Quality of Sorghum Silage Fermented with Starch of Gebanga Flour (*Corypha gebanga*) and Lactic Acid Bacteria as Additives

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ABSTRACT

The carbohydrate-rich feed was commonly used as an additive in ensiling process. However, there has been lack of scientific reports on the usage of starch of gebanga (*Corypha gebanga*) flour as additive combined with lactic acid bacteria (LAB). The objective of this study was to determine the quality of sorghum silage treated with the starch of gebanga flour and LAB as additives. Twenty units of mini silos (5 treatments × 4 replicates) were examined for chemical characteristics of sorghum silage after 21 d of ensiling period where every four mini silos contain sorghum without additives (control), and with either the starch of gebanga flour at a level of 4% (G4), 4% + 0.1% LAB (G4LAB), 8% (G8), or 8% + 0.1% LAB (G8LAB) of total dry matter of silage. Results of the study showed that the quality of sorghum silage were influenced by gebanga flour additive with or without *Lactobacillus plantarum* ($P<0.05$). Inclusion of 8% gebanga flour with or without LAB increased dry and organic matters of the silage. All treatments resulted in acidic condition and lower the pH of silage. The greatest lactic acid concentration was recorded for G8 (6.01 g/kg). In summary, the inclusion of the gebanga flour and *Lactobacillus plantarum* as additives improved the quality of sorghum silage.

Keywords: Sorghum, Silage, Gebanga, Lactic acid bacteria, Quality

INTRODUCTION

Sorghum (*Sorghum bicolor* L. Moench) originated in the tropics with high yield forages has been used for silage making. Most studies in the field of sorghum ensiling have been built up on the basic understanding that in an anaerobic condition the forage would be preserved because the unwanted bacteria that ruined the silage have been inhibited while the desirable bacteria such as Lactic acid bacteria have been promoted (McDonald *et al*., 2011). Silage can be treated using an additive to stimulate fermentation process and usually made of carbohydrates sources, inoculants and enzymes. In regards to carbohydrate sources, the studies to date have tended to use the abundantly and locally available carbohydrate materials such as cassava pomade (Utomo *et al*., 2013), palm sugar (Harlinae *et al*., 2015) and cassava pomade, pollard and ground corn (Despal *et al*., 2011).

Fuah and Pattie (2013) reported that the starch of gebanga (*Corypha gebanga*) flour has been used as an energy supplement and increased the growth rate of local goats. This local palm tree that grows naturally in the coastal area of East Nusa Tenggara Province, Indonesia had the potential to be an additive for sorghum silage. So far, the sorghum crop was cultivated for feed only. Therefore, a study has been conducted to determine the chemical qualities of sorghum silage treated with starch of gebanga flour and lactic acid bacteria as additives.

We hypothesised that the inclusion of gebanga flour only at different levels or mixed with lactic acid bacteria as additives would improved the chemical qualities of sorghum silage.

MATERIALS AND METHODS

The whole plants of sorghum (*Sorghum bicolor*) forages were harvested after 70 d of cultivation, chopped into 2 to 3 cm long were then withered to contain approximately 35% DM. Two additives included for fermentation were powder starch made of gebanga (*Corypha gebanga*) flour and *Lactobacillus plantarum* as lactic acid bacteria (LAB). A one-way completely randomised design, with two factors namely types and levels of additives, was applied for the experimental design. Treatments were forages without additive (Control) and with either gebanga flour at a level of 4% (G4), 4% + 0.1% LAB (G4LAB), 8% (G8) or 8% + 0.1% LAB (G8LAB) of total DM of silage.

The withered sorghum forages were mixed thoroughly with the additives according to treatments. The mixed materials were compacted into four polyethylene bags as replications for every treatment (5 treatments x 4 replicates = 20 experimental units) where each bag holds 2 kg silage. Compaction was done slowly by hand pressure as the materials were included into the mini silos. In addition, the residual air was sucked out using a vacuum pump to maintain an anaerobic condition before the silos were sealed and stored for fermentation.

