EFFECTS OF CONCENTRATE SUPPLEMENT ON DRY MATTER AND WATER INTAKE, NUTRIENT DIGESTIBILITY AND NITROGEN BALANCE OF N'DAMA BULL CALVES FED NAPIER GRASS BASAL DIET

Yunus,[1] A.A., Osafo,[1] E.L.K., Osman,[2] A., Apori,[3] S.O., Attoh-Kotoku,[1] V., Antwi,[1] C., Idan,[1] F. and Gyamera,[3] E.

[1] *Department of Animal Science,*
Kwame Nkrumah University of Science and Technology. Kumasi.
[2] *Dairy/Beef Cattle Research Station,*
Boadi, Kwame Nkrumah University of Science and Technology, Kumasi.
[3] *Department of Animal Science, University of Cape Coast, Cape Coast.*
Corresponding author: *frankkidan@gmail.com*

https://dx.doi.org/10.4314/gjansci.v14i1.5

ABSTRACT

An experiment was carried out to assess the effects of concentrate supplements on dry matter and water intake, nutrient digestibility and nitrogen balance of N'dama bull calves fed Napier grass basal diet. Four N'dama bull calves were randomly assigned to one of four dietary treatments in a repeated 4 × 4 Latin Square Design. The treatments consisted of Napier grass only for T1 (Nap0$_{Conc}$), T2, Napier grass + concentrate fed at 1.5% LW (Nap1.5$_{Conc}$), T3, Napier grass + concentrate fed at 2.0% LW (Nap2.0$_{Conc}$) and T4, Napier grass + concentrate fed at 2.5% LW (Nap2.5$_{Conc}$). Concentrate supplementation significantly ($P<0.05$) influenced DM intake, nutrient digestibility, and nitrogen balance. However, the average daily water intake was not affected ($P>0.05$) by the level of concentrate offered to the animals. The total DM intake of the animals ranged from 36.92 kg to 44.74 kg whereas the average DMI was in the range of 2.64 kg/d to 3.20 kg/d. Increasing the level of concentrate supplementation did not significantly increase total and average DMI but all were higher than the control. Except for ADF digestibility, all digestibility parameters measured were higher ($P < 0.05$) for the supplemented diets compared with the control. In the case of the nitrogen balance trial, supplementing Napier grass with the concentrate resulted in increased ($P <0.0001$) N-retention. It was concluded that supplementing a Napier grass basal diet with different levels of concentrates significantly improved N'dama bull calves' dry matter intake, nutrient digestibility, and nitrogen balance compared with the control. Furthermore, supplemental concentrate did not affect the animals' water intake.

Keywords: *Concentrate; digestibility; nitrogen balance; and Napier grass*

INTRODUCTION

Forages in most tropical countries used as ruminant livestock feeds are mostly poor in nitrogen, energy or some essential nutrients needed for optimum animal growth and performance (Abdou, 2010). In Ghana, the demand for animal products like milk and meat is increasing, however, these forages cannot sustain sufficient levels of animal production. Further complicating these issues is the fact that most developing countries, including Ghana, are experiencing rapid population growth, which has resulted in the loss of communal grazing land for agricultural expansion. Additionally, forages are abundant, green, palatable, succulent, and nutritious during the rainy season, with less fibre and a high degree of digestibility (Sowande, 2004). However, because some of the land is used for seasonal arable crop cultivation, it becomes inaccessible to the ruminant livestock. Similarly, there are acute shortages of these forages for feeding animals in the dry season due to bush burning and land preparation for the next cropping season. Therefore, what is available for the animal is less nutritious and fibrous leading to prolonged periods of under-nutrition and malnutrition thereby affecting the general animal growth and performance.

Dry matter intake and digestibility of poor-quality forages are improved by increasing the activity of the rumen ecosystem to maximize fibre digestion and optimize microbial protein synthesis (Abdou, 2010). It is therefore necessary to identify alternative feed resources that are more nutritious to curtail these nutritional challenges faced by ruminant livestock for improved production and animal performance. These alternatives could be achieved through the cultivation of high-yielding and quality forages like Napier grass (*Pennisetum purpureum*) which has the potential to adapt to the local environmental conditions as well as feeding concentrate supplements to improve the digestibility of such forage.

According to Wangchuk et al. (2015), Napier grass produces a lot of herbage and makes up 80% of the forage that smallholder livestock farmers in East Africa grow for their animals. Tessema and Baars (2004) investigated the chemical composition, in vitro dry matter digestibility, and rumen degradation of Napier grass supplemented with concentrate at various levels and discovered beneficial properties that contribute to improved Napier grass utilisation. To give realistic suggestions to ruminant livestock producers, this must be assessed through animal performance studies. Therefore, the objective of this study was to assess the effects of protein concentrate supplements on dry matter and water intake, nutrient digestibility and nitrogen balance of N'dama bull calves fed Napier grass basal diet.

