J. Dairy Sci. 101:1–12
https://doi.org/10.3168/jds.2018-14624

Short-term responses in production and behavior during periods of change in concentrate allowance for dairy cows

J. C. S. Henriksen,[1] L. Munksgaard, and M. R. Weisbjerg
Department of Animal Science, Aarhus University, Blichers allé 20, 8830 Tjele, Denmark

ABSTRACT

The aim of this study was to investigate the short-term responses of dairy cows during periods of change in the concentrate allowance in an automatic milking system. The experiment had a design with a 2 × 2 factorial arrangement including 2 types of concentrates and 2 amounts of concentrates (type O: mix of pelleted concentrate and steamrolled, acidified barley; type S: pelleted) in amounts of 3 and 6 kg/d. The experiment length was 11 wk. The concentrate type changed between wk 6 and 7 and included both increase and decrease in concentrate allowance for each concentrate type. The concentrate allowance was changed by 0.5 kg/d over 6 d. The 96 cows (48 Danish Jersey, 48 Danish Holstein) included in the experiment were blocked according to breed, parity, and days in milk, and randomly divided into 8 groups of treatment order. The cows visited the automatic milking unit more often when concentrate type O was offered, but not when an increased concentrate allowance was provided. The changes in concentrate intake and partial mixed ration (PMR) eating time showed a symmetrical pattern between the periods of increasing allowance and decreasing allowance. However, PMR intake and milk yield varied in the magnitude of the responses, indicating that these responses may not be driven by the same underlying mechanisms during increase and decrease in concentrate allowance. The daily lying time increased and the PMR eating rate decreased during periods of both increase and decrease in concentrate allowance. We found no significant change in milk yield during increase in concentrate allowance, despite a higher milk yield during periods with constant concentrate allowance at the high concentrate amount; however, the milk yield decreased during periods of decrease in concentrate allowance. Visit frequency, lying time, and steps changed during periods of changes in concentrate allowance without showing any differences at the constant concentrate allowance. In conclusion, these results indicate that it may be difficult to adjust the individual concentrate allowance based on the short-term responses of the cow.

Key words: dairy cow, concentrate change, production, behavior

INTRODUCTION

Since the beginning of the last century, dairy cows in Europe have been fed according to their individual milk production by adjusting the amount of concentrate in the individual ration (Østergaard et al., 1987). However, the herd size has increased (Kristensen et al., 2015) and housing has changed to loose housing instead of tiestall barns. These changes led to an increase in the use of group feeding (Østergaard et al., 1987; Schingoethe, 2017), which is a simple way to manage the feeding of a large herd; however, group feeding does not account for individual variation in nutritional requirements. Recently, the amount of automated individual data has increased due to implementation of systems such as the automatic milking unit (**AMU**; Bach and Cabrera, 2017), making it possible to adjust the individual concentrate allowance based on individual responses, and also for large herds.

The increased interest in and use of individual concentrate strategies emphasizes the need to understand how dairy cows respond to adjustments in concentrate allowance. Most previous researchers studied how cows respond to concentrate changes after an adaption period. However, to use the immediate responses to changes in concentrate allowance for further adjustment, there is a need for more research regarding the adaptation to change in concentrate allowance.

Based on existing knowledge concerning the effects of concentrate offered during periods of constant concentrate allowance, our hypotheses was that an increase in concentrate allowance would have the potential to increase milking frequency and milk yield (Halachmi et al., 2005; Weisbjerg and Munksgaard, 2008; Lawrence et al., 2015) but decrease the ad libitum partial mixed ration (**PMR**) intake (Weisbjerg and Munksgaard,

Received February 22, 2018.
Accepted May 1, 2018.
[1] Corresponding author: juliec.henriksen@anis.au.dk

2008). To the best of our knowledge, only Bach et al. (2007) included feeding behavior in a study comparing the effects of concentrate allowance, and those authors showed that a high concentrate allowance resulted in a slower PMR eating rate without affecting the daily PMR eating time. Therefore, we expected a decrease in PMR intake might be followed by a decrease in PMR eating time or a change in the eating rate, thus allowing more time for lying down. Additionally, as a previous study has shown that a more preferred type of concentrate can increase milking frequency (Madsen et al., 2010), our hypothesis was that a more preferred concentrate type may result in similar effects on the responses of the cow as increased concentrate allowance. At last, because cows are adapting to changes in the ration during periods of adjustments in concentrate allowance, we expected that the responses of the cows would show greater variation during periods of changes in concentrate allowance than during periods of constant concentrate allowance. Therefore, the aim of our study was to investigate the short-term responses in production and behavior of dairy cows in an automatic milking system during periods of increased and decreased concentrate allowance, including 2 concentrate types expected to differ in preference.

