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Effect of pasture allowance and supplementation with maize silage and concentrates differing in crude protein concentration on milk production and nitrogen excretion by dairy cows

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Abstract

Sixty cows (40 multiparous and 20 primiparous) averaging 140 days in milk (DIM) were assigned to five treatments to evaluate the effect of pasture allowance and supplements of a) maize silage b) high crude protein concentrate and, c) low crude protein concentrate on milk production and nitrogen (N) excretion. Two of the treatments (HG and LG) were offered herbage only (allowances of 20 and 15 kg dry matter (DM) per cow/day, respectively) while the remaining three treatments were offered a herbage allowance of 15 kg DM per cow/day plus 4 kg DM per cow/day of maize silage (M), a high CP concentrate (CP concentration of 194 g/kg DM) (HC), or citrus pulp (CP concentration of 69 g/kg DM) (LC). Total DM intake (DMI) was similar for HG, M, HC, and LC but was lower for LG (15.2 kg DM per cow/day) than HC (17.4 kg DM per cow/day). The reduction in pasture DMI per kg of supplement DM ingested was 0.44, 0.45, and 0.54 kg for cows offered maize silage, high CP concentrate, and low CP concentrate, respectively. Milk yield was greater for the supplemented treatments (23.7–24.7 kg/day) than for LG (20.7 kg/day) but not for HG (23.2 kg/day). Milk fat concentration was greater for HC (35.3 g/kg) than for HG, M, and LC but not greater than LG, while milk protein concentration was greater for HG (34.8 g/kg) than for LG and HC but not greater than M and LC. The greatest levels of N and PDIN intake were recorded for HG (662 and 2502 g/day) and HC (654 and 2506 g/day) which were greater than LC but not greater than LG and M. Treatment HC recorded the highest PDIE intake (1743 g/day) which was greater than LG, M and LC but not greater than HG. Output of N in milk was greater on HC (134 g/day) than on LG but was not greater than on HG, M, and LC. Faecal N excretion was greater on HG (171 g/day) than on all other treatments while estimated urinary N excretion was greater on HG and HC than LC (320 g/day). Treatment LC had a higher proportion of N output in milk (0.23) than treatment LG but not higher than HG, M and HC treatments. Urinary N expressed as a proportion of total N excretion was lower for HG (0.68) than all other treatments. The results of this study show that there is a large response in milk production to supplementing cows on a restricted grass allowance and that cows offered low CP supplements had similar levels of production to those offered high CP supplements. Nitrogen utilisation was improved by offering supplements of lower CP content.

Keywords: Dairy cows; Grazing; Milk production; Nitrogen excretion

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1. Introduction

In Ireland and other temperate areas, grazed grass is the cheapest source of forage for milk production. Due to the seasonal pattern of grass growth, the use of supplements such as concentrates and forages (*e.g.* maize silage) in autumn and spring can have an important role in efficient dairy systems when the quantity and quality of grass may be limiting. The cost of producing or purchasing forages and concentrates represents approximately 60% of the direct costs of milk production in Ireland (Dillon et al., 2003). Thus it is of vital importance that the diet offered increases dry matter intake and allows optimal production of milk and milk constituents together with good reproductive performance.

The primary purpose of offering supplements to cows is to supply nutrients that are deficient in the basal diet due to either a low quality or quantity of grazed grass which occurs particularly in early spring in Ireland. Kennedy et al. (2005) has shown that animal performance can be maintained by offering grazed grass and a small proportion of concentrate compared to offering a diet based on a high proportion of concentrate and grass silage. When grass for grazing is in short supply, large responses to supplements can be expected. However, when adequate herbage is available, offering high-energy supplements or forages such as maize silage to grazing dairy cows produces only a small increase in milk yield (Stockdale and Trigg, 1989). This is probably because of a high substitution rate, such that total intake is only slightly increased (Stockdale and Trigg, 1989).

In general, milk production is increased when dietary CP is increased from 90 g/kg to 140 g/kg (Forster et al., 1983; Kung and Huber, 1983); however, further increases in dietary CP often result in diminishing milk yield increases (Stockdale, 1995). Castillo et al. (2001) showed that milk production is not compromised by offering a low level of CP (150 g/kg DM). Therefore it may be possible to supplement grazing cows with feeds having low CP concentrations as pasture often contains CP concentrations in excess of 200 g/kg on a DM basis (Kavanagh et al., 2003).

The use of supplements, which results in a high efficiency of protein metabolism and in low levels of nitrogen excretion are desirable. Nitrogen (N) excretion was found to be 77% less when dietary CP concentration was reduced from 180 to 120 g/kg with no significant effect on milk N concentration or output (Castillo et al., 2001). Nitrogen consumed in excess of animal requirements is excreted in faeces and urine. Several studies have demonstrated that reducing dietary protein content reduces total and urinary N excretion by dairy cows (Colin-Schoellen et al., 2000). The objective of this experiment was to investigate the effect of either additional grass or supplements of maize silage, a high CP concentrate or citrus pulp with a restricted grass allowance on the milk production and N excretion of dairy cows at pasture.

2. Materials and methods

The experiment was conducted at Moorepark Research Centre, Fermoy, Co. Cork (55°10′ N, 8°16′ W). The experimental site was a free-draining, brown earth soil with a sandy loam-to-loam texture.

2.1. Treatments, experimental design and animals

Sixty (40 multiparous, 20 primiparous) Autumn calving Holstein–Friesian dairy cows were allocated to blocks of five (with multiparous and primiparous allocated separately) on the basis of days in milk (DIM) and milk yield and assigned at random from within blocks to one of five grazing treatments as follows: 1. 20 kg DM grass/day (HG); 2. 15 kg DM grass/day (LG); 3. LG+4 kg DM maize silage/day (M); 4. LG+4 kg DM high CP concentrate/day (HC); 5. LG+4 kg DM low CP concentrate/day (LC). The duration of the experiment was 9 weeks with a week prior to this used for acclimatization. Production data from the two weeks prior to the adaptation week were used in the randomization of cows. During this period, mean daily milk yield was 28.5±5.4 kg/day. The lactation number of cows on experiment was 3.1±2.1 and DIM at the start of the adaptation week were 140±24.1 days. The cows were housed during the winter period from calving until the 20th of February when they were allocated grass by day in order to allow a period to adjust to the change in diet. The diet in the adjustment week consisted of grazed grass by day and grass silage: maize silage in a 50:50 mixture by night.

2.2. Diets and grazing system

Cows were stocked at a rate of 2.62 cows/ha. All cows were offered fresh herbage once daily after morning milking in a rotational grazing system. The cows grazed in groups as follows: HG grazed as a separate group, LG grazed as a separate group and M, HC and LC grazed together as a group. All herbage offered was primary spring pasture and the paddocks remained ungrazed from the previous October.

The maize silage (cv. Goldcob) was harvested at 336 g DM/kg on the 20th of October 2004 and ensiled in