

Performance of Lactating Sahiwal Cows Fed Corn Stovers Ensiled with Molasses, Urea and Lime Solution

Research Article

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ABSTRACT

To explore the advantages of feeding corn stover silage treated with molasses, urea and lime solution in lactating Sahiwal cows on milk production 25 lactating cows were divided into 5 groups according to randomized complete block design to test the performance of 5 different silages: 1) hybrid corn silage (HCS), 2) corn stover silage (CSS), 3) corn stover ensiled with 6% molasses (CSMS), 4) corn stover ensiled with 6% molasses and 0.3% urea (CSMUS) and 5) corn stover ensiled with 4% lime solution (CSCaoS) for 15 days. Sahiwal cows were kept in separate sheds for individual feeding. Sahiwal cows fed hybrid corn silage were served as control. All the silages were offered at *ad libitum* intake. Dairy ration containing 17.5% crude protein and 74% total digestible nutrients was also offered at the rate of half of milk produced. Animals were weighed at beginning of experiment and fortnightly thereafter. A 5 days digestion experiment was performed through complete assortment of excreta (urine and feces) at last week of investigation. Blood was also collected for the analysis of blood urea nitrogen and blood glucose. Intake of dry matter (DM) was significantly better in Sahiwal cows reared on hybrid corn silage (HCS; control) followed by those fed CSS, CSMS, CSMUS and significantly lower in those fed CSCaoS. Intake of DM was similar in cows reared on CSS, CSMS, CSMUS. Milk production of animals reared on HCS was apparently higher than those reared on other treatments. Cows reared on CSS had lower milk production while those reared on CSMUS produced higher milk fat as compared to other treatments. Although the effect was negligible but plasma glucose and urea were observed within the locus interval for all treatments. Cows reared on HCS had higher dry matter (DM) and crude fibre (CF) digestibilities while it was lower in those fed CSCaoS. Nutrient digestibility was similar in CSS, CSMS and CSMUS. It was concluded that corn stover silage with molasses or molasses plus urea can replace the corn silage successfully for sustainable performance of lactating Sahiwal cows.

KEY WORDS blood metabolites, corn stover silage, milk production, nutrient digestibility.

INTRODUCTION

Crop residues and roughages like wheat and rice stubbles, straws, dried stalks, husks, date stones, and by-products make up a major portion of animal feed in almost all devel-

oping countries (Ali *et al.* 2009; FAO, 2011). Grain industry by-products and quality protein and energy concentrates are expensive to rely the farming community on crop by-products for feeding their animals. Feed intake is limited in animals reared on crop residues having low N-content, poor

digestibility and hence unable to produce at their genetic potential (Iqbal and Tauqir, 2011).

In Pakistan total production of corn grain is 5,702 thousand tones (Economic Survey, 2017), commonly grown as cash crop for the production of grains. Most of the corn stover cannot be utilized by livestock, inhibited by its hard fibrous stalk and nutritional features. Hence huge quantity is allowed to dry in the field to be used as fuel or scorched in the grounds (Fayyaz *et al.* 2018).

After removing the ears of crop, dry matter (DM) increased considerably and ultimately digestibility decreased and its ensiling becomes difficult due to improper compaction of biomass. The quality of fermentative material may be poor. Farmers have no way to adopt any alternative techniques to preserve the biomass of corn stover. Ensiling offers a best solution to preserve this residual crop and be used for animal feeding (Wanapat *et al.* 1996; Fayyaz *et al.* 2018). Objective of ensiling is to possibly conserve maximum nutritional value of the original crop. Various silage additives like molasses, starch, nitrogen (N), bacterial inoculants and different types of absorbents are being used to improve nutrient composition of silage (Tauqir, 2010).

Corn stalk is one of the important sources of feed for livestock. However, the availability of energy from corn stalk to animals is usually inadequate by its limited consumption, the chemical association between lignin and cell wall constituents and the physical constraint of the fiber fractions by microbial fermentation (Wanapat *et al.* 1996; FAO, 2011). Almost half of crop consists of leaves, husks, stalks and cobs of maize plants remaining in a field after harvest of cereal grain, called corn stover (Fayyaz *et al.* 2018).

