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Effect of concentrate feeding method on the performance of dairy cows in early to mid lactation

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ABSTRACT

The objective of the current study was to determine the effects of concentrate feeding method on milk yield and composition, dry matter (DM) intake (DMI), body weight and body condition score, reproductive performance, energy balance, and blood metabolites of housed (i.e., accommodated indoors) dairy cows in early to mid lactation. Eighty-eight multiparous Holstein-Friesian cows were managed on 1 of 4 concentrate feeding methods (CFM; 22 cows per CFM) for the first 21 wk postpartum. Cows on all 4 CFM were offered grass silage plus maize silage (in a 70:30 ratio on a DM basis) ad libitum throughout the study. In addition, cows had a target concentrate allocation of 11 kg/cow per day (from d 13 postpartum) via 1 of 4 CFM, consisting of (1) offered on a flat-rate basis via an out-of-parlor feeding system, (2) offered based on individual cow's milk yields in early lactation via an out-of-parlor feeding system, (3) offered as part of a partial mixed ration (target intake of 5 kg/cow per day) with additional concentrate offered based on individual cow's milk yields in early lactation via an out-of-parlor feeding system, and (4) offered as part of a partial mixed ration containing a fixed quantity of concentrate for each cow in the group. In addition, all cows were offered 1 kg/cow per day of concentrate pellets via an in-parlor feeding system. We detected no effect of CFM on concentrate or total DMI, mean daily milk yield, concentrations and yields of milk fat and protein, or metabolizable energy intakes, requirements, or balances throughout the study. We also found no effects of CFM on mean or final body weight, mean or final body condition score, conception rates to first service, or any of the blood metabolites examined. The results of this study suggest that CFM has little ef-

fect on the overall performance of higher-yielding dairy cows in early to mid lactation when offered diets based on conserved forages.

Key words: concentrate feeding method, total mixed ration, feed-to-yield, flat-rate, confinement

INTRODUCTION

The adoption of breeding programs with considerable emphasis on milk production has increased the milk yields of Holstein-Friesian dairy cattle populations in many countries in recent years (see review by Oltenacu and Broom, 2010). Increased milk yields are normally accompanied by an increase in feed intake potential and the increased ability of these higher-yielding cows to mobilize body tissue to provide energy for milk production in early lactation (Ferris et al., 1999). Body tissue mobilization indicates that a cow is in negative energy balance, with the adverse effects of negative energy balance on reproductive performance (Domecq et al., 1997; Berry et al., 2003; Buckley et al., 2003) and cow health (Collard et al., 2000) now well documented. In an attempt to minimize the extent of negative energy balance experienced and to allow higher-yielding cows to achieve their potential milk yields, the quantity of concentrates offered to these cows has increased. Due to the large quantities of concentrates offered to cows in many production systems, the concentrate feeding method adopted may affect cow performance.

A wide range of concentrate feeding methods is adopted in practice, both in the United Kingdom and in many other parts of the world. For example, concentrates can be mixed with the forage component of the diet as part of a mixed ration, offered separately from forage via in-parlor or out-of-parlor concentrate feeding systems, or offered via a combination of these approaches. When offered separately from forage, concentrate can be offered via several strategies, such as at a flat rate, which does not account for differences in the milk yields of individual cows, or on a feed-to-yield

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basis, where individual cows are offered specific concentrate allocations based on their actual milk yields. The latter strategy has been facilitated by developments in concentrate feeding technology, which allow feeding systems to be directly linked to milking parlor software, thereby allowing cows to be offered concentrates based on their individual milk yields.

Several studies have examined the effects of offering concentrate as part of a total mixed ration versus separately from silage on dairy cow performance. In a study involving lower-yielding cows (range of mean milk yields of approximately 18 to 22 kg/cow per day) with low concentrate DMI (1.8 to 7.0 kg/cow per day), Agnew et al. (1996) found no difference in milk yields between the 2 systems. Gordon et al. (1995) and Yan et al. (1998) reported similar findings for higher-yielding cows (29 to 35 kg/cow per day) at a higher concentrate DMI (10.9 to 12.9 kg/cow per day).

