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Nutritional Value of Fermented Maize Stover as Feed for Ruminant

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ABSTRACT

An experiment was undertaken to determine the physical and nutritional properties, *in vitro* digestibility of maize stover fermented with different levels of molasses. Maize stover was collected from field immediately after harvesting the corn, chopped and were preserved in plastic containers under normal condition and were treated, sample fermented without additives (T_1), sample with addition of water and 5% molasses (T_2). After completion of each ensiled period, nutritional properties, *in-vitro* digestibility and were determined. The result reveals that crude protein (CP), dry matter (DM), ash content of maize stover were increased ($P<0.05$) while the crude fiber (CF) contents were decreased ($P<0.01$) after ensiling and addition of molasses. The highest DM, EE and CP content was found to be 99.52%, 10.33% and 4.56% in T_2 while CF was found highest in T_1 32.79%. The OMD (organic matter digestibility) and DMD (dry matter digestibility) contents were decreased by ensiling with molasses. The highest DMD, OMD, N-NH_3, total VFA DMD values were observed in treatment T_1 which were 47.71%, 46.78%, 12.50%, 5.42% respectively. Therefore, it can be concluded that the addition of molasses improved and nutritional properties and preservation capacity of maize stover after 21 days of ensiling

Key words: Fermented, Maize stover, Molasses, Nutritional properties, Ruminant

INTRODUCTION

Maize residues are characterized by low protein and high fiber content and this limits their nutritive value for ruminants. Nitrogen (N) supplementation increases digestibility and intake. (Freer and Balch, 1962). Maximum intake of cereal straws occurs when crude protein concentration is 66-85 g/kg dry matter (DM) (Elliott and Topps, 1963; Smith *et al*, 1980). Though the annual production of maize stover in the zone is said to be high, its utilization for livestock feeding is constrained by its physical nature (its stalk) and nutritional characteristics. Maize stover is one of the available energy sources for ruminants. However, the availability of this energy to animals is generally limited by the low voluntary intake, the chemical association between lignin and cell wall carbohydrates and the physical limitation of the cell wall components for microbial fermentation.

Chemical treatment of residues also increases intake and digestibility. The benefits to be gained from alkali treatment of residues have been reviewed by Jackson (1977) and Sundstol (1981). Although Sundstol (1981) and Smith *et al.* (1984) found sodium hydroxide more effective than ammonia, the use of alkali

containing N reduces the need for protein supplementation (Smith and Balch, 1984).

In Indonesia, there is huge production of maize stover which is about 25-30 ton/ha/year (Sarker *et al.,* 2007). Maize stover has a higher crude protein content of about 6% and metabolizable energy (ME) value of about 9 MJ/kg DM (McDonald *et al.,* 1995) than rice straw though maize stover is characterized by a low protein, high fibre content and structurally too hard compared to other high quality roughages. The stover may be chopped, ensiled and fed in a similar way to maize silage (McDonald *et al.,* 1995). Different physicochemical and biological processing of maize stover may increase its nutritional and preservative quality and make it palatable to ruminants. Molasses is suitable for feeding ruminants as it is wholesome, easy to use, effective, palatable, dust free, promote fermentation and contain some concentrated nutrients. It helps in facilitating the natural preservation by lowering the pH and producing lactic acid bacteria (Premier Molasses, 2006). Addition of molasses and ensiling of chopped maize stover can be the effective means of improving the nutritive value. Considering the above evidence the present experiment was under taken to investigate the effect of addition of molasses and ensiling time on physical properties, nutritional properties, *in vitro* digestibility and metabolizable energy contents of maize stover silage.

The main problem faced in the development of ruminant livestock in Indonesia is the difficulty in sustainably fulfilling the feed availability, either in terms of quality or quantity. Various efforts in finding low price feed and the use appropriate technology in its utilization is still underway, to support the solution of feed provision. Efficient feeding strategy is utilizing the abundant and nutritional valued local resources for livestock. Maize plants by-product in South Sulawesi is increasing along with the implementation of 1.5 million tons maize production attainment program. The maize plants byproduct volume is about 5-6 ton dry weight per hectare (McDonald *et al.,* 1995). Currently, most of the corn plant byproducts are simply burned and only few of the farmers utilize them as feed. The nutrient content of the maize stover were 5.8% crude protein, 27.38% crude fiber, 1.90% ether extract, and 20.8% ash. The value of agroindustrial waste as feed material can be improved by performing physical, chemical, and biological treatments or any combination of them. Chemical processing is associated to residual production contributing to environmental pollution, that it is not frequently recommended. Biological processing by utilizing microorganism has been widely practiced recently, because it is more environmental friendly. Fungi occurring naturally are the organic food breaker and play an important role in life.