The non-grain part of harvested corn and has low water content and is very bulky. It is utilized for animal feeding during the scarcity of green fodder called lean periods. Maize stover can successfully be incorporated in ruminant rations (Fayyaz *et al.* 2018). Cellulose is almost completely digestible by ruminants as they contain the enzyme cellulase responsible for cellulose breakdown. The nutritional quality of maize stover is poor to maintain health and the milk production potential of dairy animals. Hence nitrogen supplementation could be solution in this regard.

Iqbal and Tauqir (2011) described several physical and biochemical procedures to enhance feeding value of poor quality crop residues. Using urea for addition of N is rather popular being application friendly, low cost lacking undesirable residues, out of the renowned chemical methods. The opinioned that ammonia treatment using 55 g urea per kg wheat straw could improve voluntary DM intake by 27% as compared to those fed raw diets. Dry matter digestion of straw was also augmented in similar proportions.

Low nutritive value of crop residues could be enhanced for feeding ruminants using alkali treatments has long been recognized for years. This approach is an easy and effective way for improving quality of dry roughages (Russell *et al.* 2011; Fayyaz *et al.* 2018). Both molasses and urea could escalate nutritive value of corn stover while alkali could elevate its digestibility (Wanapat *et al.* 1996).

Keeping in view the chemical composition of corn stover and its abundant availability during its production season, it is essential to preserve maximum biomass of corn stover through ensiling by using different additives. Ensiled and/or treated corn stover is being used in feed lot fattening of calves successfully but limited research has yet been performed in lactating animals. Hence, current study is planned to explore benefits of corn stover silage treated with molasses, urea and lime solution in lactating Sahiwal cows on milk production and its composition.

MATERIALS AND METHODS

Corn stover fodder collected from the fields adjacent to Livestock Production Research Institute Bahadur nagar Okara, Pakistan was chemically evaluated (Table 1) and numerous silages were prepared from chopped corn stover and Hybrid corn (control) at laboratory level and on large scale.

Preparation of lab silage

Molasses at 6, 8, 10 and 12% was sprinkled on the chopped corn stover fodder separately to enhance its carbohydrates contents (Tauqir, 2010). DM of the fodder was maintained at 30%. Silages were prepared at lab scale in plastic bags. Fodder was compressed by hand to ensure the removal of maximum air and to maintain anaerobic condition. These plastic bags were tightly tied with string and were placed in the lab for 30 days. After the completion of fermentation, physical and chemical analyses were carried out (Table 2). On the basis of results presented in Table 2, corn stover silage prepared with 6% molasses solution was proved better as compared to others silages in terms of pH and CP and hence it was selected for preparation in bulk (Fayyaz *et al.* 2018).

For escalation of the N contents of the silage, urea was added at 0.3, 0.6 and 0.9% in 6% molasses solution and sprinkled on chopped corn stover fodder. Urea was first dissolved carefully in small quantity of water before adding the molasses solution. These urea molasses solutions were sprinkled on chopped corn stover fodder and then ensiled in polythene bags, as discussed earlier (Fayyaz *et al.* 2018). After opening the lab silos samples were analyzed chemically (AOAC, 1990; Table 3).

Table 1 Chemical analysis (%) of hybrid corn fodder and corn stover

Sr. No	Particulars	Moisture	Crude protein	Ether extract	Crude fiber	ADF	NDF	Ash	pH
1	Corn stover fodder	67.69	5.40	0.28	37.71	34.42	75.42	8.22	3.89
2	Hybrid corn fodder	80.19	8.12	0.35	20.24	24.25	61.90	6.91	4.03

ADF: acid detergent fiber and NDF: neutral detergent fiber.

Table 2 Chemical composition (%) of silages with different level of molasses solution

Sr. No	Particulars	Visual texture	Moisture	Crude protein	Ether extract	Crude fiber	ADF	NDF	Ash	pH
1	Hybrid corn silage	Good	68.89	9.2	2.9	21.04	24.25	61.90	6.91	4.03
2	Corn stover silage	Good	71.39	6.92	2.58	38.51	34.42	75.42	10.22	3.89
3	Corn stover silage + 6% molasses solution	Good	76.92	7.11	2.39	34.18	45.81	70.36	11.41	4.10
4	Corn stover silage + 8% molasses solution	Good	77.74	7.3	2.25	32.76	43.42	71.76	11.82	4.21
5	Corn stover silage + 10% molasses soln.	Good	76.61	7.05	2.41	32.52	46.72	69.03	10.97	4.11
6	Corn stover silage + 12% molasses solution	Reason-able	76.82	7.2	2.28	31.96	44.75	66.09	11.78	4.47

ADF: acid detergent fiber and NDF: neutral detergent fiber.

