

Comparative Study on Biomass Yield, Morphology, Silage Quality of Hybrid Napier and Pakchong and Their Utilization in Bull Calves

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Abstract: This work was conducted to compare the potentiality between BLRI Napier-3 (BN-3) and Pakchong (PK) fodders. In a completely randomized design (CRD) layout, 10 plots (5 m × 5 m each) were prepared and stem cuttings were transplanted. Fodder plants were harvested at 70, 80 and 90 days after plantation (DAP) followed by making silage. Ten Red Chittagong Cattle (RCC) growing bull calves were selected and equally divided into two treatment groups fed only silages for nutrient utilization and growth evaluation. The highest biomass yield (69.3 ton/ha) and plant height (104.6 cm) were observed in PK at 90 DAP. The highest leaf weight (498.6 g/plant) and leaf to stem ratio (LSR) (1.53) were observed in BN-3 at 70 DAP, which was decreased gradually in progressing maturity. Conversely, stem weight was increased with progressing maturity. Dry matter (DM) (24.71%), total ash (8.35%) and acid detergent fiber (ADF) (61.89%) in PK silage were significantly higher. On the other hand, crude protein (CP) (9.86%), organic matter (OM) (91.65%) and neutral detergent fiber (NDF) (88.06%) in PK silage did not differ with BN-3 silage. Dry matter intake (DMI) and crude protein intake (CPI) from PK silage (2.25 kg/day/animal and 0.22 kg/day/animal) were significantly higher. Digestibility of DM (55.07%), CP (62.35%), OM (57.85%), total ash (30.89%), ADF (73.02%) and NDF (78.19%) for PK silage were significantly higher. N-intake (35.57 g/d) from PK silage was significantly higher, although, N-retention did not differ significantly. There were no significant differences in weight gain of calves fed PK (117 g/d) and BN-3 (68 g/d). It can be concluded that PK silage is comparatively better than BN-3 in respect to biomass yield, digestibility and nutrient utilization in growing bull calves.

Key words: PK silage, BN-3 silage, biomass yield, nutrient utilization.

1. Introduction

Livestock production is mainly constrained by lack of continuity in the supply of good quality feed, either grazing or conserved forage in developing countries like Bangladesh. Napier grass (*Pennisetum purpureum*) is one of the most popular grasses in the tropics and sub-tropics and has been the most promising and high yielding fodder with good adaptability that suppresses most tropical grasses. According to Woodard and Prine [1], Napier grass is usually harvested at short intervals to feed at an early growth stage, because the nutritive value of the grass depends on harvesting intervals. In general, although

it is harvested at proper intervals, this grass only can support low levels of animal production. This is attributed due to its high levels of neutral detergent fiber (NDF) and acid detergent fiber (ADF) and low levels of crude protein (CP) and digestibility [2]. Roy *et al.* [3] stated that farmers usually harvest this grass when plant grows 5-6 ft high (1.5-1.8 m) to achieve high yield from their small pieces of land in order to feed their huge number of livestock. Quality of this grass is often compromised to achieve high biomass yield which led to low quality of this grass. However, with the increasing demand of feeds for livestock, Napier along does not meet the requirements for the huge cattle population in Bangladesh. Alternative fodders with more vigorous growth and nutritious need to be introduced at this moment to meet up

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excessive requirements of roughages for livestock. Recently, a high yielding grass has been introduced from Thailand named Pakchong (PK) which is another variety of Napier grass and mostly adapted to the tropical climate prevailing in Bangladesh. However, it is also necessary to preserve the green grasses to some extent as silage making for lean season (winter), as well as for those areas where water logging prevails for most periods of the year. The rainy season brings an abundant production of Napier grass and at that time, cow gives milk well when fed them sufficiently. The plenty of production in the rainy season gives opportunity to store grass by making silage. Storing grass as silage allows the feed to be kept in top quality for feeding in the dry season [4]. During the winter period there is no high quality of feed available in the fields, and in order to feed high quality conserved supplements (e.g., maize) at any time of the year to complement grass to improve milk production or N utilization [5], so, silage making is a good option for solving the feed scarcity which hampers badly livestock production. Silage making is a convenient way to preserve forage crops as well as to enhance their palatability and nutritive content. Quality fodders and forages are important for optimization of production. Increasing biomass yield is as much as important, nutrient contents in fodder and forages are also important. Rusdy [2] stated that supplementation with quality forage leaves is very beneficial to increase growth performance of cattle and goats fed low quality elephant grass. This study was aimed with objectives to compare the quality assessment of PK and BLRI Napier-3 (BN-3) hybrid fodders in terms of biomass yields and plant morphology, palatability, nutrient utilization and growth performance of bull calves providing silage made from both fodders.

