Effect of Using Additives at Ensiling on the Fermentation Quality of Common Reed (*Phragmites communis* Trin.) Silage

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Introduction

The common reed (*Phragmites communis* Trin.) is a wild grass species widely distributed throughout Japan and the world, growing in thousands of abandoned paddy fields and riverside sites. Most of the common reed in Japan is burned or left to become a weed that grows thickly in canals and reclaimed lands, becoming breeding places for diseases and pests (Holm *et al.* 1977). The biodiversity of plants can be disrupted by an expanding community of common reed whose sward height is 1.5–4.0 m (Ailstock *et al.* 2001). The common reed should be controlled and made use of if possible, and a role for common reed as feed may solve a number of issues regarding this species. The common reed grown in marsh can be harvested as round baled silage using a chopping whole crop harvester (WB1030DX, Takakita Co., Mie, Japan) and a self-propelled bale wrapper (SW1110W, Takakita Co., Mie, Japan). However, few studies have been conducted on methods of preparing high-quality silage out of common reed. Here we conducted several trials using a small-scale system to determine the effects of adding glucose, lactic acid bacteria (LAB) and acremonium cellulase at ensiling on the fermentation quality of common reed silage.

Methods

Trial 1

The additive treatments were no-additive (Control), 2 % glucose on a fresh matter basis (G), 5×10^{-4} % commercial lactic acid bacteria additive (LAB) (Chikuso-1, Snow Brand Seed Co., Hokkaido, Japan) and G+LAB. The common reed in an experimental field (Ishikawa, Japan, 36°40'N, 136°41'E) was harvested as ensilage material on May 20, 2010 when the sward height reached approx. 1 m. The reeds were chopped to a length of approx. 1 cm and packed in plastic bags with the additives, by a vacuum packing machine, following the method of Tanaka and Ohmomo (1995). Five bags were prepared in each treatment and opened three months after ensiling. The extract was prepared by mixing the silage with water. The pH in each extract was determined with a pH meter, and organic acid and ammonia in the extract were measured by HPLC and the indophenol method, respectively to determine their contents in the silage. The V2-score was calculated based on the ammonia, acetic acid, propionic acid and butyric acid contents. The data were examined with an analysis of variance (ANOVA) to determine the effect of additive treatment. The Tukey method was used to compare the means among the treatments when the effect was significant.

Trial 2

The additive treatments were no-additive (Control) and 1.7×10^{-3} % commercial additive containing acremonium cellulase and lactic acid bacteria (AC+LAB) (acremo conc., Snow Brand Seed Co., Hokkaido, Japan). The common reed in the same field as Trial 1 was harvested as ensilage material on May 26, 2011 when their sward height reached approx. 1 m. Four bags of the silage in each treatment were prepared as in Trial 1 and opened three months after ensiling. The pH, organic acid and ammonia in the silage were determined by the same method as in Trial 1.The silage was dried in a drying oven at 60 °C, ground through a 1 mm screen and subjected to a feed analysis (Abe 2001). The data were analyzed by ANOVA to examine the effect of additive treatment.

Trial 3

Common reed in the same field as Trial 1 was harvested by the chopping whole crop harvester to make round bales on August 30, 2010 when their sward height reached approx. 1 m. The same commercial additive used in Trial 2 was dissolved with water, and the solution was sprayed on the common reed by the spray-machine loaded on the harvester. The round bales were wrapped with plastic film by a self-propelled bale wrapper. The round baled silage was opened four months after harvesting, and the sample was collected to determine the pH, organic acid and ammonia by the same methods as described for Trial 1.

Results

The results of analysis of the fermentation quality for all trials are shown in Table 1. The pH, acetic acid, propionic acid, butyric acid and ammonia contents from the G+LAB treatment were significantly lower than that in the control, G, and LAB, and the lactic acid content and V2-score in G+LAB were significantly higher than that in the control, G and LAB ($P<0.05$). When the V2-score of silage is more than 80 points, the silage quality is judged to the good. Only the silage from the G+LAB treatment had a V2-score higher than 80 points. We found that the addition of sugars and LAB was required to prepare high-quality

Table 1. The fermentation quality of silage in Trial 1, Trial 2 and Trial 3. Means in the same column with different letters were significantly different in Trial 1 (P<0.05). * Means were significantly different between treatments in Trial 2 (P<0.05).

Treatment	Fermentation quality						
	pH	Lactic acid (%)	Acetic acid (%)	Propionic acid (%)	Butyric acid (%)	Ammonia (mg/100g)	V2-Score
Trial 1							
Control	5.16 a	0.03 c	1.01 a	0.40 a	0.39 a	233.22 a	0.74 c
G	4.63 b	0.62 b	0.53 b	0.08 b	0.29 b	101.81 b	53.77 b
LAB	5.13 a	0.04 c	0.94 a	0.27 a	0.44 a	204.74 a	3.15 c
G+LAB	3.90 c	1.42 a	0.23 c	0.04 c	0.00 c	35.43 c	95.02 a
Trial 2							
Control	5.27*	0.08	0.65*	0.11*	0.39	172.16*	13.42
AC+LAB	4.94	0.26*	0.44	0.07	0.50*	107.64	33.23*
Trial 3							
AC+LAB	3.93	1.55	0.31	0.02	0.00	49.35	90.55

common reed silage. In Trial 2, acremonium cellulase was added in place of glucose. The pH, acetic acid, propionic acid and ammonia contents from the AC+LAB treatment were significantly lower than that from the control, and the butyric acid, lactic acid contents and V2-Score in AC+LAB were significantly higher than those of the control (P<0.05). The crude protein, ether extract and low digestible fiber contents were not significantly different among the treatments, whereas the organic cell wall (OCW) and the high digestible fiber (Oa) contents in AC+LAB were significantly lower than that in the control, and the content of nitrogen cell wall-free extract (NCWFE), which was the fraction containing sugars in AC+LAB, was significantly higher than that in the control (P<0.05). In brief, the fiber components (*i.e.*, the OCW and Oa) were digested into the sugars by acremonium cellulase. However, V2-Score in AC+LAB was low and was about 33 points because ammonia and butyric acid contents were higher. We suspect that these results were observed because the silage material was harvested just after a rainfall (Masuko 2001). In Trial 3, the common reed was harvested in season with low rainfall (late in August). The pH, lactic acid content and V2-score from the AC+LAB treatment were 3.93, 1.55 % and 90.55 points, respectively. The results showed that high-quality round baled silage of the common reed can be prepared by the addition of acremonium cellulase and lactic acid bacteria at ensiling.

Conclusion

Sugars and lactic acid bacteria were required to achieve higher fermentation quality of common reed silage. However, we found that acremonium cellulase could be used to increase the supply of sugars at ensiling, and that high fermentation quality of common reed round baled silage could be achieved through the addition of acemonium cellulase and lactic acid bacteria at ensiling.

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