Silage Preparation and Fermentation Characteristics of Pearl Millet Stover Treated with Microbial Additive in West Africa

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Key words: Crop by-product; Fermentation characteristics; Millet; Silage

Abstract

Pearl millet (*Pennisetum glaucum* L.) stover is one of the main crop by-products in West Africa. To effectively use the crop by-product resources as roughage for ruminant to cover the feed shortage in the dry season, the millet stover silage was prepared using laboratory-scale fermentation system without (control) or with lactic acid bacteria inoculant (LP, *Lactobacillus plantarum*) and cellulase enzyme (AC, *Acremonium*) in Burkina Faso, and their fermentation characteristics and chemical composition were analyzed. The dry matter (DM) of fresh millet before ensiling was 44.3%, and their organic matter, crude protein (CP), ether extract, neutral detergent fiber (NDF) and acid detergent fiber (ADF) contents were 92.34%, 0.72%, 3.75%, 69.04%, and 43.56% based on a DM basis, respectively. After 120 days of fermentation, the control silage was of poor quality, while the all additive-treated silages had good fermentation patterns, with higher ($P < 0.05$) lactic acid content and lower ($P < 0.05$) pH value, butyric acid and ammonia nitrogen contents than those of control. The silage was fermented as better quality in AC treatment than LP treatment, and the combination of LP and AC resulted in the synergistic fermentation effect. The CP content decreased in control silage, NDF and ADF contents decreased in AC-treated silage, while other chemical compositions did not differ greatly. All silages fermented stably and were not spoiled during ensiling. The results demonstrate that the millet could prepare silage as preserved feed for ruminant and the microbial additive could improve fermentation quality.

Introduction

Generally, the crop by-products are the main roughage sources for ruminants in tropical developing countries including Africa (Cai et al. 2019). The most important limiting factor for cows in the tropics is shortage of feed in the aspect of quantity and quality, especially in the dry season. Pearl millet (PM, *Pennisetum glaucum* L.) is indigenous African cereals that unlike maize and wheat, are well adapted to African semi-arid and sub-tropical agronomic conditions. The PM stover could be used for livestock feed. However, some stovers were generally discarded in the field and burned used as fertilizer (Hauser et al. 2006). Previously, interest has shifted toward natural grass silage as a main feed source for ruminant animals. Recent year,

lactic acid bacteria (LAB) inoculant and cellulase enzyme are widely used for silage production in the world. However, there is very little research information are available on silage preparation of PM. The purpose of this work to study the silage preparation and fermentation characteristics of pearl millet stover treated with microbial additive in West Africa.

Materials and methods

The PM that is widely cultivated in West Africa was selected for this experiment. PM stover including stems and leaves were harvested at maturity stage in an field of local farm, Koudougou, Burkina Faso in October 27, 2018. The PM was used for silage making by using laboratory-scale fermentation system (Cai et al. 2019). The commercial LAB inoculant Chikusou-1 (LP, *Lactobacillus plantarum*, Snow Brand Seed Co., Ltd, Sapporo, Japan) and cellulase enzyme (AC, *Acremonium cellulase*, Meiji Seika Pharma Co., Ltd, Tokyo, Japan) were used as silage additives based on the guidelines of a commercial manufacturer. Silage treatments were designed as control; LP and AC. After harvest, fresh PM stover (about 80 kg) were immediately cut into approximately 1 to 2 cm lengths by a chopper (130DX, ARS Co., Ltd, Osaka, Japan), and then approximately 8 kg were packed into 20 L used polyethylene drum (Ka-Kosher Co., Ltd, Sinaloa, Mexico) silos. The silos with triplicates for each treatment were kept at an ambient temperature (25–38°C). After 120 days of fermentation, these silos were opened for analysis of microbial population, chemical composition, and fermentation quality.