2. Materials and Methods

2.1 Location and Duration of Experiment

The study was conducted at Pachutia research farm

of Bangladesh Livestock Research Institute (BLRI), Savar, Dhaka. The experiment was conducted for a period of about 12 months including fodder cultivation, silage preparation & conservation, digestibility and feeding trial for growth performance study of growing bull calves, which was started from July 2016 to June 2017.

2.2 Topography, Soil and Climates

The experimental site is geographically located at 24°42'0" N latitude and 90°22'30" E longitude and at an altitude of 4 m above the sea level. The soil of the experimental site is clayed in texture. Soils were sampled to a depth of 20 cm collected from nine different points with an amount of about 1 kg from each point of the experimental field prior to commencement of the experiment. The samples were dried at ambient temperature for 5 d and mixed properly to make it composite sample. From the composite samples, five replications (each of 100 g) were sent to central laboratory of Soil Resource Development Institute (SRDI), Farmgate, Dhaka 1215, for soil nutrient analysis to adjust doses for fertilizer application in the experimental field.

The climate of the study area is classified as tropical. According to meteorological data taken in Savar Upazila (near the study site), the mean maximum temperature of 28.9 °C was recorded in May, which was the hottest month of the year and the mean lowest temperature of 18.8 °C was recorded in January, which was the coldest month of the year. The maximum temperature of 34.4 °C was recorded in April and the lowest of 12.1 °C in January.

The total annual rainfall was 1,990 mm and shows a unimodal distribution pattern, with the main precipitation from May to September. The precipitation was the lowest in December, with an average of 6 mm. Most precipitation falls in July, with an average of 372 mm. The mean relative humidity ranged from 54% to 83% [6].

2.3 Description of Napier Cultivars

Both cultivars were derived from interspecific crosses between common elephant grass (*P. purpureum*) and pearl millet (*P. glaucum*). BN-3 was developed by BLRI through accession selection of Napier hybrid. It is characterized by moderate height with profuse tillering and better leaf to stem ratio (LSR). It has very less barbs in leaves and stems which are not harmful for human skin. The flowering stage of this grass comes into delay and can be first harvested to 50-60 days after plantation (DAP) with 40-45 d subsequent harvests. On the other hand, PK was introduced from Thailand and developed by Department of Livestock Development, Thailand. It was reported that PK grows over 3 m height in less than 60 d, gives high yields and can be harvested after 45 d with a CP concentration of 16%-18% [7].

2.4 Land Preparation and Cultivation

For this study, 10 experimental plots (five for PK and five for BN-3) with each of 25 m² were prepared by properly weed slashing, ploughing, laddering and manuring. Farm yard manure (FYM), urea, triple super phosphate (TSP) and muriate of potash (MP) at the rate of 20 tons, 60, 70 and 30 kg per hectare, respectively, were applied before ploughing. After land preparation, stem cuttings of both cultivars were transplanted into the experimental plots with row to row spacing of 70 cm and plant to plant spacing of 35 cm. After 30 d of plantation first weeding followed by top dressing with urea at 60 kg/ha along with adequate irrigation was done. Further irrigation was done as per the requirement of the soil dryness. Fodder crops were harvested in three different periods of 70, 80 and 90 DAP.

2.5 Measurement of Biomass Yields and Plant Morphology

At the stipulated time of harvest plants within 1 m² area from five places of each plot were cut about 5 cm

above the ground level and weighed for green biomass yields and converted production to metric ton per hectare of land. For plant height measurement, the tallest tillers of randomly selected five clumps in each plot were taken and measured in inch from above the ground level to apex of the tiller. Leaves, stems and sheaths of randomly selected five plants from each of the plot were separated and weighed individually in grams. Weights of leaves were divided by weight of stem to estimate LSR.

