PERFORMANCE EVALUATION OF CORN AND CORN STOVER SILAGES WITH DIFFERENT FEED ADDITIVES IN GROWING SAHIWAL CALVES.

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Abstract:

A 90 days study was undertaken to test the performance of 5different silages (1. silage of maize hybrid, 2. silage of corn stovers,3. Silage of corn stover+6% solution of molasses and 0.3% urea,4. Silage of corn stover+ 6% molasses, 5. Silage of corn stover+ 6% solution of lime) in growing Sahiwal calves. 25 Sahiwal calves of similar age and body weigh were dived into five groups A,B,C,D & E, respectively and were kept in separate sheds for individual feeding. Group A was fed corn silage and served as control and while groups B,C,D and E were reared on respective corn stover silages at ad libitum intakes. Fattening ration having 16.73% crude protein and 73 % total digestible nutrients was also provided at the rate of 1.5% of body weight. Animals were weighed at the start of experiment and fortnightly thereafter. At last week of the study a 5 days digestibility trial was performed through complete collection of urine and feces. Blood was also collected for the analysis of blood urea nitrogen and blood glucose. Dry matter, Organic matter, NDF and ether extract digestibility values were higher in animals fed corn hybrid silage based diet as compared to those fed other diets. Inversely, animals fed corn stovers silage with 6% molasses solution showed higher ADF digestibility. Similarly, higher CP digestibility was observed in animals fed corn stover silage with molasses and urea (CDE treatments). Blood sugar and blood urea nitrogen were higher in animals fed corn hybrid and corn stover silage with 6% limesone, an indicator for availability of nutrients for growth. It was concluded that corn stover silage or with 6% molasses solution can replace the corn silage successfully in growth performance of Sahiewal calves.

Key words; Sahiwal Calves, Corn Stover, Silage, Growth Performance, Digestibility, Blood Metabolites.

Introduction

Fodder crops play pivotal role in the agricultural economy of developing countries by providing cheapest source of feed for livestock (Tauqir et al., 2007). Roughages include crops residues in the form of straws, stover and husk are the cheapest source of livestock feed in the country. The present forage production is not coping with the feeding requirements of livestock in Pakistan. Stresses for the exploitation of new feed resources and the interest for utilization of low quality crop residues as an animal feed has been increased.

But due to trend of farming community toward cash crops and reduced cultivated area has driven the farming community towards silage making of fodders and non-conventional forages. Tauqir et al. (2007) reported that non-leguminous crops are extensively being used worldwide for silage making having relatively low buffering capacity and low concentrations of fermentable carbohydrates. But conventionally silage is being made from the sorghum, barley, millet, mott grass and Jambo grass. However, any forage which has sufficient fermentable carbohydrate may be ensiled, but the most popular crop is the maize (Bolsen et al., 1998, Woolford, 1984).

Corn stover is vegetative portion consisting of leaves and stalks remained in the field after harvesting of corn. Most of the corn stover cannot be utilized by livestock due to abundant availability and low nutritional profile and hence huge quantity become dried in the field and is used as fuel purposes. It is almost half of the yield of a crop. When ears of plants are removed, they are ready to be harvested, otherwise lignin contents will increase and mostly nutrients will be leached out due to sun dry. A limited quantity of this forage is fed to animals and mostly is dried in the field and used as fuel purpose. Farmers are neither trained nor aware to adopt any alternative techniques to preserve biomass of corn stover. Maize stover is utilized for animal feeding during the scarcity of green fodder. During this period Corn stover can be as principle sources of fodder. Nutritional quality of maize stover is poor. It contains 38% cellulose , 26% hemicellulose and 19% lignin which make it acceptile feed for rumnants. After removing the ears of crop, dry matter increased rapidly and digestibility decreased and its ensiling becomes difficult there it is recommended to ensile it as early as possible in green state (Shreck et al., 2014).

Ensiling offers a best solution to preserve this residual crop and be used in animal feeding. Additions of urea and molasses before ensiling could improve its nutritional value (Bolsen et., 1998; Tauqir et al., 2007). Alkali treatments to magnify the nutritional value of low quality grass roughages for cattle have been recognized for decades. This approach is an easy and effective way for improving nutrition quality of dry roughages by enhancing its digestibility. Both molasses and urea could escalate nutritive value of corn stovers while use of alakai could elevate its digestibility. Isher et al. (2010) recommended that the amount of corn stover be limited to about 20 percent of the normal forage dry matter fed to lactating cows.

