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The use of indicators to assess the degree of mobilisation of body reserves in dairy cows in early lactation on a pasture-based diet

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Abstract

The accuracy of predicting energy balance (EB) using various milk, blood, and other indicators was determined in 23 Holstein–Friesian cows that were grazing pasture in very early lactation. The concentration of milk acetone was negatively correlated (r=−0.64) with EB (p<0.05) as were β-hydroxybutyrate 6 (BHBA) (r=0.76) and non-esterified fatty acids (r=0.56) in plasma, age (r=−0.49), and mean liveweight (r=−0.46). The concentration of plasma glucose was positively correlated (r=0.79) with EB (p<0.05) as were insulin-like growth factor-1 (IGF-1) (r=0.57) in plasma and change in liveweight (r=0.39). The best prediction model for EB included plasma glucose and plasma BHBA (r=0.84). Milk acetone alone (r=0.64) formed the best prediction model as an 'on-farm' indicator.

Milk acetone concentration was correlated (r=0.89) with plasma BHBA so that a milk acetone concentration of 0.14 mmol/L was equivalent to a blood BHBA concentration of 1.2 mmol/L (critical level for identification of cows with sub-clinical ketosis). The relationship between plasma glucose and IGF-1 was curvilinear with levels of IGF-1 rapidly increasing above a plasma glucose concentration of 3.2 mmol/L. Body condition score (BCS) converged to 4 (scale 1–8) post-partum with the loss increasing rapidly when BCS at calving was above 5.5.

The results of this study confirm that milk acetone may be an accurate and practical indicator for estimating EB of cows in early lactation on a predominantly pasture-based diet. Where cows may be sampled on a once-off basis, plasma glucose and plasma BHBA together explain a large portion of the variation in EB.

Keywords: Energy balance; Dairy; Pasture; Acetone

1. Introduction

A number of studies have shown that excess mobilisation of body reserves or 'negative energy balance' (NEB), resulting from the energetic demands

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of milk production in early lactation, is associated with a decline in reproductive performance (Lucy, 2001). The degree of mobilisation of reserves has been shown to be positively related to genetic merit for production under feedlot conditions in the Northern Hemisphere (Harrison et al., 1990) and predominantly grazing conditions in Australia (Fulkerson et al., 2001). In view of the substantial increase in genetic merit in the Australian dairy herd over recent decades, and anecdotal evidence for a drop in reproductive performance, little research has been undertaken locally on the mobilisation of body reserves for cows in early lactation. The difficulty in obtaining intake and in vivo digestibility of feed for cows grazing pasture, required to estimate energy balance (EB) for individual cows in a pasture-based system, would be one reason for the lack of research. The *n*-alkane technique, described by Dove et al. (1991), allows pasture intake and in vivo digestibility to be determined for individual cows.

Studies with cows fed a total mixed ration (TMR) (Villa-Godoy et al., 1988) or grazing pasture (C. Clark, unpublished data) have shown similar, and relatively large, between-cow variation in EB (+4.2 to −25.2 MJ/cow day and +10 to −26 MJ/cow day, respectively) at a similar level of production (about 30 L of 4% fat corrected milk (FCM)/cow day)). Thus, given the low heritability of fertility in dairy cows (Roxtrom et al., 2001), the reasonable variation in NEB, and that the predominant cause of low fertility is believed to be due to excess NEB, it would seem important to be able to accurately monitor EB. This 'monitoring' would enable more appropriate management of cows in a state of excess NEB and/or enable selection of cows that do not mobilise excess body reserves in early lactation.

The only practical indicators available on-farm to assess NEB in dairy cows are changes in body condition score (BCS), and, to a lesser extent, changes in liveweight. However, liveweight change (LWC) is too imprecise to flag excess mobilisation of reserves (Sutter and Beever, 2000) being affected by many variables, including gut fill (Moe et al., 1971). The subjective measurement of BCS (scale of 1–8, Earle, 1976; or scale of 1–5, Mulvany, 1977) and the large increments of BCS change are not sufficiently sensitive for short-term, accurate identification of NEB.

Metabolites derived from the mobilisation of body reserves in blood, or preferably in milk, may be more appropriate indicators of NEB in the dairy cow grazing pasture. Potentially useful metabolites in blood include: leptin, non-esterified fatty acids (NEFA), β-hydroxybutyrate (BHBA), and insulin-like growth factor-1 (IGF-1); and in milk: acetone, urea, protein, fat or lactose content, and the ratio of milk fat to protein content (Gravert et al., 1986; Heuer et al., 2000; Reist et al., 2002).

The objective of the present study was to quantify the variation in EB between cows at similar levels of milk production, under a pasture-based system of farming, and subsequently identify appropriate indicators of the degree of mobilisation of body reserves in dairy cows to develop a model to predict EB for cows in early lactation.

2. Materials and methods

This study was conducted at the Elizabeth Macarthur Agricultural Institute (EMAI) (Menangle, NSW, Australia) between August 25 and September 26, 2003. The experimental period during which intense monitoring was undertaken was over a 10-day period between September 16 and 26, 2003.

2.1. Details of cows in this study

The 23 multiparous Holstein–Friesian cows used in this study were selected to calve between August 25 and September 11, 2003. The mean (±S.E.) (range) on September 16 for: days in lactation was 7(±1) (0–22) days, BCS was 5(±1) (4.6–5.6) (scale of 1–8), liveweight was 536±(10) (467–620) kg, and age was 5(±1) (3–12) years.

2.2. Feed allocation and pasture intake

Until calving, cows were fed 2 kg of proprietary dairy pellets (as fed)/cow.day, 2 kg of lucerne chaff (as fed)/cow.day, and sufficient short rotation ryegrass (*Lolium multiflorum*) pasture to meet the herd's maintenance metabolisable energy (ME) requirements. After calving, cows were fed 4 kg of proprietary dairy pellets (as fed)/cow day, 2 kg of lucerne chaff (as fed)/cow day, and ryegrass pasture according to the group's