On the basis of results presented in Table 3, corn stover silage prepared with 6% molasses solution and 0.3% urea was proved better as compared to others silages in terms of pH and CP and hence it was selected for preparation in bulk.

Calcium oxide solution at 4%, 6%, 8% and 10% was sprinkled on different layers of chaffed fodder separately, mixed thoroughly and was stored in lab silos at room temperature. After 30 days samples were analyzed chemically (AOAC, 1990; Table 4). There was similar effect of various levels of CaO on the quality of silage; hence corn stover silage with 4% CaO was selected for large scale silage preparation.

Five different types of silages were prepared, 1) hybrid corn as control, 2) corn stover, 3) corn stover with 6% molasses, 4) corn stover with 6% molasses and 0.3% urea and 5) corn stover with 4% calcium oxide. All the standard practices for silage making and management were followed according to Tauqir (2010).

Feeding trial

Twenty-five lactating (second lactation) Sahiwal cows having body weight (601.4071 ± 17.77) and milk production (9.08 ± 2.32) were alienated into 5 groups (5 animals per group) according to completely randomized design. Five different silages were offered *ad libitum* intake while dairy ration containing crude protein 17.5% and total digestible nutrients 74% was provided at the rate of half of milk production.

Diets and animals were randomly allotted to each group. Weights of cows were recorded at start of research and fortnightly thereafter.

Out of 100 days trial period, first 10 days were nutritional acceptance days while rest for data recording. To calculate feed intake, daily feed offered and refusals were recorded. Milk production was recorded daily while samples of milk of each animal were taken weekly for the estimation of fat, solids non-fat (SNF), total solid, lactose and protein by using lacto scanner (EkomilkLacto Scan, Bulteh 2000 Ltd). To record the economics of production, cost of all diets was documented during course of experiment.

Digestibility trial

Before termination of the study, a 7 days digestion trial was performed through complete collection of excreta (urine and feces) to determine nutrient digestibility (Zewdie, 2019). Daily feces voided were collected, thoroughly mixed, sampled (20%) and dried at 60 °C. All the dried samples were composted by animal and 10% of these were taken for further chemical analyses (Table 5). These samples of diets and excreta were ground to 2 mm screen for DM and CP determination (AOAC, 1990), whereas fiber fractions were evaluated according to Van Soest *et al.* (1991).

Blood metabolites

For determination of blood glucose and urea 2 cows were selected out of each group at random for blood collection.

Blood sample was extracted from jugular vein 3 hours post feeding and stored. Serum was separated by centrifuging at 3500 rpm/ xg 1372. Blood urea N was determined according to Bull *et al.* (1991) while blood glucose according to Trinder (1969) using crescent diagnostic glucose enzymatic colorimetric god-pap method.

Table 3 Chemical composition (%) of silages with different level of urea plus 6% molasses solution

Sr. No.	Particulars	Visual texture	Moisture	Crude protein	Ether extract	Crude fiber	ADF	NDF	Ash	pH
1	Hybrid maize silage	Good	68.09	8.8	3	20.64	24.25	61.90	6.91	4.03
2	Corn stover silage	Good	70.59	6.52	2.68	38.11	34.42	75.42	10.22	3.89
3	Corn stover silage + 6% molasses solution	Good	76.12	6.71	2.49	33.78	45.81	70.36	11.41	4.10
4	Corn stover silage + 6% molasses solution + 0.3% urea	Good	77.35	9.11	2.2	32.88	50.74	72.88	10.25	4.46
5	Corn stover silage + 6% molasses solution + 0.6% urea	Good	76.46	9.41	2.06	36.16	47.33	74.35	10.52	5.61
6	Corn stover silage + 6% molasses solution + 0.9% urea	Good	76.9	9.6	1.93	34.35	45.62	71.39	10.15	4.46

ADF: acid detergent fiber and NDF: neutral detergent fiber.

