Short communication

Effect of a yeast culture (*Saccharomyces cerevisiae*) and monensin on ruminal fermentation and digestion in sheep

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Abstract

A metabolism trial was conducted to evaluate the effects of supplying a yeast culture containing *Saccharomyces cerevisiae* (Levucell) and monensin to sheep, on ruminal fermentation and digestibility of diets. Four Suffolk sheep (30 kg BW) with ruminal cannula were used in a Latin Square design, where treatments were control (C), 1 g/day of Levucell (L, 20 × 10⁹ CFU/g), 25 mg/day of monensin (M) and a combination of L and M. Additives were dosed directly into the rumen. The diet was based on alfalfa hay (50%) and a concentrate containing sorghum grain (60%), molasses (24%), urea (2%) and soybean meal (14%). Digestibility of dry matter, neutral detergent fiber, and dry-matter intake were not affected (p > 0.05) by treatments. The ionophore alone or in combination, reduced (p < 0.05) the molar proportion of acetate from 71.2 to 66.2, and increased propionate from 18.6 to 24.4 without any effect on butyrate. Ruminal protozoa counts (organisms ×10⁴) were greater (p < 0.05) in the control group (69.4) than with feed additives (15.9–39.7). No effects were detected in ruminal pH. Monensin and M + L increased propionate proportion, but no effects was observed with *S. cerevisiae* alone. © 2000 Elsevier Science B.V. All rights reserved.

Keywords: Yeast culture; *Saccharomyces cerevisiae*; Monensin; Rumen fermentation; Digestion

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1. Introduction

Ruminal fermentation has been manipulated with different feed additives, including microbial products and ionophores, to improve animal production (Wallace, 1994). Results with *Saccharomyces cerevisiae* have been variable and inconsistent (Mir and Mir, 1994; El Hassan et al., 1996). In contrast, monensin effects are more consistent in high-grain diets and rumen fermentation patterns (Sauer et al., 1998; Lana et al., 1997).

A diet with yeast culture has improved body weight in lambs (Mendoza et al., 1996) using monensin, and in steers (Mir and Mir, 1994) that received lasalocid. The t-malic acid present in the *S. cerevisiae* stimulates growth and lactate uptake by *Selenomonas ruminantium* (Nisbet and Martin, 1991). Combinations of dicarboxylic acids with monensin produced more propionate, less lactate and increased final pH (Martin, 1998), suggesting that combinations of both the additives may improve ruminal fermentation. This trial was designed to evaluate the combination of a yeast culture (*S. cerevisiae*; Levucell) and monensin, on ruminal fermentation and digestibility in sheep.

2. Materials and methods

Four Suffolk sheep (30 kg BW) equipped with ruminal cannulas were randomly distributed in a 4 x 4 Latin square design. Treatments were control (C), 1 g/day of Levucell (L, 2 x 10^9 CFU/g), 25 mg/day of monensin (M) and a combination of L and M. The additives were dosed daily directly into rumen. Basal diet contained (dry basis) 50% alfalfa and 50% concentrate (17% CP) with sorghum grain (30%), molasses (12%), urea (1%) and soybean meal (7%). A mineral premix was offered ad libitum during the trial (Ca 10%, P 12%, S 1.5%, Mg 2%, K 2%, Co 0.0015%, Cu 0.07%, Fe 0.15%, I 0.005%, Mn 0.25%, Se 0.0008%, Zn 0.25%). Diet contained 14.2% CP, 56.6% NDF and 47.0% ADF.

Sheep were fed ad libitum during the adaptation period (12 days) and then restricted during the collection period (6 days) at 90% of the intake feed that was offered at 7:00 and 16:00 h. Ruminal fluid samples were collected at 4 and 8 h after feeding. Fluid pH was measured immediately after sampling and 50 ml of the ruminal fluid was acidified with 1 ml of HCl 6 N, and stored in a freezer (−20°C) for further analysis. Volatile fatty acids (VFA) were determined by gas chromatography in samples prepared with metaphosphoric acid (Erwin et al., 1961). Ammonia-N was measured by the indophenol method (McCullough, 1967). A ruminal fluid sample was also used to count protozoa, mixing 5 ml of ruminal fluid with a 5-ml iodine solution (Coleman, 1978) -stored at 10°C and counted per ml of ruminal fluid with a hemocytometer.

Chromic oxide was dosed intraruminally (1 g/day) and fecal grab samples were collected during 4 days as recommended by Stock et al. (1987). Feed and fecal samples were oven-dried (55°C, 24 h) and ground to pass through a 1-mm screen and composited. Dry matter, organic matter and nitrogen were analyzed by standard methods (AOAC, 1984). Neutral detergent fiber (NDF) was determined by procedures outlined by Van
Soest et al. (1991). Chromium was measured by atomic absorption spectroscopy (Williams et al., 1962).