2.6 Preparation of Silage

For preparation of silage, two Napier cultivars were harvested at 120 d after first plantation and chopped with a chaff cutter into 0.5-1.0 inch pieces. The chopped particles were poured into silo pits in the ground. Before filling, 3-4 inches thick layer of paddy straw was spread inside the pit, to prevent moisture absorption from the soil. To withdraw air completely from the vacuum space inside the pit, the chopped grasses were repeatedly compressed by legs after filling some amounts, so that there was no vacuum inside the pits. After proper compaction and filling, the tops of the pits were covered with polythene sheet and finally covered with soil and stored up to a period of six months until start of the feeding trial.

2.7 Selection and Management of Animals and Feeding Silage

A total of 10 Red Chittagong Cattle (RCC) growing bull calves aged between 12-15 months having almost homogenous body weight (ranged from 110 kg to 120 kg) were selected and equally divided into two treatment groups for feeding silage of two different fodders. All the experimental animals were stall fed with zero grazing. No concentrate feeds were supplied to the animals, except that of silage *adlib* provided twice in a day (once at 8:00 am and rest at 4:00 pm) and consistently supplied up to the end of the observation periods. Always fresh and clean drinking water was supplied to the animals during that period.

The growth of animals was calculated from final body weight deducted by initial body weight and the resultant was divided by duration of feeding periods and finally expressed as gram per day.

2.8 Trial for Nutrient Digestibility and N-Utilization

At the time of feeding trial, all animals were kept in individual metabolic crates. During that period, daily feed supply and leftover were recorded for estimating actual daily intake of silage by subtracting the leftover from the amount supplied in a day. In order to determine nutrient digestibility of silage, a 7-day collection period during the middle of the trial period was conducted. At that time, the amount of silage refusal collected every morning was stored for chemical analysis. The feces were collected manually from floor scrapping immediately after voiding and kept in polythene bags to avoid losses of N by evaporation and to avoid contamination. The feces voided by each animal along the day were weighed up to 7 d. Total feces were then mixed properly and about 5% of the well mixed feces of each animal were taken for sun dry and 50 g was kept in the refrigerator for estimation of dry matter (DM) and N. At the end of collection period, the sun dried feces collected for 7 d were composited and grinded to pass through 20 mm screen sieve for proximate analysis. Besides, urines voided by each animal along the day were collected individually by connecting the plastic pipe into the collection bottles previously set in the metabolic crates. After measuring the volume, 10% urine was taken out and mixed with other urine sample during collection period. The urine sample at 10% was taken out for proximate analysis. Remain urine at the same collecting place was then stored in the refrigerator for N estimation. The proximate analysis was conducted at Animal Nutrition Laboratory, BLRI. The calculations of DM and N-utilization were as follows:

$$\text{DM intake of silage} = (\text{feeding amount} \times \% \text{ DM}) -$$

$$(\text{remain amount} \times \% \text{ DM}) \quad (1)$$

$$\text{N-intake from silage} = \text{amount of DM intake} \times \% \text{ N} \\ \text{in silage} \quad (2)$$

$$\text{N-retention in feces} = \text{amount of feces} \times \% \text{ DM} \times \% \\ \text{N} \quad (3)$$

$$\text{N-retention in urine} = \text{amount of urine} \times \% \text{ N} \quad (4)$$

$$\text{N-balance} = \text{total N intake} - (\text{N-retention in feces} + \\ \text{N-retention in urine}) \quad (5)$$

2.9 Chemical Analysis

The supplied feed samples, leftover and faeces were analyzed by the method of Association of Official Analytical Chemist (AOAC) [8] for determination of DM, CP, organic matter (OM) and ash. On the other hand, ADF and NDF were determined by Van Soest *et al.* [9]. All the samples were analyzed in duplicate and mean values were recorded.