A feeding trial was undertaken to optimize the conditions to ensile the corn stover under laboratory level by using different additives like molasses, urea and lime and performance evaluation of corn stover silage in growing Sahiwal calves to test its the palatability, growth rate, feed efficiency and nutrient digestibilities.

Material and Method

Procurement of corn stover fodder

Corn stover fodder collected from the fields adjacent to Livestock Production Research Institute Bahadurnagar Okara, Pakistan was evaluated chemically and biologically at the institute. Various silages were prepared from corn stover and Hybrid maize (control) at laboratory level zand on large scale.

Chemical analysis of fodder

Chopped fodder was dried in hot air overn at $55^{O}C$ and ground to 2mm screen for chemical analysis. Chemical analysis is shown in table-1 .

Table.I; Proximate analysis of maize fodder and corn stovers

Sr.No	Fodder	Moisture%	Crude Protein%	Crude Fat%	Crude Fiber%	Ash%	pH	ADF %	NDF %
1	corn stover fodder	67.69	5.4	0.28	37.71	10.22	5.89	34.42	75.42
2	hybrid maize fodder	80.19	8.12	0.345	20.24	5.91	6.03	24.25	61.90

Preparation of silage

Optimization of different molasses conditions

Molasses at 6, 8, 10 & 12% was sprinkled on the chopped fodder of corn stover to enhance the carbohydrates contents of fodder and increasing the microbial activity for

fermentation. Molasses was mixed in water to sprinkle on the fodder and DM of the fodder was maintained at 30%. These silages were prepared in plastic bags. Fodder was compressed by hand to ensure the removal of maximum air and to maintain anaerobic condition for better fermentation. These plastic bags silages were tightly tied with string and were placed in the lab for 30 days (Tauqir, 2010). After opening the silos chemical analysis was performed for their pH, nutrient and fiber composition (Table II). All the silage prepared with different molasses levels showed similar results and hence silage prepared with 6% molasses was selected to be prepared on large scale.

Table II; Chemical analysis of silages with different level of molasses solution.

Sr.No	Details	Visual texture	Moisture%	Crude Protein%	Crude Fat%	Crude Fiber%	Ash%	pH	ADF %	NDF %
1	Hybrid maize silage	Good	67.69	8.4	2.60	20.24	5.91	4.03	24.25	61.90
2	corn stover silage	Good	70.19	6.12	2.28	37.71	10.22	3.89	34.42	75.42
3	corn stover silage + 6% molasses soln.	Good	75.72	6.31	2.09	33.38	11.41	4.10	45.81	70.36
4	corn stover silage +8% molasses soln.	Good	76.54	6.50	1.95	31.96	11.82	4.21	43.42	71.76
5	corn stover silage + 10% molasses soln.	Good	75.41	6.25	2.11	31.72	10.97	4.11	46.72	69.03
6	corn stover silage + 12% molasses soln.	Reasonable	75.62	6.40	1.98	31.16	11.78	4.47	44.75	66.09

Optimization of different urea conditions

To increase nitrogen contents of the silage urea solution was used at 0.3, 0.6 and 0.9% with 6% molasses solution and sprinkled on chopped corn stover fodder. These silages were again ensiled in polythene lab silos for 30 days (Chemical composition Table –III). All the silage prepared with different urea with 6% molasses showed similar results and hence silage prepared with 0.3% urea and 6% molasses was selected to be prepared on large scale.

Table III; Chemical analysis of silages with different feed additives.

Sr.No	**Details**	**Visual texture**	**Moisture%**	**Crude Protein%**	**Crude Fat%**	**Crude Fiber%**	**Ash%**	**pH**	**ADF %**	**NDF %**
1	Hybrid	Good	67.69	8.4	2.60	20.24	5.91	4.03	24.25	61.90

	maize silage									
2	corn stover silage	Good	70.19	6.12	2.28	37.71	10.22	3.89	34.42	75.42
3	corn stover silage + 6% molasses soln.	Good	75.72	6.31	2.09	33.38	11.41	4.10	45.81	70.36
4	corn stover silage + 6% molasses soln. +0.3% urea	Good	76.95	8.71	1.80	32.48	10.25	4.46	50.74	72.88
5	corn stover silage + 6% molasses soln.+0.6% urea	Good	76.06	9.01	1.66	35.76	10.52	5.61	47.33	74.35
6	corn stover silage +6% molasses soln.+ 0.9 % urea	Good	76.50	9.20	1.53	33.95	10.15	4.46	45.62	71.39
7	corn stover silage 6% lime soln.	Good	72.99	6.15	0.05	34.25	20.44	5.06	28.42	67.84

Ensiling of treated corn stover with calcium oxide (CaO)

Calcium oxide solution was sprinkled on different layers of chaffed fodder, mixed thoroughly and was stored in lab silos at room temperature. After 30 days samples were taken for chemical analysis (Table IV). There was least effect of various levels of CaO on the quality of silage, hence corn stover silage with 6% CaO was selected for large scale silage trial.

