A Comparison of Fermentation Kinetics in the Rumen of Grazing Sheep on a Dwarf Bamboo Pasture and a Grass Pasture

Masato Yayota
Gifu University, Japan

Noriya Tanaka
Gifu University, Japan

Kazuya Doi
Gifu University, Japan

Shigeru Ohtani
Gifu University, Japan

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Masato Yayota, Noriya Tanaka, Kazuya Doi and Shigeru Ohtani

Faculty of Applied Biological Sciences, Gifu University, Gifu 501-1193, Japan, www.gifu-u.ac.jp/english/index.shtml
Contact email: yayo@gifu-u.ac.jp

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Introduction

Native grasses grown as forest understory are important forage resources for grazing ruminants and in agroforestry. Dwarf bamboo is one such typical grass and has traditionally been used in Japan. The name "dwarf bamboo" refers to a group of native grasses from certain genera (*e.g., Sasa spp*. and *Pleioblastus spp*.). These grasses are generally rhizomatous, perennial, and semi-woody (Usui, 1961). The results of an earlier study suggested that the *in sacco* ruminal degradation of the dwarf bamboo was inferior to that of a common tropical grass (Yayota *et al.* 2009), and cattle grazing on a forest pasture dominated by a dwarf bamboo could not satisfy their energy requirement in fall regardless of forage availability (Nakano *et al.* 2007). However, little information is available about the fermentation kinetics of dwarf bamboo or of many other native forage plants in the rumen. Understanding fermentation kinetics will be useful to improve the utilization of this grass and to plan supplemental feeding strategies.

The objective of this study was to clarify the fermentation kinetics of a dwarf bamboo (*Pleioblastus argenteostriatus* f. *glaber*) in the rumen relative to the fermentation kinetics of a common grass.

Methods

This study was conducted at the Minokamo livestock farm, Gifu University, located in central Japan (35°18'N, 137°00'E). A pasture dominated by dwarf bamboo (*P. argenteostriatus* f. *glaber*) and an Italian ryegrass (*Lolium multiflorum* Lam.) pasture were used for the experiment. The dwarf bamboo pasture was in the vegetative stage and included some forbs and shrubs. The Italian ryegrass pasture was in the regrowth and late vegetative stage, and included a small proportion of other grass species such as *Digitaria ciliari*. Eight mature Suffolk ewes (mean body weight ± SD, 50 ± 13 kg) fitted with ruminal cannulae were divided into two groups. Each group was assigned to a different study pasture and allowed to graze throughout the day. Water and a mineral mixture were provided ad libitum.

A day prior to the start of the grazing period, the herbage mass in each pasture was measured in 9 quadrats (each 50 cm × 50 cm), and a sample of approximately 300 g of herbage was collected. The grazing experiment lasted for 29 days. The first 5 days were used to allow the ewes to adjust to the pasture environment, and the following 7 days were used to measure the forage intake and forage digestibility using a double-indicator method with chromic oxide and acid detergent insoluble ash. The remaining 17 days were used for measuring ruminal fermentation. The rumen contents were emptied manually through the cannula, mixed thoroughly, and sampled on d 13 at 0800, d 16 at 1200, d 19 at 1600, d 22 at 2000, d 25 at 0000, and d 29 at 0400. The remaining digesta were returned to the rumen.

The herbage samples were analyzed for dry matter (DM) and crude protein (CP) content according to the AOAC method (AOAC 2006). The ash-free neutral detergent fiber (NDFom), ash-free acid detergent fiber (ADFom), and acid detergent lignin (ADL) content of the herbage were measured according to the method of Van Soest *et al.* (1991). Volatile fatty acids analysis of the rumen contents was performed using gas chromatography. The NH_3-N concentration of the rumen contents was estimated by the phenol-hypochlorite method (Weatherburn 1967). Forage intake and digestibility were analyzed using a one-way ANOVA with the grazing pasture as a fixed factor. The ruminal VFA and NH_3 concentrations were analyzed using a repeated measures mixed model. The model included the sampling day as a repeated measure, the grazing pasture as a fixed factor, and the animals as a random factor nested within the fixed factor. All statistical procedures were performed using JMP ver5.0 (SAS Institute Inc. 2002).