2.10 Experimental Design and Analysis

A 2×3 factorial experiment (two cultivars: BN-3 and PK \times 3 harvest periods: 70, 80 and 90 d) was laid out having three replications for each treatment combination. For the study of silage quality, each treatment (cultivar) had five replications (animals) in a completely randomized design (CRD). All the data generated from different areas of study were analyzed by IBM SPSS 20.0 statistical program. Duncan's multiple range test (DMRT) was also done to compare the treatment means for different parameters.

3. Results

3.1 Biomass Yields and Plant Morphology

The effects of cultivar and stage of maturity (cutting interval) on green fodder yield and plant morphology are presented in Table 1. The cultivar had a significant effect on biomass yield, plant height, leaf yield, sheath yield, stem yield and LSR. The highest biomass yield and plant height were obtained from PK. On the other hand, BN-3 performed better than PK in terms of leaf yield and LSR. The highest stems were yielded from PK.

Table 1 Comparative performances of BLRI Napier-3 (BN-3) and Pakchong (PK) fodder at different stage of maturity (SM).

SM	Biomass yield (MT/ha)		Plant height (inch)		Leaf weight (g/plant)		Sheath weight (g/plant)		Stem weight (g/plant)		Leaf: Stem (LSR)	
	BN-3	PK	BN-3	PK	BN-3	PK	BN-3	PK	BN-3	PK	BN-3	PK
70 d	50.1 (4.2)	46.6 (10.5)	64.7 (1.9)	90.0 (7.0)	498.6 (21.6)	154.6 (54.5)	131.4 (8.4)	93.3 (21.2)	325.9 (12.6)	231.6 (44.9)	1.53 (0.08)	0.68 (0.2)
80 d	43.5 (4.1)	62.4 (10.5)	76.2 (2.8)	101.3 (7.0)	429.1 (15.3)	146.6 (54.5)	148.0 (5.9)	79.0 (21.2)	350.6 (17.8)	258.0 (44.9)	1.23 (0.05)	0.58 (0.2)
90 d	41.3 (2.9)	69.3 (10.5)	80.5 (2.8)	104.6 (7)	355.3 (21.6)	142.6 (54.5)	171.8 (8.4)	128.3 (21.2)	556.3 (17.8)	276.3 (44.9)	0.65 (0.08)	0.53 (0.2)
Overall mean	44.9	59.5	73.9	98.7	427.8	148.0	150.5	100.2	411.0	255.3	1.17	0.63
SEM	2.2	6.1	1.5	4.1	11.4	31.5	4.4	12.3	9.4	25.9	0.04	0.12
Sig. (cultivar)	*		***		***		***		***		***	
Sig. (SM)	NS		NS		NS		NS		***		*	
Cultivar × SM	NS		*		NS		NS		**		**	

Values in the parenthesis are standard errors; *** significant at 0.1% level ($p < 0.001$); ** significant at 1% level ($p < 0.01$); * significant at 5% level ($p < 0.05$); NS = not significant ($p > 0.05$).

The stage of maturity had no significant effect on most of the morphological parameters, except those of stem weight and LSR. The stem yields increased significantly for both cultivars with increasing stage of maturity. Conversely, LSR decreased for both cultivars with progressing stage of maturity. There were significant cultivar × stage of maturity effects on plant height, stem weight and LSR.

The nutrient composition of silage made from PK and BN-3 is depicted in Table 2 which shows that there are significant differences for some nutrients between two silages. PK silage has significantly higher DM, ash and ADF contents than that of BN-3 silage.

3.2 Intake, Digestibility and N Utilization of Silage

Intakes of silage by the animals of two groups are shown in Table 3. The results reveal that fresh silage intake by the animals of two Napier cultivars did not vary significantly ($p > 0.05$).

Table 4 shows the nutrient digestibility of silage prepared from two Napier cultivars. The digestibility of PK silage was significantly higher than the digestibility of BN-3 silage for all nutrients contained in the silage.

Table 5 shows that N intake was proven to have significantly difference between feeding groups,

approximately at 35.59 g/day/animal for PK silage and 29.36 g/day/animal for BN-3 silage.

The amount of fecal N as shown in Table 5 (13.39 g/day/animal from PK silage and 13.86 g/day/animal from BN-3 silage) was proven to have no significant difference between feeding groups.

