Effect of diets containing graded levels of groundnut haulms on Dry matter intake, nutrient digestibility and Nitrogen balance of Friesian x Bunaji Bulls

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Abstract

An experiment was conducted to determine the effect of feeding concentrate diets containing varying levels of groundnut haulms on dry matter intake, nutrient digestibility and nutrient balance in Friesian x Bunaji bulls. The feed consisted of four concentrate mixed diets formulated to contain on average 14.45- 14.65% crude protein. Groundnut haulms (GH) in the concentrate diets were on nitrogen basis at 0, 25, 50 and 75% levels with control diet having 0% inclusion of GH. Sixteen bulls aged 12-18 months were divided into four each and were randomly allotted to the four treatment diets in a completely randomized design for metabolic trial. During trial, the bulls were housed in metabolic crates and fed Gamba hay adlib and the basal or particular test concentrate mixture at 40% of estimated DM intake. Chemical composition and energy contents of the diets were determined. Dry matter intake (DMI) and organic matter intake (OMI) were also determined. The CP value averaged 14.45 ± 0.44 - $14.65 \pm 1.22\%$ for the four experimental diets. The metabolizable energy content expressed in Kcal/kg of diets decreased with increase in GH level from 0-75% (3166-1752 kcal/kg). There was no significant ($P > 0.05$) difference on voluntary DMI and OMI. The digestibility coefficients of DM, OM, CP, CF, EE, NDF, ADF, hemicellulose and ash were significantly ($P < 0.05$) higher at 75% level of groundnut haulms. CF and ADF digestibility were significantly influenced ($P < 0.05$) when groundnut haulms level reached 25%. Conversely, the digestibility of NFE did not differ ($P > 0.05$) across treatments. Nitrogen balance were similar ($P > 0.05$) among animals fed concentrate mixtures. Nitrogen balance expressed in percent was slightly higher at 75% level of groundnut haulms. It is concluded that inclusion of GH in concentrate diets of crossed bulls up to 75% can improve nutrient digestibility and the percent Nitrogen balance.

Keywords: Groundnut haulms, Feed intake, digestibility, Nutrient balance, Friesian x Bunaji Bulls.

Introduction

In recent years, the use of forage legumes in livestock production systems for ruminants in the tropics as alternative to oil seed cakes has increased. Forage legumes and fodder trees provide high quality proteins as well as digestible cell wall carbohydrates. Groundnut (*Arachis hypogaea*) is an important legume crop grown for seed and forage in smallholder crop livestock farming systems in the sub humid zone of

West Africa (Oloranju *et al.*, 1996). The forage (haulms) after pod harvesting is commonly fed to ruminants, especially in the dry season. Supplementation with groundnut haulm contributes fermentable energy to the rumen in the form of available cellulose and hemicellulose which stimulate fibre digestion (Silva and Orskov 1988). The availability of groundnut hay among arable farmers who keep small livestock and the variation in results obtained from ruminants fed groundnut

haulms underscore the need for more studies on how best its potential as animal feed can be exploited. This study was carried out in order to determine the effect of feeding concentrate diets containing graded levels of groundnut haulms on dry matter intake, digestibility and nitrogen balance of Friesian x Bunaji Bulls.

Materials and methods

Location

The study was carried out in the Dairy Research Programme Farm of the National Animal Production Research Institute, Ahmadu Bello University, Shika- Zaria. Shika is located in the Northern Guinea Savannah on latitude 11° 12'N, longitude 7° 33'E, altitude 610m. Mean annual rainfall is 1100mm lasting from May to October with peak rainfall between July and September with relative average humidity is about 72% at this period, The mean temperature is about 24.4°C (14.5 – 39.3°C) with the lowest temperature occurring during early dry season (November to January). Higher temperatures are experienced during the late dry season (February – April) with mean relative humidity between 20-37% (Google Map, 2013).