In addition, several authors have examined the effect of concentrate allocation strategy, in which cows are offered concentrates separately from silage at a flat rate or on a feed-to-yield basis (where both groups received the same total amount of concentrates) and reported no difference in milk yields between these strategies (Gordon, 1982; Taylor and Leaver, 1984a,b). However, these studies involved low- or moderate-yielding cows (range of mean treatment milk yields across these studies of 22 to 26 kg/cow per day) and relatively low concentrate DMI (7.5 to 7.8 kg/cow per day). In addition, within the feed-to-yield treatments examined in the 3 latter studies, the entire concentrate components of the diets were offered via either in-parlor or out-of-parlor concentrate feeding systems. However, in many feed-to-yield systems adopted in practice, cows are offered a basal diet consisting of a forage-plus-concentrate mix, which is generally designed to provide a cow's maintenance energy requirement plus the energy required for the production of a specific milk yield. Additional concentrates are then offered to support milk yields above those sustained by the basal diet. This approach was adopted by Lawrence et al. (2015), who found no difference in the performance of cows offered concentrates at a flat rate or on a feed-to-yield basis. However, that study involved relatively low-yielding cows (23 to 25 kg of milk/cow per day) with low concentrate DMI (3.9 to 7.0 kg/cow per day).

We are unaware of studies that have examined the effects of concentrate feeding method, consisting of different concentrate feeding systems (i.e., mixed with the forage versus separate from forage) and concentrate allocation strategies (flat rate versus feed-to-yield), on the performance of high-yielding dairy cows (i.e., those with milk yields of approximately 40 kg/cow per day) when housed and offered conserved forage based diets.

Given the differences in the physical presentation of the diets and in how concentrates are allocated to individual cows with the approaches described above, it is possible that cow performance would be affected by concentrate feeding system. Thus, the objective of this study was to examine the effects of concentrate feeding method on milk production and composition, BW and BCS, reproductive performance, energy balance, and blood metabolites of higher-yielding dairy cows in early to mid lactation.

MATERIALS AND METHODS

This study was conducted at the Agri-Food and Biosciences Institute (**AFBI**), Hillsborough, Northern Ireland. All experimental procedures were conducted under an experimental license granted by the Department of Health, Social Services & Public Safety for Northern Ireland in accordance with the Animals (Scientific Procedures) Act 1986.

Prepartum Housing and Management

For 3 wk before their expected calving date, 88 multiparous Holstein-Friesian dairy cows [mean (SD) lactation number of 3.4 (1.36); mean PTA for milk fat-plus-protein yield of 15.1 (13.2) kg; mean Profitable Lifetime Index of £162 (£148.1): December 2014 proof run] were housed and given ad libitum access (1.07 of the previous day's intake) to a grass silage-based diet. Cows had a mean calving date of October 16, 2011, with all cows calving between August 29, 2011, and January 5, 2012.

During the 3-wk prepartum period, cows were housed as a single group in a freestall house with concrete flooring and had access to individual cubicles that were fitted with rubber mats and bedded with sawdust. The cubicle-to-cow ratio was $\geq 1:1$ at all times, thus meeting the recommendations of FAWC (1997). The floor area was scraped every 3 h using an automated system. During this time, cows were given ad libitum access to grass silage supplemented with precalving minerals and calcined magnesite, with the latter being mixed in the silage to achieve target intakes of 150 and 30 g/cow per day, respectively.

Concentrate Feeding Methods

Following parturition, cows were allocated to 1 of 4 concentrate feeding methods (**CFM**; 22 cows per treatment), with these CFM comprising different concentrate feeding systems and allocation strategies. Cows on each CFM were balanced for 305-d milk yield during the previous lactation; parity; PTA for milk fat,

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