Table 5 shows the amount of N excreted through urine which differed significantly between feeding groups. Higher N was excreted from PK silage (16.02 g/day/animal) as compared to BN-3 silage (10.78 g/day/animal).

The N-retention (6.16 g/day/head from PK silage and 4.72 g/day/head from BN-3 silage) as shown in Table 5 did not differ significantly between feeding groups.

3.3 Feeding Effect of Silage on Growth of Bull Calves

Table 6 illustrates the feeding effect of silage made from PK and BN-3 silage on growth performance of bull calves. It is shown in Table 6 that initial body weights between two feeding groups have no significant variations, indicating that there was no bias of randomization between groups. Up to a 32 d feeding period, the final body weights of animals between groups were not varied significantly. Consequently, a total of 3.88 kg live body weight gain obtained by PK silage and a total of 2.26 kg live weight

Table 2 Nutritive values of PK and BN-3 silage.

Nutrients	PK silage (mean ± SE)	BN-3 silage (mean ± SE)	Level of significance
Dry matter (DM) (%)	24.71 ± 0.07	20.11 ± 0.15	**
Crude protein (CP) (%)	09.86 ± 0.20	09.14 ± 0.13	NS
Organic matter (OM) (%)	91.65 ± 0.52	93.11 ± 0.12	NS
Total ash (%)	08.35 ± 0.23	06.89 ± 0.09	*
Neutral detergent fiber (NDF) (%)	88.06 ± 0.58	86.45 ± 0.39	NS
Acid detergent fiber (ADF) (%)	61.89 ± 0.52	56.09 ± 0.31	**

SE = standard error; NS = not significant ($p > 0.05$); * significant at 5% level ($p < 0.05$); ** significant at 1% level ($p < 0.01$).

Table 3 Intake of silage prepared from two Napier cultivars.

Parameters	PK silage (mean ± SE)	BN-3 silage (mean ± SE)	Level of significance
Fresh silage intake (kg/day/animal)	9.12 ± 0.01	9.95 ± 0.48	NS
DM intake (kg/day/animal)	2.25 ± 0.004	2.00 ± 0.9	*
CP intake (kg/day/animal)	0.22 ± 0.003	0.18 ± 0.008	**
%DM intake on live weight	1.90 ± 0.15	1.68 ± 0.12	NS

NS = not significant ($p > 0.05$); ** significant at 0.1% level ($p < 0.001$); * significant at 5% level ($p < 0.05$).

Table 4 Nutrient digestibility in growing bull calves fed silage of two Napier cultivars.

Digestibility (%)	PK silage (mean ± SE)	BN-3 silage (mean ± SE)	Level of significance
DM	55.07 ± 1.15	45.63 ± 1.69	**
CP	62.35 ± 1.02	52.66 ± 1.23	***
OM	57.85 ± 1.24	46.58 ± 1.87	***
Ash	30.89 ± 2.02	20.57 ± 2.45	*
ADF	73.02 ± 1.05	65.09 ± 0.90	***
NDF	78.19 ± 0.746	71.42 ± 1.47	**

SE = standard error; *** significant at 0.1% level ($p < 0.001$); ** significant at 1% level ($p < 0.01$); * significant at 5% level ($p < 0.05$).

Table 5 N-intake and utilization in growing bull calves from PK and BN-3 silage.

Parameters	PK silage (mean ± SE)	BN-3 silage (mean ± SE)	Level of significance
N-intake (g/day/animal)	35.57 ± 0.07	29.36 ± 1.41	**
Fecal N (g/day/animal)	13.39 ± 0.36	13.86 ± 0.53	NS
Urinary N (g/day/animal)	16.02 ± 0.50	10.78 ± 0.35	***
N-balance (g/day/animal)	06.16 ± 0.42	04.72 ± 0.68	NS

SE = standard error; NS = not significant at 5% level ($p > 0.05$); *** highly significant at 0.1% level ($p < 0.001$); ** highly significant at 1% level ($p < 0.01$).

Table 6 Growth performance of bull calves feeding with sole PK and BN-3 silage.