MATERIAL AND METHODS

Study site

The experiment was carried out at the University of Cape Coast Teaching and Research Farm of the School of Agriculture, Cape Coast, Ghana. It is located on longitude 1° 15'W and latitude 5° 06'N. The annual minimum and maximum temperature ranges are 24° and 34°C, respectively, and the relative humidity ranges from 50% to 85%. The region has a bimodal pattern of rainfall. The annual rainfall ranges from 800 to 1500 mm on average (Ghana Statistical Service, 2014).

Animals and housing

Four N'dama bull calves averagely six months of age and weighing 61.63 kg were used in a 13-week (91 days) experiment of which 14 days were used for the adaptation period, 56 days for data collection and 21 days of rest in between the treatments. The animals were individually housed in 2 m × 3 m (6 m^2) roofed pens with enough air circulation. The bull calves were ear-tagged in order to facilitate their identification and handling. The animals were offered Napier grass basal diet at 3% DM of LW plus 1.0 kg DM of the concentrate during the 14 days adaptation period. At the start of the experiment, the calves' body weights were recorded using a weighing balance early morning before they were allowed access to feed and water.

All animals were treated for both internal and external parasites using Ivermectin 1% (each ml contains 10 mg active ingredient Ivermectin) and Albendazole (Oral suspension 10%; Hebei New Century Pharmaceutical Company Limited, China) respectively.

Experimental design and feeding management

The animals were randomly assigned to one of the four dietary treatments in a repeated 4 × 4 Latin Square Design. The treatments were as follows:

T1 – Napier grass only ($Nap0_{Conc}$).
T2 – Napier grass + concentrate fed at 1.5% LW ($Nap1.5_{Conc}$)
T3 – Napier grass + concentrate fed at 2.0% LW ($Nap2.0_{Conc}$)
T4 – Napier grass + concentrate fed at 2.5% LW ($Nap2.5_{Conc}$)

The animals were adapted to the experimental diets for 14 days before being individually weighed and randomly assigned to one of the four dietary treatments. The Napier grass basal diet was harvested 60 days after planting, chopped into 10 cm lengths, and fed to the bull calves individually. The concentrate supplement was compounded using Maize (30%), Rice Bran (50%), Palm Kernel Cake (19.5%), Oyster Shells (0.3%), Common Salt (0.1%) and Vitamin Premix (0.1%).

The concentrate supplement was offered at 07:30 am after which the basal diet was offered at 08:30 am. Bull calves had access to clean water and a mineral block containing Sodium Chloride 95.5%, Calcium Carbonate 2.7% and Calcined Magnesia 1.0% *ad libitum* in individual plastic bowls attached to the pen. The animals were weighed at the end of each period which lasted for 14 days and were rested for 7 days after each period to acclimatize to new treatments and diets for the next period.

Data Collection

Feed intake

The amounts of each feed offered were weighed daily and recorded. Samples of basal diet refusals were collected in the morning each day at 07:00 am, stored in plastic bags and recorded before offering a fresh feed. Feed intake was determined by calculating the amounts of offered and refused feed. At the end of the experiment, the composite samples were pooled, and 200 g were collected as a representative refusal sample for each animal for laboratory analysis. The same process was used with the concentrate supplement. The concentrate refusals were observed during the first two periods of the experiment. A top pan balance was used to measure the feeds offered and the refusals.

Digestibility and nitrogen balance trial

Faecal output for each animal was manually collected daily, kept in plastic bags and stored in a freezer until needed for analysis. Daily faecal output was weighed and sub-samples (10%) of the faeces were taken at the end of the experiment for faecal dry matter (FDM) determination (oven dried to a constant weight at 55 °C for 48 hours). This was later bulked for proximate analysis, NDF and ADF.

Daily urine output was collected in a plastic bottle containing 100 ml 0.1N H_2SO_4. Ten percent (10%) of the daily urine was taken from each animal, sub-sampled and stored in the freezer for Nitrogen determination.

The apparent digestibility was calculated as:

$$\textit{Apparent digestibility (\%)} = \frac{\textit{feed intake - faeces}}{\textit{feed intake}} \times 100$$

The nitrogen balance was calculated as:

N-balance = Nitrogen intake – (Urine nitrogen + Faecal nitrogen)

Chemical analysis

The dry matter (DM), crude protein (CP), ash and ether extract were determined by proximate analysis according to the Association of Official Analytical Chemists (A.O.A.C., 1990). The NDF and the ADF fractions were determined following the technique described by Goering and Van Soest (1970).