Table IV; Chemical analysis of silages with different level of calcium oxide (CaO).

Sr.No	Details	Visual texture	Moisture%	Crude Protein%	Crude Fat%	Crude Fiber%	Ash%	pH	ADF %	NDF %
1	Hybrid maize silage	Good	67.69	8.40	2.60	20.24	5.91	4.03	24.25	61.90
2	corn stover silage	Good	70.19	6.12	2.28	37.71	10.22	3.89	34.42	75.42
3	corn stover silage plus 4% CaO	Good	76.00	6.22	2.01	32.98	11.85	4.10	45.81	70.25
4	corn stover silage plus 6% CaO	Good	76.92	6.49	2.00	32.00	12.00	4.00	43.00	70.00
5	corn stover silage plus 8% CaO	Good	75.00	6.22	2.25	32.00	11.60	4.25	46.00	72.05
6	corn stover silage plus	Reasonable	75.84	6.00	2.00	32.55	12.00	4.47	45.00	71.00

	10% CaO									

Phase II. Preparation of silage on large scale

Five different types of silages were prepared on large scale from fodders presenting better results in first phase 1) Hybrid Maize, 2) Corn stovers, 3) Corn stover with 6% molasses and 0.3% urea, 4) Corn stover with 6% molasses and 5) Corn Stover treated with 6% calcium oxide. The silos filled quickly and were pressed properly to remove the air for good anaerobiasis. Each pit was covered with a plastic sheet. The plastic sheet plastered with a blend of wheat straw and mud to avoid any cracking while drying (Tauqir, 2010). It was ensured that the plastic sheet and mud plastering would provide the anaerobic conditions for proper silage making. After 30 days, the plastic sheet was removed to take the silage for feeding.

Feeding Trial:-

25 Sahiwal male calves of similar age and body weight were divided into 5 groups A,B,C,D & E, respectively (5 calves in each group) according to completely randomized design. Calves of group A were fed corn silage and served as control and while B,C,D and E were fed respective corn stover silages at ad libitum intakes. In addition to silage a mixed ration having 16.73% crude protein and 73% total digestible nutrients was also provided at the rate of 1.5% of body weight. Animals were weighed at the start of experiment and fortnightly thereafter. Diets and animals were randomly allotted to each group. Fresh and clean water was accessible to each animal round the clock. Experimental period lasted for 90 days with first 10 days as transitional period. Feed offered and refusals were recorded on daily basis. Cost incurred on each diet was also calculated to determine the economics of feeding.

Digestibility Trial:-

At last week of the study a 5 days digestibility trial was performed through complete collection of urine and feces. Out *of* collected feces 20% were sampled and dried at 55°C. At the end of collection period, dried fecal samples were composited and 10% of these were taken for chemical analysis. Samples of feed and feces were ground to 2 mm screen and analyzed for DM and CP (AOAC, 2012), while NDF and ADF were analyzed using method described by Van Soest et al. (1991).

Blood Metabolites:-

Two calves were selected randomly from each group for blood collection. Blood samples were collected three hours post feeding from jugular vein. Serum was extracted by centrifuging it at 3500 rpm. Blood urea nitrogen was determined according to the method prescribed by Bull et al. (1991). Blood glucose was also determined by using crescent diagnostic glucose enzymatic colorimetric god-pap method (Trinder, 1969).

Statistical Analysis:-

The data collected for all parameters were analyzed using General Linear Model procedure of SPSS (SPSS 10.0.1., 1999) and means were compared by Duncan's Multiple Range Test (Steel et al., 1997).

