



## Comparing the effects of $\beta$ 1-4 galacto-oligosaccharides and L-cysteine to monensin on energy and nitrogen utilization in steers fed a very high concentrate diet

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### Abstract

Effects of including monensin,  $\beta$ 1-4 galacto-oligosaccharides (GOS) or L-cysteine on nutrient digestibility, methanogenesis, rumen fermentation, blood metabolites, purine derivatives as well as energy and nitrogen utilization were investigated in steers fed a very high concentrate diet. Monensin was incorporated at 30 mg/kg concentrates, whereas L-cysteine was incorporated as L-cysteine hydrochloride at 1.56 g/kg of concentrate. Four Holstein steers were assigned in a 4 × 4 Latin square design in individual metabolism stalls. Dietary treatments were (1) basal diet consisting of 200 g/kg DM mixed hay and 800 g/kg DM concentrates; (2) same as basal diet but concentrates blended with monensin; (3) concentrates blended with L-cysteine; (4) GOS to replace 200 g of concentrate. Steers

*Abbreviations:* AA, amino acids; ADF, acid detergent fiber; ADL, acid detergent lignin; BW, body weight; CP, crude protein; DE, digestible energy; DM, dry matter; DMI, dry matter intake; DOMI, digestible organic matter intake; EMNS, efficiency of microbial nitrogen synthesis; GE, gross energy; GOS, galacto-oligosaccharides; MCR, methane conversion ratio; ME, metabolizable energy; MN, microbial nitrogen; N, nitrogen; NDF, neutral detergent fiber; NEFA, non-esterified fatty acids; OM, organic matter; ORP, oxidation reduction potential; PD, purine derivatives; PUN, plasma urea nitrogen; S.E.M., standard error of the mean; VFA, volatile fatty acids

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were fed ad libitum twice daily to allow 100 g/kg refusals. Steers fed L-cysteine blended diets had higher ( $P < 0.01$ ) acid detergent fiber (ADF) and cellulose digestibility than steers fed control diets. Ruminal pH was not affected by any treatment, although the oxidation-reduction potential (ORP) was higher ( $P < 0.01$ ) in steers fed GOS containing diets. Ruminal ammonia N was lower ( $P < 0.05$ ) in steers fed monensin diets versus steers fed control diets. Total volatile fatty acid (VFA) concentrations were higher ( $P < 0.05$ ) in steers fed L-cysteine containing diets versus steers fed control diets due to higher ( $P < 0.01$ ) acetate concentrations. Molar proportions of propionate were higher ( $P < 0.05$ ) in steers fed monensin-containing diet versus steers fed the control diet. However, microbial N supply, and the efficiency of microbial N synthesis (EMNS) were lower in steers fed monensin or L-cysteine containing diets versus steers fed the control diet. Plasma glucose concentrations were higher ( $P < 0.05$ ) in steers fed the monensin containing diet versus those fed the control diet. Energy retention per gross energy intake was higher ( $P < 0.01$ ) in steers fed the L-cysteine containing diet. Steers fed on supplemented diets had higher ( $P < 0.05$ ) retained N per N digested versus steers fed on control diets. Supplementation of L-cysteine and GOS has comparable effects on some physiological parameters, as does monensin in steers fed very high concentrate diets.

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*Keywords:* Monensin; L-cysteine; Galacto-oligosaccharides; High Concentrate; Steers

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## 1. Introduction

The ionophore monensin has been extensively studied in beef cattle and its effects on increased propionate production, decreased methanogenesis (Goodrich et al., 1984), decreased ruminal proteolysis (Bergen and Bates, 1984; Russell and Strobel, 1989) and increased feed efficiency (Goodrich et al., 1984) have been reported. Galacto-oligosaccharides (GOS) are prebiotics, which are non-digestible in non-ruminants but known to stimulate beneficial microbes in the gastrointestinal tract. Increased proportions of propionate (Santoso et al., 2003), and reduced methane production (Mwenya et al., 2004a, 2004b), have been observed in ruminants supplemented with GOS. Sulfur is essential to ruminants as a vital constituent of the amino acids cysteine, cystine and methionine, the vitamins thiamin and biotin, as well as some enzymes. The sulfur containing amino acid, L-cysteine has been known to reduce methanogenesis in sheep (Takahashi et al., 1997).

The objective of the present study was to compare effects of galacto-oligosaccharides and L-cysteine to monensin on rumen fermentation, blood metabolites, purine derivatives, methanogenesis as well as on energy and N utilization in steers fed a very high concentrate diet.

## 2. Materials and methods

### 2.1. Animals and their management

Four Holstein steers with an initial live weight  $291 \pm 11$  kg were used in a  $4 \times 4$  Latin square treatment design. Steers were fitted with stanchions in four individual metabolism stalls in a monitor room with rubber-padded concrete flooring under controlled temperature ( $21 \pm 2$  °C). The metabolism stalls were equipped with electrical powered mechanical

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