Results and Discussion

The dry matter (DM) of PM stover was 43.15%. The organic matter (OM), crude protein (CP), ether extract (EE), neutral detergent fiber (NDF), and acid detergent fiber (ADF) contents were 93.37, 4.18, 0.75, 77.10, and 48.30%, respectively on a DM basis. The aerobic bacteria dominated PM stover with 10^5, while the LAB was below 10^2 colony-forming unit (cfu)/g on a fresh matter (FM) basis. After 120 days of fermentation, the chemical composition did not show marked differences among the control, LP, and AC-treated silages. In the control silages, aerobic bacteria (10^5 cfu/g of FM) was the dominant species, but the LAB of the LP and AC-treated silages were the dominant population with 10^5 cfu/g of FM (Fig. 2). The counts of coliform bacteria and molds in the PM stover silages were below detectable levels ($< 10^2$ cfu/g of FM). During ensiling, LAB can use sugars to produce lactic acid, thereby reducing the pH and inhibiting the growth of harmful bacteria, in turn resulting in good-quality silage (Cai et al. 1999). The control silage was of poor quality, with low lactic acid content (0.40% of FM), and a relatively high pH (4.64) and ammonia nitrogen (NH_3-N) values (0.48 g/kg of FM). When silage inoculated with additives, their fermentation quality were improved (Fig. 3). These results suggest that the PM can be prepared as silage and the LAB inoculant and cellulase enzyme can improve the fermentation quality.

Conclusions

The fresh PM stover contained a certain amount of nutrient, and the microbial additives could improve silage fermentation, and that the fresh stover prepared as silage, are well-suited for preservation to serve as roughage sources to cover animal feed shortages during the dry season in West Africa.

Acknowledgements

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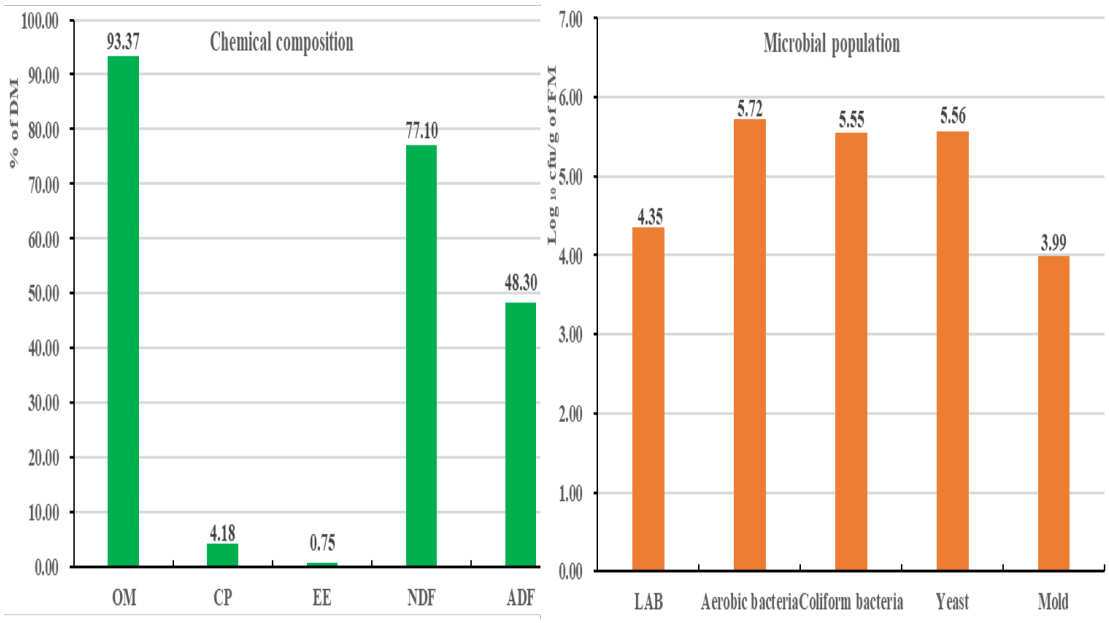

Fig. 1 Chemical composition and microbial population of pearl millet (PM) stover before ensiling

