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EFFECT OF ADDITION OF MOLASSES AND PERIOD OF PRESERVATION ON PHYSICAL AND NUTRITIONAL PROPERTIES OF MAIZE STOVER SILAGE

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Abstract

An experiment was undertaken to determine the physical and nutritional properties, *in vitro* digestibility and metabolizable energy of maize stover ensiled with different levels of molasses at three different ensiling times (45, 90 and 135 days). Maize stover was collected from field immediately after harvesting the corn, chopped and were preserved in plastic containers under normal condition and were treated as control (T_0) (sample only), sample ensiled without additives (T_1), sample with addition of 20% water (T_2), sample with addition of 20% water and 2% molasses (T_3), samples with addition of 20% water and 4% molasses (T_4), sample with addition of 20% water and 6% molasses (T_5). After completion of each ensiled period, physical and nutritional properties, *in-vitro* digestibility and metabolizable energy were determined. The result reveals that physical properties (color, smell, softness and fungal growth) of maize stover were improved in molasses treatments. It was also improved with increasing the ensiling time from 45 to 135 days. Among the treatments T_4 was found best, as there were no fungal growth. The crude protein (CP) content of maize stover was increased ($P<0.01$) and the dry matter (DM), organic matter (OM) and crude fibre (CF) contents were decreased ($P<0.01$) after ensiling and addition of molasses. The highest DM, OM and CF content was found to be 72.33, 87.70 and 37.08% in T_0 and highest CP was found to be 10.67% in T_4 but the lowest DM, OM, CF and CP was found to be 63.17% in T_2, 82.68% in T_3, 28.18% in T_5 and 6.28% in T_0. The DM, OM, CP and CF contents were similar ($P>0.01$) at different ensiling time (45 to 135 days). The OMD (organic matter digestibility) and ME (metabolizable energy) contents were increased by ensiling with molasses. The highest OMD and ME values were observed in treatment T_4 which were 42.01% and 6.50 MJ/kg DM, respectively. Therefore, it can be concluded that the addition of molasses improved the physical and nutritional properties and preservation capacity of maize stover after 135 days of ensiling.

Key words : Maize stover, Ensiling, Physical and nutritional properties, *In vitro* digestibility

Introduction

Cultivation of maize is increasing as maize corn is using as the main ingredient of poultry feed and confectionaries and poultry farming is now the second largest industry in

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Bangladesh. 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 physico-chemical 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.

Materials and Methods

The experiment was conducted in the Laboratory of the Department of Animal Science, Faculty of Animal Husbandry, Bangladesh Agricultural University, Mymensingh, Bangladesh. Maize stover was chopped, ensiled with 0, 2, 4 and 6% molasses in addition to 20% water and was kept into airtight plastic container for period of 45, 90 and 135 days. At three intervals of 45, 90 and 135 days, 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 stovers were collected from the field of Sherpur upazila of Bogra district just after collection of corn cobs. 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 (3 kg) was placed in a plastic bowl, mixed well with 20% water and 2, 4 and 6% 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 45, 90 and 135 days.

The treatment groups were as follows :

Treatments

T_0	=	Control (fresh sample)
T_1	=	Sample, ensiled without water and molasses
T_2	=	Sample ensiled with 20% water and 0% molasses
T_3	=	Sample ensiled with 20% water and 2% molasses
T_4	=	Sample ensiled with 20% water and 4% molasses
T_5	=	Sample ensiled with 20% water and 6% molasses

Observation and collection of samples

The ensiled sample of the each plastic container was opened after 45, 90 and 135 days respectively. The physical changes of all ensiled samples were observed and documented. Fungus was detected with visual estimation. During the observation 100g of sample was taken out from each replication for chemical analysis. The DM and OM content was measured on fresh basis. All the samples were air dried and ground with the help of grinding machine of about 1mm in diameter for chemical analysis and *in vitro* digestibility technique.

Chemical analysis

Untreated and treated maize stover samples were analyzed for DM, Ash, OM, CP and CF according to the methods of AOAC (1984).

Measurement of *in vitro* gas production (IVGP), organic matter digestibility (OMD) and metabolizable energy (ME)

Hohenheim gas test was used to measure *in vitro* gas production (IVGP), to calculate the organic matter digestibility (OMD) and metabolizable energy (ME) 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 SPSS statistical programme (SPSS75 version), using two factorial experimental design and means were compared using Duncan's Multiple Range Test (DMRT).