Statistical analysis

Data were analysed as a 4 × 4 Latin square using the General Linear Model (GLM) of the Statistical Analysis System (SAS, 2012) and means that were significantly different were separated using Tukey's test at $p<0.05$.

RESULTS AND DISCUSSION

Chemical composition of the diet

Table 1 shows the chemical composition of the experimental diets. The dry matter (DM) and crude protein (CP) values of the Napier grass basal diet at 60 days of harvesting were found to be 269.0 g/kg and 98.2 g/kg, respectively. The DM value in this study is lower than the values reported by Ansah et al (2010) who reported a DM value of 484.0 g/kg at 60 days of harvesting. The differences could be a result of soil as well as climatic factors as both experiments were carried out at different ecological zones. The CP value recorded, however, was consistent with the result obtained by Ansah *et al*. (2010), who reported a CP level of 97 g/kg in Napier grass after 60 days of harvesting. The CP level reported in this study was higher than the critical CP level (70 g/kg) needed for voluntary feed intake in ruminant livestock as suggested by Nori *et al*. (2009). Furthermore, earlier studies have shown that diets containing more than 80 g/kg CP enhance rumen fermentation, which subsequently improves animal performance (Norton, 1994; Antwi *et al*., 2014; Idan *et al*., 2023). According to the current study, all of the experimental diets had CP contents that were higher than the 80 g/kg level which has been shown to be ideal for rumen microbial activity. The neutral detergent fibre (NDF) and acid detergent fibre (ADF) values of the Napier grass were 615.3 g/kg and 452.7 g/kg respectively. In contrast, the values reported in this study were lower than those reported by Ansah *et al*. (2010) who recorded higher NDF (728 g/kg) and ADF (724 g/kg) values at 60 days of harvesting. The low NDF values recorded in this current study have the potential to enhance intake and rumen microbial fermentation. According to Gusha *et al*. (2015), high ADF and low N lead to a slow rate of degradation thus causing rumen fill resulting in a feed intake that is too low to meet the nutrient requirements of the goats. High-quality forage has low ADF and NDF compared to low-quality forage (Upreti and Shrestha, 2006). The ADF values recorded in this current study suggest that the forage is of good quality and will not hinder digestibility.

Table 1: Chemical composition of Napier grass *(Pennisetum purpureum)* and concentrate supplement

Chemical composition	
Napier grass	**Values**
Dry matter, g/kg	269.0
Organic matter g/kg DM	242.7
Moisture g/kg DM	731.0
Crude protein g/kg DM	98.2
Ash g/kg DM	26.3
Ether extract g/kg DM	13.5
Crude fibre g/kg DM	200.5
NDF g/kg DM	615.3
ADF g/kg DM	452.7
Hemicellulose g/kg DM	162.6
Concentrate	
Dry matter g/kg	850.0
Moisture g/kg DM	150.0
Crude protein g/kg DM	143.0
Ash g/kg DM	89.4
Ether extract g/kg DM	61.5
Crude fibre g/kg DM	328.0
Nitrogen Free Extract (NFE)	175.0
Neutral Detergent Fibre (NDF)	826.1
Acid Detergent Fibre (ADF) g/kg DM	623.7
Calcium %	0.21
Phosphorus %	1.00
*Metabolizable energy Kcal/kg	1,812

**Metabolizable energy (ME) was estimated according to Pauzenga (1985). ME (Kcal/kg) = (35 * %CP) + (81.8 * % EE) + (35.5 * % NFE)*

The DM and CP values of the concentrate supplement were 850 g/kg and 143 g/kg respectively. The concentrate supplement contributed to the total dry matter and protein intake in the study.

The effect of concentrate supplement on dry matter and water intake

The Napier grass DM intake was not statistically significant (P>0.05) in all treatment groups as shown in Table 2. Conversely, there were significant (P<0.05) differences in the total DM intake. Animals fed Napier grass only (Nap0) had the lowest DM intake compared to those fed the supplemented diets. However, increasing the level of concentrate supplementation did not affect the total DM intake of the animals fed the supplemented diets. In contrast to the current study, Otaru *et al*. (2016) observed an increase in dry matter intake with increasing levels of concentrate supplements in the diet. The authors attributed the increased DMI to higher ingestion of protein and energy from the concentrate supplemented at 2.5% body weight, which, in synergy, facilitated rumen bacteria growth to enhance digestion and absorption by the ruminant. These observations are similar to those of Sairanen *et al*. (2005) and Arriola *et al*. (2011) who reported that daily feed intake increased with increasing levels of concentrate in dairy cows. Similarly, Mohammad *et al*. (2015) observed that goats fed a mixture of Napier grass and oil palm frond supplemented with soya waste had higher dry matter intake per kg unit of body weight than goats fed only Napier grass or oil palm frond. Moreover, the effect of supplemental concentrate level on DMI demonstrated in this study was consistent with the findings of Mele *et al*. (2008), who discovered that feeding increasing levels of concentrate to goats consuming a basal roughage diet did not influence dry matter intakes. The disparity between this study's findings and those of Otaru *et al*. (2016) could be attributed to forage quality.

