Bangladesh Journal of Animal Science 51 (2): 62-67, 2022 https://doi.org/10.3329/bjas.v51i2.60497

Bangladesh Journal of Animal Science
Journal homepage: http://www.banglajol.info/index.php/BJAS

Effect of Napier silage on milk production of Holstein Friesian Crossbred Cow

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ARTICLE INFO

Article history:
Received: 18 May 2022
Revised: 05 June 2022
Accepted: 08 June 2022
Published: 30 June 2022

Keywords:
Napier silage, silage quality, Crossbred dairy cow, milk production

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ISSN: 0003-3588

OPEN ACCESS

ABSTRACT

This work aspired to evaluate the quality of different types of silage on milk production made from whole napier grass, napier stem, and napier leaf. Napier grass *(Pennisetum Purpureum)* was harvested at 70 days of age and made into three types of silage in three different silo pits under proper anaerobic conditions for 45 days. A feeding program of 60 days duration was designed on nine (9) lactating (110-140 days after calving) Holstein Friesian crossbred dairy cows of 2^{nd} parity (age 6-7 years, live weight 500±5 kg). The cows were divided into 3 groups and assigned to 3 dietary treatments, basal ingredients with whole napier grass silage (T_1), basal ingredients with chopped napier leaf silage (T_2), and basal ingredients with napier stem silage (T_3). After ensiling, it was found that napier stem silage possesses the highest pH value indicating low-quality silage whereas napier leaf silage possesses the lowest pH value. The pH value of whole napier grass silage was slightly higher than that of napier leaf silage. Concentrations of CP and NH_3-N were highest in napier leaf silage and lowest in napier stem silage. The CP value was almost similar in whole napier grass silage and napier leaf silage but the NH_3-N value of whole napier grass silage was lower than that of napier leaf silage. Among the three groups, the cows of napier leaf silage group gave significantly ($P<0.05$) higher milk yield than the cows of whole napier grass and napier stem silage group. On the other hand, the cows of napier stem silage group gave significantly ($P<0.05$) lower milk yield than the cows of whole napier grass and napier leaf silage group. It can be concluded that napier leaf and whole napier grass silage are comparatively better than napier stem silage in respect to milk production of dairy cows.

Introduction

Milk production from dairy cows is highly related to providing good quality feeds and fodders. The lowest structural carbohydrates of youngling fodder have resulted the foremost quality and digestible cattle feed (Ijaz, 2021). In Bangladesh, the severe scarcity of green fodder is one of the most significant barriers to producing optimum milk yield from dairy cows. Khan *et al.* (2012) reported that there is an acute shortage of feed supply during the dry season and the available feed during this period is of sluggish quality. The seasonal deficits can considerably be reduced by the conservation of excess forage produced in the productive season and feeding to animals in periods of scarcity.

Conservation of forages can be achieved by making hay or silage. Preservation of fodder by silage making is done under anaerobic conditions where microorganisms use the fermentable sugars in fodder to produce organic acids, mainly lactic acid (Bolsen *et al.*, 1996) and disintegrate some nutrients of fodders to plain forms so that they can be digested and utilized by the animals easily. The practice of feeding processed fodder as silage remain popular in dairy farming because it keep down loss of nutrients from harvest through storage, allow for effortless feeding, and often allows greater efficiency and labour saving

How to Cite
MAA Habib, MA Akbar and ZH Khandaker (2022). Effect of Napier silage on milk production of Holstein Friesian Crossbred Cow. *Bangladesh Journal of Animal Science*, 51 (2): 62-67. https://doi.org/10.3329/bjas.v51i2.60497.

of feed mixing and handling on the farm than dry forages (Mahanna and Chase, 2003). According to Kung *et al.* (2000), the primary purpose of making silage is to maximize the preservation of original nutrients in the forage crop for feeding at a later date.

Napier grass can be harvested at a short interval to fed at an early growth stage with high nutritional value (Woodard and Prine, 1991). Silage making is a trouble-free way to preserve forage crops as well as to magnify their palatability and nutritive content (Sarker *et al.,* 2019). Thus, good quality silage is important for the optimization of milk production. Therefore, the target of this study was to collate the quality of silages made from whole napier grass, napier leaf, and napier stem on milk production from Holstein Friesian crossbred dairy cow.