Table 4 Chemical composition (%) of silages with different level of calcium oxide (CaO)

Sr. No.	Particulars	Visual texture	Moisture	Crude protein	Ether extract	Crude fiber	ADF	NDF	Ash	pH
1	Hybrid corn silage	Good	68.09	8.80	3.00	20.64	24.25	61.90	6.91	4.03
2	Corn stover silage	Good	70.59	6.52	2.68	38.11	34.42	75.42	10.22	3.89
3	Corn stover silage plus 4% CaO	Good	76.40	6.62	2.41	33.38	45.81	70.25	11.85	4.10
4	Corn stover silage plus 6% CaO	Good	77.32	6.89	2.40	32.40	43.00	70.00	12.00	4.00
5	Corn stover silage plus 8% CaO	Good	75.40	6.62	2.65	32.40	46.00	72.05	11.60	4.25
6	Corn stover silage plus 10% CaO	Reason-able	76.24	6.40	2.40	32.95	45.00	71.00	12.00	4.47

ADF: acid detergent fiber and NDF: neutral detergent fiber.

Table 5 Nutrient and chemical composition (%) of supplement

Ingredients	%
Maize grain (crushed)	18.80
Rape seed meal	5.80
Canola meal	2.20
Maize gluten meal 30%	24.20
Wheat bran	33.00
Molasses cane	14.00
Mineral mixture/premix	1.00
Sodium-bi carbonate	1.00
Chemical composition, %	
Dry matter	88.26
Crude protein	17.00
Ether extract	5.10
Crude fiber	11.20
Acid detergent fiber	22.00
Neutral detergent fiber	40.00
Ash	8.43

Statistical analysis

Feed intake, nutrient digestion, blood urea N, blood glucose, milk production and economics were subjected to statistical analysis according to randomized complete block design (SPSS, 2011). In case of significant differences, means were compared by Duncan's Multiple Range Test (Steel *et al.* 1997). The model used was:

$$Y_{ij} = \mu + \beta_k + \tau_j + \varepsilon_{ijk}$$

Where:

μ : overall mean.

β_k and τ_j : effect of block and treatment (5 treatments) respectively.

ε_{ijk} : difference within treatments (error term).

RESULTS AND DISCUSSION

Intake of DM was significantly higher in Sahiwal cows reared on hybrid corn silage (HCS; control treatment) followed by those fed CSS, CSMS, CSMUS and significantly lower in those fed CSCaoS. Intake of DM was similar in cows reared on CSS, CSMS, CSMUS treatments (Table 6).

Milk production of animals reared on hybrid corn silage was apparently higher than those reared on other treatments. Animals reared on silage of corn stover had lower milk production, while others were similar in milk production (Table 6). Similar results were also observed for 4% fat corrected milk (FCM) although the milk fat% was significantly variable (Table 7).

Cows reared on corn stover silage ensiled with 0.3% urea plus 6% molasses produced higher fat percentage followed by those reared on other treatments (Table 7). There was no difference of milk composition for solid not fat, total solids and milk CP in animals reared on control and four other test silages. It reveals that molasses and urea treatment increased the carbohydrates and N contents of silage which ultimately increased volatile fatty acids content for improved milk and milk fat content.

Results revealed that animals feeding corn stover ensiled with 4% lime had the lowest blood urea N (BUN) and moderate blood glucose as compared to other groups. However, cows fed hybrid corn silage had relatively higher BUN and blood glucose but the treatment effect was negligible (Table 8). The plasma concentrations of urea and glucose were observed within the normal reference value in all treatments.

Animals reared on hybrid corn silage had higher DM and CF digestibilities as compared those reared on all other treatments. Dry matter (DM) and crude fibre (CF) digestibilities were lower in cows fed corn stover ensiled with 4% lime.

This may be due to more digestible carbohydrates and low fibrous material in control diet that improved nutrient digestibility. Nutrient digestibility was similar in corn stover ensiled as such, with molasses and molasses plus urea (Table 9).

Thomas and Thomas (1985) opined that the low dry matter intake (DMI) with CSCaoS diet was possibly because of its palatability as compared to hybrid corn and corn stover silages. Intake of silage had negative correlation with its pH, concentrations of volatile acids (Rook and Thomas, 1982) and silage moisture content (NRC, 2001; Sarwar and Hasan, 2001). It was further debated that these differences in intake might be due to variations in fiber contents of experimental rations that led the variations in microbial fermentation of fodder during ensilation (Bolsen *et al.* 1996; Tauqir, 2010). The current study has supported the findings of Wanapat *et al.* (1996) who reported after a series of studies that urea molasses and alkali treatment of fibrous crop residues not only improved feed intake but also the nutritional status of animals and their performances (FAO, 2011).