Experimental animals and design

Sixteen young Friesian x Bunaji bulls aged 12-18 months and averaging 200 ± 2.44kg, were randomly divided into four groups on the basis of their body weights and allocated to the complete diets in a completely randomized design. The young Friesian x Bunaji bulls were fed the experimental diets in a metabolic trial to determine nutrient digestibility and nitrogen balance. The animals were housed in individual metabolic crates, ideal for easy collection of faeces and urine as described by Osuji *et al.* (1993).

The bulls were dewormed with Albendazole® 2500mg boli (Eagle

Chemicals Co. Limited. Chungchongnamdo, Korea) at the rate of 5mg/Kg body weight, before the commencement of the growth trial. They were treated against ticks and other ectoparasites by dipping in a long-walk dip containing acaricide Steladone (Novartis Inc. Basle, Switzerland) before the commencement of the trial. The animals were vaccinated against Contagious Bovine Pleuro-Pneumonia (CBPP), Black Quarter (BQ) and Foot and mouth disease (FMD).

Experimental feeds and feeding

Dried groundnut haulms (GH) was procured from markets in Zaria and its environs. Gamba (*Andropogon gayanus*) hay was obtained from the Forage Production Unit of National Animal Production Research Institute, Ahmadu Bello University, Zaria. Groundnut haulms was crushed manually and bagged. Molasses was procured from L and Z Farms in Kano.

Concentrate mixture was formulated consisting of maize grain, wheat offal, cottonseed cake, bone meal, common salt and vitamin-mineral premix which formed the treatment diets (Table 1). The dietary treatments consisted of four iso-nitrogenous, iso-caloric concentrate diet (14.6%CP) in which groundnut haulms was included at 0, 25, 50 and 75% levels. The low metabolizable energy content in concentrate mixtures containing groundnut haulms (GH) was compensated by daily mixing of molasses.

During trial, the bulls were fed Gamba hay *ad libitum* and test concentrate diets at 40% of estimated DM intake. Each diet was fed during a 10 day adaptation period followed by a 7 day measurement, period of faeces and urine collection. After the adjustment period, animals were fed concentrate diets at feeding level of 1.5% of body weight, while Gamba hay was fed *ad libitum*. All the

animals were weighed for 3 consecutive days before and after completion of the metabolic trial. Leftover feed was weighed and recorded daily before the morning feeding.

Sample collection

Samples of the experimental feed were taken daily, bulked, mixed thoroughly and sub samples taken for chemical analysis. The samples were then milled to pass through a 1 mm-mesh sieve and stored in an airtight bottle until required for analysis. Sample collected were oven- dried at 60°C for 48 hours, ground and 10% of the mixed samples taken for chemical analysis. The samples were analysed for proximate composition according to methods approved by AOAC (1990) and cell wall constituents (Goering and Van Soest, 1970).

Daily urine output from each bull was collected in a plastic container (sample bottles) containing 100ml 0.1N H₂SO₄ placed under the metabolism crates. Daily, 10% of the urine was collected from each bull and stored in a refrigerator. The urine samples were bulked and 10% taken for keeping in refrigerator until required for analysis.

Statistical analysis

Data collected were analyzed using the least square method of SAS (1990) package. The differences between means were separated using the Duncan Multiple Range Test Method (Steel and Torrie, 1980). The model used is as shown below:

$$Y_{ijk} = \mu + \alpha_i + e_{ijk}$$

Where Y = dependent variable (BWt, intake, digestibility, milk yield)

α_i = effect of i^{th} treatment ($i=1 \dots 4$)

e_{ijk} = random error

Table 1: Ingredient composition of concentrate containing varying levels of groundnut haulms
Levels of groundnut haulms in concentrate diets (%)