Results and Discussion

Physical properties of ensiled maize stover

The physical properties of untreated and treated and ensiled maize stover at different periods were shown in Table 1. Result indicates that ensiled maize stover (T_1 and T_2) without molasses had unacceptable colour, smell, softness and there was much fungal growth. Molasses treatments (T_3, T_4 and T_5) had good colour, smell and softness but some fungal

growth was observed with T_3 and T_5. In the present experiment brown colour was increased with increasing the level of molasses from 2 to 6%. Otieno *et al.* (1986) also found that maize stover ensiled with 5% molasses produced brownish colour silage and had typical silage smell. Fermentation with addition of molasses indicates good silage quality as well as colour, smell and no fungal growth (Snijders and Wouters, 2004). Ensiling with 3, 6 and 9% molasses produced acceptable colour of brownish yellow or yellow brown and typical smell but with 6 and 9% molasses there were some spoilage due to fungal growth (Man and Wiktorsson, 2003). In the present experiment, based on the colour, smell and fungus appearance, the silages considered to be acceptable with 4% level of molasses than those of 2 and 6% levels. It was supported by Man and Wiktorsson, (2003) who reported that the low level of molasses (3%) was better than the high level (6 and 9%) of molasses in terms of colour, softness and fungal growth. Snijders and Wouters (2004) reported that, addition of 3% molasses obtained good quality silage. The level of 5% molasses may be sufficient for producing good quality silage (Thanh *et al*., 2000). The presence of fungus in silage is undesirable because it uses silage nutrients and toxins are sometimes produced (Man and Wiktorsson, 2003).

Table 1. Effect of different treatments and ensiling durations on the physical properties of maize stover

Parameters	Days	Treatments[#]					
		T_0	T_1	T_2	T_3	T_4	T_5
Colour	45	Greenish	Blackish	Blackish	Grey brown	Brownish	Brownish
	90	Grey	Black	Blackish	Brownish	Brownish	Brownish
	135	Grey	Black	Blackish	Brownish	Brownish yellow	Blackish
Smell	45	Natural smell	Bad	Bad	Moderately good	Good	Good
	90	Natural smell	Bad	Bad	Moderately Good	Good	Good
	135	Natural smell	Bad	Bad	Good	Very Good	Good
Softness	45	Hard	Hard	Hard	Hard	Moderately soft	Moderately soft
	90	Hard	Hard	Hard	Moderately soft	Soft	Soft
	135	Hard	Hard	Hard	Soft	Soft	Soft
Fungus	45	Absent	Present	Present	Absent	Absent	Present
	90	Absent	Present	Present	Present	Absent	Present
	135	Absent	Present	Present	Present	Absent	Present

[#] T_0 = Untreated and unensiled, T_1 = Untreated and ensiled, T_2 = Ensiled with 20% water, T_3 = T_2 + 2% molasses, T_3 = T_2 + 4% molasses T_3 = T_2 + 6% molasses. Hard indicating not acceptable by ruminants by (cattle, sheep, goat *etc*). Soft indicating accepted by ruminants (cattle, sheep, goat *etc*)

In the present experiment fungal growth in some samples were increased with increasing ensiling time from 45 to 135 days, but the colour, smell and softness of maize stover were improved with increasing the ensiling duration when specially molasses (T_3, T_4 and T_5) was added. Though fungus was found in 2 and 6% molasses treatments, in that case fungal growth increased with increasing ensiling period from 45 to 135 days. Man and Wiktorsson, (2003) found that ensiling of maize stover with molasses increased the degree of brown

colour with increasing ensiling time (from 2 to 4 months) in the silage but fungus was observed after 4 months of ensiling. Two months of ensiling with 5% molasses treated maize stover results a good appearance (brownish colour) and typical silage smell (Otieno *et al.,* 1986). Changing in colour and improvement in brown colour from 20 to 50 days was also observed by Hiep and Man (2003) but fungal growth was increased with increasing the ensiling time. Spoiling increased with the long-term storage and with the high level of molasses (Man and Wiktorsson, 2003). Ensiling time may have effects on increasing in fungal growth (Petersson, 1988).