Growth parameters	PK silage (mean ± SE, $n = 5$)	BN-3 silage (mean ± SE, $n = 5$)	Level of significance
Initial LWT (kg)	117.52 ± 11.01	118.24 ± 6.34	NS
Final LWT (kg)	121.40 ± 9.83	121.50 ± 6.42	NS
Total LWT gain (kg)	3.88 ± 1.20	2.26 ± 0.62	NS
ADG (kg/d)	0.117 ± 0.04	0.068 ± 0.02	NS

LWT = live body weight; ADG = average daily gain; SE = standard error; n = number of animal; NS = not significant at 5% level ($p > 0.05$).

gain obtained by BN-3 silage did not vary significantly.

Daily body weight gain (0.117 kg/d) obtained by PK silage was though higher than their counterpart of BN-3 silage (0.068 kg/d), but the difference is not statistically significant.

4. Discussion

4.1 Biomass Yields and Plant Morphology

The effect of cultivar on green fodder yield and other plant morphological characters as obtained in this study conforms to the earlier studies [10-12]. Biomass production of hybrid Napier is characterized by variety or cultivar specific and is associated with some plant morphological factors like plant height, number of tillers, leafiness, stem circumference, etc. The highest plant height and stem weight could be the reason for significantly higher biomass production of PK compared to BN-3. However, plant height is controlled genetically that can be modified mostly by selection with little extent to environmental factors. Assuero and Tognetti [13] stated that the control of tillering in grasses is the contribution of genetic and physiological factors and their interaction with environmental factors. Significant variation of LSR between cultivars could be due to variable characteristics of stem and leaves of the cultivars. Some varieties may be characterized by thin stem and numerous numbers of leaves, however, other may differ. Better LSR as obtained from BN-3 was due to higher leaf weight of BN-3 as compared to PK. The supremacy of BN-3 in terms of LSR makes it highly palatable for animals. The increasing harvest interval results in the increased weight of stem. This could be due to maturity of the plants; as plant grows, the stems become stronger and thicker. The LSR declined sharply as the harvest period increased. This is in agreement with the studies of earlier investigators Wangchuk *et al.* [10], Tessema *et al.* [14] and Smart *et al.* [15]. According to Butt *et al.* [16], decrease in

LSR with longer cutting intervals is a function of the longer periods of physiological growth with reduced defoliation frequency stimulating stem growth at the expense of leaf production.

This could be due to lower LSR in PK as shown in Table 1. Higher DM is associated with higher fibrous materials contained in stem. Bureenok *et al.* [17] in their study on Napier silage preserved with different additives had shown DM in silage to be 28.9% when preserved with no additive, 28.0% preserved with molasses and 26.5% preserved with fermented juice of epiphytic lactic acid bacteria. Their DM values of silages are comparatively higher than the present study, which could be due to difference of maturity of plant and type of silo or duration of preservation. Ishrath [18] reported CP and ash contents to be ranged from 8.09% to 11.59% and 6.67% to 10.56%, respectively, in silage prepared from Napier grass harvested at 45, 60 and 75 d, which are in agreement with this study. On the contrary, Bureenok *et al.* [17] obtained lower values of CP (4.1% to 4.9%) in silages preserved with different additives.

Aganga *et al.* [19] studied ash contents in Napier hybrid silage added with sole molasses 5% and molasses 5% with urea 1%, and they reported ash contents to be 7.1% to 12.27% depending on different cutting heights with increasing height resulting in higher values of ash. Khandaker and Uddin [20] reported 7.55% to 12.0% total ash contents in maize silage preserved at four different silos. The ash contents in silages as obtained in this study fall within the range of their study. Khaleduzzaman [21] and Broderick *et al.* [22] clarified that the lower ash content could be the possible reasons for releasing greater amount of energy and increasing nutrient digestibility during fermentation. Ash content in silage gives the information of OM as well as mineral content. However, the highest ash contents sometimes might cause kidney problems to the cattle [23]. According to the study of Ranjhan [23], ash content in feed should be below 10%. Bureenok *et al.* [17] in

their study had shown 39.2%-48.8% ADF and 62.3%-72.6% NDF in silages preserved with different additives which are lower than this study. The variations could be due to differences of cultivar or methods and storing duration of silage.

