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Feeding Value of Millet Harvested as Silage or Hay Fed to Buffalo Calves Supplemented with Concentrate on Growth Performance and Nutrient Digestibility

Muhammad Iqbal Anjum* and Aman Ullah Cheema
Animal Nutrition Program, Animal Sciences Institute, National Agricultural Research Centre, Park Road, Islamabad

ABSTRACT

Growth and digestion trials were conducted to evaluate the feeding value of forage millet (*Pennisetum glaucum*) harvested for silage or hay at milky stage (31% DM) on buffalo calves supplemented with mixed concentrate. Millet silage (MS) or millet hay (MH) offered *ad libitum* to twelve Nili-Ravi buffalo calves (about 10-12 months old and 157±7.20 kg average BW) as 6 calves on each diet. All calves were also supplemented concentrate (CP=15% and TDN=67%) individually at 1% of their BW. The growth trial lasted for 90 days. Daily feed intake and fortnightly weights were recorded. The digestibility and nitrogen (N) balance trial was carried out after the end of the growth trial. Total faeces, urine and feed samples were measured daily. Average daily weight gain (0.69 vs. 0.65 kg/head) and FCR (6.22 vs. 7.21 kg/kg) was significantly (P<0.05) better in calves fed MS than did calves fed MH, respectively. Intakes of dry matter (DM), crude protein (CP), crude fiber (CF), neutral detergent fiber (NDF) and acid detergent fiber (ADF) were statistically similar (P>0.05) on both dietary treatments. Total apparent digestibility of DM was not affected by MS or MH, while the digestibility of CP (67.05 vs. 61.82%), NDF (64.97 vs. 60.25%) and ADF (59.66 vs. 52.66%) was higher (P<0.05) in calves fed MS than those fed MH based diet. The N intake or N retention was not affected (P>0.05) by feeding of MS or MH. Calves drank less (P<0.05) water when eating MS based diet compared to MH. The economic return value (ratio of output to input) was better (1.23 vs. 1.13) with MS compared to MH fed as basal diet. These results suggest that millet silage when compared with millet hay is best for higher performance and nutrients digestibility in buffalo calves and finally higher economic return.

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Key words

Millet fodder, preservation method, concentrate, digestibility, buffalo calves.

INTRODUCTION

In most of the Asian countries the nutritional requirements of ruminants are mainly fulfilled by feeding of green and dry roughages and post harvest crop residues, eventually reduced growth (Jabbar *et al.*, 2006), production and reproduction (Nisa *et al.*, 2008). In Pakistan forage contribution in animal feeding is more than 75% and are considered cheaper source of nutrients (Sarwar *et al.*, 2002). However, consistent supply of green fodder throughout the year is limited due to severity of season two times in a year *i.e.*, May to June and November to December when green fodders with reasonable nutritional contents are not adequate. This inadequate supply of quality fodders has been identified as one of the reasons for poor livestock productivity (Anjum *et al.*, 2012) Farmers practiced daily cut and carry fodders in conventional feeding system resulting increase in lignin content with the maturity and advancement of age. This issue may be resolved by conserving surplus fodder in the form of silage or hay when fodder crops are at maximum production. When grains are in milky stage, the surplus fodder if conserved as silage or hay, it will not only provide nutritionally uniform fodder but also spare land for other crops cultivation (Mandal *et al.*, 2003). Conserved fodder (silage or hay) may be used throughout the year especially during fodder scarcity periods (Azim *et al.*, 2000) for consistent growth and production of dairy animals (Touqir *et al.*, 2007). Both hay and silage production are imperative components in forage livestock production system, and both have particular advantages and disadvantages. At the same time cost effective feeding approach is needed for profitable beef and dairy entrepreneurs.

In Pakistan pearl millet (*Pennisetum glaucum)* is mainly grown for summer fodder production used as green-chop roughages for ruminants feeding. Millet is a tropical, heat and drought resistant fodder crop may be harvested as hay, green chop, or silage. Several studies have evaluated the potential of pearl millet as silage for

* Corresponding author: mianjum_narc@yahoo.com
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ruminants (Messman *et al*., 1992; Hill *et al*., 1999) but making hay is usually difficult due to its large stems. Limited data exist regarding the feeding value of pearl millet silage or hay harvested at milky stage of cutting. The present study, therefore, is planned to evaluate the nutritional value of millet silage versus hay conserved at milky stage of cutting on buffalo calves.

