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Ensiling characteristics of silages of Stylo legume (*Stylosanthes guianensis*), Guinea grass (*Panicum maximum*) and their mixture, treated with fermented juice of lactic bacteria, and feed intake and digestibility in goats of rations based on these silages

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ABSTRACT

The aim of the current study was to evaluate the ensiling characteristics of silages prepared from Guinea grass, Stylo legume or Stylo legume mixed with Guinea grass (50:50 w/w). Guinea grass and Stylo legume were harvested 45 and 60 days after regrowth, respectively and treated with a fermented juice of lactic acid bacteria (FJLB) prior to being ensiled. After 45 days, selected ensiling characteristics were determined. The nutritive value of rations based on the experimental silages was evaluated using six male, rumen cannulated crossbred Anglo Nubian × Native goats in a replicated 3 × 3 Latin square design study. Concentrate was provided at 0.9% body weight and experimental silages ad libitum. Apparent fecal macronutrient digestibility was determined. The pH values, NH_3-N and lactic acid contents were not different between the silages but greater contents ($P < 0.05$) of acetic and butyric acid were found in the silage prepared from Guinea grass. Voluntary silage intake was similar for the three silages. Digestibility of dry and organic matter did not differ between treatments. However, the digestibility of crude protein, neutral detergent fiber and acid detergent fiber was greater ($P < 0.05$) when the rations contained silage from Stylo legume instead of Guinea grass. In conclusion, the process of fermentation of silages is similar for Stylo legume and Guinea grass. The feeding of rations based on silage from Stylo legume versus Guinea grass can enhance animal production due to its higher nutritive value.

1. Introduction

Stylo (*Stylosanthes guianensis* CIAT184) is a tropical legume that combines a high potential dry matter (DM) yield with a good resistance to anthracnose (Noble et al., 2000; Phaikaew and Hare, 2005). As fresh Stylo legume cannot be dried during rainy reason, ensiling may be a practical way to preserve this forage (McDonald et al., 1991; Arbabi and Ghoorchi, 2008; Bureenok et al., 2011). However, Liu et al. (2011, 2012) reported high pH and NH_3-N values in ensilaged Stylo, indicating an unsuccessful process of fermentation. As legumes have a relatively low concentration of water soluble carbohydrates (WSC) and a high buffering capacity after harvesting, the process of fermentation is more complicated compared to grasses (McDonald et al., 1991; Yahaya et al., 2004).

Besides Stylo legume, Guinea grass (*Panicum maximum TD*58) is also a widely available forage for ruminant production in tropical areas (Aganga and Tshwenyane, 2004). However, both the DM content and the concentration of WSC are considered too low for successful ensiling. This consideration is corroborated by Bureenok et al. (2005a) who reported high pH, NH_3-N and butyric acid values in silage from Guinea grass. However, addition of fermented juice of lactic acid bacteria (FJLB) prior to ensiling appears to be an effective method to improve the silage quality of unwilted forages with a low DM content (Ohshima et al., 1997; Bureenok et al., 2005b; Wang et al., 2009). As such, treatment of Stylo legume with FJLB prior to ensiling may increase the success of achieving a stable, nutritious silage. The first objective of this study was to assess the quality of FJLB treated silages from either Guinea grass or Stylo legume alone or Stylo legume mixed with Guinea grass. The silage prepared from Guinea grass alone served as a control. In general, silage making and the feeding of silage from Stylo legume is not customary in tropical regions. Consequently, there is limited infor-

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Table 1
Chemical composition of fresh Guinea grass and Stylo legume and the experimental silages ($n = 3$) after an ensiling period of 45 days in plastic pouches containing an initial amount of 100 g forage.

	Before ensiling		Experimental silages				
	Guinea grass	Stylo legume	Guinea grass	Stylo legume	Guinea grass + Stylo legume	SEM[1]	*P*-value
Dry matter (DM, g/kg)	204	272	188[c]	289[a]	235[b]	4.7	<0.01
Epiphytic LAB[2] (log cfu/g)	5.0	4.7	NA[3]	NA	NA		
Buffering capacity (mequiv./g DM)	180	260	NA	NA	NA		
NH_3-N (g/kg total N)	NA	NA	79	69	70	3.5	0.20
pH	5.72	5.64	4.43	4.43	4.45	0.02	0.62
g/kg DM							
Water soluble carbohydrates	11	41	NA	NA	NA		
Crude ash	75	84	77	81	80	1.1	0.15
Crude protein	69	106	67[c]	101[a]	97[b]	0.9	<0.01
Neutral detergent fiber	725	615	737[a]	690[b]	686[b]	6.5	<0.01
Acid detergent fiber	424	442	379[b]	435[a]	458[a]	6.0	<0.01
Hemicellulose	301	173	358[a]	255[b]	228[b]	7.9	<0.01
Lactic acid	NA	NA	77	60	58	6.9	0.60
Acetic acid	NA	NA	70[a]	45[b]	40[b]	2.8	<0.01
Butyric acid	NA	NA	5.0[a]	0.9[b]	0.0[b]	0.6	<0.01

