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Effect of a calcified-seaweed extract as rumen buffer on ruminal disappearance and fermentation in steers

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In the last 3 decades, steers with elevated daily weight gains have been fed diets with a relatively high concentration of grain Laving high concentration of rapidly fermentable carbohydrates that reduce rumen pH, degradation of structural carbohydrates, feed intake, and productivity (Soto-Navarro *et al*. 2000). The effects of ruminal buffers (salt, weak acid, oxide or hydroxide) able to neutralize acids and reduce drastic changes of rumen pH (Staples and Lough 1989) were variable, mostly due to the wide variety of conditions in which these were tested (Erdman 1988). Rumen buffers seem to improve feed efficiency of ruminants fed diets with high-grain concentration (Kennelly *et al*. 1999). In the last decade, new ruminal buffers have emerged such as calcified-seaweed extracts (CSE). Therefore, the objective of this study was to evaluate the effects of CSE on ruminal disappearance and fermentation of steers fed diets with 30% forage and 70% concentrate.

Holstein steers (3), weighing 450±15 kg were used in a crossover design within 2 periods. Each period lasted 15 days (10 day diet adaptation; 3 day *in sacco* disappearance; 2 day rumen fluids samples). The basal diet consisted of 30 g kg DM^{-1} forage (15 g kg DM^{-1} alfalfa hay, and 15 g kg DM^{-1} corn silo), and 70 g kg DM^{-1} concentrate (47 g kg DM^{-1} ground sorghum, 8 g kg DM^{-1} soybean meal, 7 g kg DM^{-1} molasses cane, 6.8 g kg DM^{-1} corn gluten, 1.2 g kg DM^{-1} vitamin and mineral premix). Corn silo was substituted in the basal diet to incorporate the rumen buffers.

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The experimental treatments were control (basal diet without ruminal buffer), 1g kg DM^{-1} sodium bicarbonate (SB), and 0.5 g kg DM^{-1} CSE. According to the manufacturer, CSE is from *Lithothamnium calcareum* with 28 g kg DM^{-1} Ca, 5 g kg DM^{-1} Mg, and 3 g kg DM^{-1} Cl. The 0.5 g kg DM^{-1} of CSE in the diet was previously evaluated by Marsh and Reeve (2006).

The steers were housed in individual pens where they had free access to fed and water. Feed was offered twice a day (8:00 and 20:00 h). Feed offered and refused was measured daily. Diets were sampled each experimental period and samples were composited. Feed samples were ground and passed through a 1 mm screen for chemical analysis, and passed through a 2 mm screen for *in sacco* disappearance trial. Diets were analyzed for dry matter (DM), crude protein (CP), ash (AOAC 2007), neutral detergent fiber (NDF), and acid detergent fiber (ADF) (Van Soest *et al*. 1991). Rumen disappearance of DM and NDF was measured as per Vanzant *et al.* (1998). Nylon bags (10 cm× 15 cm; pore size 50±10 mm) with 5 g DM of diet were incubated in rumen for 8, 16, 24, 48, and 72 h. To measure the soluble fraction of the diets, the content of the bags was rinsed with distilled water for 15 min. The DM and NDF were measured before and after the ruminal incubation. The DM was quantified at 65°C for 48 h. The NDF was measured by nearly infrared equipment.

Rumen fluids were collected at 1 h intervals, starting 1 h before diurnal fed (8:00 h) and finishing 10 h after it. The ruminal fluid pH was immediately measured with a portable pH meter. After 6 h of the diurnal meal, 4 ml of rumen fluid was collected and mixed with 1 ml of metaphosphoric acid 25% (4:1 dilution), cooled at 4°C and centrifuged (25 000 g ×, 4°C, 20 min). Volatile fatty acid (VFA) and ammonia N were determined by the Erwin *et al*. (1961) and McCullough (1967) procedures, respectively. The ruminal disappearance data were analyzed using the Ørskov and McDonald (1979) model. The fractions were calculated using the NLIN procedure de SAS (1999). The pH values and VFA were analyzed using the MIXED procedure de SAS (1999). Means

were compared by Tukey (SAS 1999), and differences were considered at P≤0.05.