MATERIALS AND METHODS

Preparation of silage/hay and concentrate

Millet for forage was grown in Livestock Research Station, National Agricultural Research Centre (NARC), Islamabad. Millet forage was manually harvested at milky stage of maturity (with 31% DM) and conserved as silage or hay (6-8 tons each) during October at Animal Nutrition Programme, NARC. Forage was chopped at theoretical length of 2-3 cm by chopper machine, dumped it in underground cemented silo pit (measuring 9 × 8 × 8 feet in length × width × depth, respectively), then pressed by rolling of tractor, made sloppy heap for rain drain and then finally sealed with polyethylene sheet and mud to stop any air circulation and maintain anaerobic conditions.

Same forage was also used for hay making. Whole stalks with leaves and heads were left in the field for drying under sunlight. The frequency of turning over was continued on skip a day basis until the moisture content remains below 15%. It is then gathered in bales and stack stored in roofed shed two feet above from ground floor. Prior to feeding the hay bales were chopped with electric chopper fitted with 2-3 cm length screen. Mixed concentrate with 15% CP and 67% TDN was prepared at Feed Technology Unit, NARC. Chemical composition of mixed concentrate, millet green forage, silage and hay is given in Table I.

Animals, feed and management

For this experiment twelve buffalo calves of Nili-Ravi breed between 10-12 months age and 157±7.20 kg body weights (BW) were taken from Livestock Research Station, NARC, Islamabad and randomly divided into two equal (n=6) groups followed by Completely Randomized Design. All calves were fed mixed concentrate at the rate of 1% of BW plus millet silage (MS) to first group while millet hay (MH) to second group as a basal diet. Mixed concentrate was offered in the morning feeding and 3-4 hours after silage or hay was offered to experimental animals' *ad libitum.* Calves were weighed fortnightly to monitor the growth rate after restriction of feed and water intake for 16 hours. Feed conversion ratio (FCR) was calculated as kilograms of feed intake per kilogram of live weight gain. Before starting the trial, 15 days adaptation period was given to get animals adjusted to various diets. Feeding trial was consisting of 90 days. Fresh water was provided 4-5 times per day. Before starting the experiment subcutaneous Promectine® injection (Vetaria Pharmaceuticals, Lahore, Pakistan) at the rate of 3 ml/animal was given to control the parasites. De-worming and vaccination was done according to local managemental practices.

Nutrient digestibility and nitrogen balance

In the last week of the experiment, digestibility and nitrogen (N) balance trial for 7 days duration was carried out. During these trials, calves were placed in individual pens (measuring 4 ft × 9 ft) having the facility to collect faeces and urine separately.

Analytical procedures

Forage (silage/hay), concentrate feed, orts and faecal samples were analyzed for proximate composition (AOAC, 1990) and cell wall constituents (Van Soest *et al*., 1991). Urine and faeces samples were also analyzed for N by AOAC (1990) method. Fifty grams of silage sample was mixed in 450 mL of distilled water then blended with blender for 1 min at high speed. The resulting homogenate was filtered through Whatman 1 filter paper. The pH of the filtrate was measured with a pH meter (Inolab 720, WTW, Germany). A proportion of the filtrate (50 mL) was acidified with 100 µL of 50% H_2SO_4 and then frozen before being used for determination of concentration of lactic acid as reported by Khorasani *et al.* (1997). Total digestible nutrients (TDN) were calculated by Wardeh (1981) equation based on proximate composition (TDN = 40.32 + 0.5398CP + 0.448FE + 1.422EE - 0.7007CF).

Economic return

The economic return value, expressed as the ratio of output to input, is calculated based on feed price, calves body weight, and growth performance as follows:

$$\text{Output/input} = (\text{ADG}\times\text{MPBW})/ (\text{DMI}\times\text{MPF})$$

Where ADG is the average daily gain (kg/head), MPBW is the average market price of body weight (Rs/kg), DMI is the daily DM intake (kg/head/day), and MPF is the market price of feeds (Xie *et al*., 2012).

Statistical analysis

Data collected were analyzed with a linear model using student's paired t-test described by Steel *et al.* (1997). Data are given as means plus or minus the standard error of the mean.

Table I.- Composition (%) of experimental feeds.

