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Effect of feeding maize (*Zea mays*) silage on milk yield and composition of lactating crossbred cows during lean period

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ABSTRACT

The present study was conducted on 10 crossbred cows (20–60 days in milk, 6th to 7th stage of lactation), to study the effect of feeding maize silage on milk yield and composition during lean period (15th November to 15th December 2019; 30 days). The animals were randomly divided into two groups on the basis of average body weight and milk production (349.70±9.77 kg and 7.41±0.39 kg/day; n=5). All the animals were fed concentrate mixture as per thumb rule method in addition to 3–4 h of daily/routine morning grazing in paddock. Wheat straw (WS) was offered @ 7 kg/day to control group whereas in treatment group WS was offered @ 2 kg/day/animal, however, maize silage was fed additionally @ 6 kg/day/animal after evening milking. The results revealed similar average milk yield in both the groups, but mean fat corrected milk yield (4% FCM) was found higher for cows fed with silage (7.39 vs. 6.47 kg/d). Although, no beneficial effect of maize silage supplementation was observed in milk composition (%), but average milk fat yield (MFY) and milk total solids yield (MTSY, kg/d) was significantly increased in treatment group (16.67% increase in MFY and 14.87% increase in MTSY, respectively). In term of economics, the treatment group incurred highest returns of ₹ 28/animal/day in comparison to untreated animals and thus ultimately incurred highest benefit cost ratio of 1.28 than control group with corresponding value of 1.03. Hence, it may be concluded that maize silage supplementation in feeding regimen of crossbred cows during lean periods is beneficial which is evident by increased 4% FCM, milk yield, MFY, MTSY, besides improving benefit : cost ratio.

Keywords: Crossbred cows, Milk composition, Milk yield, Silage

Green forages and livestock rearing is an integral part of the Indian agricultural system as it contributes about 4.11% to the Gross Domestic Product (GDP) and 25.6% to the Agricultural Gross Domestic Product (AGDP) (Livestock Census, GoI 2019). Globally, India is leading in milk production but livestock productivity is very low, viz. 20 to 60% lower than the global average due to lack of quality fodder. According to report of 'Revisiting National Forage Demand and Availability Scenario' India is deficit of 23.4% in the availability of dry fodder, 11.24% green fodder and 28.9% for concentrates (Anonymous 2021). The deficiency of dry fodder is attributed due to low production of fodder, straw burning and promotion of dwarf varieties. The total fodder production of Jammu and Kashmir is 86.5 lakh tonnes of which green fodder contributes 61.4 and dry fodder 25.1 lakh tonnes. Jammu and Kashmir is also 67% deficit in green fodder and 27.31% in dry fodder (Ahmad *et al*. 2016). Further, seasonal variability is also found in our country as surplus fodder is found during *kharif* and *rabi* season and scarcity during lean periods. Mostly, this fodder scarcity is aggravated during lean periods of May–June and November–December where the farmers have no option of green fodder. But they have to feed their milch animals either with poor quality straws/stovers which further deteriorates animal health and productivity or have to feed concentrates to their animals as it constitutes 60 to 70% of the milk production cost. This makes dairy enterprise uneconomical or not viable option (Anonymous 2021). Thus, both quantitatively and qualitatively, there exists a huge gap in availability and supply of feed nutrients which is further compounded during lean and scarcity period (Kumar *et al*. 2016). So, there is an urgent need for preservation of surplus green forages for feeding the livestock during lean period in the form of preserved fodder i.e. silage or hay. Silage is fermented and is as nutritious as green fodders, as it preserves the nutrients in their original form and thus qualitatively it is as good as animal feeding on green fodder itself (Kumar *et al*. 2019).

Maize crop is popular among silage crops as it possesses good ensiling characteristics, required dry matter % and fermentable carbohydrates that lowers *p*H to 3.5, i.e. desirable for silage making (Roth and Heinrichs 2001).

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Also, it provides high energy in the form of starch to high yielding milch animals, thus ensures the energy requirements (Danicke *et al*. 2020) by increasing feed intake, having high digestibility, palatability and acts as an essential component of successful dairy farming, further increasing milk yield and milk protein content (Khan *et al*. 2012). Although silage technology has been available for years (Hasanah *et al*. 2017), but their utilization under subtropical regions of Jammu has not been yet popular. Thus, the main aim of the present experiment was to study the effect of feeding maize (*Zea mays*) silage on milk yield and composition of lactating crossbred cows during lean period.

