Chemical compositions, feed intakes and digestibilities of crop -residue based rations in non-lactating Red Sokoto goats in the sub -humid zone of Nigeria

Bunmi Sherifat MALAU-ADULI[1], Lawrence EDUVIE[2], Clarence LAKPINI[2] and Aduli Enoch Othniel MALAU-ADULI[2]*

1. Department of Animal Science, Ahmadu Bello University, PMB 1044 Zaria, Nigeria.

National Animal Production Research Institute, Ahmadu Bello University, PMB 1096 Zaria, Nigeria.

*Present address of corresponding author: Laboratory of Animal Breeding an d Reproduction, National Agricultural Research Centre for Western Region,

60 Yoshinaga, Kawai, Oda, Shimane 694 -0013, Japan.

E-mail: aduli40@yahoo.co.uk, aduli@ affrc.go.jp

Tel: +81-90-6837-1953, +81-854-82-1285

Fax: +81-854-82-2280

RUNNING TITLE: CROP-RESIDUES IN RED SOKOTO GOAT FEEDING

Abstract

This study was conducted to evaluate the chemical composition, intake and digestibility of crop-residue based rations by Red Sokoto goats maintained on natural pastures and Digitaria smutsii hay during the dry season of the year. Twenty eight non-lactating does were blocked for weight and assigned to 7 treatment groups comprising of 4 does each in a completely randomized design. Ration A the conventional concentrate ration, was used as the positive control, Rations B and C were the two crop residue based test rations, while Ration D the unsupplemented treatment, was used as the negative control. Each of the supplementation rations was fed at 1 and 2% of the doe's body weight. Ration A had the highest crude protein percentage of 17.19% while Rations B and C had 9.54 and 10.38% respectively. The naturally grazed pastures and Digitaria smutsii hay (Ration D) contained the least protein: 2.76 and 4.75% respectively. Ration D also had the highest percentages of acid detergent fibre, neutral detergent fibre and lignin (49.14, 74.73 and 9.49% in hay and 50.29, 8.27 and 11.5% in grazed pastures, respectively). Ration A on the other hand, had the least percentages of acid detergent fibre (20.00%), neutral detergent fibre (40.01%) and lignin (4.64%). The results indicated that the supplemented group of does had significantly higher (P<0.05) dry matter and crude protein intakes as well as nutrient digestibilities than the unsupplemented groups. A comparison of the unsupplemented animals with all the other treatment groups revealed that dry matter digestibility improved by a range of 4.1 to 27.9%, while crude protein digestibility improved by 17.1 to 42.2%, the highest value being in does on Ration A. It was concluded that goats were able to subsist and make appreciable gains in the long dry season on crop-based diets that compared favourably with the conventional concentrate rations. Of the two tested crop-residue based rations, Ration C is a better supplementation package than Ration B.

Key words: Red Sokoto goats, crop residue, feed intake, digestibility, dry season

Introduction

The Northern regions of Nigeria are concentrated with most of the nation's ruminant livestock. However, these areas are characterised by a long and pronounced dry season (6-9 months), and this often causes serious shortage of feed for the ruminants. The problem of dry season livestock feeding in particular, has directed research efforts towards harnessing and enhancing the utilization of abundant arable by-products and crop residues. The abundance of crop residues makes them cheap sources of nutrients for ruminants. Nevertheless, they are generally low in nutrients (Nicholson 1984). Various strategies have been adopted in improving their nutrients and utilisation. One of such is by judicious supplementation to provide the most limiting nutrients (Preston 1982; Alhassan 1988). Balancing the nutrients that provide the major building blocks for tissue synthesis and milk production should be the primary concern of the nutritionist (Leng 1990). This can be achieved by careful blending of the crop residues to meet the nutrient requirements of the ruminants.

Supplementation using residues such as maize offal (Fadugba 1990), groundnut haulms and shells (Adu & Lakpini 1983; Ikhatua & Adu 1984; Alawa & Umunna 1993) and cowpea vines and husks (Alhassan et al. 1984) have been documented. From these studies, the inclusion of supplements in small ruminant rations has often resulted in increased feed intake as a compensation for the reduced energy concentration of such diets. However, appropriate packages to guide small ruminant producers have not been developed. Also, relevant information on cheap, alternative sources has not been passed on to the producers. Therefore, this study was undertaken to determine the nutrient composition and digestibilities of some locally available and affordable crop residue feed resources in comparison with the conventional supplementation in Red Sokoto goats in the sub-humid zone of Nigeria.