Ingredients, %	Concentrate	Forage[1]	Silage	Hay
Maize grains	10	-	-	-
Rice polishing	15	-	-	-
Wheat bran	20	-	-	-
Maize gluten feed	25	-	-	-
Cottonseed cake	10	-	-	-
Molasses	13	-	-	-
Di-calcium phosphate	1	-	-	-
Limestone	0.5	-	-	-
Salt	0.5	-	-	-
Total	100	-	-	-
Chemical composition (DM)				
Dry matter, % as fed	91.59	32.15	31.97	88.29
Crude protein, %	15.65	7.12	7.08	6.25
Crude fiber, %	17.63	21.82	22.15	24.00
Neutral detergent fiber, %	33.59	69.81	71.82	67.15
Acid detergent fiber, %	20.22	42.93	44.15	46.45
Total digestible nutrient, %	67.29	52.55	55.18	49.40
Lactic acid, %	-	-	6.18	-
pH	-	-	4.12	-

[1]Green forage, silage and hay of millet crop

RESULTS AND DISCUSSION

The chemical composition of mixed concentrate, fresh forage, silage and hay of millet is presented in Table I. At harvest fresh millet forage contained 30.15% DM, 6.12% CP, 21.82% CF, 69.81% NDF, 42.93% ADF and 52.55% TDN. The present study results are supported by Utley *et al.* (1995) who reported almost similar values of ADF 39% and NDF 67%, but higher CP 11.50% in millet fodder than current study that may be due to stage of maturity, soil fertility and environmental factors. Because as forage matured fiber content increases whilst digestibility and crude protein content decreases. In millet silage, CP, NDF and TDN contents were higher ($P<0.05$), while DM and ADF were lower when compared with millet hay. Dry matter (29.97%) content of millet silage was within normal range (Coblentz, 2005) and was 3.78% and 66% lower than millet fresh fodder and millet hay, respectively. Millet silage pH and lactic acid values were 4.10 and 6.18%, respectively, which were within the optimal range reported by previous researchers (Keles *et al*., 2014; Weissbach, 1996). Keles *et al*. (2014) reported that the pH values of the silages generally ranged from 4.0 to 4.6 along with DM contents between 35 and 50% is an indicative character of well preserved silage.

Table II.- Growth performance of buffalo calves.

Parameters	Dietary treatments*	
	MS	MH
Number of calves	6	6
Average initial weight (kg)	157.03±2.46	158.50±3.14
Average final weight (kg)	219.60±2.19	217.20±2.22
Average weight gain (kg/head/day)	0.69^{a} ±0.01	0.65^{b} ±0.02
Total DM intake (kg/head/day)	4.29±0.20	4.69±0.22
DM intake % body weight	2.28±0.12	2.49±0.18
Water intake % body weight	9.95^{a}±1.21	12.68^{b}±1.28
Feed conversion ratio (FCR)	6.22^{a}±0.03	7.21^{b}±0.27

Values with different superscripts in the same row differ ($p<0.05$)

* Millet silage (MS) or millet hay (MH) offered *ad libitum* while concentrate (CP=15% and TDN=67%) was supplemented individually at 1% of their BW to all animals.

Growth performance of buffalo calves fed on millet silage or millet hay as basal diet and supplemented with mixed concentrate at the rate of 1% of BW is summarized in Table II. Total dry matter (DM) intake (4.29 vs. 4.69 kg/day) or DM intake on per 100 kilogram BW basis (2.28 vs. 2.49 kg/day) in calves fed silage or hay as basal diets did not differ significantly ($P>0.05$). Similarly, intake of crude protein (CP), neutral detergent fiber (NDF) and acid detergent fiber (ADF) were almost same ($P>0.05$) on both dietary treatments (Table III). The results of the current study are consistent with the findings of Beck *et al*. (2009), who reported that growing calves fed with 20% or 40% wheat hay or silage, the feed intake of hay or silage was similar when wheat harvested at the booting stage. In the present study higher ($P<0.05$) daily weight gain (0.69 vs. 0.65 kg/head) and better feed conversion ratio (6.22 vs. 7.21 kg/kg) were observed in calves fed silage than those fed hay as basal diet. This improved performance in calves may be due to less leaf loss in case of silage than hay, resulting more CP content of silage be available to the animals than hay.

Contrary to the findings of the present study, Waldo *et al*. (1965) reported that Holstein heifers fed alfalfa hay gains higher weight than those fed silage. This difference may be due to alfalfa as leguminous fodder harvested as hay is nutritionally better than silage. Because nutrient profile of ensiled feeds alters during ensiling process especially protein (Kohn and Allen, 1995) whereas, in the current study, millet (non-leguminous) hay or silage was used as basal diet for buffalo calves.

Table III.- Nutrients intake, their digestibility and nitrogen balance in buffalo calves.

