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Long-term oral drenching of crude glycerol to primiparous dairy cows in early lactation

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ABSTRACT

The objective of this experiment was to study the long-term effects of supplemental oral drenching of crude glycerol (CG) on feed intake, milk yield and composition, plasma metabolites and energy balance indices of primiparous dairy cows in early lactation. Fourteen primiparous Holstein dairy cows were paired according to body weight (BW) and body condition score (BCS) at calving, and allocated at random to either a treatment or a control group. Both groups were fed a basal diet, containing 11.4 MJ kg^{-1} DM metabolisable energy and 103 g/kg DM metabolisable protein, twice a day. Silage (*ad libitum*) and a pelleted concentrate mixture with mineral mix were fed separately during the three six-day periods from days 4 to 21 *post partum*. An oral drench of 500 ml of CG mixed with lukewarm water was fed supplementally before the morning feedings to the treatment groups, while the control group were given no oral drench. Blood samples were collected on two consecutive days at the end of each six-day period before administration of glycerol. Results showed that long-term administration of CG increased silage intake ($P<0.001$), and total dry matter intakes (DMI; $P=0.023$). Oral drenching with glycerol increased milk yields ($P<0.01$), and milk lactose content ($P<0.001$). Supplemental glycerol had no effect on estimates for milk energy, milk constituent ratios or milk acetone content. No differences in BCS changes or on concentrations of plasma glucose, insulin, and β-hydroxybutyrate (BHB) were found between the two groups. Dairy cows given oral glycerol had lower concentrations of plasma urea ($P=0.005$) during the *post partum* period. There was a treatment and time interaction effect on the non-esterified fatty acids (NEFA) concentration ($P=0.048$), although this was complex, and the only period of significant differences was in the first six-day period, when NEFA concentration was higher ($P=0.025$) in the control group. The data indicate that prolonged oral drenching of supplemental CG in the early lactation period improves total DMI, and therefore has a positive effect on milk yield of primiparous dairy cows in this period.

Abbreviations: ADF, ADF expressed inclusive of residual ash; BCS, body condition score; BW, body weight; CG, crude glycerol; DIM, days in milk; DMI, dry matter intake; DM, dry matter; BHB, β-hydroxybutyrate; aNDF, NDF assayed with a heat stable amylase and expressed inclusive of residual ash; NEB, negative energy balance; NEFA, non-esterified fatty acids; TMR, total mixed ration.

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1. Introduction

Early lactation is the most critical period of lactation, associated with reduced dry matter intakes, and increased energy and glucose demands for milk secretion (Grummer, 1993). As the energy intake does not meet the energy requirements a negative energy balance may occur, and hence fatty acid mobilisation from adipose tissue increases. Transition dairy cows have increased requirements for glucose, by the mammary gland, to support lactose synthesis (Overton and Waldron, 2004). In practice, several glucogenic substances are thought to increase the supply of glucose and therefore improve the metabolic status of the periparturient cow (Ingvartsen, 2006). Several studies have shown glycerol to be a potential glucogenic feed additive, increasing the proportion of propionic acid in the rumen of dairy cows (DeFrain et al., 2004; Linke et al., 2004; Carvalho et al., 2011). Elevation of glucose concentration alone (Goff and Horst, 2001), or together with insulin concentration (Linke et al., 2004), have been reported after drenching large amounts of glycerol *via* an oesophageal pump (Goff and Horst, 2001) or orally (Linke et al., 2004). Earlier studies (Johnson, 1951; Fisher et al., 1971) have also indicated that glycerol can be used as an appetite stimulant, thus alleviating the potential risk of ketosis and also improving milk yield and blood glucose concentrations.

To study the effect of glycerol supplementation on dairy cow performance different administration strategies have been used. Glycerol has been fed to transition cows (DeFrain et al., 2004; Ogborn, 2006), early lactation cows (Chung et al., 2007; Wang et al., 2009), and mid-lactation dairy cows (Khalili et al., 1997; Donkin et al., 2009) to improve DMI and milk performance. Glycerol has been either fed top-dressed (Chung et al., 2007; Lomander et al., 2012a), added to the total mixed ration (TMR; DeFrain et al., 2004; Wang et al., 2009) or orally drenched (Goff and Horst, 2001; Ogborn, 2006) to dairy cows to alleviate the symptoms of negative energy balance (NEB) or improve fertility (Lomander et al., 2012b) at transition period or in early lactation. Multiparous Holstein dairy cows are more vulnerable to metabolic disorders, as they mobilise significantly more body energy in early lactation (Friggens et al., 2007), therefore more attention has been paid to them. It is nevertheless important to know the effects on younger cows, who additionally partition their energy for growth, and this experiment was designed to focus on such animals in the *post partum* period.

There are limited data in the literature regarding the long-term oral drenching of glycerol for a period longer than five days, and effects on primiparous cows. The hypotheses were that long-term oral drenching of glycerol improves lactation performance and indices of energy status of primiparous dairy cows. The objectives of this experiment were to study the effects of orally administered crude glycerol on feed intake, milk yield and composition, indices of energy status and blood parameters of primiparous dairy cows throughout the first three weeks of lactation.

2. Materials and methods

2.1. Animals and experimental design

The study was carried out on Eerika Experimental Farm (Märja 61406, Estonia) of the Estonian University of Life Sciences. Fourteen primiparous Holstein dairy cows were involved in the study, from days four to 21 of lactation; which was divided into three six-day periods. The cows were tethered in individual stalls, bedded on rubber mats, and they were milked and sampled in their stalls. Stratified random sampling was used to pair cows, according to body weight and body condition score (using the system proposed by Edmonson et al., 1989) at calving, into either a treatment or a control group (Fig. 1). The mean BWs (mean ± SD) were 557.6 ± 38.0 kg for the control and 551.3 ± 42.1 kg for the treatment group cows at the beginning of the experiment (P=0.50, pairwise *t*-test); the mean BCSs at parturition were 3.46 ± 0.09 and 3.46 ± 0.20 (P=1.00, pairwise *t*-test), respectively. Experimental procedures were performed as licensed under the regulations of the Ethics Board of the Estonian Ministry of Agriculture for experiments with live animals.

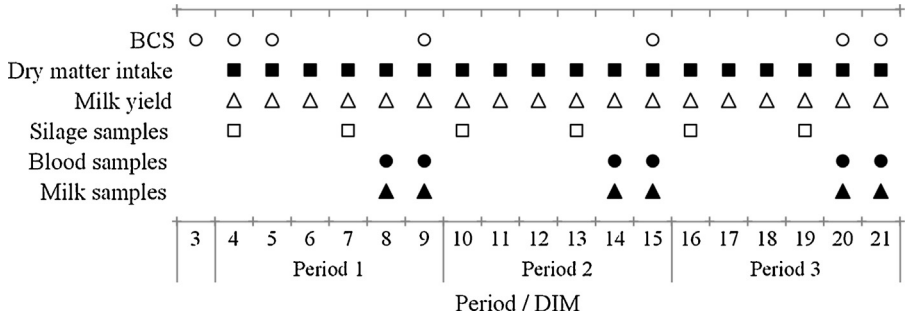

Fig. 1. Measurement and sample collection days of different parameters. BCS, body condition score; DIM, days in milk.