4.2 Intake, Digestibility and N Utilization of Silage

In general agreement, Khaleduzzaman [21] stated that there were no significant differences of intakes among silages of different categories even though in Napier silage due to low pH and high $\text{NH}_3\text{-N}$ of silage compared to that of fresh grass. Although fresh silage intakes of two Napier cultivars did not differ significantly, DM intake of PK silage was significantly higher than DM intake of BN-3 silage. This could be attributed due to higher DM contents in PK silage as compared to BN-3 silage (Table 2). This result agrees well with the earlier studies of Khaleduzzaman [21], Sawar and Hasan [24], Sawar *et al.* [25] and Yahaya *et al.* [26] who reported that the moisture content and pH of silage negatively affect intake. Khaleduzzaman *et al.* [27] reported DM intake of Napier silage to be 1.93 kg/d which closely agrees with this study. Earlier, Khandaker and Uddin [20] studied quality of maize silage preserved in four different silos and reported DM intake to be highest of 2.71 kg/d and lowest of 2.22 kg/d which are also in agreement with this study. As a result of higher DM intake from the PK silage, CP intake from the same silage was significantly higher than CP intake from BN-3 silage. This result conforms to the earlier studies of Khaleduzzaman [21] and Sawar *et al.* [28] who reported that nutrient intake followed a similar trend as observed in DM intake. The total voluntary DM intakes (% on live weight, LW) were 1.90% and 1.68%, respectively, for PK and BN-3 silages with no significant difference between cultivars. Basically, the amount of DM an animal will eat will depend on its body weight, quality of the feed and type of animal. However, it is important to calculate the average daily intake to ensure feeding the correct amount by body

weight or that the animal is able to obtain enough nutrients from a certain feed determined by intake limits. It was investigated that cattle and sheep generally consume between 2%-3% of their live weight in DM daily. Bureenok *et al.* [17] reported 2.12%-2.41% of total voluntary intakes from silage added with different additives which included same amount of concentrate feeds and 0.77%-1.06% excluded concentrate feeds. Less voluntary DM intake (% on live weight, LW) as compared to their study might be attributed due to the fact that no concentrate feeds were provided to the animals in this study.

The digestibility of silages of two Napier cultivars falls within the range of Yokota *et al.* [29] who reported *in vitro* digestibility ranged from 49.4% to 69.2% for DM and 48.6% to 71.9% for OM. Randa *et al.* [30] obtained 42.23% DM digestibility of Napier silage which closely agrees with 45.63% for BN-3 in this study. But they obtained 79.47% OM digestibility which is higher than this study. Khaleduzzaman *et al.* [27] reported DM, CP and OM digestibility of Napier silage to be 55.22%, 55.47% and 58.37% which are in accordance with this study. Bureenok *et al.* [17] in their study reported DM, CP and OM digestibility of Napier silage to be 75.64%, 76.95% and 77.43%, respectively, without mixing any additive and 81.54%, 81.09% and 83.22%, respectively, when adding molasses. Their findings do not conform to this study. The underlying reason is not clear but it might be speculated that harvest age and structural components of plant cell like cellulose, hemicellulose and lignin may vary among different fodder crops. Yokota *et al.* [29] reported that lignin is a chemical component in forage cell walls, increases with the development of the grass and is most associated with reduced digestibility of fiber. Bureenok *et al.* [17] reported ADF and NDF digestibility of Napier silage ranged from 65.22% to 76.33% and 66.60% to 76.75%, respectively depending on different additives added to the silages, which conforms to this study. Khaleduzzaman *et al.* [27] obtained ADF and NDF digestibility of Napier

silage to be 52.43% and 54.63%, respectively, which are lower than this study. The NDF digestibility of this study is accorded with Randa *et al.* [30] who got 74.23% in Napier silage, while they obtained 38.34% ADF digestibility which is lower than this study. The higher digestibility of DM, CP, OM, ash, ADF and NDF in PK silage compared to its counterpart indicates the supremacy of PK fodder in terms of nutrient utilization.