Values within the same row with different superscripts were significantly different ($P < 0.05$).
[1] Standard error of mean.
[2] Lactic acid bacteria.
[3] Not analyzed.

mation on the feeding value of whole rations based on silage from Stylo legume or Stylo legume mixed with Guinea grass. Therefore, the experimental silages described above, were used to formulate three rations to evaluate the effects of silage type on feed intake, selected indices of rumen fermentation and apparent digestibility of macro-nutrients in goats.

2. Materials and methods

2.1. Preparation of FJLB

Fermented juice of lactic acid bacteria was prepared according to the method described by Bureenok et al. (2005b). Briefly, 200 g fresh Guinea grass or Stylo legume was macerated in 1000 ml sterilized distilled water in a blender. Then, the forage specific content of the blender was filtered over a double layer of cheesecloth into a glass bottle and 2% glucose added. The bottles were capped and stored under anaerobic conditions at 30 °C for 2 days. This procedure yielded forage specific FJLB of Guinea grass and Stylo legume containing 5.50 log10 and 5.67 log10 colony-forming units (cfu)/g of lactic acid bacteria (LAB), respectively. The FJLB used for the mixture of Guinea grass and Stylo legume, was prepared by mixing the individual forage specific FJLB in a 1:1 ratio (v/v).

2.2. Silage preparation

Guinea grass and Stylo legume were harvested on the same day, 45 and 60 days after regrowth, respectively and subsequently chopped with a forage cutter to 2–4 cm. Guinea grass and Stylo legume used to assess ensiling characteristics, was sampled immediately after harvesting. The nutrient composition of the fresh forages is shown in Table 1. The crops were not wilted and the three experimental forages were prepared immediately after cutting, i.e., 100% Guinea grass, 100% Stylo legume and a mixture of Guinea grass and Stylo legume (50:50 w/w). Thereafter, 1% (fresh weight) of forage specific FJLB was added to each experimental forage and subsequently tightly packed in either oxygen impermeable plastic pouches (100 g in 20.32 × 33 cm pouches, 120 μ thickness; M-PLASPACK, Bangkok, Thailand) or 100 l plastic drums with clamp lid (60 kg of forage as fed). Air was withdrawn from the plastic pouches by means of a vacuum sealer while the forages were manually compacted when the forages were stored in the drums. Three pouches for each experimental forage were prepared to assess the ensiling characteristics and nutrient composition after ensiling and the pouches were stored for 45 days at ambient temperatures (27–30 °C). The experimental forages were ensiled for 30 days in the plastic drums before being used to asses feed intake, digestibility and selected indices of rumen fermentation.

2.3. Animals and feeding

All procedures were approved by the Ethical Principles for the Use of Animals for Scientific Purposes of the National Research Council of Thailand. Six, male Anglo Nubian × Thai native, rumen cannulated, crossbred goats with a mean body weight (BW) of 40 ± 5.0 kg were used. Prior to the experiment, the goats were dewormed by means of Ivomectin (IVOMEC F plus, Bangkok, Thailand) and injected with vitamin A (500,000 I.U.), D_3 (75,000 I.U.) and E (50 I.U.) (Biotecnocem, Dallas, USA). The goats were individually housed in pens (60 × 120 × 90 cm) and water was available at all times. The trial had a replicated 3 × 3 Latin square design (Cochran and Cox, 1957). The goats were randomly assigned to each sequence of feeding on the three experimental silages, i.e., 100% Guinea grass, 100% Stylo legume and a the mixture (50/50, as fed) of Guinea grass and Stylo legume. The silages were provided ad libitum to the goats. Next to the experimental silage, goats were offered concentrates (Table 2) at a level of 0.9% of body weight. Each experimental period lasted 21 days with a 14-day adaptation followed by a 7-day collection period. The experimental rations were provided three times per day in equal portions at 08.00, 12.00 and 16.00 h. The goats were weighed before the morning feeding at the beginning and end of each experimental period.

2.4. Collection of samples

Samples taken at 45 day after closure of the plastic pouches were subsamples (50 g fresh material), macerated with 150 ml of distilled water and stored in a refrigerator at 4 °C for 12 h (Bureenok et al., 2006). Then, the material was filtered (filter paper no. 5; Whatman, England) and the pH of the filtrate recorded (SI analytics, Mainz, Germany) before being stored at −20 °C until analysis of lactic acid, volatile fatty acids (VFAs) and ammonia-*N* (NH_3-N). Samples from the center of the plastic drums were taken immediately after opening the drums. Samples from both types of ensiling