The results obtained from the current study indicated that concentrate supplementation did not affect the water intake of the animals. From (Table 2), the average daily water intake ranged from 7.99 l/day in Nap0 to 9.47 l/d in Nap2.0$_{Conc}$ with no treatment effects (P = 0.1833). Even though no differences were observed in daily water intake, it was observed that water intake increased with increased dry matter intake up to 2.0% of body weight concentrate supplementation and then declined (Figure 1). This agreed with the findings of Hicks *et al.* (1998), who stated that water consumption increased with an increase in dry matter intake. From the study, the reason for the decline in water intake at 2.5% concentrate supplementation was not immediately known but probably due to the nature of the concentrate fed to the animals. It could be due to the limitation of space in the stomach as a result of the increased intake of dry matter. Also, when the stomach is full of feed, less water can be consumed before the animal reaches its limit of stomach distention.

Effect of concentrate supplement on nutrient digestibility of N'dama bull calves fed Napier grass basal diet

The effects of supplemental concentrate on the nutrient digestibility of the experimental animals are presented in Table 3. The results showed that

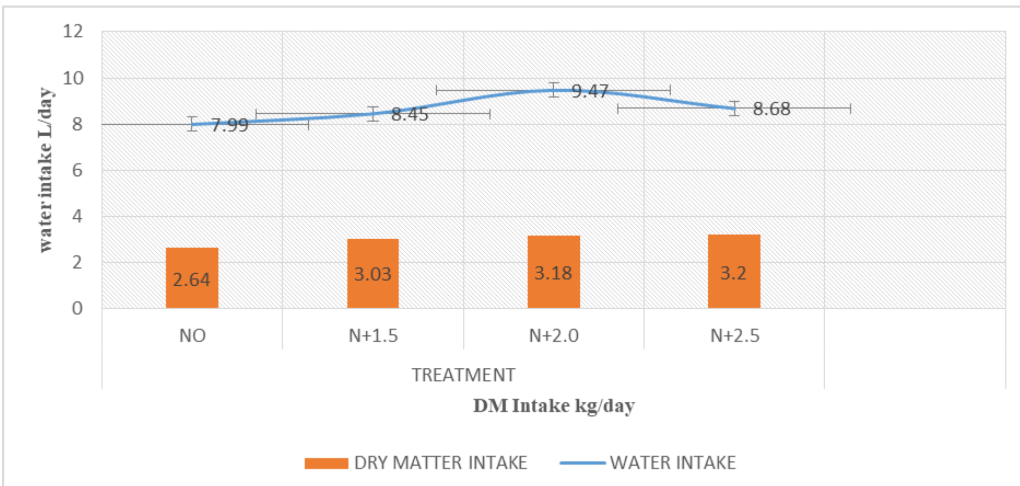

Figure 1: Relationship between water intake and dry matter intake

Table 2: Effect of concentrate supplement on dry matter and water intake of N'dama bull calves fed Napier grass basal diet

Parameters	Treatments				SEM	*P*
	Nap0 $_{Conc}$	Nap1.5$_{Conc}$	Nap2.0$_{Conc}$	Nap2.5$_{Conc}$		
DM intake of grass (kg)	36.92	37.59	38.18	37.65	0.361	0.2088
DM intake of concentrate (kg)	0.00^{b}	4.79^{a}	6.37^{a}	7.09^{a}	0.568	0.0005
Total DMI (kg)	36.92^{b}	42.37^{a}	44.55^{a}	44.74^{a}	0.619	0.0003
Average DMI (kg/day)	2.64^{b}	3.03^{a}	3.18^{a}	3.20^{a}	0.044	0.0003
Average water intake (L/day)	7.99	8.45	9.47	8.68	0.415	0.1833