The results of the current study have supported the findings of Christensen (1991), Ruiz *et al.* (1992) and Khorasani *et al.* (1993) who described that production of 4% FCM was not affected by type of diet when their digestibilities were similar. The higher feed intake versus similar milk production in animals fed various silage-based diets has also been reported by number of researchers (Mahr-un-Nisa *et al.* 2005; Tauqir *et al.* 2008; Tauqir, 2010). Weinberg and Muck (1996) reported that the cows consumed significantly less inoculant treated silage than that of untreated silage and yet produced the same volume of milk and quantity of milk constituents. In contrast, Gordon (1989) compared responses in milk yield arising from feeding formic acid treated, un-treated and inoculant treated silages. The use of the inoculant resulted in an increase in silage intake by 12% over the untreated and the positive response in milk yield was 10%. Higginbotham *et al.* (1998) did not show any beneficial responses to the use of the same inoculant as used by Gordon (1989) for dairy cows. Higher milk yield in animals fed hybrid corn silage-based diet was probably because of more digestible nutrient intake compared to those fed other experimental diets. In Tanzania molasses-urea mixture containing 3% urea and minerals is fed at the rate of 0.5 kg/day/100 kg live weight to Zebu Shorthorn cows (250 to 300 kg live weight (LW)) producing 5 to 6 kg milk/day on top of the milk suckled by the calf. It is sprayed on the zero fed roughage (banana leaves, alongside roads cut grasses, and maize stover in dry season). According to farm records average increase in milk production of 0.5 kg per kg molasses-urea mixture fed is shown (Laurent and Centres, 1990; FAO, 2011).

Table 6 Dry matter intake and milk production of Sahiwal cows fed different silages

Description	Treatments					SEM	Trend comparison		
	HCS	CSS	CSMS	CSMUS	CSCaoS		Linear	Quadratic	Cubic
Dry matter intake, kg/day	13.14 ^a	11.17 ^b	11.18 ^b	11.36 ^b	10.69 ^c	0.17	0.00	0.00	0.00
Milk production, litres	9.52	8.86	7.06	8.96	8.46	0.33	0.32	0.14	0.57
4% fat corrected milk, liters	10.09	9.43	7.52	9.73	8.80	0.37	0.36	0.23	0.45

HCS: hybrid maize; CSS: corn stover; CSMS: corn stover sprinkled with 6% molasses; CSMUS: corn stover sprinkled with 6% molasses and 0.3% urea and CSCaoS: corn stover treated with 4% calcium oxide.

SEM: standard error of the means.

Table 7 Milk composition of Sahiwal cows fed different silages

Description	Treatments					SEM	Trend comparison		
	HCS	CSS	CSMS	CSMUS	CSCaoS		Linear	Quadratic	Cubic
Milk fat	4.40 ^{ab}	4.42 ^{ab}	4.42 ^{ab}	4.56 ^a	4.26 ^b	0.03	0.48	0.04	0.04
SNF	7.26	7.39	7.33	7.37	7.20	0.05	0.70	0.28	0.95
TS	11.66	11.73	11.76	11.94	11.50	0.07	0.83	0.16	0.27
Milk CP	3.96 ^a	4.09 ^a	3.95 ^a	3.47 ^b	3.81 ^{ab}	0.06	0.08	0.82	0.00

HCS: hybrid maize; CSS: corn stover; CSMS: corn stover sprinkled with 6% molasses; CSMUS: corn stover sprinkled with 6% molasses and 0.3% urea and CSCaoS: corn stover treated with 4% calcium oxide.

SNF: solids non-fat and TS: total solids.

The means within the same row with at least one common letter, do not have significant difference (P>0.05).

SEM: standard error of the means.

Table 8 Blood metabolites of Sahiwal cows fed different silages

Description	Treatments					SEM	Trend comparison		
	HCS	CSS	CSMS	CSMUS	CSCaoS		Linear	Quadratic	Cubic
BUN	20.88	18.82	19.56	18.74	17.82	0.93	0.39	0.93	0.68
Glucose	33.60	32.00	30.00	29.40	32.20	1.69	0.68	0.51	0.77

HCS: hybrid maize; CSS: corn stover; CSMS: corn stover sprinkled with 6% molasses; CSMUS: corn stover sprinkled with 6% molasses and 0.3% urea and CSCaoS: corn stover treated with 4% calcium oxide.