Ingrediants and Chemical composition of fattening ration

INGREDIENTS	**PERCENT**
Maize grains (crushed)	19.00
Rapeseed meal	6.00
Canola meal	2.00
Maize gluten 30%	24.00
Wheat bran	34.00
Cane molasses	13.00
Mineral mixture	1.50
Sodium-bi-carbonate ($NaHCO_3$)	0.50
CHEMICAL COMPOSITION	**PERCENT**
Dry matter	87.96
Crude Protein	16.73
Ether Extract	4.8
Crude Fiber	10.9
Ash	8.43
Acid detergent fiber	21.9
Neutral detergent fiber	39.7

RESULTS AND DISCUSSION

Dry Matter Intake:-

Dry matter intake (DMI) was 6.71±1.10, 6.63±1.04, 6.60±1.04, 6.67±1.06 and 5.60±1.05 kg daily in animals of group A, B, C, D and E, respectively. But there was no treatment effect statistically. Results of the current study have supported the findings of Bilal et al. (2001) who reported that DMI was not affected in Nili Ravi buffaloes by feeding silage based diet as total mixed ration or in combination with fresh fodder. Hilscher et al. (2016) reported that feeding silage of 37% DM resulted in greater daily gain and lower Feed: Gain compared to 43% silage in cattle calves. However DMI remained the same in all experimental animals. In contrast Adam et al. (2014) fed CaO treated wheat straw (5% of DM) and corn stovers with wet distillers grains plus solubles (WDGS) during a 69-day study to four hundred sixty growing steer calves and observed greater DMI and improved Feed: Gain compared to corn stover diets. Alkaline treatment increased DMI and improved Feed: Gain. Similarly Ali et al. (2012) reported that Dry matter intake per unit of metabolic weight was higher ($p < 0.01$) in sheep fed the NH3 and the urea-treated corn stover diets compared to the untreated Stover. Intake was higher ($p < 0.10$) for sheep fed 3% NH3 treated corn stover, than the Urea treated stovers. In the current study mixed ration was fed @ 1.5% of the body weight to the sahiwal calves which might have marked the difference in palatability of various silage diets and ultimately feed intake was not affected by treatments. However, in the studies where various silages or forage based diet was fed to experimental animals, the difference in DMI was apparent.

Table V: Performance of Sahiwal Calves fed maize silage compared with corn stover silage with or without additives.

GROUP	DM consumed	FCR	Growth
(A) (Control) Hybrid maize silage	6.71±1.10	6.53±1.82^{b}	1.06±0.26^{a}
(B) corn stover silage	6.63±1.04	7.79±1.48^{ab}	0.86±0.18^{ab}
(C) corn stover silage + 0.3% urea+ 6% molasses soln.	6.60±1.14	8.42±2.37^{a}	0.813±0.22^{b}
(D) corn stover silage +6% molasses soln.	6.67±1.06	7.94±1.61^{ab}	0.848±0.17^{b}

(E) corn stover silage+ 6% lime soln.	6.60±1.05	8.77±2.31[a]	0.784±0.22[b]

Growth performance and feed to gain ratio:

Animals fed Hybrid maize Silage (group A) gained significantly higher weight (1.06±0.257 kg daily) followed by those of group B (0.86±0.180 kg daily) fed corn stover silage. The results were similar in animals fed other three silages, 0.813±0.221, 0.848±0.17, 0.784±0.22 kg. Conversely, mean values of feed conversion ratio (FCR) were significantly lower in animals fed Hybrid maize Silage (group A; 6.53±1.82) followed by those of group B (7.79±1.48) fed corn stover silage (Table V). The results were similar in animals fed other three silages. Alemu et al. (2005) reported no difference ($p>0.05$) in weight gain between the weaned crossbred calves fed on the urea treated stover diet and those fed hay based diet. Similar results were also observed by Tran and Nguyen (2000) who concluded that urea treated maize stover could be used to replace grass for ruminant feeding as cattle had acceptable weight gains. Hilscher et al. (2016) reported decreasing trend in ending BW and ADG, while Feed :Gain was increased, when steers were fed 43% DM silage compared to 37% DM silage (88% silage inclusion). Elias and Fulpagare (2015) quoted non-significant difference in weight gain among the treatments (4% urea treated corn stover & concentrates) fed to three groups of crossbred heifers and thus treatment variations were unable to express their effect on the growth performance. Russell et al. (2011) observed no differences in finished body weights of steers fed the CaO-treated stover silage diet either during the growing or both the growing and finishing phases, steers fed untreated stover silage diet during both the growing and finishing phases, versus control.

