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Effects of glycerol on lactation performance, energy balance and metabolites in early lactation Holstein dairy cows

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ABSTRACT

The objective was to evaluate effects of glycerol supplementation on feed intake, milk yield and milk composition, blood metabolites and energy balance in Holstein dairy cows from 4 to 63 days in milk (DIM). Thirty-six multiparous cows, blocked by lactation number, previous 305 day mature equivalent milk production and expected calving date, were arranged into four groups in a randomized block design. Treatments were: control (without glycerol), glycerol-low (LG), glycerol-medium (MG) and glycerol-high (HG) with 100, 200 and 300 g glycerol per cow per day, respectively. The supplement of food grade glycerol (0.998 g/g glycerol) was hand-mixed into the top one-third of the daily ratio. Cows were fed *ad libitum* a total mixed ratio consisting of equal proportions of forage and concentrate. Feed intake, milk yield and its components were not affected by glycerol supplementation. The energy balance, expressed as differences between energy input NE_I and output ($NE_M + NE_L$) in MJ per cow per day, was higher ($P < 0.04$) as glycerol supplementation level increased, especially during the first 17 and last 20 days of the 63 day period. Glycerol-supplemented cows tended ($P < 0.06$) toward less loss of BW, especially first 17 and last 20 days of the 63 day period. Concentrations of glucose in plasma were higher for cows fed glycerol relative to control (54.1 mg/dL *versus* 58.1 mg/dL, respectively) and linearly increased

Abbreviations: ADF, acid detergent fibre; BHBA, beta-hydroxybutyrate; BW, body weight; CP, crude protein; DIM, day in milk; DM, dry matter; NDF, neutral detergent fibre; NEFA, non-esterified fatty acids; NE, net energy; NE_M, net energy required for body maintenance; NE_L, net energy required for lactation; TMR, total mixed ratios.

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($P < 0.01$) with increasing glycerol supplementation level. Concentrations of non-esterified fatty acids, beta-hydroxybutyrate and urine ketones were lower for glycerol-supplemented cows at 7, 14 and 21 days of lactation and linearly ($P < 0.01$) decreased with increasing glycerol supplementation. Although milk yield and feed intake were not affected, glycerol-supplemented cows has a more positive energy status (higher concentrations of plasma glucose, lower concentrations of plasma beta-hydroxybutyrate, lower concentrations of urine ketones), suggesting that net energy availability may have been increased.

1. Introduction

Satisfying the nutritional requirements of high producing dairy cows can be a challenge. Feed dry matter (DM) intake may decrease as much as 30% during the week before calving (Bertics et al., 1992) and cows often continue to be in a negative energy balance during the first 5 week of lactation. Because of the frequent inability to overcome the DM intake depression, producers often use oral drenches and pastes to provide glucose precursors to prevent ketosis and other metabolic disorders.

Glycerol is an important structural component of triglycerides and phospholipids, and its glucogenic propertys are well established (Cori and Shine, 1935). Glycerol enters the metabolic pathway to glucose at a different step than other glucogenic precursors (Leng, 1970). Thus, when cows use body fat reserves as a source of energy, glycerol and fatty acids are released into the bloodstream. The glycerol component can be converted to glucose by the liver or kidneys (Krebs and Lund, 1966) to provide energy for cellular metabolism. Glycerol has been shown to be an effective treatment against ketosis in dairy cattle (Leng, 1970). Cows fed glycerol at 374 g/d lost less body weight (BW), and remained in more positive energy balance, than those fed 174 g/d glycerol (Fisher et al., 1973). Bodarski et al. (2005) reported increased milk production of 14.6 and 12.5%, respectively, for cows fed glycerol at 300 and 500 ml/day over 10 weeks of lactation, and feeding glycerol increased the ratio of acetate to propionate in the rumen without altering digestibility in the total tract (Remond et al., 1993; Schröder and Südekum, 1999). However, other studies showed no improvement in milk production (DeFrain et al., 2004; Ogborn, 2006) or inhibition of growth and cellulolytic activity of ruminal bacteria (Roger et al., 1992; Paggi et al., 2004). Glycerol also reduced the proteolytic activity of bovine rumen fluid by about 20% when concentrations of glycerol in the medium ranged from 50 to 300 mM (Paggi et al., 1999).

As glycerol supplies become higher due to increasing biodiesel production as a renewable energy resource, information on feeding values of glycerol in ruminants are needed. The aim of this study was to evaluate effects of glycerol supplementation on feed intake, milk yield and composition, blood metabolic profiles and energy balance in early lactation Holstein dairy cows.

2. Materials and methods

2.1. Animals and expeirmental design

Thirty-six multiparous Holstein dairy cows, 620 ± 17.2 of BW and 8491 ± 370.3 kg of milk from the previous lactation were used during d 4–63 of lactation. Cows were blocked by lactation number, previous 305 day mature equivalent milk production and expected calving date and were arranged into four groups in a randomized block design. Treatments were: control (without glycerol), LG, MG and HG with 100, 200 and 300 g glycerol fed per cow per day, respectively. The supplement of food grade glycerol (0.998 g/g glycerol, Yangxi Spice Factory, Guangdong, China) was purchased commercially and hand-mixed into the top one-third of the daily ratio. Cows were housed in a naturally ventilated tie-stall barn after calving and allowed to exercise for 2 h in an open dry lot before each milking. Cows were milked three times daily at 06:00, 14:00 and 21:00 h and were fed *ad libitum* a total mixed ratio