Materials and methods

Location and management of experimental animals

The experiments were conducted in the Experimental Unit of the Small Ruminant Research Programme of the National Animal Production Research Institute, Shika, Zaria, Nigeria. Shika falls between latitudes 11 and 12°N and between longitudes 7 and 8°E, with an altitude of 640m above sea level. Shika is located within the Northern Guinea Savannah Zone with an average annual rainfall and temperature of 1,107 mm and 24.4 °C respectively. The seasonal distribution of the annual rainfall is approximately 0.1% (11.0 mm) in the late-dry season (January-March), 25.8% (285.6 mm) in the early-wet season (April-June), 69.6% (770.4 mm) in the late-wet season (July-September) and 4.5 % (49.8 mm) in the early dry season (October-December). The experiments were conducted during the dry seasons (between October and March). The animals were routinely dewormed with anthelmintic drugs and dipped in an acaricide (Asuntol) solution against ecto parasites. The animals were housed in well-ventilated pens during the night.

Digestibility trial: Twenty eight adult Red Sokoto does ranging between 24.6 and 26.4 kg were used for this experiment. The animals were balanced for weight and blocked into seven groups with four animals per group. The component ingredients in the different rations are shown in Table 1. Each doe was individually offered its appropriate corresponding ration to evaluate the digestibility of the diets. The study comprised a two-week preliminary period of realimentation and adjustment, and one week of sample collection. The animals were housed in individual metabolism cages with facilities for separate collection of faeces and urine. The animals were weighed at the beginning and end of the study. Feces were collected each morning just before feeding. 10% of each daily faecal output was collected for chemical analyses. Samples of the different rations fed were taken daily and bulked, from which sub-samples were taken for laboratory analysis. Also, samples of the individual feed ingredients were analysed in the laboratory. Water was made available to the animals *ad libitum*. The inventory, abundance and palatability of the plant species in the grazed paddock was conducted as described by Lakpini et al. (1997).

Laboratory analyses: Proximate analyses of feed and faecal samples were carried out by the AOAC (1980) methods. Dry matter of samples was determined in an oven at 105 °C for 48 hours. Nitrogen determination was by the Micro Kjedahl method, while the Soxhlet extraction procedure was used for ether extraction. Crude fibre was determined by alternate refluxing with weak solutions of H_2SO_4 and KOH. The detergent fibre fractions (Neutral detergent fibre, acid detergent fibre and lignin) were determined according to Goering and Van Soest (1970).

Dry matter intake (DMI) was determined using the following equation:

DMI (g/day) = %DM/100 x feed intake.

Dry matter digestibility (DMD (%)) was calculated as:

100 x [DM intake (g) – DM output (g)] /DM intake (g)].

The other digestibilities were calculated as above.

Statistical analysis: Differences in intake and digestibility were analysed using the Generalised Linear Models Procedure (PROC GLM) of SAS (1987) in a one-way analysis of variance. The effect of treatment was tested and significant differences between treatment means established by Duncan's Multiple Range Test.

