatments [high grass allowance (HG), low grass allowance (LG), grass with a low concentrate allocation (GCL), grass with a low grass silage allocation (GSL), grass with a high concentrate allocation (GCH), and grass with a high grass silage allocation (GSH)] to measure the effects of using baled grass silage or concentrate as supplements to grazed grass. Effects on intake, milk yield, milk composition and N fractions, and N utilization efficiency were measured. Treatments HG and LG received 17 and 14 kg of dry matter (DM) grass/cow per d, respectively. Treatments GCL and GSL were offered 14 kg of DM grass/cow per d and 3 kg of DM of supplementation/cow per d. Treatments GCH and GSH were offered 11 kg of DM grass/cow per d and 6 kg of DM of supplementation/cow per d. Milk yield was greatest in the GCH treatment and milk solids yield was greatest in both concentrate-supplemented treatments. The HG and LG treatments excreted a greater quantity of N as a proportion of N intake than the supplemented treatments. The HG treatment also excreted the greatest total quantity of N. This indicates an improvement in N utilization efficiency when supplementation is offered compared with grazing only. Offering 6 kg of DM of either grass silage or concentrate as supplementation decreased milk true protein concentration compared with offering a grass-only diet. This suggests that increasing the proportion of supplementation relative to grass may negatively affect milk processability, which is associated with milk true protein concentration.

Received October 25, 2014.
Accepted April 12, 2015.
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Key words: nutrition, grass silage, grass, concentrate, nitrogen, milk protein

INTRODUCTION

The ability to grow between 10 and 16 t grass DM/ha gives a competitive advantage because, in countries such as Ireland, grass is the cheapest feed source for milk production (Finneran et al., 2010). Seasonal grass growth patterns lead to deficits in the spring and autumn. When grass supply is limited, the grass-based diet of the dairy cow must be supplemented to ensure that cow nutritional requirements are met to extend the lactation at a low cost. Supplements such as grass silage and concentrates are commonly used to fill the feed deficit that arises when grass supply is limited (Kennedy et al., 2005).

Grass silage is the most important feed source available to Irish dairy cows after grazed grass (Finneran et al., 2010). Recent innovations in grassland management involve the preservation of grass as baled silage during times of grass surplus in the main grazing season. Baled grass silage can therefore be used as a tool to manage surplus grass and grass utilization. Grass silage bales are often made from higher quality grass than the conventional method of ensiling grass in a pit (McEniry et al., 2011). The effect on milk yield and milk composition of offering grass silage as a supplementary feed to grazing dairy cows in late lactation has been investigated with varying results. A review by Phillips (1988) concluded that offering grass silage to cows offered a grass-based diet in late lactation increased milk yield, decreased milk fat concentration, and had variable effects on milk protein concentration compared with grass-only diets. The experiments considered in the review all used grass silage, which was ensiled in a pit. O'Brien et al. (1996) investigated the effect of varying levels of grass silage and concentrates as supplementation to spring-calving grass-based dairy cows in late lactation; they concluded that supplementation with silage caused a linear decline in milk solids yield. Milk yield and milk solids yield were increased linearly with increasing concentrate supplementation. Grass was grazed to a target postgrazing sward height of 6 to 7 cm, which is substantially greater than the current recommendation of 4 to 4.5 cm. The grass silage used in the study was also from a pit.

Concentrate is often used as a supplement in late lactation. Although concentrate is more expensive than grass silage, the milk response (**MR**) to concentrate is greater than the MR to grass silage (Peyraud et al., 2004). Feeding supplementary concentrate to late lactation cows in autumn is also recommended to maintain milk lactose concentration above the target of 42.0 g/kg (O'Brien, 2008).

Researchers are interested in improving the nitrogen utilization efficiency (**NUE**) of dairy cows to reduce the N excreted in urine (Peyraud et al., 2004). Urinary N is the primary route for urea excretion (Spek et al., 2013). Olmos Colmenero and Broderick (2006) showed that the concentration of N in urine is directly related to the diet. Urine N excretion can be high in grass-based diets due to the high dietary protein concentration (Dijkstra et al., 2013).