After 21 d of the ensiling period, the silos were opened, sub-sampled and the chemical qualities were determined in duplicate. The procedures to evaluate the silage qualities were as described by Harris (1970) for total dry and organic matter, Nahm (1992) for pH, as well as Chaney and Marbach (1962) cited by Utomo (2015) for lactic acid.

Collected data were analysed with a One-way analysis of variance, ANOVA test (IBM SPSS Statistics for Windows, Version 23.0). The differences across treatments as a post Hoc multiple comparisons were compared with Duncan's test. The data were presented as mean ±SEM, and significant difference was at level of 0.05.

RESULTS AND DISCUSSION

Recorded data for chemical qualities of sorghum silage as responses to the additives treatment is presented in Table 1.

Table 1. Chemical qualities of sorghum silage with additives of gebanga (*Corypha gebanga*) flour at 4% and 8% level mixed with *Lactobacillus plantarum*

Parameters	Control	G4	G4LAB	G8	G8LAB	P-Value
Dry matter (%)	17.89 ^{a} ±0.72	20.06 ^{b} ±1.34	19.56 ^{ab} ±0.86	22.51 ^{c} ±1.70	22.52 ^{c} ±1.11	*
Organic matter (%)	86.10 ^{a} ±0.70	87.98 ^{bc} ±0.43	88.05 ^{bc} ±0.17	89.23 ^{c} ±0.15	89.68 ^{c} ±0.26	*
pH	4.79 ^{b} ±0.17	4.44 ^{a} ±0.03	4.43 ^{a} ±0.05	4.45 ^{a} ±0.04	4.44 ^{a} ±0.03	*
Lactic acid (g/kg)	2.02 ^{a} ±0.10	4.45 ^{b} ±0.26	4.77 ^{b} ±0.26	6.01 ^{b} ±1.26	4.93 ^{b} ±0.18	*

* P-Values marked by different letters in the same row differ significantly; P < 0.05 and NS = not significantly different

In general, the chemical qualities of sorghum silage were significantly influenced by the starch of gebanga flour additive with or without *Lactobacillus plantarum* ($P<0.05$). The dry matter percentage of silage was enhanced by gebanga additive level; but the inclusion of LAB had no effect. Similarly, the organic matter contents were raised by additives. The dry and organic matter contents of sorghum silage were linearly increased accordingly to the level of gebanga flour additive. The scientific reports on the usage of this locally available additive on sorghum silage were lacking. However, the function of the gebanga flour as a carbohydrate source to stimulate the fermentation in the present study was clear. This finding was in line with another study on rumen content silage using cassava pomace as an additive at different levels by Utomo *et al*. (2013) who reported that dry and organic matter content of the silage were increased as the levels of cassava pomace were levelled up. The dry powder of gebanga flour in the present study or cassava pomace by Utomo would explain the increase dry matter content of the silage.

All levels and types of additive have similar effect on pH of sorghum silage (P>0.05) as shown that the silage becomes more acidic by additives as compared to that of Control. The pH values in the treated silos agreed with the three to fourfold increase of levels of lactic acid as compared to that of Control. The acidic condition of the silage recorded in this study suggested that the ensiling process had been improved by the inclusion of gebanga flour and LAB. McDonald *et al*. (2011) stated that lactic acid bacteria ferment sugars in the crop by nature to produce lactic acid. This acid would then inhibit the growth of undesirable bacteria such as clostridia and enterobacteria which usually ruined the silage. Consequently, the desirable lactic acid bacteria population should have been increased and this was evident in the present study where 2.02 g/kg of lactic acid bacteria in the sorghum silage without additives was lower than those with additives (Table 1). This finding confirmed a previous study by Cahyanto *et al*. (2008) who reported that about eleven stains of *Lactobacillus plantarum* have been found to grow in the corn silage and gave result in reducing the pH of the silage.

CONCLUSIONS

It can be concluded that the inclusion of the starch of gebanga (*Corypha gebanga*) flour and *Lactobacillus plantarum* as additives improved the chemical quality of sorghum silage. The usage of gebanga flour at 8% DM silage with or without LAB enhanced levels of both dry and organic matters. A series of cause–effect relationship in this study was that these two additives enhanced lactic acid concentration, causing acidic condition in the silos, thus increased silage pH.

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