^{abc} *Values having different superscripts in the same row are significantly different at p<0.05, SEM=Standard error means; Nap0 $_{Conc}$ = Napier grass only, Nap1.5$_{Conc}$ = Napier grass + concentrate fed at 1.5% LW, Nap2.0$_{Conc}$ = Napier grass + concentrate fed at 2.0% LW and Nap2.5$_{Conc}$ = Napier grass + concentrate fed at 2.5% LW* dry matter digestibility varied significantly (P = 0.0005) among treatment diets and ranged from 512.8 to 638.1 g/kg, with animals fed Nap0 having the lowest DM digestibility. One of the most important factors in the measurement of the nutritional value of animal feed is feed digestibility which is largely expected to increase ruminant performance (Al-Arif et al, 2017). Feed digestibility determines the relationship between nutrient contents and energy. The DM digestibility in the current study was within the range of those recorded by Sani *et al*. (2017) in Bunaji bulls fed diets containing graded levels of palm kernel cake. In contrast, Wong and Wan Zahari, (1997) recorded a DM digestibility range of 564 to 758 g/kg when growing Sahiwal-Friesian bulls were fed diets containing PKC and cocoa pod husk. The dry matter digestibility values recorded in this study are enough to meet the production and maintenance requirements of the animals.

There was a significant difference in crude protein digestibility due to the treatment effect ($p<0.05$) as shown in Table 3. The least crude protein digestibility was recorded in Nap0 (564.0 g/kg). The higher crude protein digestibility values observed in the supplemented treatment groups could be attributed to the higher crude protein intake compared to the control group. In agreement with similar studies, Abdul Razak *et al*. (1997) reported a higher apparent crude protein digestibility coefficient in *Bos taurus/Bos indicus* steers offered Napier grass basal diet with concentrate supplement as compared with the control animals. Their findings were due to higher crude protein content in the supplemented diet compared with the control which provided more nitrogen for microbial utilization.

Organic matter and ash digestibility followed a similar trend as that of the CP digestibility. According to Hughes *et al*. (2012), organic matter digestibility gives an indication of the proportion of organic matter in the feed that is apparently digested in the digestive tract of the ruminant animal and can be used to estimate the availability of energy in the diet. In this study, animals fed Napier grass plus concentrate supplement had organic matter digestibility values of above 600 g/kg, which puts them in the group of high-quality feeds as suggested by Meissner et al. (2000). Kariuki et al. (1999) reported that concentrate supplement enhanced organic matter

Table 3: Effect of concentrate supplement on nutrient digestibility of N'dama bull calves fed Napier grass basal diet

Nutrient digestibility (g/kg)	Treatments				SEM	*p*
	Nap0 $_{Conc}$	Nap1.5$_{Conc}$	Nap2.0$_{Conc}$	Nap2.5$_{Conc}$		
Dry matter	512.8^{b}	629.0^{a}	638.1^{a}	611.4^{a}	1.035	0.0005
Crude protein	564.0^{b}	723.8^{a}	739.7^{a}	733.3^{a}	0.587	<0.0001
Organic matter	250.3^{b}	682.6^{a}	658.2^{a}	623.1^{a}	1.862	<0.0001
Ash	278.6^{b}	498.0^{a}	502.7^{a}	514.5^{a}	1.850	0.0003
Ether extract	496.2^{b}	764.6^{a}	753.2^{a}	751.3^{a}	1.738	<0.0001
Neutral detergent fibre	512.5^{b}	609.0^{a}	636.4^{a}	663.2^{a}	1.175	0.0005
Acid detergent fibre	393.2^{a}	347.6^{ab}	332.6^{b}	319.4^{b}	1.146	0.0167
Hemicellulose	222.1^{b}	478.5^{a}	493.5^{a}	506.7^{a}	1.145	<0.0001

^{abc} Values having different superscripts in the same row are significantly different at $p<0.05$, SEM=Standard error means; Nap0$_{Conc}$ = Napier grass only, Nap1.5$_{Conc}$ = Napier grass + concentrate fed at 1.5% LW, Nap2.0$_{Conc}$ = Napier grass + concentrate fed at 2.0% LW and Nap2.5$_{Conc}$ = Napier grass + concentrate fed at 2.5% LW

digestibility in Sahiwal and Friesian dairy heifers fed Napier grass basal diet leading to improved animal performance.

In the case of fibre digestibility, significant differences ($P < 0.05$) among treatment diets were observed in both NDF and ADF digestibility as shown in Table 3. From the results obtained, animals fed the concentrate-supplemented diets had higher ($P = 0.0005$) NDF digestibility compared with the control group. However, increasing the level of concentrate supplementation did not increase NDF digestibility. The lower NDF digestion in the control group fed only Napier grass could be due to insufficient protein for rumen microorganisms to improve the digestion of the feed. In contrast to the findings of the current study, Ba *et al*. (2008) reported a decline in NDF digestibility with increasing concentrate consumption which is consistent with reports by Dung *et al*. (2013).