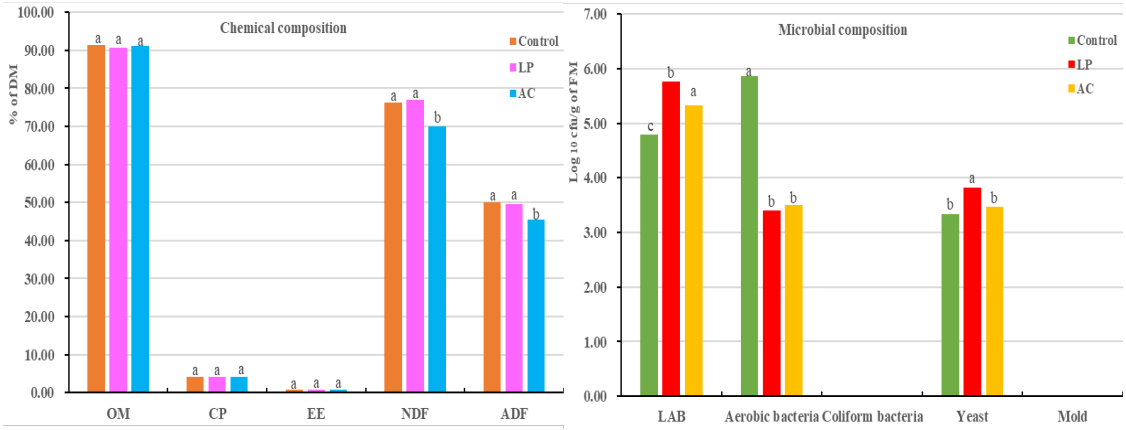

Fig. 2 Chemical composition and microbial composition of pearl millet (PM) stover silages after 120 days of fermentation.

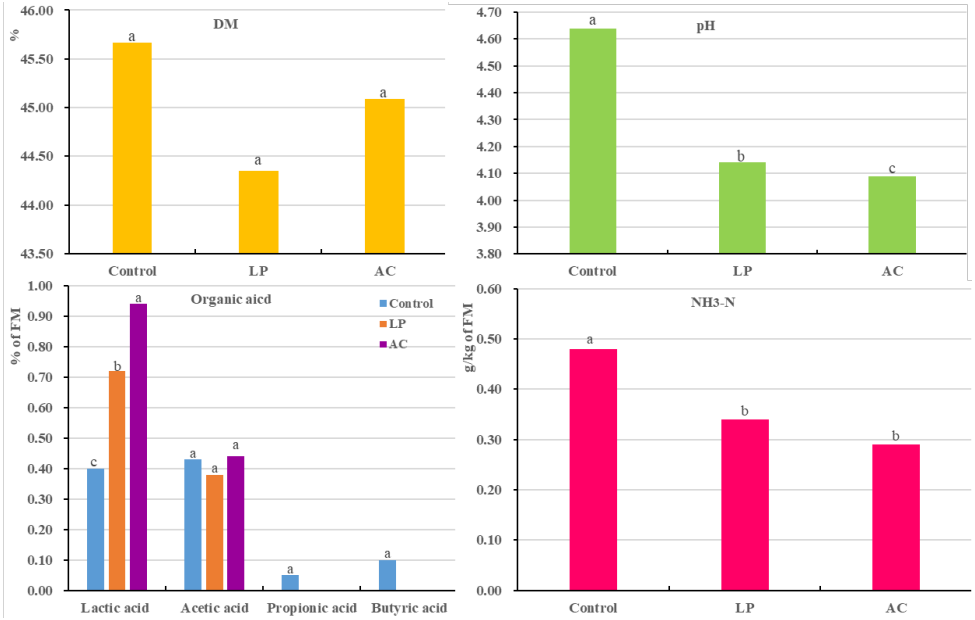

Fig. 3 DM and fermentation quality of pearl millet (PM) stover silages after 120 days of fermentation.