Parameters	Dietary treatments*	
	MS	MH
Nutrients§ intake (kg/day)		
DM	4.29±0.20	4.69±0.22
CP	0.45±0.18	0.46±0.15
NDF	2.41±0.55	2.56±0.65
ADF	1.48±0.55	1.72±0.35
Nutrients digestibility (%)		
DM	58.88±0.49	60.48±0.51
CP	67.05^{a}±2.10	61.82^{b}±2.02
NDF	64.97^{a}±0.44	60.25^{b}±0.45
ADF	59.66^{a}±1.65	52.66^{b}±1.81
N balance (g/day)		
N intake	72.62±2.10	73.64±2.18
N retention	35.08±3.15	34.92±3.07
Retention % of intake N	48.31±3.10	47.42±3.15

Values with different superscripts in the same row differ ($p<0.05$)

*Millet silage (MS) or millet hay (MH) offered *ad libitum* while concentrate (CP=15% and TDN=67%) was supplemented individually at 1% of their BW to all animals.

§Where DM= Dry matter, CP= Crude protein, ADF= Acid detergent fiber, NDF= Neutral detergent fiber, N= Nitrogen

n=6 buffalo calves per treatment

Total tract DM digestibility of silage based diet fed to buffalo calves did not differ significantly ($P>0.05$) than those fed on hay based diet. However, digestibility of CP (67.05 vs. 61.82%), NDF (64.97 vs. 60.25%) and ADF (59.66 vs. 52.66%) was significantly ($P<0.05$) higher with silage than hay (Table III). This increased in digestibility of CP, NDF and ADF with silage based diet may be due to fermentation process which makes the organic matter, soluble and degradable protein more available or readily available to rumen microorganisms. Kohn and Allen (1995) and Verbic *et al*. (1999), reported higher CP digestibility in silage than hay forages who supported our results.

Nitrogen (N) balance was positive for all calves (Table III), however, there was non-significant ($P>0.05$) differences in N intake and N retention whether expressed as gram per day or as a percentage of N intake between the dietary treatments.

On per 100 kg BW basis, calves when eating silage as basal diet drank significantly ($P<0.05$) less water (9.55 vs. 12.68 lit/day) than those fed hay (Table II) may be due to higher moisture content in silage (68.03%) than hay (11.71%).

Economic return has been shown in Table IV. In this experiment, price per kilogram of feed was Rs. 25.67, 17.25 and 7.00 for mixed concentrate, millet hay and millet silage, respectively. Price of one kilogram live weight of animal was considered as Rs. 185. Daily feed cost (Rs/head) for silage (104.20) was lower than hay (106.27). Similarly, the feed cost per kg gain (Rs) with silage was markedly (8.26%) lower than hay (151.01 vs 163.49). Therefore, economic benefits (ratio of output/input) with silage based diet were higher than hay (1.23 vs 1.13). The results of the current study were supported by Shi *et al*. (2014) who reported that profit returns was mainly relying on efficiency of feed utilization by animals and feed cost. Indication of economic returns can be obtained by comparing the cost of the supplements and basal feed with the value of the live body weight produced (Mirza *et al*., 2004; Xie *et al*., 2012).

Table IV.- Economic analysis of experimental rations fed to buffalo calves .

Parameters	Dietary treatments*	
	MS	MH
DM intake (kg/head/day)	1.73	1.74
Mixed concentrate	2.56	2.95
Millet silage/hay	4.29	4.69
Total		
Feed cost (Rs/head/day)**		
Mixed concentrate	48.20	48.49
Millet silage	56.00	--
Millet hay	--	57.78
Total feed cost (Rs/head/day.)	104.20	106.27
Average weight gain (kg/head/day)	0.69	0.65
Feed cost per kg gain (Rs.)	151.01	163.49
Economic benefits (output/input)	1.23	1.13

*Millet silage (MS) or millet hay (MH) offered *ad libitum* while concentrate (CP=15% and TDN=67%) was supplemented individually at 1% of their BW to all animals.

**Per kilogram market price of feed was Rs. 25.67, 17.25 and 7.00 for mixed concentrate, millet hay and millet silage, respectively, whereas price of one kilogram live weight of animal was considered to be Rs. 185.

n=6 buffalo calves per treatment

CONCLUSION

It is concluded from the results that millet silage basal diet proved economically feasible due to its low cost with higher nutrient digestibility and more weight gain than millet hay for buffalo calves when they were supplemented with mixed concentrate.

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Conflict of interest statement

Authors have declared no conflict of interest.

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