Materials and Methods

Study area

The experiment was carried out in a village called Alokdiar under the Shajadpur Upazila of Sirajgonj district which is geographically located at $24^0 8'30.901''$ N latitude and $89^0 35'44.621''$ E longitude. The analyses for the chemical composition of silages were accomplished in the laboratory of the Department of Animal Nutrition, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh.

Silage preparation

BLRI hybrid napier fodder at 10 weeks was harvested (2nd cutting) at morning and kept in an open space till the afternoon of the sunny day in mid-April to obtain desirable moisture content for silage preparation. For both napier leaf and napier stem silage, leaf and stem were chopped at 2-3 cm using a grass chopper machine (BRRI Power Chopper). Napier grass was used in full length (not chopped) for making whole napier grass silage.Three silo pits of 100^3ft were prepared by manually digging on a high and plane land. The plastic sheet was spread all over the pit with the four well-extended sides so that the pit (after filling with silage) can be well covered with this extended part to make it completely airtight. Then the first pit was filled with whole Napier grass, the second one with Napier leaf, and the rest with Napier stem. Finally, all pits were covered by 3 separate plastic sheets and loose soil to ensure it for completely airtight. All silo pits were opened after 45 days of their date of preparation.

Selection of dairy cows

Nine (9) Holstein Friesian crossbred dairy cows were selected from the farmer of the village of Alokdiar for this experiment. The cows were almost similar in live weight (500±5 kg) and 6-7 years old. They were all at 2nd parity and at mid-lactation (110-140 days after calving).

Diet formulation

10 kg Rice straw and 3 kg mixed ready feed were supplied to each experimental cow as the basal ingredients. The mixed ready feed includes 20% wheat bran, 20% rice polish, 10% mustard oil cake, 45% molasses, 3% mineral mixture, and 2% common salt. Three rations were prepared (i) basal ingredients with whole napier grass silage (T_1); (ii) basal ingredients with chopped napier leaf silage (T_2); and (iii) basal ingredients with napier stem silage (T_3). The supplied amount of specific silage for each treatment was 5 kg. The selected nine (9) Holstein Friesian crossbred dairy cows were divided into 3 groups where each group containing 3 cows. Then each group of cows was selected for a specific treatment so that one group of cows received a specific ration. The amount of silage was supplied to the cows as a supplement to the basal diet. The ingredients and nutritional composition of different dietary groups are presented in Table 1.

Methods of feeding

At first, a little amount of silage was provided to the cows to habituate with Napier silage then gradually increased the amount over a few days. Half of the total amount of feeds was given in the morning and the rest amount in the afternoon. Silage and dietary ingredients were supplied separately and silage was given first followed by dietary ingredients. Drinking water was available all the time to the cows.

Chemical analysis

Dry matter of silage was determined by the elimination of moisture from the silage samples by low heating in an oven at 50^0C at the start and thereafter slowly increasing here to 80^0C in 2 days. During heating, a considerable amount of moisture was removed and the remaining residue was the dry matter of the silage.

Crude protein of silage was determined by the Kjeldahl method according to AOAC (2005). The weighted silage sample was digested with sulfuric acid to convert the total organic nitrogen into ammonium sulfate. Ammonia was formed and it was distilled into a boric acid solution in alkaline conditions. Then the solution was titrated with hydrochloric acid, by which the content of nitrogen represents the amount of crude protein in the sample. The amount of protein was calculated by multiplying % N by the factor of 6.25.

Table 1: Formulation of different diet (%) as per treatment group

Feed type	Ingredients (Kg)	Dietary Treatments		
		T_1	T_2	T_3
Roughage	Whole napier grass silage	27.8	-	-
	Chopped napier leaf silage	-	27.8	-
	Chopped napier stem silage	-	-	27.8
	Rice straw	55.5	55.5	55.5
Concentrate	Wheat Bran	3.35	3.35	3.35
	Rice Polish	3.35	3.35	3.35
	Mustard oil cake	1.67	1.67	1.67
	Molasses	7.5	7.5	7.5
	Mineral Mixture	0.5	0.5	0.5
	Common Salt	0.33	0.33	0.33
Total fresh amount (Kg)		100	100	100
Nutrients (%DM basis)	DM	67.75	68.58	65.66
	CP	4.2	4.3	4.0
	CF	25.6	25.3	25.2
	Ash	9.5	9.6	9.2
	ME (MJ/Kg DM)	4.97	5.05	4.79