MATERIALS AND METHODS

An experimental trial of thirty days (15th November to 15th December 2019) was conducted at dairy unit of ILFC, F.V.Sc. and AH, SKUAST Jammu, RS Pura to evaluate the effect of silage feeding on milk yield and composition of lactating crossbred cows. Lactating crossbred HF cows (10) were randomly divided in two groups (n=5) on the basis of mean body weight (349.70±9.77 kg) and average milk production (7.41±0.39 kg/day). Animals were 20–60 days in milk and bearing 6th to 7th stage of lactation. All the standard protocols of deworming and vaccination were followed.

Experimental feeding: All the animals (control and treatment) group were grazed routinely for 3–4 h in morning in the paddock. The concentrate mixture was fed as per thumb rule method, i.e. 1 kg maintenanance ration plus 1 kg concentrate for 2.5 kg milk yield and was offered in two proportions at milking time. The ingredient composition (%) of concentrate mixture was crushed maize (Makki Dala): 35%, wheat bran (Patri/Choker): 20%, rice polish (Bugdu): 3%, cotton seed cake (Binolla Khal): 32%, gram husk (Chilka): 5%, gram husk with grain parts (Fandar/ Khanda): 2%, mineral mixture (Agrimin forte): 2% and salt: 1%. Whereas, wheat straw was offered @ 7 kg/day/animal to control group and 2 kg/day/animal to treatment group throughout the experiment. All the animals had free access to drinking water thrice daily. However, in treatment group, maize silage was fed additionally @ 6 kg/day/animal in evening after milking. During the period of trial, daily milk yield was recorded by hand milking twice at 06:30 AM and 05:00 PM.

Silage preparation and estimation of silage characteristics: Maize fodder was selected for preparation of silage in silo bags of 500 kg capacity. Maize fodder at milk stage (as it contains high protein and low fibre) was harvested in evening time and was chopped next day by using single phase electronic chaff cutter and cut into 1 to 1.5 inches in length (moisture content was checked by hand grab test). Additionally, 2% molasses and 1% salt was added on fresh basis to facilitate early growth of *Lactobacillus* spp. Then the treated material was tightly packed in the silo bags to maintain anaerobic condition and hanged from roof to check the rodent attack. Silage was opened after 28 days of packing.

Silage so prepared was analyzed for *p*H, colour, smell and texture. The *p*H was measured immediately by taking a representative sample, viz. 20 g of silage in a glass beaker along with 50 ml of distilled water using a *p*H meter. Texture was observed by pressing the silages between two fingers, whereas colour was observed visually and was also smelled.

Estimation of body weight: The body weight (kg) of dairy animals was estimated at start of trial and thereafter 15 days interval by Minnesota formula as presented below.

$$\text{Weight (kg)} = (L \times G2)/600$$

where, L, length of animal from point of shoulder to point of buttocks (inches); G, chest girth (inches).

Milk parameters: Daily milk yield was recorded of each animal individually by using platform type weighing balance. Whereas, fat corrected milk (4%) was calculated by the following equation (Tyrrell and Reid 1965)

$$4\%\ \text{FCM (kg)} = 0.4\ M + (15 \times F \times M)/100$$

where, M, milk yield (kg) and F, fat (kg).

The milk samples were collected at start and end of trial and analyzed for composition includes milk fat, protein, lactose, solid not fat (SNF) and total solids as per standard method (AOAC 2005) by using automatic milk analyzer (Lactostar). The feed offered to the animals, consists of wheat straw, concentrate mixture and maize silage was also analysed for proximate composition (AOAC 2005).

Statistical analysis: The data generated in the experiment was subjected to statistical analysis as per standard protocol of Suedecor and Cochran (1994).

RESULTS AND DISCUSSION

The results of maize silage characteristics and its proximate composition (opened after 30 days of ensiling) revealed that silage had desirable *p*H value (4.54±0.06), greenish brown colour with firm and softer texture and lactic acid odour, signifying that silage prepared was of desirable quality. The crude protein (CP), total ash (TA) and organic matter (OM) in maize silage (on % dry matter basis) was 12.55±0.07, 13.02±2.14 and 86.98±1.99, respectively. Similar to our results, Khan *et al*. 2014 reported similar silage characteristics and composition of oat silage. Also, Karsten *et al*. 2003 stated that the good fermented maize silage should be leafy, soft in touch, yellowish-brown, mild pleasant and sour smell, and in addition the silage must be high in CP. It was observed that maize silage had higher CP content than its fodder counterpart which may be attributed to fermentation and microbial synthesis of protein (Htet *et al*.2016). However, CP, TA and OM (%) on dry matter basis in wheat straw and concentrate was 3.01±0.10, 11.12±1.84, 88.88±1.65 and 21.98±0.74, 6.93±0.57, 93.07±0.43, respectively.

