Relationship between Early Lactation BCS and Mid-Lactation Feed Efficiency in Dairy Cattle

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Lydia Hardie, Graduate Student;
Diane Spurlock, Associate Professor,
Department of Animal Science

Summary and Implications

The relationships between body condition score (BCS) observed during the first 45 days of lactation and two measures of feed efficiency, residual feed intake (RFI) and gross efficiency (GE) defined as milk energy / DMI, measured during mid-lactation were assessed in 255 first lactation Holstein cows. No significant differences in BCS at calving and at approximately 40 days in milk (DIM) nor in BCS loss during the first 25 and first 45 DIM were observed between the most feed efficient and feed inefficient cows when either RFI or GE was used as the measure of feed efficiency. However when feed efficiency was measured as GE, feed efficient cows had significantly lower BCS at 40 DIM. Our findings suggest that selection based on RFI as a measure of feed efficiency during mid-lactation should not impact BCS loss during early lactation.

Introduction

Feed efficiency, especially during mid-lactation when the cow is at peak feed intake and milk production, is becoming an increasingly important trait when selecting profitable dairy cows. However, there is the concern that selecting for a more feed efficient cow may inadvertently select for cows that undergo extreme body tissue loss to meet the demands of milk production. By measuring feed efficiency as RFI while accounting for BCS, we can keep feed efficiency phenotypically independent of body tissue change during the measurement period. However, this does not guarantee that feed efficiency will be unrelated to body tissue loss in early lactation when having adequate body tissue reserves is most critical for a smooth transition to lactation. The goal of this study was to determine if RFI measured in mid-lactation was related to early lactation BCS in Holstein cows. Additionally, we wanted to determine the relationship between early lactation BCS and the traditional measure of feed efficiency, GE, specifically milk energy produced per kg DMI.

Materials and Methods

Weekly BCS up to 45 days in milk (DIM) were observed on all first lactation Holstein cows at the Iowa State University dairy farm from 2012 to 2014. Shortly thereafter, starting 50 to 110 days in milk, all clinically healthy cows had daily milk production measured and feed intake recorded using a Calan Broadbent feeding system for approximately 60 days. During this time, weekly body weights, BCS, and milk component data were also collected. In total 255 cows had all of these data recorded.

Early lactation BCS was predicted for days without observations. Four early lactation BCS traits were generated: average daily change in BCS during the first 25 DIM, average daily change in BCS during the first 45 DIM, BCS at calving—measured as the average predicted BCS for DIM 3 through 5, and BCS post-transition period—measured as the average predicted BCS for DIM 41-43. RFI was calculated as the error term in the regression of dry matter intake (DMI) on milk energy, change in body energy, which accounts for changes in BCS and body weight, and metabolic body weight. Fixed effects of replicate and DIM were included. GE was calculated as the ratio of milk energy over DMI, corrected for replicate and DIM. The relationships between feed efficiency and the early lactation BCS traits were assessed individually using a mixed model. Differences in the early lactation BCS traits were assessed for the 25 most and 25 least feed efficient cows, defined using RFI or GE.

Results and Discussion

RFI for the 25 most feed efficient cows ranged from -4.47 to -1.66 kg/d and RFI for the 25 least feed efficient cows spanned form 1.54 to 5.33 kg/d. As expected, daily mean milk energy output, metabolic body weight, and change in body energy did not differ between RFI efficiency group (Table 1). Daily DMI significantly differed between the two RFI groups, with efficient RFI cows eating an average of 18.9 kg per day and inefficient RFI cows eating 23.7 kg/d. In contrast, feed efficient cows defined by GE produced significantly more milk, were smaller, gained less body weight, and carried less body condition during mid-lactation compared to the inefficient GE cows. However they only tended to eat less feed suggesting that more of the energy for milk production came from body tissue reserves. The average BCS at calving, average BCS loss during the first 25 DIM, and average BCS loss during the first 45 DIM did not differ between feed efficiency groups for either measure of feed efficiency. For RFI, this is reflected in the nearly parallel lines denoting the daily predicted BCS for each group in Figure 1a. Conversely, BCS at 40 DIM significantly differed between feed efficient and feed inefficient cows defined by GE, with feed efficient cows having an average BCS of 3.20 and feed inefficient cows 3.42. From this study, we conclude that cows differing in efficiency measured as RFI during mid-lactation will likely not experience differences in BCS or BCS change during early lactation, whereas cows considered feed efficient

based on GE might experience increased mobilization of body tissues. Thus, the use of RFI measured in mid lactation as a selection tool for feed efficiency should not adversely impact cows during the transition period.

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Table 1. Means for feed efficient and feed inefficient cows defined by residual feed intake (RFI) or gross feed efficiency (milk energy per kg DMI, GE).

	RFI				GE			
	Efficient(n=25)		Inefficient (n=25)		Efficient (n=25)		Inefficient (n=25)	
Trait	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Early lactation								
BCS at calving (4 DIM)	3.91	0.079	3.80	0.079	3.87	0.078	3.66	0.078
Change in BCS - 25 DIM , /d	-0.019	0.0032	-0.018	0.0032	-0.019	0.0029	-0.015	0.0029
Change in BCS - 45 DIM , /d	-0.015	0.0024	-0.014	0.0024	-0.016	0.0021	-0.011	0.0021
Post-transition BCS (42 DIM)	3.33	0.082	3.28	0.082	3.20*	0.063	3.42*	0.063
Mid-lactation								
Milk energy, Mcal/d	26.9	0.71	26.5	0.71	29.4***	0.66	22.4***	0.66
Metabolic body weight, kg^0.75	121	1.7	122	1.7	115***	1.6	124***	1.6
Change in body weight, Mcal/d	2.6	0.41	3.0	0.41	1.7***	0.32	3.5***	0.32
BCS	3.31	0.084	3.26	0.084	3.06***	0.079	3.58***	0.079
Dry matter intake, kg/d	18.9***	0.41	23.7***	0.41	19.6†	0.52	21.0†	0.52

†P < 0.10, *P < 0.05, **P < 0.01, ***P < 0.001

Figure 1: Mean predicted BCS for feed efficient and feed inefficient cows defined by residual feed intake (1a) or gross feed efficiency (milk energy per kg DMI, 1b).