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MATERIALS AND METHOD

The experiment was conducted in the Laboratory of the Department of Animal Science, Faculty of Agriculture, Sriwijaya University, Indonesia. Maize stover was chopped by cuter equipment, ensiled with 0%, and 5% molasses in addition into water and was kept into airtight plastic container for period of 21 day, the preserved samples were observed and sub-sampled for physical observation, chemical analysis and *in vitro* digestibility determination

Collection of the Experimental Materials

The maize stover were collected from the field of Indralaya Kabupaten Ogan Ilir, South Sumatera, Indonesia. Commercial cane molasses were purchased from local market

Processing and Preservation of the Materials

After collection, maize stover samples were chopped into 3-4 cm length. The chopped maize stover (1 kg) was placed in a plastic bowl, mixed well with water and 0 and 5% molasses. The properly mixed samples were poured into previously leveled container, pressed, squeezed sufficiently to make airtight by hand pressure and tightly closed the cover. The ensiled samples were then kept at room temperature (28 to 32°C) for 20 days.

The treatment groups were as follows:

Treatments

T_1 = Sample, ensiled without water and molasses

T_2 = Sample ensiled with water and 5% molasses

Chemical Analysis

Untreated and treated maize stover samples were analyzed for dry matter, ash, crude protein, ether extract and crude fiber according to the methods of AOAC (1984).

Measurement of *In vitro* Gas Production (IVGP), Organic Matter Digestibility (OMD)

Hohenheim gas test was used to measure *in vitro* gas production (IVGP), to calculate the organic matter digestibility (OMD) and dry matter digestibility (DMD) content of maize stover sample using hay as standard and blank was used for correction of gas measurement. The method was based on the *in vitro* gas production technique described by Menke *et al.* (1979) and Menke and Steingass (1988).

Statistical Analysis

The data of proximate components and *in vitro* digestibility were analyzed using t-test statistical program.

RESULTS AND DISCUSSION

Effect of different treatments and ensiling time on the composition of maize stover is shown in Table 1. The highest DM content was (99.52%) found in treated (T_2) maize stover and lowest (99.28%) in untreated molasses (T_1) maize stover ($P<0.01$). The DM content was increased significantly with the addition of water and molasses (T_2) treated maize stover. The reason of increasing the DM content in the present study may be due to addition of water, to properly mix the molasses and for proper compactness of ensiling. Nour, (1990) reported that ensiling with 5% molasses reduced the DM content. The DM content loss also found by Otieno *et al.* (1986), Hiep and Man (2003), and Man and Wiktorsson (2003). The findings were similar to the trend of DM level which was reported by Man and Wiktorsson,(2003) where DM content was increased from 26.7 to 27.7% with 0 to 9 % molasses, from 20.83 to 22.77% with 5% molasses (Otieno *et al.*, 1986) and from 26.5 to 28.1% with 4% molasses (Hiep and Man, 2003) in maize stover. In the present study, it was observed that DM content was increased with ensiling time from 99.28 to 99.52%.

Table 1. Proximate analysis of Maize stover control and treatments

Parameters	Control (maize stover)	Treatment (maize stover + molasses)	P-Value
Dry Matter (%)	99.28±0.09	99.52±0.14	ns
Crude Fiber (%)	32.79±11.44	19.80±6.10	ns
Crude Protein (%)	4.25±1.77	4.56±2.38	*
Ether Extract (%)	9.64±0.51	10.33±58	ns
Ash (%)	1.68±0.20	2.16±0.30	ns

Notes : ns = non-significant. *, significant at 5% level

The CP content was highest (4.56%) in 5% molasses treated (T_2) maize stover and 4.25% in T_1 untreated of maize stover. It was observed that the CP content was highest in the 5% molasses treated (T_2) maize stover (4.56%) followed by T_1. So, the CP content increased from 4.25 to 4.56% in molasses treatment (T_2). Similar results also found by some researchers. Lanari *et al.* (1987) reported that molasses treatment increases the CP content of maize stover. Andrighelto *et al.* (1988) found the result that addition of liquid residue derived from molasses of 100-kg/t silage increase the CP content from 7.9 to 11.3%. Ensiling with 1.5% molasses increase of CP content from 4.6 to 5.0% (Chauhan, 1985) and from 6.08 to 6.85% in maize stover silage (Otieno *et al.*, 1986). Lee *et al.* (1986) found that addition of energy source from 0-30% increased the CP content from 7.9 to 13.6% in maize stover ensiling. In the present experiment the CP content increment in the molasses treated may be due to the readily available energy from the molasses, which was used by the