Nutritional properties

Effect of different treatments and ensiling time on the composition of maize stover is shown in Table 2. The highest DM content was (72.33%) found in untreated (T_0) and lowest (63.17%) in 20% water treated (T_2) maize stover ($P<0.01$). The DM content was decreased significantly ($P<0.05$) with the addition of water and molasses (T_2, T_3, T_4 and T_5) treated maize stover. The reason of decreasing 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 3% 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). Among the molasses treatments (T_3, T_4 and T_5) DM content was increased from 64.22 to 66.78% with increasing the level of molasses from 2 to 6% ($P<0.01$). 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 decreased with ensiling time from 67.41 to 66.45% with the increase of duration from 45 to 135 days ($P>0.01$). There were some experiments where in the ensiled maize stover, the DM content decreased from 22.58 to 20.83% (Otieno *et al.*, 1986), from 29.1 to 26.5% (Hiep and Man, 2003), from 28.0 to 26.4%, (Man and Wiktorsson, 2003) with increasing the ensiling time.

The OM content was highest (87.70%) in the untreated (T_0) and lowest (82.68%) in 2% molasses treated (T_3) maize stover ($P<0.01$). In the present experiment, OM content was decreased ($P<0.05$) from 87.70% (T_0) to 82.68% (T_3) after ensiling with molasses (Table 2). Similar observation was reported by Hiep and Man (2003) where the OM content reduced from 91.0 to 88.90% with '0' to 4% molasses in maize stover silage. The OM content in different ensiling time 45, 90 and 135 days were 84.79, 84.18 and 84.97%, respectively. The present study indicates that there was no effect of ensiling time on the OM content ($P>0.01$). Man and Wiktorsson, (2003) reported that OM content is reduced in cassava top silage with increasing ensiling time. Due to ensiling time in the presence or absence of additives, organic matter may be increased or decreased, which may be depends on different factors such as biochemical or microbial reactions during ensiling period.

Table 2. Effect of different treatments and different ensiling time on the composition of maize stover (% on DM basis)

Parameters	Days	Treatments[#]						Mean	SEM	Level of Sig.
		T_0	T_1	T_2	T_3	T_4	T_5			
DM	45	72.40	71.11	64.69	63.88	65.90	66.50	67.41^{a}	1.43	NS
	90	72.94	69.77	62.44	64.38	65.42	66.95	66.98^{a}	1.56	NS
	135	71.66	67.84	62.38	64.42	65.54	66.88	**66.45^{a}**	1.30	NS
	Mean	72.33^{a}	69.57^{b}	63.17^{e}	64.22^{de}	65.62^{cd}	66.78^{c}	-	-	
	SEM	0.37	0.95	0.76	0.17	0.14	0.14	-	-	
Level of sig.		**	**	**	**	**	**			
OM	45	87.31	86.52	84.28	81.76	84.75	82.39	84.50^{a}	0.90	NS
	90	87.07	84.37	83.39	80.87	82.32	84.29	83.72^{a}	0.86	NS
	135	88.74	85.36	83.99	85.42	81.37	85.13	**85.00^{a}**	0.98	NS
	Mean	87.70^{a}	85.42^{ab}	83.89^{b}	82.68^{b}	82.81^{b}	83.94^{b}	-	-	
	SEM	0.43	0.65	0.42	0.77	0.63	0.57	-	-	
Level of sig.		**	**	**	**	**	**			
CP	45	6.34	6.31	7.15	8.58	8.48	9.50	7.73^{b}	0.54	NS
	90	6.24	6.55	8.34	8.40	11.73	11.54	**8.8^{a}**	0.97	NS
	135	6.25	7.12	7.47	9.16	12.99	8.49	8.58^{a}	0.98	NS
	Mean	6.28^{e}	6.66^{ed}	7.65^{bcd}	8.71^{bc}	11.07^{a}	9.84$^{a\,b}$	-	-	
	SEM	0.07	0.13	0.23	0.21	0.81	0.50	-	-	
Level of sig.		**	**	**	**	**	**			
CF	45	36.73	35.06	33.85	31.51	27.38	28.22	32.13^{a}	1.54	NS
	90	37.64	34.41	33.36	32.27	30.38	27.52	**32.60^{a}**	1.42	NS
	135	36.88	36.15	32.44	28.95	27.08	28.79	31.72^{a}	1.68	NS
	Mean	37.08^{a}	35.21^{ab}	33.22^{b}	30.91^{c}	28.28^{d}	28.18^{d}	-	-	
	SEM	0.29	0.32	0.38	0.69	0.70	0.41	-	-	
Level of sig.		**	**	**	**	**	**			

[#] T_0 = Untreated and unensiled, T_1 = Untreated and ensiled, T_2 = Ensiled with 20% water, T_3 = T_2+ 2% molasses, T_3 = T_2+ 4% molasses T_3 = T_2+ 6% molasses

Values in superscripts within row and column are significantly different (P<0.05)