BUN: blood urea nitrogen.

The means within the same row with at least one common letter, do not have significant difference (P>0.05).

SEM: standard error of the means.

Table 9 Nutrient digestion in Sahiwal cows fed different silages

Nutrient	Treatments ¹					SEM	Trend comparison		
	HCS	CSS	CSMS	CSMUS	CSCaoS		Linear	Quadratic	Cubic
Dry matter	66.59 ^a	59.13 ^b	58.21 ^b	62.2 ^{ab}	59.69 ^b	0.78	0.00	0.00	0.00
Crude protein	71.59	72.20	71.80	71.58	71.32	0.16	0.34	0.27	0.42
Crude fiber	57.59 ^a	50.13 ^b	49.21 ^b	53.2 ^{ab}	50.69 ^b	0.78	0.01	0.00	0.00

HCS: hybrid maize; CSS: corn stover; CSMS: corn stover sprinkled with 6% molasses; CSMUS: corn stover sprinkled with 6% molasses and 0.3% urea and CSCaoS: corn stover treated with 4% calcium oxide.

The means within the same row with at least one common letter, do not have significant difference (P>0.05).

SEM: standard error of the means.

There was no difference of milk composition for solid not fat, total solids and milk crude protein (CP) in animals reared on control and four other test silages. It reveals that molasses and urea treatment increased the carbohydrates and N contents of silage which ultimately increased volatile fatty acids content for improved milk and milk fat content. [Bilal et al. \(2001\)](#) fed lactating buffaloes different combinations (100:0, 75:25, 25:75 and 0:100%) of Mott grass fodder and its silage and reported a non-significant trend in 4% FCM produced and milk composition among all treatments. The composition of milk also remained unchanged.

[Cameron et al. \(1990\)](#) fed lactating Holstein-Friesian cows a diet containing hydrogen peroxide treated wheat straw with corn silage as forage with different proportions

according to 4 × 4 Latin square design. They found that SNF percentage did not differ among the treatments. Milk fat percentage increased (from 3.07 to 3.32%) and milk protein percentage decreased (from 2.61 to 2.56%) as the proportion of treated wheat straw increased in the diet. They further explained that cows fed the higher proportions of treated wheat straw had increased ruminal concentrations of total volatile fatty acids (VFA) and molar percentage of acetate but decreased molar percentage of propionate, resulting in greater acetate to propionate ratio and ultimately higher milk fat percentage. [Canale et al. \(1990\)](#) reported increased concentrations of total rumen volatile fatty acids and acetate while decreased isobutyrate concentration and pH when dairy cows were fed NaOH treated alfalfa-orchard

grass forage verses control. In the current study corn hybrid provided more digestible nutrients than various corn stover silages which ultimately led to the production of more VFA, better acetate to propionate ratio and ultimately higher milk fat percentage and milk constituents in Sahiwal cows.

Results revealed that animals feeding corn stover ensiled with 4% lime had the lowest blood urea N (BUN) and moderate blood glucose as compared to other groups. However, cows fed hybrid corn silage had relatively higher BUN and blood glucose but the treatment effect was negligible. The plasma concentrations of urea and glucose were found within the reference interval in all treatments. It corresponds to an end product of protein metabolism, used as a sensitive indicator of crude protein intake and ruminal protein-energy synchrony (Hwang *et al.* 2001; Melendez *et al.* 2003).

The lower urea concentrations recorded in corn stover ensiled with 4% lime was attributed to a better synchrony and utilization of energy and N released in the rumen (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.

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. Tesfaye *et al.* (2005) observed an improvement of 9% in *in vitro* DM digestibility in weaned cross bred calves fed treated and untreated corn stover silage. These improvements in terms of chemical composition, intake and digestibility led to higher ($P<0.05$) live weight gain of animals fed urea treated corn stover diet. It was reported previously that ensilation of fodder crops (Nadeau *et al.* 1996) and fibrous crop residues (Wanapat *et al.* 1996) increased DM and neutral detergent fiber (NDF) degradability resulted from improvement in the ruminal environment by availability of readily fermentable cell wall substrate for cellulolytic bacteria ultimately improved performance of livestock.

CONCLUSION

It was concluded that corn stover ensiled with molasses or molasses plus urea can replace the corn silage successfully for sustainable performance of lactating Sahiwal cows and can aid to overcome the wastage of valuable biomass.