Milk processability, which is the suitability of milk for processing into dairy products, can be improved by increasing particular N components in the milk, specifically CN (Hermansen et al., 1999). Casein concentration in milk is closely related to the diet of the dairy cow and can be increased with increases in both dietary CP and energy (Sutton et al., 1996).

Few data are available in the literature on the effect of including high-quality baled grass silage, in comparison with concentrate, in the diet of grazing dairy cows in late lactation in autumn. The effects on dairy cow N excretion and on the protein parameters in milk that effect milk processability are lacking. The objective of the current study was to measure the effects of offering different supplementary feeds to grazing dairy cows in late lactation on milk yield and composition, NUE, and milk N fractions. We hypothesized that when supplementary feeds were offered with a low-allowance, grass-only diet (14 kg of DM >4 cm), the milk and milk solids yield response would be positive. We also hypothesized that using concentrate as the supplement would result in a greater milk yield response than grass silage. Finally we hypothesized that using a larger allocation of grass, compared with grass silage supplementation, would give a greater milk and milk solids yield response.

MATERIALS AND METHODS

The experiment was conducted at Teagasc, Animal and Grassland Research and Innovation Centre, Moorepark, Fermoy, County Cork, Ireland (50°09′N, 8°16′W, 35 m above sea level). The area used was under permanent pasture with a predominantly perennial ryegrass (*Lolium perenne* L.) sward. The grass sward was composed of 50% Astonenergy and 50% Tyrella cultivars. The average age of the pasture was 4 yr. Prior approval for animal use was attained from the Teagasc Animal Ethics Committee (Ref–TAEC 14/2013) and the Irish Medicines Board (Ref–AE19132/P001).

The experiment was a complete randomized block design and was conducted between September 30 and November 16, 2013. Eighty-four lactating dairy cows (66 multiparous and 18 primiparous) at, on average, 212 DIM (SD = 23 d) were selected from the Teagasc Moorepark spring-calving dairy herd. The average calving date of the cows was March 2, 2013 (SD = 23 d). Prior to the beginning of the study, cows were offered 16 kg of DM grass/cow per d and no concentrate.

Treatments and Grazing Management

The cows were blocked based on DIM, lactation number (3 ± 1.3; mean ± SD), milk yield (19 ± 3.1 kg of milk/cow per day), milk protein concentration (37.0 ± 2.7 g/kg), milk solids yield (1.6 ± 0.21 kg), BW (525 ± 54 kg), and BCS (3.2 ± 0.28; 1–5 scale of Edmonson et al., 1989). From within block, cows were randomly assigned to 1 of 6 feeding treatments: high grass allowance only (**HG**), low grass allowance only (**LG**), grass with a low concentrate allocation (**GCL**), grass with a low grass silage allocation (**GSL**), grass with a high concentrate allocation (**GCH**), and grass with a high grass silage allocation (**GSH**). Treatments HG and LG received 17 and 14 kg of DM grass/cow per d, respectively. Treatments GCL and GSL were offered 14 kg of DM grass/cow per d and 3 kg of DM of supplementation/cow per d. Treatments GCH and GSH were offered 11 kg of DM grass/cow per d and 6 kg of DM of supplementation/cow per d. Fresh grass was offered daily. The GCL and GCH treatments received their concentrate allocation in 2 equal measures during morning and afternoon milkings via the Dairymaster feed delivery system (Dairymaster, Causeway, Co. Kerry, Ireland). The grass silage was offered on an outdoor feeding pad. A self-locking stall swing (O'Donovan Engineering, Coachford, Co. Cork, Ireland) was used to secure cows within the GSL and GSH treatments and ensure that they received the correct grass silage allocation. Treatment GSL had approximately 1 h to consume their supplementary feed. Treatment GSH had approximately 1 h 30 min to consume their supplementary feed. The DM of the grass silage was assessed 6 times per week to calculate the daily fresh weight grass silage allocation per cow per day. Samples of the grass silage bale were taken the day before feeding,