Results

The chemical composition of the individual feed ingredients and the experimental diets are shown in Tables 2 and 3 respectively. Table 3 shows that all the rations had high dry matter (DM) contents with a mean value of about 95%. Ration A had the highest crude protein (CP) value of 17.19% followed by Rations B and C with 9.54 and 10.38%, respectively. The CP value of the grazed pastures (dry season) was the lowest (2.76%), while that of Digitaria hay was 4.75%. The least ash content value was obtained in Ration D with the hay having 8.47% and the grazed pasture having 7.02%. The highest ash content value of 13.85% was obtained in Ration A. Ration A also had the highest ether extract (EE) value of 14.08% and Ration D, the least (0.78 and 2.40% for grazed pasture and Digitaria hay, respectively). Acid detergent fibre (ADF), neutral detergent fibre (NDF) and lignin contents were least in Ration A with values of 20.00%, 40.01% and 4.64% respectively. Ration D on the other hand, contained the highest ADF, NDF and lignin values of 49.14%, 74.73% and 9.49% for hay and 50.29, 80.27 and 11.5% for grazed pasture respectively. The calculated chemical analysis of the experimental rations (Table 3) reveals that Ration A had a CP content of 17.05% while the test rations B and C had 9.82 and 10.85%, respectively. Ration A also had a metabolisable energy (ME) of 11.17 MJ/kg DM, while Rations B and C had 10.29 and 10.17 MJ/kg DM respectively. Table 4 shows the DM and CP intakes and digestibilities of the nutrients. The Table shows that generally, the supplemented groups had significantly higher ($P<0.05$) DM and CP intakes and digestibilities than the unsupplemented group except animals on Ration B that had similar values to the unsupplemented group. It was also evident that increasing the level of supplementation also resulted in increased DM and CP intakes of all the experimental rations, with these increases being significant ($P<0.05$) and similar for Rations A and C. It was also observed that supplementation increased the digestibility of all the nutrients. However, animals on Ration B recorded very poor digestibility values and their counterparts in the unsupplemented group had the least. Even though the digestibility of nutrients decreased with increasing levels of supplementation, these decreases were not significant ($P>0.05$). Ration 1A (the conventional concentrate at 1% of body weight) gave the highest digestibility values. A comparison of the unsupplemented animals with all the other treatment groups reveals that DM digestibility improved by a range of 4.1 to 27.9% and CP digestibility by 17.1 to 42.2%, the highest being in animals on Ration A at 1% level. Similar improvements trends were also noticeable for neutral detergent fibre (NDF) and acid detergent fibre (ADF). A simple economic analysis (Table 4) revealed that the conventional concentrate feed was the most expensive for supplementation particularly, at the 2% level (4.42 naira per animal per day). Of the two tested crop -residue rations, Ration 1B was significantly cheaper ($P<0.05$) than Rations 2B and 2C, but similar to Ration 1C.

Discussion

The quantity and type of ingredients used in f ormulating the rations influenced their chemical compositions. In Ration A, the inclusion of wheat offal and cottonseed cake boosted the protein level of the ration giving it a value of 17.19%. This value is higher than the recommended CP level of 15% for optimum maintenance of production by Nuru (1985) and 8.9 – 16.0% by NRC (1975). The metabolisable energy (ME) value of Ration A (11.17 MJ/kg DM) is also higher than the 9.5 MJ/kg DM recommended for maintenance by INRA (1988), but lower than the latter's recommended value for pregnant and lactating 65 -kg Saanen goats yielding 4 Kg of milk per day. Rations B and C had similar CP and ME values indicating that they are isocaloric and isonitrogenous rations. The preponderance of crop residues in Rations B and C was responsible for their high crude fibre and lignin levels. The current study showed that inspite of Rations B and C being isocaloric and isonitrogenous, animals on Ration C had better intakes and digestibilities than those on Ration B, possibly due to t he low palatability, hence low voluntary intake, and poor digestibility of Ration B.

The observed higher digestibilities of DM, CP, NDF and ADF at 1% level in comparison to 2% level can be attributed to the higher feed intake at the 2% level of inclusion . It has been established that higher feed intake results in a faster rate of passage of digesta from the reticulo-rumen (Swan & Lamming 1967). This does not allow for effective degradation, hence lowering the digestibility of feed. Increasing the level of crop residue inclusion in the diet also increases the amount of lignin, which depresses the digestibility of the ration (McDonald et al. 1988), because the rate of microbial colonisation of a feed with high fibre content is comparatively lower (Silva & Orskov 1988). The poor intake and digestibility values obtained for the unsupplemented animals is due to the fact that Ration D had crude protein levels that are below the recommended minimum values for maintenance. This shows that there is the need for dry season supplementation in goats because the available feeds at that time are limiting in crude protein. It should also be clearly stated at this point that because of cumulative effects derived from residuals, there was a difference in chemical composition between Tables 2 and 3. It was obvious that these amounts of residuals were dependent on feeding level and feed quality, for instance, it was possible to obtain differences between Rations 1B and 2B as clearly demonstrated in Table 4 where DMI significantly differed between Rations 1B (0.21 kg/day) and 2B (0.30 kg/day).

