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Short communication

Effects of slow-release urea and molasses on ruminal metabolism of lambs fed with low-quality tropical forage

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ABSTRACT

The effects of two sources of slow-release urea (SRU) with a source of soluble carbohydrates on ruminal fermentation in lambs fed with a low-quality forage hay were evaluated. Optigen is a commercial source of slow-release urea, whereas Surelease is an ethyl cellulose-coated urea prepared in the Laboratorio de Farmacotecnia at the Metropolitan Autonomous University. Five Pelibuey lambs cannulated in the rumen and duodenum (24.8 ± 0.4 kg BW) were used in a Latin Square design. Lambs were fed a basal diet that consisted of *Brachiaria brizantha* hay and concentrate (ratio 67:33) with the following treatments: (1) feed-grade urea; (2) Surelease-coated urea (SRU-S); (3) SRU-S + molasses; (4) SRU Optigen (OPT); and (5) OPT + molasses. All sources of urea were dosed daily intra-ruminally (0.6 g/kg/BW), and molasses was fed at 1.2 g/kg BW. Compared to feed-grade urea, both sources of SRU decreased ruminal pH between 3 and 6 h after dosing ($P < 0.05$). At 3 and 9 h after dosing and at 15 and 21 h, both sources of slow-release urea reduced the rumen ammonia compared to urea ($P < 0.05$). The two sources of slow-release urea did not improve the total tract or rumen digestibility of dry matter (DM) and neutral detergent fiber (NDF) or the rate of microbial protein synthesis in growing lambs fed low quality forage.

1. Introduction

Urea is rapidly hydrolyzed to NH_3 in the rumen in the first hour post-ingestion, and when fed in excess, it may be partially responsible for the low efficiency of N capture in the rumen by ruminal bacteria (Johnson and Clemens, 1973; Calsamiglia et al., 2010). This excess NH_3 may be detrimental to the animal (Bartley et al., 1981) and can contribute to environmental pollution (Broderick et al., 2009). To improve the utilization of ammonia released from urea, slow-release sources have been designed to promote the constant availability of N-NH_3 over long periods of time (Taylor-Edwards et al., 2009a). The combination of urea with soluble carbohydrates has also been recognized as an important factor in the utilization of ammonia by ruminal microbes (Hristov and Ropp, 2003).

Polymer-coated urea is effective at reducing the ammonia concentration compared to urea. However, its use does not necessarily reduce N excretion or improve the performance of steers (Taylor-Edwards et al., 2009b). The potential benefits of slow-release urea (SRU) sources could be manifested in low-quality diets such as those based on tropical forages. Steers grazing tropical pastures supplemented with slow rumen degradation rate protein sources have shown better productive performance than those supplemented with urea (Ramos et al., 1998). Ribeiro et al. (2011) were able to increase dry matter intake in cattle fed low-quality hay and given a slow-release polymer-coated urea source.

Given that most evaluations of SRU have been conducted in intensive beef production systems based on

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temperate forages (Kononoff et al., 2006), corn silage (Taylor-Edwards et al., 2009b), 50% concentrate diets (Galo et al., 2003; Golombeski et al., 2006) with conventional urea and have shown no response, the aim of this experiment was to evaluate the effect of two SRU sources and urea mixed with molasses on N metabolism and ruminal digestibility in lambs fed a low-quality tropical forage.

2. Materials and methods

This experiment was conducted under the supervision and approval of the Ethics and Animal Welfare Committee of the Autonomous University of Yucatán, Mérida, México.

2.1. Slow-release urea sources

Two sources of SRU were evaluated. The first was Optigen® II (Alltech, Inc.), a commercial blended urea product that involves coating urea pills with vegetable oil. The second source consisted of urea cores (Fermex®) with a size fraction between 2 and 2.38 mm that were coated with a polymer of ethyl cellulose (Surelease® Colorcon de México). The coating was carried on an aqueous dispersion of Surelease® prepared at 15% as described by Melgoza et al. (2007). The Surelease-coated urea was prepared in the Laboratorio de Farmacotenia from the Universidad Autonoma Metropolitana, Mexico.

2.2. Animals and treatments

Five Pelibuey lambs (24.8 ± 0.4 kg BW) cannulated in the rumen and duodenum were used in a Latin Square design (sheep and periods) and fed a basal diet that consisted of *Brachiaria brizantha* hay and concentrate (67:33) with the following additions: (1) feed-grade urea; (2) ethyl cellulose Surelease®-coated urea (SRU-S); 3) SRU-S + cane molasses; (4) SRU Optigen (SRU-O); and (5) SRU-O + cane molasses. The concentrate was elaborated from Nutrimentos Peninsulares S.A. de C.V (Yucatán, México). All sources of urea were dosed daily intraruminally (0.6 g/kg BW), and molasses was fed at 1.2 g/kg BW. Forage, concentrate, molasses and minerals were mixed as a total mixed ration. Sheep were housed in metabolic crates supplied with a feeder and water was available at all times. Feed was offered in the morning at 3.7% of BW, and minerals were added at 0.5 g/kg BW daily. Each period consisted of 10 days of adaptation and 5 sample collection days. The composition (%) of the forage and concentrate was 91.6 dry matter (DM), 3.4 crude protein (CP) and 76.5 neutral detergent fiber (NDF) 41.4 acid detergent fiber (ADF) and 12.0 lignin, and 88.0 DM, 15.3 CP, 24.2 NDF, 10.9 FDA and 1.5 lignin, respectively. Mineral premix (Fogysal Ovino®) contained the following per kg: Ca 60 g, P 40 g, Mg 20 g, Se 3 mg, Co 5 mg, Mn 1000 mg, Cu 2 mg, I 25 mg, Zn 1000 mg, vitamin A 60 IU, vitamin D2 1 IU and vitamin E 120 UI.