There was no significant effect of silage feeding on body weight (BW) as presented in Table 1. But after 30 days of experimental feeding, treatment group incurred 2.25% increase in BW over initial weight. Whereas, in control

group after 30 days 0.80% decrease in BW was found. Contrary to our results, Darren *et al*. 2005 reported higher body weight in beef steers while feeding silage. The difference found in the two studies may be explained in the light of fact that beef steers were used in the latter study. But, in the present study, animals were in mature phase (6–7th stage of lactation), thus BW showed no difference, but numerically higher BW reflects better nutritional status.

A significant increase in milk yield (kg/d) was found in treatment animals (8.56±0.70) at 30 days in comparison to control group (7.00±0.57; Table 1). The percentage increase in mean milk yield after 30 days was 4.99% and 14.75% over initial milk yield (0 day) in control and treatment group, respectively. Similarly, animals fed on silage recorded 7.36% increase in mean milk yield over control animals (mean value of trial). Maize silage is an excellent high energy supplement, and may be the probable reason for increased milk yield. Likewise, Brar *et al*. (2016) also reported 15.5% increase in average milk yield of HF crossbred cows when fed maize silage.

Whereas, data presented in Table 1 for 4% fat corrected milk yield (FCM) showed that mean values of 4% FCM

Table 1. Effect of feeding maize silage on body weight (kg), milk yield (kg/day) and 4% fat corrected milk yield (FCM, kg/day) of lactating crossbred cows during lean period

Group	Body weight (kg)			Milk yield (kg/day)				4% fat corrected milk yield (FCM, kg/day)		
	0* day	30 day	Overall mean±SEM	0* day	15 day	30 day	Overall mean±SEM	0 day	30 day	Overall mean±SEM
Control	352.00± 15.62	349.20± 14.39	350.60± 10.02	7.36± 0.56	7.62± 0.47	7.00± 0.57^{a}	7.33± 0.29	6.72± 0.40	6.22± 0.42	6.47^{X}± 0.29
Treatment	347.40± 13.54	355.20± 13.83	350.95± 6.63	7.46± 0.61	7.58± 0.86	8.56± 0.70^{b}	7.87± 0.41	6.84^{A}± 0.43	7.95^{B}± 0.51	7.39^{Y}± 0.37
Overall mean±SEM	349.70± 9.77	352.20± 9.46		7.41± 0.39	7.60± 0.46	7.78± 0.50		6.78± 0.28	7.09± 0.43	

0*, denotes values recorded on last day of adaptation period; Observations with different superscripts: (A and B) differ significantly (P<0.05) within the row, (X and Y; a and b) differ significantly (P<0.05) within the column.

Table 2. Effect of feeding maize silage on milk composition (%) and milk component yield (kg/d) of lactating crossbred cows during lean period

Group	Milk composition			Milk component yield (kg/d)		
	0* day	30 day	Overall mean±SEM	0* day	30 day	Overall mean±SEM
		Milk fat (%)			*Milk fat yield* (*kg/d*)	
Control	3.460±0.172	3.292±0.128	3.376±0.105	0.025±0.001	0.023^{A}±0.001	0.024^{X}±0.001
Treatment	3.500±0.212	3.572±0.167	3.536±0.128	0.026±0.002	0.030^{B}±0.002	0.028^{Y}±0.001
Overall mean±SEM	3.480±0.129	3.432±0.109		0.026±0.001	0.027±0.002	
		Milk protein (%)			*Milk protein yield* (*kg/d*)	
Control	3.020±0.086	3.080±0.058	3.050±0.05	0.022±0.001	0.022±0.002	0.022±0.001
Treatment	3.232±0.040	3.126±0.063	3.179±0.039	0.024±0.002	0.027±0.002	0.025±0.001
Overall mean±SEM	3.126±0.057	3.103±0.041		0.023±0.001	0.024±0.002	
		Milk lactose (%)			*Milk lactose yield* (*kg/d*)	
Control	3.906±0.127	3.882±0.086	3.894±0.072	0.029±0.001	0.027±0.002	0.028±0.001
Treatment	3.940±0.129	3.900±0.101	3.920±0.078	0.029±0.002	0.033±0.003	0.031±0.002
Overall mean±SEM	3.923±0.085	3.891±0.063		0.029±0.001	0.030±0.002	
		Milk SNF (%)			*Milk SNF yield* (*kg/d*)	
Control	6.940±0.200	6.989±0.128	6.964±0.112	0.051±0.003	0.049^{A}±0.003	0.050±0.002
Treatment	7.186±0.151	7.059±0.136	7.123±0.098	0.053±0.004	0.060^{B}±0.004	0.057±0.003
Overall mean±SEM	7.063±0.125	7.024±0.089		0.052±0.002	0.054±0.003	
		Milk total solids (%)			*Milk total solids yield* (*kg/d*)	
Control	10.400±0.361	10.281±0.255	10.340±0.209	0.076±0.004	0.071^{A}±0.005	0.074^{X}±0.003
Treatment	10.686±0.353	10.631±0.272	10.659±0.210	0.079±0.005	0.090^{B}±0.006	0.085^{Y}±0.004
Overall mean±SEM	10.543±0.243	10.456±0.185		0.078±0.003	0.081±0.005	