Ingredients	0	25	50	75
Maize grain	35	25	15	6
Cotton seedcake	20	17	14	12
Wheat offal	42	30	18	4
Bone meal	2	2	2	2
Common salt	0.75	0.75	0.75	0.75
Vit-min premix	0.25	0.25	0.25	0.25
Molasses	0	2	4	5
Total	100	100	100	100
Calculated composition				
% CP	14.65	14.64	14.63	14.65
ME (Kcal/Kg)	2133	2133	2121	2117

Nagge mix® dairy cattle: High potency vitamins and Trace minerals premix for dairy cattle at recommended rate of 2.5kg/ ton of feed contains= Vitamins A 6250000IU, D3 875000IU, E 6250mg, K3 625mg, B1 625mg, B2 625mg, Niacin 25000mg, B6 625mg, Choline chloride 12500mg, Calcium 172500, Cobalt 75mg, Copper 7600mg, Iodine 107mg, Iron 23750, Zinc 396000, Magnesium 375000mg, Mn 63000mg, Phosphorus 135000mg, Selenium 80mg, Antioxidants 3750mg

Results

Chemical composition of diets fed in experiment

Chemical composition and ME content of Gamba (*Andropogon gayana*), groundnut haulms and concentrate diets containing

graded levels of groundnut haulms are shown in Table 3. The results showed that gamba hay and groundnut haulms used in the study had crude protein contents of 2.63 and 14.41 and NDF contents of 83.64 and 53.78% respectively. Organic matter and

NFE tended to decrease with increase in the levels of GH in the concentrate diets. Crude fibre ADF and NDF contents increased as levels of GH in the diets were increased with the highest values recorded at 75%

level of GH. Crude protein values were similar across treatments averaging between 14.5 and 14.7%. The metabolizable energy content expressed in Kcal/kg of diets decreased with increase in GH level from 0-75%.

Table 2: Chemical composition of concentrate diets, gamba hay groundnut haulms on % DM basis

Nutrients	Levels of Groundnut haulms in concentrate diets (%)					
	0	25	50	75	GB hay	GH
OM	78.51	84.53	79.82	75.49	89.93	72.88
CP	14.65	14.48	14.63	14.45	2.63	14.41
ASH	7.28	9.28	11.16	16.82	4.30	12.28
EE	11.89	10.10	6.70	11.78	9.49	8.73
CF	18.99	18.81	21.63	19.24	50.04	48.66
NFE	47.19	47.42	45.88	37.71	34.92	16.51
NDF	41.48	45.58	47.09	48.01	83.64	53.78
ADF	30.11	29.8	30.58	33.02	61.61	47.09
ME(kcal/Kg)	3166	3022	2695	2619	2095	1825

GB Hay= Gamba hay; GH=Groundnut haulms; ME= Metabolizable energy

Nutrient digestibility and Nitrogen balance

Digestibility and nitrogen balance results are shown in Table 3. The digestibility of DM, OM and CP was significantly higher ($P<0.05$) in bulls fed concentrate diets containing GH as compared to the control or the bulls fed concentrate diet without GH. The DM digestibility was higher ($P<0.05$) in bulls fed 75% than those fed 25 and 50% levels of GH in the diet. The digestibility of OM and CP was highest in 75 and 50% levels of GH in concentrate diets. The CF digestibility was highest in diet with 25% GH followed by diets with 0, 50 and 75% levels of GH inclusion. Ether extract digestibility was higher ($P<0.05$) in treatment with 75% level of GH as compared to the other treatments. The digestibility of NFE was statistically comparable among the different treatment groups. The NDF digestibility was higher ($P<0.05$) in diet with 75% groundnut haulms, followed by diets with 25, 50 and

75% GH. The ADF digestibility was higher ($P<0.05$) in treatments with 25, 50 and 75% GH as compared to treatment with 0% GH in concentrate diet.