Nutrient Digestibilities

Dry matter, Organic matter, NDF and ether extract digestibility values were higher in animals fed corn hybrid silage based diet as compared to those fed other diets. Inversely, animals fed corn stovers silage with 6% molasses solution showed higher ADF digestibility. Similarly, higher CP digestibility was observed in animals fed corn stover silage with molasses and urea (CDE treatments). Elias and Fulpagare (2015) observed significantly higher ($p<0.05$) values of DM digestibility (67.63% and 67.42%) in T1 (25% treated corn stover with 4% urea) and T2 (50% treated corn stover with 4% urea) from T0 (25% untreated corn stover) however, T1 and T2 were at par to each other. Digestibility of CP found to be significantly high in T1 (57.77%)

and T2 (57.26%) over T0 (47. 68%), T1 and T2 were at par to each other. Alemu et al. (2005) observed an improvement of 9% in *in vitro* dry matter digestibility in weaned cross bred calves fed treated and untreated corn stover silages. These improvements in terms of nutrient composition, intake and digestibility led to enhanced weight gain of animals fed urea treated stover diet compared to those fed untreated corn stover diet. Results of the current study have sported the finding of Tauqir (2010) who observed that ensilation of fodders increased DM and NDF degradability resulted from improvement in the ruminal environment by readily fermentable cell wall substrate for cellulolytic bacteria. Improved CP digestibility in calves fed corn stover silage with 6% molasses and 0.3% urea may be due to combination of nitrogen content and molasses that provided carbon chain and nitrogen for the synthesis of protein by rumen microbes (Tauqir, 2016) and hence CP digestibility was improved.

Table VI. Nutrient digestibilities of Sahiwal Calves fed maize silage compared with corn stover silage with or without additives

GROUP	DM Digestibility	CP Digestibility	EE Digestibility	ADF Digestibility	NDF Digestibility	OM Digestibility
(Control, **A)** Hybrid maize silage	60.77±7.86^{a}	57.41±11.96^{b}	79.02±9.48^{a}	73.57±3.18^{c}	70.86±.37^{a}	64.70±6.61^{a}
(B) corn stover silage	57.77±12.67^{b}	58.31±11.72^{b}	76.19±1.61b^{c}	74.08±9.35^{c}	69.71±12.75^{ab}	59.89±11.49^{a}
(C) corn stover silage + 0.3% urea+ 6% molasses solution.	56.42±3.71^{b}	61.73±3.24^{a}	77.52±1.92^{b}	80.80±4.62^{b}	71.25±7.97^{a}	60.65±3.17^{b}
(D) corn stover silage +6% molasses solution.	55.31±2.58^{b}	61.34±4.20 ^{a}	77.30±1.56^{b}	86.95±1.60^{a}	71.38±1.25^{a}	66.83±2.79^{a}

(E) corn stover silage+ 6% lime solution.	56.82±5.79[b]	59.47±2.40 [a]	75.51±1.99[c]	81.83±1.15[b]	64.95±6.36[b]	65.33±5.32[a]

**p≤.05, **p≤.01*

Blood Metabolites

Blood urea nitrogen (BUN) was significantly higher in animals fed C, D and E diets followed by those control and B diets. The higher BUN in animals fed C, D and rations may be due to added urea and molasses in these silages which not only provided nitrogen and carbon chain for the synthesis of protein in the rumen but also improved their digestibility. Conversely, blood glucose values were higher in animals fed control, B and E diets. Escalated nutrient digestibility in animals fed control, B and E rations could be a reason for improved blood glucose in these animals. Triggered nutrient digestibilities provided more nutrient flow towards lower digestive tract which when absorbed have improved blood glucose level of treatments.

The plasma concentration of urea was within the reference interval in all treatments (averaging 4.36 mmol/L), considering acceptable values between 2.6 and 7.0 mmol/L (Wittwer, 2000). It corresponds to an end product of protein metabolism, used as a sensitive indicator of crude protein intake and ruminal protein-energy synchrony (Wittwer et al., 1993; Hwang et al., 2001; Melendez et al., 2003). The lower urea concentrations recorded in the high CS treatment are attributed to a better synchrony and utilization of energy and nitrogen release in the rumen, due to the energy intake through the corn silage (Barrientos et al., 2013). Serum glucose, total protein and albumin concentrations in calves were not affected when holstein calves were fed milk replacer containing different amounts of energy and protein (Lee et.al, 2008).

Table VII. Blood urea nitrogen and blood glucose in Sahiwal Calves fed maize silage compared with corn stover silage with or without additives.

GROUP	Blood Urea Nitrogen	Blood Glucose
(Control group) Hybrid maize silage **(A)**	7.17±2.16[b]	89.8±15.33[a]
corn stover silage **(B)**	8.65±0.96[b]	85.7±9.85[a]
corn stover silage + 0.3% urea+ 6% molasses soln. **(C)**	10.47±3.51[a]	72.7±3.98[b]
corn stover silage +6% molasses soln. **(D)**	11.55±2.72[a]	78.5±11.96[b]

corn stover silage+ 6% lime soln. **(E)**	11.47±2.85[a]	87.3±21.97[a]

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