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Ruminal fermentation and nitrogen metabolism in sheep fed a silage-based diet supplemented with *Yucca schidigera* or *Y. schidigera* and nisin

Budi Santoso [a,*], B. Mwenya [b], C. Sar [b], J. Takahashi [b]

[a] *Department of Animal Nutrition, Papua University, Manokwari 98314, Indonesia*
[b] *Department of Animal Science, Obihiro University of Agriculture and Veterinary Medicine, Obihiro 080-8555, Japan*

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Abstract

Three ruminally cannulated Cheviot wethers (55.8 ± 5.8 kg BW) were used in a 3 × 3 Latin square design to determine effects of supplementing *Yucca schidigera*, with or without nisin, on ruminal fermentation patterns and N metabolism. The wethers were fed twice daily (08:00 and 16:00 h) with a basal diet consisting of timothy silage and a concentrate (85:15 on a dry matter (DM) basis). Dietary treatments were basal diet (control), basal diet plus 240 ppm (DM) of *Y. schidigera* per day (YS), basal diet plus 240 ppm (DM) of *Y. schidigera* and 6 mg/kg $BW^{0.75}$ of nisin per day (YN). Results showed that YS and YN supplemented diets had lower (P<0.05) rumen ammonia N concentrations compared to the control diet. The molar proportion of acetate was lower (P<0.05) in sheep receiving the YS and YN diets compared to the control diet, and molar proportions of butyrate and *iso*-acids were higher (P<0.05). Urinary N was lower (P<0.01) for YS and YN diets *versus* the control diet, and microbial N supply and efficiency of microbial N synthesis were higher (P<0.05) in sheep fed the YS diet *versus* those fed the YN and control diets. Results indicate that *Y. schidigera* can be used to modify rumen fermentation in order to decrease ruminal ammonia concentrations

Abbreviations: ADF, acid detergent fiber; BW, body weight; CP, crude protein; DM, dry matter; DOMI, digestible OM intake; DOMR, digestible OM apparently fermented in the rumen; EMNS, efficiency of microbial N synthesis; MN, microbial N; NDFom, neutral detergent fiber; PD, purine derivatives; VFA, volatile fatty acids

* Corresponding author. Tel.: +62 986 212156; fax: +62 986 211455.
E-mail address: budi_santoso@unipa.ac.id (B. Santoso).

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and reduce urinary N excretion thereby reducing the environmental impact of ruminant production systems.

Keywords: *Yucca schidigera*; Nisin; Ruminal fermentation; N metabolism; Sheep

1. Introduction

Feeding silage-based diets to ruminants results in a peak in rumen ammonia concentration following meals (Thomas and Thomas, 1985). Excess ammonia in the rumen is absorbed into the blood stream, converted to urea in the liver and subsequently excreted in urine, thereby creating a negative environmental impact (Tamminga, 1992).

Increasing attention has been placed on use of natural products, instead of chemical feed additives such as antibiotics and ionophores, as manipulators of rumen fermentation. As stated by Russell and Rychlik (2001), there has been an increased perception that antibiotics and chemical compounds should not be routinely used as feed additives.

Previous studies have indicated that the glyco-fraction in *Yucca schidigera* is effective in binding ammonia both *in vitro* and *in vivo* (Wallace et al., 1994; Takahashi et al., 2000; Santoso et al., 2004). Accordingly, a slow release form of N to maintain a lower ammonia concentration might enhance fermentation by maintaining adequate rumen N for microbial growth after feeding. Yucca saponins also have strong antiprotozoal activity and may serve as an effective defaunating agent (Wallace et al., 1994), thereby increasing microbial protein flow to the intestine and enhancing overall animal performance. Nisin is a low molecular weight antimicrobial protein, or bacteriocin, produced by certain strains of *Lactococcus lactis* (subsp. *Lactis*) and is widely used in the food industry as a safe and natural preservative (Delves-Broughton et al., 1996). Callaway et al. (1997) reported that nisin inhibited growth of *Clostridium amoniphylum*, an obligate amino-acid fermenting bacteria.

The purpose of this study was to determine effects of *Y. schidigera*, with or without nisin, on ruminal fermentation characteristics (*i.e.*, pH, concentrations of ammonia N and volatile fatty acids (VFA)), and N metabolism in sheep fed a silage-based diet.

2. Materials and methods

2.1. Animals, diets and experimental design

Three Cheviot wethers with a body weight (BW) of 55.8 ± 5.8 kg and fitted with a rumen cannula were assigned to one of three dietary treatments in a 3 × 3 Latin square design. Wethers were fed twice daily (08:00 and 16:00 h) at maintenance level of energy (55 g dry matter (DM)/kg $BW^{0.75}$/day) with a basal diet consisting of timothy silage and a commercial concentrate (85:15 on DM basis; Table 1). The three dietary treatments were a basal diet (control), a basal diet supplemented with 240 ppm (DM) of *Y. schidigera* per day (YS), and a basal diet supplemented with 240 ppm (DM) of *Y. schidigera* and 6 mg/kg $BW^{0.75}$ of nisin per day (YN). Supplements were top-dressed on the basal diet. The *Y. schidigera* contained