The ADF digestibility ranged from 319.4 g/kg in animals fed Nap2.5$_{Conc}$ to 393.2 g/kg in those fed the Nap0 diet. Contrary to the NDF digestibility, the ADF digestibility was higher ($P = 0.0167$) for the control group compared with the supplemented groups. In the case of the supplemented diets, increasing the level of concentrates did not influence the ADF digestibility values. The range of ADF digestibility found in this study was less than that observed by Sani *et al*. (2017) in Bunaji bulls and heifers fed diets containing a graded level of palm kernel cake. This was, however, similar to that found by Sani (2014) in fattening Bunaji bulls fed raw or parboiled rice offal as an energy source.

Effect of concentrate supplement on nitrogen balance of N'dama bulls fed Napier grass basal diet

There was a significant ($P<0.05$) difference in nitrogen intake between the treatment animals and the control group (Table 4). The control animal recorded the least nitrogen intake (Nap0, 38.94 g/day). Nitrogen intake and faecal nitrogen excreted increased as the level of concentrate supplementation increased. There were significant ($P<0.05$) differences in urinary nitrogen excreted among the treatment animals and the control. Concentrate supplementation resulted in a higher ($P<0.05$) excretion of urinary nitrogen. A similar observation was made in the total nitrogen output.

There was a significant ($P<0.05$) difference in nitrogen retained among the treatment animals and the control group (Table 4). Animals in Nap2.0$_{Conc}$ recorded the highest nitrogen retention (86.61 g/day) and this could be a result of low faecal nitrogen excreted than Nap2.5$_{Conc}$ (86.03 g/day). There was no significant ($P>0.05$) difference in the percentage of nitrogen intake between the treatment groups and the control.

Table 4: Effect of concentrate supplement on nitrogen balance of N'dama bull calves fed Napier grass basal diet

Parameters	Treatments				SEM	*p*
	Nap0 $_{Conc}$	**Nap1.5$_{Conc}$**	**Nap2.0$_{Conc}$**	**Nap2.5$_{Conc}$**		
Nitrogen intake (g/day)	38.94^{b}	113.94^{a}	119.79^{a}	120.32^{a}	4.395	<0.0001
Urinary nitrogen (g/day)	3.07^{b}	6.06^{a}	6.22^{a}	5.98^{a}	0.204	<0.0001
Faecal nitrogen (g/day)	9.15^{b}	26.01^{a}	26.97^{a}	28.31^{a}	1.622	0.0005
Total nitrogen output (g/day)	12.22^{b}	32.07^{a}	33.19^{a}	34.29^{a}	1.649	0.0002
Nitrogen balance (g/day)	26.73^{b}	81.87^{a}	86.61^{a}	86.03^{a}	2.852	<0.0001
% Nitrogen Intake	67.74	71.65	72.20	71.46	2.317	0.2954

^{abc} Values having different superscripts in the same row are significantly different at p<0.05, SEM=Standard error means; Nap0 $_{Conc}$ = Napier grass only, Nap1.5$_{Conc}$ = Napier grass + concentrate fed at 1.5% LW, Nap2.0$_{Conc}$ = Napier grass + concentrate fed at 2.0% LW and Nap2.5$_{Conc}$ = Napier grass + concentrate fed at 2.5% LW

According to Mohamed et al. (2001), the nitrogen content of the feed and the intake of dry matter both influence nitrogen intake. The nitrogen balance of the animals on concentrate supplement in this study was higher than 48.50g/day – 54.85 g/day reported by Sani et al. (2017) and 72.01 g/day –79.48 g/day reported by Yusuf (2016); these differences could be as a result of nitrogen concentration in the supplementary diet fed to the animals. In contrast, Lamidi (2005) reported a higher value of 130 g/day – 180 g/day and 146.67 g/day – 206.6g/day when Bunaji bulls were fed sundried layer and broiler litters respectively. The results obtained in this study also revealed that both the concentrate-supplemented calves and the control group had positive nitrogen balance. This suggests that the nitrogen was well absorbed and utilized by the animals for better performance. Abdu et al. (2012) noted that nitrogen balance is an indicator used to evaluate the protein nutrition status of ruminant livestock and is particularly important for growing animals such as calves. It was also observed that nitrogen intake increased with concentrate supplementation of the basal diet. This observation agrees with the findings made by McDonald et al. (2002) who reported that dietary nitrogen intake is directly correlated to the proportion of nitrogen concentration in the diet of the animal. The results also showed increased faecal nitrogen and reduced urinary nitrogen with increasing levels of concentrate supplement of the basal diets. This agrees with the findings of Al-Asfoor (2010) who noted that the concentration of nitrogen in the faeces is strongly dependent on the nitrogen concentration of the diet.