Experimental diets contained 80.2% DM, 18.5% CP, 39.5% NDF, and 14.2% ADF. The pH of the ruminal fluids drastically reduced after morning feeding (Fig. 1) and continued for 4 h. pH values started to increase 4 to 5 h after feeding. The highest rumen pH values were at 10 h after feeding. This pattern of pH change was previously reported by Tucker *et al.* (1992). Rumen pH values of steers fed CSE were higher than control. Also, steers fed CSE had higher rumen pH values than steers fed SB, but it was more evident from 4 to 10 h after feeding. Similarly results with CSE were found by Cruywagen *et al.* (2007) and Calitz (2009) in dairy cows and steers. The mechanism of CSE to increase rumen pH is probably the same than SB such as the increase of water intake, dilution of acids and reduced production of propionate in rumen (Melo and Moura 2009). Our findings indicated that rumen pH values of steers fed SB were higher than control, but it was only observed when pH values were lower than 5.9. It may be partially due to the more effective buffer capacity of the sodium bicarbonate at ruminal fluid pH inferior to 6 (Kovacik *et al*. 1986). VFA concentrations and molar proportion of acetate, propionate and butyrate did not change.

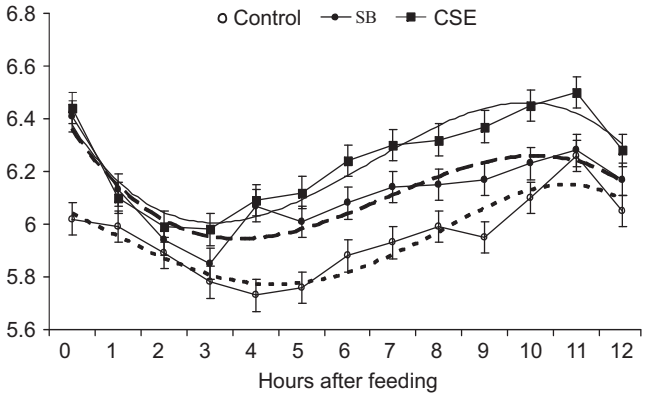

Fig. 1. Rumen pH values of steers fed diets with sodium bicarbonate (SB) or calcified-seaweed extract (CSE; P <0.05; SEM 0.06)

Both CSE and SB did not affect ruminal fermentation and ruminal disappearance of experimental diets as compared to control (Table 1). It is in agreement with previous studies (Tucker *et al*. 1992). Despite the positive effects of rumen buffers on pH values, there were no differences on fibre disappearance. It could be because the rumen pH values were not low enough to reduce fibre digestibility (McKinnon *et al*. 1990).

It is concluded that CSE increase rumen pH values in steers fed diets with 70% concentrate, but it did not improve the ruminal disappearance of fibre. Further research is needed to evaluate the CSE in ruminants fed diets with a feed grain proportion greater than 70%.

Table 1. Effect of sodium bicarbonate (SB) and calcified-seaweed extract (CSE) in rumen fermentation and disappearance of diets in steers

	Control	SB	CSE	SEM
Rumen characteristics				
Ammonia-N, mg/dL	28.5	33.3	39.5	1.01
Acetate, mol/100 mol	64.6	64.8	65.6	5.41
Propionate, mol/100 mol	21.3	19.8	19.9	3.89
Butyrate, mol/100 mol	14.1	15.4	14.5	2.07
Total VFA, mmol/L	108.1	97.8	93.9	9.99
Acetate : propionate	3.0	3.3	3.3	0.24
In sacco disappearance				
Dry matter fraction %				
Soluble (a) %	38.1	38.7	39.7	0.58
Potentially disappearing (b)	48.6	47.2	48.8	0.69
a + b	84.0	84.1	86.0	0.49
Disappearance rate (k) /h	4.2	4.4	4.4	0.09
NDF, %				
Potentially disappearing b	77.8	78.1	75.7	0.28
Disappearance rate (k) /h	2.2	2.3	2.7	0.08

SUMMARY

This study was conducted to evaluate the buffering effect of a calcified-seaweed extract (CSE) and its effect on ruminal disappearance and fermentation in steers. In a crossover design, 3 Holstein steers (450±15 kg body weight) fitted with permanent rumen cannula and fed diets with 30% forage and 70% concentrate were assigned to the following treatments: control (without buffer), 1% sodium bicarbonate (SB), and 0.5% CSE. Rumen pH values of steers fed CSE were higher than control and SB. However, buffers did not affect the ruminal disappearance kinetics and fermentation in steers fed diets with 30% and 70% concentrate. Further research is needed to evaluate the CSE in ruminants fed diets with a feed grain proportion greater than 70%.

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