There was a significant difference ($P<0.05$) in nitrogen intake across treatments, with animal fed the control diet (0% groundnut haulm) having the highest Nitrogen intake, while those fed the groundnut haulm diets having slightly different but not significantly different Nitrogen intake. Faecal N declined, though not significant ($P>0.05$) with increase in the levels of groundnut haulms in the diet. Slightly higher urinary nitrogen were recorded in animals fed 0 and 75% groundnut haulm diets, than in those fed 25 and 50% diets, however, the differences were not statistically significant ($P>0.05$). Nitrogen balance had higher values recorded in animals fed 0 and 75% compared to 50 and 25% levels of groundnut haulm inclusion. However, the difference was not significantly different ($P>0.05$).

Table 3 : Digestibility of nutrients and Nitrogen balance in young bulls influenced by levels of groundnut haulm inclusion

Parameters	Levels of Groundnut haulms in concentrate diets (%)					
	0	25	50	75	SEM	LOS
Nutrient Digestibility (%)						
Dry Matter	44.83 ^c	50.04 ^b	49.51 ^b	54.05 ^a	1.65	*
Organic Matter	61.08 ^c	72.77 ^b	75.07 ^a	76.97 ^a	1.93	*
Crude Protein	60.55 ^c	64.90 ^b	66.94 ^{ab}	70.64 ^a	1.89	*
Crude Fibre	51.16 ^b	55.93 ^a	50.97 ^b	46.14 ^c	0.29	*
Ether Extract	63.14 ^b	61.17 ^b	59.09 ^b	75.75 ^a	3.92	*
Nitrogen Free Extract	65.20	66.75	64.08	61.88	2.72	ns
Neutral Detergent Fibre	54.15 ^b	57.35 ^{ab}	54.55 ^b	59.47 ^a	2.07	*
Acid Detergent Fibre	53.00 ^b	63.23 ^a	60.62 ^a	60.16 ^a	1.91	*
Nitrogen balance (g/d)						
Nitrogen Intake	84.90 ^a	74.36 ^{ab}	64.46 ^b	76.32 ^{ab}	0.19	*
Faecal N ₂	27.16	27.02	23.16	22.66	3.49	ns
Urinary N ₂	5.23	3.86	4.97	5.49	2.09	ns
N ₂ Balance	52.51	43.49	36.33	48.17	9.72	ns
N ₂ Balance (%)	61.84	58.49	56.36	63.12	6.78	ns

Means within the same row bearing different superscripts differ significantly. LOS=Level of significance * =P<0.05; ns = No Significance.

Discussion

Chemical composition

The 2.63% CP of Gamba in this study is comparable to 2.8% reported by Zemmeling (1974) and 1.5-3.5% by Hagggar (1970) when Gamba was cut between October and February. The CP content of GH is higher than reported range of 7.4 to 8.8 % (Ahmed and Pollot 1977) or 8.6-9.1% (Etela and Dung, 2004). It was however comparable to the values of 14.7% Murthy *et al.* (2004) and 12.8 % Asaolu *et al.* (2010). The low total ash content of gamba (4.3%) when compared with groundnut haulms (12.28%) agrees with Lufadeju *et al.* (1992) that poor quality roughages have low ash content. However, the Metabolizable energy (ME) and Nitrogen free extract (NFE) values of gamba (2095kcal/kg and 34.92) as against groundnut haulms (1825 kcal/kg and 16.51%) respectively showed that gamba has more prospects of generating energy than groundnut haulms with proper management. The progressive reduction of

ME content of diets as level of groundnut haulms increases from 0-75% is probably because of the relatively lower level of Metabolizable energy in groundnut haulms. Conversely, the continuous increased in ash content of diet with increase in groundnut haulms level of diets suggest that the high content of ash in groundnut haulms is responsible.

The crude protein content of the concentrate diets ranged from 14.45 and 14.65% indicating that the diets were isonitrogenous. The mean CP concentrations in the four concentrate diets were all higher than the minimum of 8% necessary to provide the minimum ammonia levels required by rumen microorganisms to support optimum activity (Norton, 2003). The Crude fibre (CF) value of 48.66% obtained in this study for groundnut haulms was higher than the values of 39.5 % reported by (Ahmed and Pollot, 1977). The observed variations in groundnut haulms nutrient composition in this study could have been due to non-

uniformity in their harvesting and collection methods from one source to another since the groundnut haulms used in this study, was purchased from the opened market. Leng (1990) classified groundnut hay on the basis of quality to be location-dependent.