CONCLUSION

Providing quality feed during the dry season ensures the optimum performance of ruminants and profitability to smallholder farmers. Feeding protein concentrate as a supplement to Napier grass basal diet improved total and average dry matter intake in N'dama bull calves. Furthermore, increased digestibility of DM, CP, OM, Ash, NDF, and Hemicellulose in N'dama bull calves implies that there was improved rumen function and feed digestibility by cattle fed the supplemented diets. In addition, water intake improved as dry matter intake increased but declined when the concentrate level was increased from 2.0% to 2.5%. Protein concentrates as a supplement to Napier grass basal diet again improved both the nitrogen intake and nitrogen balance in N'dama bull calves and thus could be used to enhance the quality of poor forages, especially during the dry season where natural pastures are quantitatively and qualitatively poor.

REFERENCES

Abdou, N. (2010). The effect of supplementing millet stover with groundnut haulms and cereal brans on feed intake and growth performance of sheep. MSc Thesis, University of KwaZulu-Natal, Pietermaritzburg, South Africa.

Abdu, S.B., Ahmed, H., Jokthan, G.E., Adamu, H.Y. and Yashim, S.M. (2012). Effects of levels of Ficus (Ficus sycomorus) supplementation on voluntary feed intake, nutrient digestibility and nitrogen balance in Yankasa rams fed urea treated maize stover basal diet. *Iranian Journal of Applied Animal Science* 2 (2): 151-155.

Abdul Razak, S.A., Muinga, W., Thrope, R.W. and Orskov, E.R. (1997). The effect of supplementation with *Gliricidia sepium or Leucena leucocephala* forage on intake, digestion and live-weight gains of *Bos taurus/Bos indicus* steers offered Napier grass. Journal of Animal Science, 63: 381-388.

Al-Arif, M.A., Suwanti L.T., Estoepangestie, A.T.S and Lamid, M. (2017). The Nutrients Contents, Dry Matter Digestibility, Organic Matter Digestibility, Total Digestible Nutrient, and NH3 Rumen Production of Three Kinds of Cattle Feeding Models. VMIC. [online] Available at:<https://knepublishing.com/index.php/KnE-Life/article/view/1142/2924> [Accessed 3 Mei.2021]

Al-Asfoor, H., (2010). Effects of different feeding regimes on the digestibility and faecal excretion of nitrogen, soluble carbohydrate and fibre fractions in water buffaloes kept under subtropical conditions. MSc Thesis, University of Kassel. Accessed from http://www.uni-kassel.de/fb11/dec/research-training-group- 397_en.html on 12th February, 2013.

Antwi, C., Osafo, E. L. K., Donkoh, A., and Adu -Dapaah, H. 2014. Chemical composition, gas production and degradation characteristics of haulms of improved dual-purpose Cowpea (Vigna unguiculata l. walp) cultivars. Livestock Res. for Rural Dev. 26:194. Retrieved January 27, 2022, from http://www.lrrd.org/lrrd26/11/antw26194.html

Arriola, K.G., Kim, S.C., Staples, C.R. and Adesogan, A.T. (2011). Effect of fibrolytic enzyme application to low- and high concentrate diets on the performance of lactating dairy cattle. Journal of Dairy Science, 94, 832–841.

Dung, D.V., Ba, N.X., Van, N.H., Phung, L.D., Ngoan, L.D. and Cuong, V.C. (2013). Practice on improving fattening local cattle production in Vietnam by increasing crude protein level in concentrate and concentrate level. Trop Anim Health Prod. 45:1619–26.

Ghana Statistical Service (2014). 2010 Population and Housing Census. District Analytical Report. Cape Coast Municipal. *www.statsghana.gov.gh*

Gusha, J., Halimani, T. E., Ngongoni, N. T., and Ncube, S. (2015). Effect of feeding cactus legume silages on nitrogen retention, digestibility and microbial protein synthesis in goats. Animal Feed Science and Technology, 206, 1-7.

Hicks, R. B., Owens, F. N., Gill, D. R., Martin, J. J. and Strasia, C. A. (1998). Water Intake by Feedlot Steers. *Animal Science Research Report*. 12: 45-52

Hughes, M.P., Jennings, P.G.A., Mlambo, V. and Lallo, C.H.O. (2012). Effect of season and harvesting method on chemical composition, predicted metabolizable energy and in vitro, organic matter digestibility of rotationally grazed tropical pastures. Online Journal of Animal and Feed Research. 1(5): 405-417.