T_1, Whole napier grass silage; T_2, Chopped napier leaf silage; T_3, Chopped napier stem silage

Acid Detergent Fiber (ADF) and Neutral Detergent Fiber (NDF) were determined according to Van Soest *et al.* (1991). At first 1 gm of dried sample was put into a 600 ml beaker glass, added with 100 ml premade neutral detergent solution (Di-sodium EDTA + Na2B407) , and gently boiled for 60 min. The glass beaker was swirled several times during the time of boiling to suspend the solids. The residue was separated from the supernatant fluid through filtration using a crucible and regarded as NDF. The determination of ADF was similar to that of NDF except that the solution used was a premade acid detergent solution (Cetrimonium bromide + $1NH_2SO_4$).

Ammonia-N (NH_3-N) of the silage samples were determined by using Markham still following a standardized method through a rapid and efficient steam distillation of digested sample by adding excess alkali in a Markham still-jacketed apparatus. This experiment was accomplished in the Animal Nutrition laboratory of the DLS, khamarbari, Farmgate, Dhaka.

Record of milk production

All dairy cows were milking two times in a day which was recorded in a register book throughout the experimental period.

Statistical analysis

The data generated during the experimental period were subjected to statistical analysis of variance (ANOVA) by completely randomized design (CRD) with 3 replication for each treatment. The significant differences among the treatment means were determined by using DMRT.

Results and Discussion

Physical Quality and p^H of Silage

The data on physiochemical quality of whole Napier grass silage, Napier leaf silage, and Napier stem silage are presented in Table 2.

In the laboratory analysis, the pH value was found low in Napier leaf silage, medium in whole Napier grass silage, and high in Napier stem silage. Properly fermented silage possesses a lower pH value than the initial forage. Kung and Shaver (2002) stated that pH values of good quality grass and legume silage in the tropics range between 4.3 and 4.7. Generally, higher pH lowers the silage quality. In this study, the comparison among the three types of silage in terms of pH indicated that Napier leaf silage was best followed by whole grass and stem silage.

Silage usually maintains the initial colour of the forage ensiled (Mannetje, 2000). The colour of silage in this study was yellowish indicates that the silages were of good quality.

The silages of whole Napier grass and Napier leaf exhibited a pleasant aroma, which indicates well-built silage as has been reported by Kung and Shaver (2002) stated that pleasant smell was an indication of well-made silage.

Good quality silage should be cooled at the opening and at the feed-out stage having a usual room temperature (McDonald *et al.,* 1995). Bolsen *et al*. (1996) reported that any extra heat production develops a Millard or browning reaction which can bring down the digestibility of protein and fiber components. In this experiment the temperature of the silage was around 20^0C indicates that the silages were well-made and of good quality.

Table 2: Physio-chemical quality of silage

Parameter	Whole Napier grass silage	Napier leaf silage	Napier stem silage
pH	4.51 ± 0.18	4.21 ± 0.12	4.85 ± 0.15
Color	Straw yellowish	Straw yellowish	Pale yellowish
Smell	Fruity	Fruity	Alcoholic
Temperature (^{0}C)	21	20	22

Nutritional Value of Silage

The data on the chemical composition of silages are presented in Table 3.

The dry matter (DM) content of silage is a good indicator to determine its potentiality. Generally the higher the dry matter the higher the potential intake of silage (Devaney and adviser 2017). The DM values found in the wilting silage ranged from 24.85 to 31.8% (Oliveira *et al.,* 2017). We found the DM value of silages within this range except for Napier stem silage. Napier stem silage possesses a lower value of DM might be due to the low level of moisture loss during the time of wilting.

Crude protein levels are a direct reflection of the quality of the grass at the time of harvest. Young leafy grass produces high protein silage while older steamy grass produces low protein silage (Devaney and Adviser 2017). We also found lower CP value in Napier stem silage than whole grass Napier and Napier leaf silage. Nurjana *et al.* (2016) found 6.76% CP in Napier silage which was similar to Napier leaf silage and close to whole Napier grass silage.

Digestibility of organic matter has a negative correlation with NDF, ADF and, hemicelluloses (Forejtova *et al.,* 2005). A significant negative correlation was found between digestible organic matter and NDF (%) in organic matter (Ceresnakova *et al.,* 1996). The ADF and NDF value of napier leaf silage was the lowest among the three silages indicating that the digestibility of organic matter is high in it.