microorganism for their growth and increased microbial protein in the silage. Microbial nitrogen supply increased with increasing the supply of nitrogen, fermentable carbohydrate, sulfur and probably the other essential nutrients (Tolera and Sundstol, 2000), where molasses may serve the major supply of these essential nutrients. The magnitude of increase varies according to factors such as the nature of the material, the environment and the treatment process (Hiep and Man, 2003). The CP content increased with increasing the ensiling time during the present study (P>0.01). Parigi-Bini *et al.* (1987) reported that ensiling time with molasses treatment increased the CP content of maize stover, which was also supported by Lanari *et al.* (1987). The CP content increased with increasing ensiling time (Man and Wiktorsson, 2003 and Snijders *et al.*, 2004) and with molasses increament (Snijders and Wouters, 2004).

The CF content was highest (32.79%) in untreated (T_1) and lowest (19.80%) in 5% molasses treated (T_2) maize stover . It was observed that in the present The EE content was highest (10.33%) in 5% molasses treated (T_2) maize stover and 9.64% in T_1 untreated of maize stover. It was observed that the CP content was highest in the 5% molasses treated (T_2) maize stover (10.33%) followed by T_1 so, the CP content increased from 9.64 to 10.33% in molasses treatment (T_2). Similar results also found by some researchers. Lanari *et al.* (1987) reported that molasses treatment increases the CP content of maize stover. Andrighelto *et al.* (1988) found the result that addition of liquid residue derived from molasses of 100-kg/t silage increase.

In-vitro OMD and DMD

The *in vitro* organic matter digestibility (OMD) and dry matter digestibility (DMD) and Total VFA contents after different treatments and ensiling of maize stover was presented in Table 2.

Table 2. *In Vitro* gas produce technique

Parameter	Control (maize stover)	Treatment (maize stover+molasses)	P-Value
Dry Matter Digestibility	47.71±7.68	32.25±6.11	*
Organic Matter Digestibility	46.78±7.66	31.51±5.32	*
N-Ammonia	12.50±0.79	10.90±0.74	*
pH	6.38±0.24	7.11±0.18	*
Total VFA	54.50±0.72	42.53±0.19	*

Note: *) = significant at 5% level

The predicted OMD was (46.78%) found highest (P<0.05) in 0% molasses treatment. In the present experiment DMD content was decreased significantly (P<0.05) with treatment and ensiling. Highest DMD content was (47.71%) in the 0% molasses treatment (T_1). In

the present experiment Total VFA content was decreased significantly (P<0.05) with treatment and ensiling. Highest Total VFA content was (54.50%) in the 0% molasses treatment (T_1). Also, it was revealed that the OMD and DMD content were significantly increased with increasing the ensiling time (P<0.05). Hiep and Man (2003) observed that molasses treatment and ensiling increase (P<0.05) the predicted OMD of maize stalks from 63.7 to 70.2% with 4% molasses level. Molasses treatment increased the predicted DMD content was also observed by Otieno *et al.* (1986), Lanari *et al.* (1987), and Nour (1990). Molasses as the energy source may increase the DMD content in maize stover silage. Experiment the value of CF was significantly (P<0.01) decreased in the treatments (T_1 to T_2) of maize stover. The reason of decrease of CF content may be due to addition of water in the treatment groups. The findings were supported by Skultety *et al.* (1991) who reported that CF might be decreased with addition of water. In the present experiment CF content was decreased from 32.79 to 19.80%. Similar result was observed by Hiep and Man (2003) where they reported that, the fibre content of maize stover reduced from 70.7 to 65.3% due to ensiling time. Ensiling time reduce the CF content of maize stover with water and molasses (Lanari *et al.*, 1987). Decrease of CF content with increasing ensiling time in maize stover, sugarcane tops, sorghum stover was also found by Otieno *et al.* (1986).

CONCLUSION

Results indicated that addition of molasses helps to improve the physical and nutritional properties and preservation capacity of maize stover. Addition of 5% molasses and 21 days ensiling of maize stover showed good color, smell, softness, nutritional quality and longer preservation capacity. Therefore, Maize stover may be ensiled for 21 days by adding 5% molasses water. However, further investigation is needed to conduct *in vivo* feeding trial with maize stover silage using molasses to justify the present findings

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