Idan, F., Adogla-Bessa, T., Sarkwa, F. O. Frimpong, Y. O., and Antwi, C. (2023). Effects of supplementing rice straw with two fodder tree leaves and their combinations on voluntary feed intake, growth, and nitrogen utilization in sheep, Translational Animal Science, txad004, https://doi.org/10.1093/tas/txad004

Kariuki, J.N., Gitau, G.K., Gachuiri, C.K., Tamminga, S., Van Bruchem, J. and Muia, J.M.K. (1999). Performance of SahiwaFriesian heifers fed on Napier grass supplemented with graded levels of lucerne. S. Afr. J. Anim. Sci. 29, 1–11.

Lamidi, O.S. (2005). The use of some conventional protein sources for fattening cattle. Ph.D. Thesis. Department of Animal Science, Ahmadu Bello University, Zaria, Nigeria. Pp 67

McDonald, P., Edwards, R. A., Greenhalgh, J. F. D. and Morgan, C. A. (2002). Animal nutrition. Sixth Edition. Prentice Hall, Pearson Education, London, England. pp: 568.

Mele, M., Serra, A., Buccioni, A., Conte, G., Pollicardo, A., & Secchiari, P. (2008). Effect of soya bean supplementation on milk fatty acid composition from Saanen goats fed diets with different forage: concentrate ratios. Italian Journal of Animal Science, 7, 297–311. https://www.tandfonline.com/loi/tjas20.

Meissner, H.H., Zacharias, P.J.K. and Reagain, P.J. (2000). Forage quality (feed value). In: Tainton, N.M. (Ed.), Pasture Management in South Africa. University of Natal Press, Pietermaritzburg. 66–88 pp.

Mohammad, M.R., Ramli B.A., Wan E.W.K., Toshinori., N. and Ryo, A. (2015). Feed intake and growth performance of goats fed with Napier grass and oil palm frond supplemented with soya waste, Journal of Applied Animal Research, 43:3, 256-260, DOI: 10.1080/09712119.2014.963095

Otaru, S. M., Adamu, A. M., Ehoche, O. W., & Lakpini, C. A. M. (2016). Effect of graded levels of concentrate mixture containing 4% palm oil on digestion and nitrogen retention by Red Sokoto goats fed a basal diet of *Digitaria smutsii* hay. *Bulletin of Animal Health and Production in Africa, 64*(1), 95–105. https://www.ajol.info/index.php/ Bahia/article/ view/150414.

Sairanen, A., Khalili, H., Nousiainen, J.I., Ahvenjarvi, S. and Huhtanen, P. (2005). The effect of concentrate supplementation on nutrient flow to the omasum in dairy cows receiving freshly cut grass. Journal of Dairy Science, 88, 1443–1453.

Sani, R.T. (2014). Evaluation of raw or parboiled rice offal as an energy source in fattening Bunaji bulls. M.Sc. Thesis. Department of Animal Science, Ahmadu Bello University. Zaria, Nigeria. Pp 17-35.

Sani R.T., Lamidi O.S., Dung, D.D., Hassan, M.R. (2017). Performance of yearling Bunaji bulls fed diets containing a graded level of palm kernel cake. *Nigerian J. Anim. Sci. 2017 (2):235 - 246*

Sowande, O.S. (2004). Response of West African sheep to dry season feed based on preserved elephant grass, layer dropping and cassava peels. Ph.D. Thesis. Department of Animal Production and Health. University of Agriculture, Abeokuta, Nigeria

Tessema, Z. and Baars, R.M.T. (2004). Chemical composition, in vitro dry matter digestibility and ruminal degradation of Napier grass (Pennisetum purpureum (L) Schumach) mixed with different levels of Sesbania sesban (L) Merr. Anim. Feed Sci. Technol. 117, 29–41.

Upreti, C.R and Shrestha, B.K (2006) Nutrients contents of feeds and fodder of Nepal. Animal Nutrition Division, NARC Kathmandu, Nepal. 179p. www.narc-nepal.org

Wong, H.K and Wan Zahari, M. (1997). Nutritive value of palm kernel cake and cocoa pod husks for growing cattle. *Journal of Tropical Agriculture and Food Science*. 25 (1): 125–131

Yusuf, M. (2016). Evaluation of Brewers‟ dried grain on the performance of Bunaji yearling Bulls raised under intensive system"" MSc.Thesis. Department of Animal Science, Ahmadu Bello University, Zaria, Nigeria