Observations with different superscripts: (A and B; X and Y) differ significantly (P<0.05) within the column; 0*, denotes values recorded on last day of adaptation period.

were significantly higher ($p<0.05$) for cows fed with silage (7.39±0.37) than those of untreated animals (6.47±0.29). Also, a significant increase of 16.23% was noticed in 4% FCM yield of silage fed animals at 30 days over initial milk FCM of the same animals. This may be due to high nutritive value of silage as it preserves the nutrients in the original form and also because of ongoing process of fermentation, the silage becomes soft, digestible and hence good for animal feeding as green fodder itself, thus enhancing milk FCM. Similar results were reported by Abido *et al*. (2007).

Although there was no significant change in milk composition with silage supplementation, milk fat (%) increased numerically from 3.50 to 3.57 after 30 days (Table 2). Similarly other parameters of milk composition, viz. milk protein (%), milk lactose (%), milk SNF (%) and milk total solids (%) did not differ with silage supplementation. No difference in milk composition with corn silage was found by Khan *et al*. 2012. But silage feeding has significant impact ($P<0.05$) on milk component yield (kg/day), viz. milk fat yield, milk SNF yield and milk total solids yield in lactating crossbred cows (Table 2). Crossbred cows fed with maize silage produced 16.67% and 14.86% more mean milk fat yield and milk total solids yield than control group (Table 2). Further, maize silage supplementation significantly increased milk SNF yield to the tune of 0.06 kg/day than control group (0.049±0.003 kg/d). The increase in milk component yield was presumably associated with an improved diet nutrient balance while feeding maize silage as wheat straw replacer in dairy cows. High digestibility, palatability and correct balance of nutrients may be the probable reasons for higher milk component yield in silage fed group. Similar to our findings, Teshome and Mengistu (2017) also reported higher yield of milk components on maize silage supplementation along with linseed cake.

The daily feed cost in treatment group (₹ 138/animal/day) was recorded lower as compared to control group (₹ 144/animal/day). Higher feed cost in control was on account of feeding more wheat straw (WS) as WS was comparatively costlier than maize silage (Table 3). Whereas, the treatment group incurred highest returns of ₹ 28/animal/day in comparison to untreated animals due to higher milk productivity to the tune of average ½ kg/animal/day (Table 1). Thus, ultimately this incurred highest B : C ratio (1.28) in silage fed animals than control group (1.03). This may be attributed to the fact that the treatment cows consumed less amount of wheat straw, cheaper maize silage and produced more milk. These results are in line with the findings of Waziri and Uliwa (2020) that maize silage feeding reduces cost per litre milk production.

Table 3. Effect of feeding maize silage on economics (₹/day/animal) in lactating crossbred cows during lean period

Attribute	Control	Treatment
Average cost of concentrate (₹)	102	102
Average cost of silage (₹)	nil	24
Average cost of wheat straw (₹)	42	12
Total (₹)	144	138
Gross milk returns (₹)	293	315
Net milk returns (₹)	149	177
B:C ratio	1.03	1.28

Concentrate @ ₹ 23/kg; Silage @ ₹ 4/kg; Wheat straw @ ₹ 6/kg and Milk rate @ ₹ 40/kg.

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