Table 3: Chemical composition of silage (g/100g DM)

Parameter	Whole napier grass silage	Napier leaf Silage	Napier stem silage	P-value
DM	25.06^{b} ± 0.28	28.1^{a} ± 0.16	17.49^{c} ± 0.07	0.046
CP	6.02^{a} ± 0.13	6.76^{a} ± 0.09	5.07^{b} ± 0.19	0.028
ADF	42.97^{b} ± 0.54	39.05^{c} ± 0.32	45.96^{a} ± 0.24	0.037
NDF	68.5^{ab} ± 0.82	67.52^{b} ± 0.27	69.98^{a} ± 0.66	0.023
Ammonia-N	7.72^{b} ±0.18	10.21^{a} ±0.21	5.34^{c} ±0.05	0.041

DM, Dry Matter; CP, Crude Protein; ADF, Acid Detergent Fiber; NDF, Neutral Detergent Fiber; ^{abc} Means with uncommon superscripts within the same row differ significantly (p<0.05)

The ammoniacal nitrogen is a good indicator in the rating of silage, since it shows the amount of degraded protein during the fermentation period (Pires *et al.,* 2013). According to Costa *et al*. (2016), the concentration of ammoniacal nitrogen in the silages should be less than 10% of the total nitrogen in the silage, thus conferring good quality to the product. This statement is close to the present study.

Silage Feeding and Milk Production

Milk yield data of the dairy cows were collected at 15 days intervals are given in Table 4.

The data shows that there were significant ($p<0.05$) differences among the mean values of milk yield of cows fed different rations at all the fortnights. The average milk production (L/d) from each group of cows for whole Napier grass, Napier leaf, and Napier stem silage were found as 13.25, 13.55, and 12.68 respectively during the 60 days feeding trial period. Milk yield data in the Table 4 shows that Napier leaf silage and whole Napier grass silage-fed animal groups have given significantly ($p<0.05$) higher yields than that of the Napier stem silage-fed animal group. This might be due to the higher digestibility of Napier leaf and whole Napier grass silage compared to that of Napier stem silage.

Table 4: Effect of feeding different types of silage on milk production of dairy cows

Groups	Milk yield (L/d) at 15 days interval				
	1st	2nd	3rd	4th	Avg.
T1	11.68^{b} ± 0.11	12.73^{ab} ± 0.08	13.85^{a} ± 0.14	14.75^{a} ± 0.21	13.25^{a} ± 0.13
T2	12.34^{a} ± 0.16	13.12^{a} ± 0.13	13.92^{a} ± 0.17	14.84^{a} ± 0.15	13.55^{a} ± 0.15
T3	11.60^{b} ± 0.12	12.47^{b} ± 0.19	13.14^{b} ± 0.05	13.54^{b} ± 0.33	12.68^{b} ± 0.17
p-value	0.029	0.049	0.017	0.035	0.021

T_1, Whole napier grass silage; T_2, Napier leaf silage; T_3, Napier stem silage; Avg., Average; ^{abc} Means with uncommon superscripts within the same column differ significantly ($p<0.05$)

Napier leaf contains plenty of soluble carbohydrates, part of which can be broken down to produce sufficient lactic acid during ensiling to better preserve the silage materials. The leaves are generally rich in proteins, vitamins, and minerals (Banerjee, 1988). Where Napier stem contains less sugar for microbial fermentation and consequently less lactic acid production during ensiling for preservation. Based on this assumption, it was expected that whole Napier grass silage would give significantly ($p<0.05$) higher milk yield than that of Napier stem silage, and Napier leaf silage would give also significantly ($p<0.05$) higher milk yield than that of whole Napier grass silage.

Banerjee (1988) mentioned that lignin is found in the woody parts (stem) of the plants which is tightly bound to plant polysaccharides at various points and these bonds prevent swelling of plant fiber and thereby resist microbial fermentation. For that reason, the Napier stem silage was of lower quality than Napier leaf silage and whole Napier grass silage.

Conclusion

The result concluded that Napier leaf and whole Napier grass silage can be an effective processed fodder during the period of fodder scarcity for continuing the optimum milk production from dairy cows. Napier leaf and whole Napier grass can produce better silage for increasing milk production from Holstein Friesian crossbred dairy cow compared to Napier stem.

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