The higher digestibilities of DM, OM, CP, EE, NDF, ADF and ash at 75% groundnut haulm inclusion compared to those at 0% groundnut haulms can be attributed to lower feed intake. Higher intake often results to a faster rate of passage of ingested food from the reticulo-rumen (Swan and Lamming, 1967). This could have reduced the efficiency of degradation thus, lowering the digestibility of feed. Nouala *et al.* (2006) reported increased *in vitro* digestibility on the proportion of *Moringa oleifera* when the supplement increased. Although, type and level of diet included determined digestibility. The authors noted a higher digestibility with *Moringa oleifera* as a sole supplement compared to concentrate as sole supplement at whatever level of supplement.

Fondevilla *et al.* (2002) reported negative effects of feeding diets high in carbohydrates, as they modify the environmental conditions of the rumen towards an unfavourable condition for the fibrolytic micro organisms. However, supplementation with leguminous leaves invariably alleviate nitrogen deficiency and other mineral deficiencies, and increase the intensity of rumen microbial activity thus, increasing the digestibility (Hove *et al.* 2001). The high digestibility of DM and OM in this study is an indication of the possible boost to digestibility of the gamba hay, since supplemental forage in a straw-based diet have been shown to improve the digestibility of basal diet even at relatively small levels of supplementation (Cheng *et al.*, 1990). This was probably because of the

rate and extent of colonization of fibre and the biomass of adherent organisms, since fibres are rapidly colonized by free-floating pool of bacteria in the rumen (Kreb *et al.*, 1989). Groundnut haulms incorporation as high digestible forage in an otherwise low digestible gamba hay could have brought to bear a large effect on digestibility by providing a highly colonized fibre source to seed bacteria to the less digestible gamba fibre. In addition to this, the ability of groundnut haulms to contribute fermentable energy to the rumen in form of available cellulose and hemicelluloses possibly stimulated fibre digestion. Although, Manyuchi *et al.* (1994) reported that groundnut hay did not alter the *in sacco* degradation of poor quality grass hays, it is possible that the number of available sites for microbial attachment was altered thus, changing the degradation of the basal diet as a result of increased microbial activities and this could have resulted to the non significant difference in the NFE digestibility.

Murthy *et al.* (2004) reported that digestibility of nutrients was not significantly affected by inclusion of varying levels of groundnut haulms as roughage source in the ration for growing GIR calves. Hadjipanayiotou (1988) reported that GH significantly increased apparent digestion coefficients of DM 60%, OM 65%, CP 63% and gross energy 65%. Although nitrogen (N_2) intake were significantly different across treatments, positive nitrogen balance was recorded in all the bulls fed groundnut haulms diet. The lack of significant difference in nitrogen retention across treatment indicated that the nitrogen obtained from groundnut haulms inclusion in concentrate diet was adequate for the amount of energy available from its fermentation. The values of N_2 - balance g/d were however, higher than 12.5g/d and 21.4

g/d recorded by Pham *et al.* (2007) for cattle and buffaloes fed cottonseed and *Sesbania* on paragrass basal diet, or ammoniated wheat straw based complete diets (Sureskhumar *et al.*, 2000). Nitrogen balance obtained in this study was within the normal range of 52.8-64.6% reported by Prakash *et al.* (2003).

Conclusions

The study suggested ground nut haulms could supply enough rumen nitrogen for microbial activities as supplement to Gamba hay diet for growing crossed heifers. Inclusion of groundnut haulms in concentrate diets up to 75% could influence dry matter, organic matter, Neutral detergent fibre and Acid detergent fibre digestibility.

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