NS = Non-significant. **, Significant at 1% level

The CP content was highest (10.67%) in 4% molasses treated (T_4) maize stover (P<0.01) followed by 9.84, 8.71, 7.65, 6.66 and 6.28% inT_5, T_3, T_2, T_1 and T_0 of maize stover. It was observed that the CP content was highest in the 4% molasses treated (T_4) maize stover (10.67%) followed by T_5, T_3, T_2, T_1 and T_0 (P<0.01). So, the CP content increased from 6.28 to 10.67% in molasses treatment (T_4). 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 (37.08%) in untreated (T_0) and lowest (28.18%) in 6% molasses treated (T_5) maize stover ($P<0.01$). It was observed that in the present experiment the value of CF was significantly ($P<0.01$) decreased in the treatments (T_1 to T_5) of maize stover. The CF content of the 2, 4 and 6% molasses treated (T_3, T_4 and T_5) maize stover was statistically similar, ($P>0.05$). 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 29.46 to 28.74 % with increasing the ensiling time from 45 to 135 days but statistically not significant ($P>0.01$). 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).

It was revealed that the DM, OM and CF content was decreased by 12.66, 4.34 and 24%, respectively, where the CP content was increased by 69.90% or 1.7 times ($P<0.01$) by ensiling with 4% molasses. It was also observed that, the change in the DM, OM, CP and CF content were not significant ($P>0.01$) with increasing the ensiling time from 45 to 135 days.

***In-vitro* OMD and ME**

The *in vitro* organic matter digestibility (OMD) and metabolizable energy (ME) contents after different treatments and ensiling of maize stover was presented in Table 3. The predicted OMD was (42.01%) found highest ($P<0.01$) in 4% molasses treatment (T_4) followed by T_5, T_3, T_2, T_1, and T_0, respectively. In the present experiment ME content was increased significantly ($P<0.05$) with treatment and ensiling. Highest ME content was 6.50 MJ/kg DM in the 4% molasses treatment (T_4) followed by T_5, T_3, T_2, T_1, and T_0, respectively. It was revealed that the OMD and ME content were increased by, 105, 38 and 44%, respectively. Also, it was revealed that the OMD and ME 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 ME

content was also observed by Otieno *et al.,* 1986; Lanari *et al.*, 1987 and Nour, 1990. Molasses as the energy source may increase the ME content in maize stover silage.

Table 3. *In vitro* organic matter digestibility (OMD) and metabolizable energy (ME) contents in maize stover after different treatments and ensiling

Parameters	Days	Treatments[#]						Mean	SEM	Level of Sig.
		T_0	T_1	T_2	T_3	T_4	T_5			
OMD	45	29.37	31.16	33.74	41.51	41.93	40.65	30.82^{c}	0.61	**
	90	30.28	33.26	36.12	40.66	44.11	41.57	**37.63^{b}**	1.92	**
	135	31.51	29.31	31.06	42.71	39.97	39.88	41.35^{a}	0.64	**
	Mean	30.38^{c}	31.24^{bc}	33.64^{b}	41.62^{a}	42.01^{a}	40.70^{a}			
	SEM	0.62	1.14	1.46	0.60	1.20	0.49			
Level of sig.		**	**	**	**	**	**			
ME	45	4.34	4.62	5.56	6.17	6.24	6.03	4.78^{b}	0.43	**
	90	5.41	6.56	6.05	7.21	7.23	7.05	**6.00^{a}**	0.30	**
	135	3.75	3.98	5.01	5.98	6.02	5.99	6.43^{a}	0.23	**
	Mean	4.50^{d}	5.05^{cd}	5.54^{cd}	6.45^{abc}	6.50^{abc}	6.36^{bc}			
	SEM	0.49	0.78	0.30	0.38	0.37	0.35			
Level of sig.										

[#] T_0 = Untreated and unensiled, T_1 = Untreated and ensiled, T_2 = Ensiled with 20% water, T_3 = T_2 + 2% molasses, T_3 = T_2 + 4% molasses T_3 = T_2 + 6% molasses

Values in superscripts within row and column are significantly different ($P<0.05$)

*, Significant at 5% level, **, Significant at 1% level.

Conclusion

Results indicated that addition of molasses helps to improve the physical and nutritional properties and preservation capacity of maize stover. Addition of 4% molasses and 90 days ensiling of maize stover showed good color, smell, softness, nutritional quality and longer preservation capacity. Therefore, Maize stover may be ensiled for 90 days by adding 4% molasses and 20% 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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