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REFERENCES

- Ali I.J., Fontenot P. and Allen V.G. (2009). Palatability and dry matter Intake by sheep fed corn stover treated with different nitrogen sources. *Pakistan Vet. J.* **29**(4), 199-201.
- AOAC. (1990). Official Methods of Analysis. 19th Ed. Association of Official Analytical Chemists, Arlington, Washington, DC., USA.
- Barrientos L., Noro M., Wittwer F. and Pulido R. (2013). Response to meta-metallic pasteurization and pasteurization supplements and supplementation with concentrated or fibrous. *J. Fac. Vet. Sci. Univ. Zulia.* **23**, 318-324.
- Bilal M.A., Abdullah M. and Lateef M. (2001). Effect of Mott dwarf elephant grass (*Pennisetum purpureum*) silage on dry matter intake, milk production, digestibility and rumen characteristics in Nili-Ravi buffaloes. Pp. 25-31 in Proc. 54th Ann. Recip. Meat Conf. Indianapolis, Indiana.
- Bolsen K.K., Ashbell G. and Weinberg Z.G. (1996). Silage fermentation and silage additives: Review. *Asian-Australasian J. Anim. Sci.* **9**, 483-489.
- Bull R.C., Everson D.O., Olson D.P., Kelley K.W., Curtis S. and Tzou G. (1991). Concentrations of serum constituents in cold-stressed calves from heifers fed inadequate protein and (or) energy. *J. Anim. Sci.* **69**(2), 853-863.
- Cameron M.G., Fahey Jr G.C., Clark J.H., R.Merchen N. and Berger L.L. (1990). Effects of feeding alkaline hydrogen peroxide-treated wheat straw-based diets on digestion and production by dairy cows. *J. Dairy Sci.* **73**(12), 3544-3554.
- Canale C.J., Abrams S.M., Varga G.A. and Muller L.D. (1990). Alkali-treated orchardgrass and alfalfa: Composition and *in situ* digestion of dry matter and cell wall components. *J. Dairy Sci.* **73**(9), 2404-2412.
- Christensen D.A. (1991). Is cereal silage a viable alternative to Alfalfa? Pp. 211-218 in Proc. West Canada Dairy Semin. Adv. Dairy Technol. Univ. Alberta, Edmonton, AB, Canada.
- Economic Survey. (2017). Government of Pakistan, Finance division, Economic Advisors Wing. Islamabad, Pakistan.
- Elias S.T. and Fulpagare Y.G. (2015). Effects of urea treated maize stover silage on growth performance of crossbred heifers. *IOSR J. Agric. Vet. Sci.* **8**(5), 58-62.
- FAO. (2011). Successes and failures with animal nutrition practices and technologies in developing countries. Pp. 110-115 in Proc. FAO Elect. Conf. Rome, Italy.