MATERIALS AND METHODS

Experimental Facilities and Animals

The experiment was conducted at the Danish Cattle Research Center using an automatic milking system (DeLaval AB, Tumba, Sweden) with free cow traffic. The barn had a slatted floor covered with rubber in the waiting area in front of the AMU and cubicles with mattresses; a mixture of cut rapeseed straw and sawdust was used as bedding. The experiment included 48 Danish Holstein (**DH**) cows in a group of 58 cows, on average (minimum = 54; maximum = 64), and 48 Danish Jersey (**DJ**) cows in a group of 59 cows, on average (minimum = 56; maximum = 61). Each group had access to 1 AMU. The AMU system recorded the amount of concentrate allocated to each cow and was equipped with a device for weighing individual concentrate leftovers. The maximum output of concentrate was set according to the treatment, and the allowance was divided on an hourly basis and allocated at each visit. The concentrate was allocated at a rate of 500 g/min, allowing a maximum of 50% of the daily allowance per visit. The AMU could save up to 50% of the daily allowance for the next day. The concentrate feeder in the AMU was calibrated every second week. Each AMU had a weighing platform to record the BW of the cow at each milking (Danvaegt, Hinnerup, Denmark). The cows had free access to water and were fed the PMR for ad libitum intake in feed bins for automatic recording of individual feed intake (**RIC**; Insentec Roughage Intake Control system, Insentec BV, Marknesse, the Netherlands). The PMR fed in these feed bins had a concentrate-to-forage ratio of 35:65. All feed bins in each section were available to all cows, with 28 feed bins in the DH section and 25 feed bins in the DJ section. The PMR was mixed once a day in a mixer wagon, and the feed bins were refilled with the PMR 4 times/d and emptied for leftovers 3 times/wk.

Experimental Design

The experiment had a crossover design with a 2 × 2 factorial arrangement, including 2 types of concentrates and 2 amounts of concentrates (3 vs. 6 kg; Table 1). The experiment was carried out over a period of 11 wk, including a shift in concentrate type after wk 6. Concentrate type S was a pelleted concentrate, and concentrate type O was a mix of pelleted concentrate and steamrolled, acidified barley. In a previous study, cows showed a higher preference for concentrate type O compared with concentrate type S (Primdal et al.,

Table 1. The 8 orders of treatments, including 2 levels of concentrate amount[1] and 2 concentrate types[2] during constant concentrate allowance, increase in allowance, and decrease in allowance[3]

Week	1	2	3	4	5	6	7	8	9	10	11
1	S3	S3	S↑6	S6	S↓3	S3	O3	O3	O↑6	O6	O↓3
2	S3	S3	S↑6	S6	S↓3	S3	O↑6	O6	O↓3	O3	O↑6
3	S↑6	S6	S↓3	S3	S↑6	S6	O↓3	O3	O↑6	O6	O↓3
4	S↑6	S6	S↓3	S3	S↑6	S6	O6	O6	O↓3	O3	O↑6
5	O3	O3	O↑6	O6	O↓3	O3	S3	S3	S↑6	S6	S↓3
6	O3	O3	O↑6	O6	O↓3	O3	S↑6	S6	S↓3	S3	S↑6
7	O↑6	O6	O↓3	O3	O↑6	O6	S↓3	S3	S↑6	S6	S↓3
8	O↑6	O6	O↓3	O3	O↑6	O6	S6	S6	S↓3	S3	S↑6

[1]3 = 3 kg/d; 6 = 6 kg/d.

[2]S = concentrate type S (pelleted concentrate); O = concentrate type O (mix of pelleted concentrate and steamrolled, acidified barley).

[3]↑ = increase in concentrate allowance; ↓ = decrease in concentrate allowance.