2.3. Sample collection and analyses

Feed, feces and orts were collected daily during the collection period, rumen fluid (60 mL) was sampled on day 4 at 0, 1.5, 3, 6, 9, 12, 15, 18, 21 and 24 h after feeding and pH was measured immediately. Samples were acidified with 1 mL of sulfuric acid (30%) and then frozen at −20 °C until laboratory analyses. Ten milliliters of rumen fluid were prepared with metaphosphoric acid and centrifuged (40,000 × *g* × 10 min), and the supernatant was used in measurements of the proportion of volatile fatty acids (VFA) via gas chromatography (Erwin et al., 1961). Ammonia N was measured using the indophenol method (McCullough, 1967). Duodenal samples were collected according to Stock et al. (1987) from day 1 to day 5 of the collection period to estimate ruminal digestion and N duodenal flow. Feed and duodenal samples were analyzed according to AOAC (1990) for dry matter (DM, method number 981.10), crude protein (CP, method number 967.03) and NDF and ADF fractions according to Van Soest et al. (1991) with a heat-stable amylase and expressed include residual ash. Feed, orts, feces and duodenal contents were used to determine acid insoluble ash as an internal marker to estimate digestibility (Van Keulen and Young, 1977). The amount of microbial protein synthesis was measured using purines (Zinn and Owens, 1986).

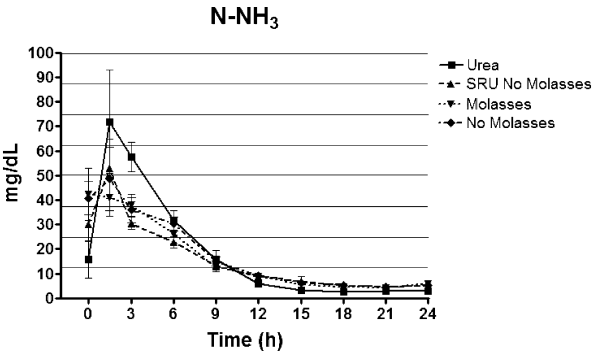

Fig. 1. Effect of slow release urea (SRU) and cane molasses on ruminal ammonia nitrogen in lambs fed tropical forage. Contrast I: urea vs. SRU sources (without molasses); Contrast II: molasses vs. no molasses.

2.4. Statistical analyses

The data were analyzed as a 5 × 5 Latin Square design using the GLM procedure SAS Inc. (2007). If the response variable was measured more than once, data were analyzed using the repeated analyses from GLM (SAS, 2007), and the following contrasts were tested: CI. urea vs. slow-release urea sources (without molasses) and CII. molasses vs. no molasses.

3. Results and discussion

3.1. Ammonia N and ruminal pH

Rumen ammonia N concentrations from the contrasts tested are presented in Fig. 1. Between 3 and 6 h after dosing and at 15 and 21 h, both sources of slow-urea release reduced the rumen ammonia compared to urea (Contrast I: $P < 0.05$). There was a time × treatment interaction ($P < 0.018$). There were no effects of molasses on ammonia N concentration in all sampling times. The mean value of rumen N-NH_3 was 18.8 mg/dL, a value that allows fibrolytic activity in the rumen (Satter and Slyter, 1974). As shown in this study, other authors have also reported an increase in rumen N-NH_3 concentration within 1–3 h post-ingestion and its late gradual decline with slow-release urea sources (Pinos-Rodriguez et al., 2010; Xin et al., 2010). Tikofsky and Harrison (2006) evaluated the effect of two levels of non-protein nitrogen (urea or Optigen II) in an in vitro experiment with single-flow rumen-simulating fermenters and found no effect on pH or ammonia. In agreement with our results, no significant differences were found between polymer-coated urea and feed-grade urea in terms of N-NH_3 release (Galo et al., 2003) in most of the incubation times.

Ruminal pH readings from the contrasts tested are presented in Fig. 2. Compared to feed-grade urea, both sources of SRU decreased the ruminal pH between 3 and 6 h after dosing (Contrast II: $P < 0.05$). In hour 3, the ruminal pH was reduced by molasses; however, between 15 and 21 h ruminal pH was higher with molasses (Contrast II: $P < 0.05$). Most of the time, ruminal pH values were above 6.2 (Fig. 2). As observed in other studies, there were no major differences in ruminal pH between different sources of urea (Taylor-Edwards et al., 2009b; Tedeschi et al., 2002). Puga et al. (2001) found no differences in the pH and ammonia concentration between treatments in a ruminal