Results and discussion

The CP and NDF contents of the dwarf bamboo and Italian ryegrass were 163 and 135 g/kg DM and 712 and 540 g/kg DM, respectively (Table 1). The DM and NDFom intake did not differ between the groups, whereas the DM and NDF digestibility were lower in the ewes grazing on the dwarf bamboo pasture than in the ewes on the Italian ryegrass pasture (Table 2). The total VFA content changed similarly in both groups over time (Fig. 1), and no difference in the mean total VFA content was detected between the groups. In contrast, the NH_3 content for the ewes grazing on the dwarf bamboo pasture was always lower than that for the ewes on the Italian ryegrass pasture regardless of sampling time.

The fermentation pattern of the VFA and NH_3 was almost fully synchronized in the ewes grazing on the Italian ryegrass pasture; however, the corresponding pattern was not necessarily synchronized during the day in the ewes grazing on the dwarf bamboo pasture. This difference might be due to the lower degradation rate of NDF in dwarf bamboo (Yayota *et al.* 2009).

Table 1. Herbage mass, dry matter (DM), crude protein (CP), ash-free neutral detergent fiber (NDFom), ash-free acid detergent fiber (ADFom), and acid detergent lignin (ADL) content of dwarf bamboo (*P. argenteostriatus* f. *glaber*) and Italian ryegrass.

	Herbage mass (t DM/ha)	DM (g/kg)	CP (g/kg DM)	NDFom (g/kg DM)	ADFom (g/ kg DM)	ADL (g/kg DM)
Dwarf bamboo	1.5	348	163	712	331	39
Italian ryegrass	3.1	171	135	540	278	36

Table 2. Intake, digestibility, ruminal volatile fatty acid (VFA) and NH_3 content of sheep grazing on a dwarf bamboo (*P. argenteostriatus* f. *glaber*) pasture and an Italian ryegrass pasture.

	Intake (g DM/h/d)		Digestibility (g/g)		NH_3-N	Total VFA
	DM	NDF	DM	NDF	(mmol/l)	(mg/dl)
Dwarf bamboo	705.1	502.1	0.491	0.563	73.9	9.34
Italian ryegrass	692.8	374.1	0.657	0.714	85.5	12.02
P-level	0.95	0.33	0.02	0.02	0.12	0.05

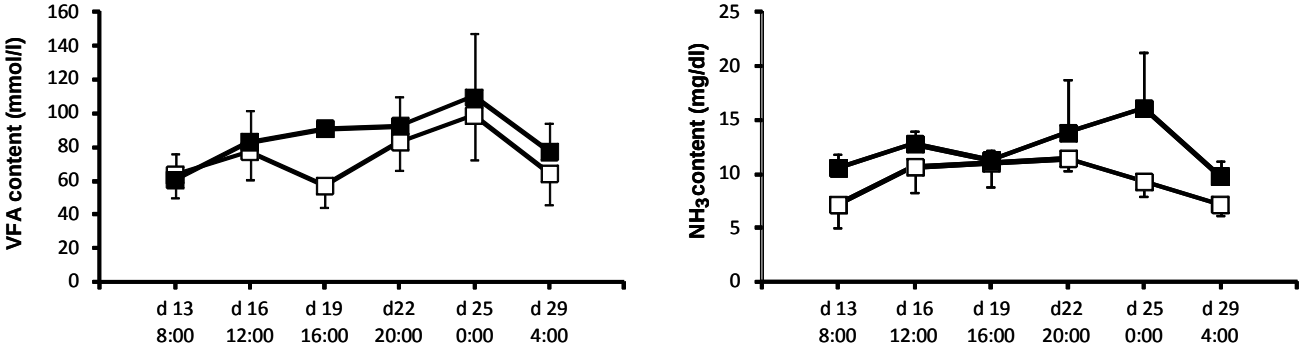

Figure 1. Change in total VFA and NH_3 in the rumen of grazing sheep on a dwarf bamboo pasture (□) and an Italian ryegrass pasture (■) during subsequent samplings.

Conclusion

The results suggested that the rate and extent of ruminal carbohydrate degradation were not synchronized with those of protein, leading to inefficient production by grazing ruminants on a dwarf bamboo pasture.

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