Sunarso [31] studied the effect of king grass silage on N-balance in goat and obtained no significant differences of N-intake among different combinations of diets. In principle, N-intake depends on DM intake and N contents of the ration. Higher DM and CP intakes from PK silage as compared to BN-3 silage investigated by this study have proved to be higher N-intake from PK silage. Principally, the amount of N consumed by ruminants is used by rumen microbes for synthesis process and to support growth of associated microbes, and rest of the amount will pass from degradation process in reticula-rumen and then moved to digestion organ behind the rumen. The quality and quantity amount of distributed N is equal to available N which will be absorbed and utilized. Increasing amount of quantity and quality of available N will increase positive impact on livestock performance.

In general agreement, Sunarso [31] reported the same effect for different rations in goat. The amount of N in feces is the portion of total amount of N intake which cannot be absorbed in digestion process and passes away through feces. Increasing passing out N, results in lower absorption or utilization of N. Thus, less N compensation through feces is expected as to more utilization of N for increasing production support to animals.

This could be due to the reason that total N-intake from PK was significantly higher than that of BN-3 silage. Sunarso [31] reported to have no significant differences of fecal N excretion among different rations, which is not in the line of this study. Variation

between findings could be attributed due to differences of diet or species. Principally, urinary N is the amount of un-utilized N of available N absorbed through digestive tract and mix with few amount of N endogenous from the body itself. Increased urinary N leads to increase of un-utilized N-absorbed. The higher the N excreted through urine, the lower the utilization of N, which results in the declination of performance of animals.

This result conforms to Sunarso [31]. Indeed, the more N-retention, the more utilization of N resulting good performance of livestock. For livestock ruminant, available N is $\pm 60\%$ which included contribution of rumen microbe protein, 30%-40% of feeding-N and 1%-2% obtained from N-endogenous. Rumen microbe includes CP at $\pm 70\%$ which consists of complete essential amino acid and has high biological value [32]. N-balance with no statistical difference between silages of two Napier cultivars implies that nutritional values of both fodders are alike.

4.3 Feeding Effect of Silage on Growth of Bull Calves

Recently, Nazli *et al.* [33] studied body weight gain of beef cattle after feeding corn silage, rice straw and combination of both and obtained no significant changes of final live weight which corresponds to this study, although they obtained significant differences for average daily weight gain. Bahri *et al.* [34] also reported significant changes of daily average weight gain of Bali cattle in Indonesia fed different combinations of corn straw and peanut straw silage. However, they also provided constant amount of concentrate feeds to animals of different treatment groups. That could be one of the reasons why the result of this study contradicts with their findings. Total DM and CP intakes from PK silage were significantly higher than those intakes from BN-3 silage. Nevertheless, quality of PK silage regarding palatability, nutrient intake and digestibility was superior. As a result, live weight gain was supposed to be higher in animals fed PK silage. The fundamental

reason is not clear. However, it may be speculated that N utilizations from both silages were not significantly different which leads to similar weight gains of both groups. According to FAO [35], beef meat contains 25% DM. DM in meat has around 16% N. However, Jones factor of 6.25 is used to determine total protein from total N contents in meat and fish. Based on the value, it can be accounted that 1 g N retention is equal to 6.25 g $\{(100/16.0) \times 1 \text{ g}\}$ DM of meat. Due to the amount of DM content in meat being 25%, it can be calculated that fresh meat obtained from 1 g N retention is 25.0 g $\{(100/25) \times 6.25 \text{ g}\}$. The results indicate that N retentions were accounted to 6.16 g/day/animal and 4.72 g/day/animal, respectively, for feeding PK and BN-3 silages. Based on the above equation, the animals should have gained 154.0 g $(6.16 \times 25.0 \text{ g})$ per day and 118.0 g $(4.72 \times 25.0 \text{ g})$ per day, respectively. As per these estimates, weight gains from both silages were not sufficient. Therefore, further investigation should be conducted.

5. Conclusions

This study reveals that PK fodder is comparatively better than that of BN-3 fodder in respect to biomass yields, intake, digestibility and nutrient utilization in growing bull calves. However, it does not prove to be superior for growth performance of growing animals.

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