- Fayyaz A., Tauqir N.A., Tahir N., Asghar A., Mujahid N., Karamat K., Abbas A., Hannan A., Muhammad R., Bilal B., Dera G. and Khan K. (2018). Performance evaluation of corn and corn stover silages with different feed additives in growing Sahiwal Sahiwal calves. *Int. J. Sci. Engin. Res.* **9(5)**, 2269-2282.
- Gordon H.K. (1989). An evaluation through lactating cows of a bacterial inoculant as an additive for grass silage. *Grass Forage Sci.* **44**, 169-179.
- Higginbotham G.E., Mullar S.C., Bolsen K.K. and Depeters E.J. (1998). Effects of inoculants containing propionic acid bacteria on fermentation and aerobic stability of corn silage. *J. Dairy Sci.* **81**, 2185-2192.
- Hwang S.Y., Lee M.J. and Peh H. C. (2001). Diurnal variations in milk and blood urea nitrogen and whole blood ammonia nitrogen in dairy cows. *Asian-Australasian J. Anim. Sci.* **14**, 1683-1689.
- Iqbal Z. and Tauqir N.A. (2011). Exploring Non-Conventional Feed Resources for Feeding of Ruminants. VDM Verlag Dr. Müller Aktiengesellschaft and Co., Germany.
- Khorasani G.R., Okine E.K., Kennelly J.J. and Helm J.H. (1993). Effect of whole crop cereal grain silage substituted for alfalfa silage on performance of lactating dairy cows. *J. Dairy Sci.* **76**, 3536-3546.
- Laurent C. and Centres J.M. (1990). Dairy Cattle Breeding in Tanzania. A development program for small producers in the Kilimanjaro and Arusha regions. Versailles. I.N.R.A. Department of Research on Agrarian Systems and Development, Versailles, Dijon, Mirecourt.
- Mahr-un-Nisa N., Tauqir A., Sarwar M., Ajmal Khan M. and Mumtaz Akhtar M. (2005). Effect of additives and fermentation periods on chemical composition and *in situ* digestion kinetics of mott grass (*Pennisetum purpureum*) silage. *Asian-Australasian J. Anim. Sci.* **18(6)**, 812-815.
- Melendez P., Donovan A., Hernandez J., Bartolome J., Risco C., Staples C. and Thatcher W.W. (2003). Milk, plasma, and blood urea nitrogen concentrations, dietary protein, and fertility in dairy cattle. *J. American Vet. Med. Assoc.* **223(5)**, 628-634.
- Nadeau E.M., Buxton G.D.R., Lindgren E. and Lingvall P. (1996). Kinetics of cell-wall digestion of orchard grass and alfalfa silages treated with cellulase and formic acid. *J. Dairy Sci.* **79**, 2207-2216.
- NRC. (2001). Nutrient Requirements of Dairy Cattle. 7th Ed. National Academy Press, Washington, DC., USA.
- Ruiz T.M., Sanchez W., Sanchez K., Straples C., Straplesand R., Sollenberger E. and Sollenberger L. (1992). Comparison of "Mott" dwarf elephant grass silage and corn silage for lactating dairy cows. *J. Dairy Sci.* **75**, 533-543.
- Rook J.A.F. and Thomas P.C. (1982). Silage for Milk Production. National Institute for Research in Dairying, Ayr, Scotland.
- Russell J., Loy D., Anderson J. and Cecava M. (2011). Potential of Chemically Treated Corn Stover and Modified Distiller Grains as a Partial Replacement for Corn Grain in Feedlot Diets. Industry Report, Iowa State University Animal, USA.
- Sarwar M. and Hasan Z.U. (2001). Nutrient Metabolism in Ruminants. Friends Science Publishers, Faisalabad, Pakistan.
- SPSS Inc. (2011). Statistical Package for Social Sciences Study. SPSS for Windows, Version 20. Chicago SPSS Inc., USA.
- Steel R.M., Torrie J. and Dickey D. (1997). Principles and Procedures of Statistics: A Biometrical Approach. Mcgraw Hills Book Co. Inc., New York.
- Tauqir N.A. (2010). Silage-A Vital Solution to Fodder Scarcity in Developing Countries. VDM Verlag Dr. Müller Aktiengesellschaft and Co., Germany.
- Tauqir N.A., Nisa M., Sarwar M. and Bhatti S.A. (2008). Impact of varying moisture levels, different additives and fermentation periods on nutritive value of leguminous and non-leguminous fodder silages in lactating Nili-Ravi buffaloes. *Pakistan J. Agric. Sci.* **45(2)**, 386-402.
- Tesfaye A., Chairatanayuth P., Vijchulata P. and Tudsri S. (2005). The Potential of Urea Treated Maize Stover for Growth Performance of Weaned Crossbred Calves. *Kasetsart J. Nat. Sci.* **39**, 638-646.
- Thomas C. and Thomas P.C. (1985). Factors affecting the nutritive value of grass silage Pp. 223-256 in Recent Advances in Animal Nutrition. W. Haresign and D.J.A. Cole, Eds. Butterworths, London, United Kingdom.
- Trinder P. (1969). Glucose god-pap method enzymatic colorimetric method. *Ann. Clin. Biochem.* **6**, 24-27.
- Van Soest P.J., Robertson H.B. and Lewis B.A., (1991). Method of dietary fiber and non-starch polysaccharides in relation to animal material. *J. Dairy Sci.* **74**, 3583-3597.
- Wanapat M., Chenost M., Munoz F. and Kayouli C. (1996). Methods for improving the nutritive value of fibrous feed: Treatment and supplementation. *Ann. Zootech.* **45(1)**, 89-103.
- Weinberg Z.G. and Muck R.E. (1996). New trends and opportunities in the development and use of inoculants for silage. *FEMS Microbiol. Rev.* **19**, 53-68.
- Zewdie A.K. (2019). The different methods of measuring feed digestibility: A review. *EC Nutr.* **14(1)**, 68-74.