Data were analyzed as a 4 × 4 Latin square design with factorial arrangement 2 × 2 (Steel and Torrie, 1980) and means were compared using the Tukey test when interaction L × M was significant (SAS Institute Inc., 1985).

3. Results and discussion

Dry-matter intake was not affected (p > 0.05) by treatments (Table 1). A reduced intake with monensin is usually observed in high-grain diets (Lana et al., 1997; Purvis and Whittier, 1996); however, in forage diets results have been inconsistent (Vagnoni et al., 1995; Galloway et al., 1993). Monensin alone or in combination with yeast culture reduced voluntary intake in diet with 50% concentrate and 50% corn stover (Mendoza et al., 1996). The reduction on intake could be associated with the magnitude of changes in fermentation patterns. It has been shown that propionate is a metabolite involved in the regulation of intake in the central nervous system (Fisher, 1996).

In some experiments S. cerevisiae yeast culture has increased DM intake of rations with 50–60% forage and 50–40% concentrate (Plata et al., 1994; Williams et al., 1991) and has been associated with changes in digestibility (Wallace, 1994), however, in other assays intakes were not affected (Avendáño et al., 1997).

Digestibility of DM and NDF was not affected by the feed additives (Table 1). Vagnoni et al. (1995) observed a decrease with monensin in the potential extent of DM and NDF disappearance of Bermuda grass hay, but the effects on fractional rate of digestion were not consistent. In another study, Surber and Bowman (1998) working on high-concentrate
diets detected only a reduction in ruminal digestion of nitrogen, without changes in other nutrients. Other studies show no effect of monensin on digestibility of nutrients in different forages (Dinius et al., 1976; Galloway et al., 1993). Results from Van Nevel and Demeyer (1977) showed that monensin does not affect cellulolytic bacteria, but it has a negative effect on microbial growth efficiency.

In some reports, the use of *S. cerevisiae* had no effect on nutrient digestibility (Avendaño et al., 1997; Hadjipanayiotou et al., 1997), whereas in other reports a positive response has been observed in vivo or in situ (Sommart et al., 1993; Plata et al., 1994). Results from Roa et al. (1997) indicate that the quality of the forage may determine the effects of yeast culture on NDF digestion; the higher the roughage quality the greater is the response. However, at this moment responses to yeast culture are unpredictable.

Ionophore alone or in combination with L, reduced (*p* < 0.05) molar proportion of acetate in comparison with the other treatments and increased propionate without effect on butyrate (Table 1). Research conducted under different dietary conditions has shown that the increment in propionate (Galloway et al., 1993; Vagnoni et al., 1995; Lana et al., 1997; Surber and Bowman, 1998) is associated with some toxic effects on Gram-positive bacteria (Van Nevel and Demeyer, 1977) and protozoa (Mendoza et al., 1993). Yeast did not influence VFA concentration and fermentation pattern as reported previously (Chademana and Offer, 1990; Flachowsky et al., 1992).

Ruminal protozoa counts were greater (*p* < 0.05) in the control group (69.4°) than in the treatments. Monensin has been reported to decrease numbers of protozoa (Mendoza et al., 1993). Results with *S. cerevisiae* have been inconsistent. In some studies, protozoa counts were elevated with *S. cerevisiae* (Plata et al., 1994), whereas in others they were reduced (Angeles et al., 1995), or remained unchanged (Miranda et al., 1996). Stimulatory effects of the yeast are probably associated with nutritional factors in cultures, such as L-malic acid (Nisbet and Martin, 1991), whereas negative effects might be associated with accumulation of ethanol in the medium (Bruning and Yokoyama, 1988).

Ruminal pH was not affected by *S. cerevisiae*. There are several studies where ruminal pH was unaffected by yeast supplementation (Angeles et al., 1995; Avendaño et al., 1997; Plata et al., 1994).

It has been reported that yeast culture stimulates growth of cellulolytic bacteria and improve anaerobiosis in the rumen (Wallace, 1994), whereas monensin reduces proteolytic activity, stimulates lactate-utilizing bacteria, and reduces methane production (Van Nevel and Demeyer, 1977; Schelling, 1984). It has been demonstrated that L-malic acid is one of the mechanism of action of the *S. cerevisiae* (Nisbet and Martin, 1991), and its combination with ionophore could decreased lactate production by monensin-sensitive bacteria and increase lactate utilization by the monensin-resistant *Selenomonas ruminantium* (Martin, 1998). Although some studies have shown a beneficial effect when ionophores are combined with *S. cerevisiae* (Mir and Mir, 1994; Mendoza et al., 1996), in our experiment, there was no evident advantage when both the additives were combined.

According to the results of this trial, supplementing sheep with a combination of *S. cerevisiae* and monensin had no effect on digestibility or ruminal fermentation. However, monensin alone or in combination, improved the fermentation pattern.
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References