Of the two tested rations, Ration C seemed to have produced better intakes and digestibilities in the animals, possibly due to the composition of the rations. It contained maize offal which has very low fibre content (Alawa & Umunna 1993), groundnut haulms which have been demonstrated to be better quality roughages than Digitaria smutsii hay and contain adequate protein to maintain ruminants without any form of supplementation during the periods of feed scarcity (Ikhatua & Adu 1984). The groundnut shells fed to the animals were also crushed before inclusion into the ration as suggested by Alawa and Umunna (1993). This must have aided their consumption and digestibility. Even though Ration B contained groundnut haulms, the combination of Guinea corn bran and cowpea husk which had low crude protein percentages, must have reduced the intake and digestibility of the ration. Alhassan et al. (1984) observed lower digestibility values in sheep and goats (48.8 and 56.3% respectively) compared with cattle (73.6%) when they fed them cowpea vines. This might imply that cattle do better on cowpea residues than small ruminants. From the economic analysis, the high cost of the conventional concentrate ration shows that it is beyond the reach of a typical smallholder goat farmer, whereas the crop-residue based rations seem quite affordable. Even though Ration B had the least cost, it was glaring that it had lower intake and digestibility compared to Ration C, indicating in essence, that Ration C had a better efficiency of utilisation

In conclusion, goats are able to subsist and make appreciable gains even in the long dry seasons of the sub-humid zone of Nigeria on crop-residue based diets that compare favourably with conventional concentrate rations. Ration C is a better package than Ration B and is therefore recommended and at 1% level of inclusion, to small ruminant farmers due to its high intake and digestibility as well as its affordability than at 2% leve l of inclusion.

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Table 1 Component ingredients in the different rations

Ration	Ingredients	% inclusion	Remarks
1A + Basal diet	Maize Wheat offal Cottonseed cake Bone meal Salt	40 35 20 3 2	Positive control (conventional concentrate) offered at 1% of body weight
2A + Basal diet	✔	✔	Positive control (conventional concentrate) offered at 2% of body weight
1B + Basal diet	Guinea-corn bran Cowpea husk G/Nut haulms Salt	39.5 30 30 0.5	Test Ration 1 offered at 1% of body weight
2B + Basal diet	✔	✔	Test Ration 1 offered at 2% of body weight
1C + Basal diet	Maize offal G/Nut shells G/Nut haulms Salt	49.5 20 30 0.5	Test Ration 2 offered at 1% of body weight
2C + Basal diet	✔	✔	Test Ration 2 offered at 2% of body weight
D (Basal Diet)	Digitaria hay and natural grazed pasture	Ad libitum	Negative control (unsupplemented)

Table 2 Chemical composition of the major feed ingredients (DM basis) (%)

Feedstuff	DM	CP	CF	Ash	EE	NFE
Maize	90.73	9.56	2.20	9.67	4.05	74.52
Wheat offal	87.60	16.90	11.30	6.40	3.80	61.60
Cottonseed cake	93.60	29.94	23.50	5.16	5.76	35.64
Bone meal	75.00	36.00	3.00	49.00	4.00	8.00
Guinea corn bran	93.33	7.60	24.80	6.95	3.01	59.90
Cowpea husks	91.41	7.10	33.40	7.14	0.65	58.91
Groundnut haulms	93.65	15.63	23.26	8.00	2.43	51.00
Maize offal	89.07	10.08	1.50	0.80	1.70	60.30
Groundnut shells	96.05	5.90	31.8	8.50	1.31	50.30

Table 3 Chemical composition of the experimental diets (dry matter basis) (%)

Ration	DM	CP	Ash	EE	ADF	NDF	LIGNIN
Ration A	93.87	17.19	13.85	14.08	20.00	40.01	4.64
Ration B	94.97	9.54	10.55	10.43	38.10	68.42	8.94
Ration C	95.94	10.38	11.97	12.45	36.65	54.74	8.23
Ration D Hay	94.78	4.75	8.47	2.40	49.14	74.73	9.49
Ration D Natural pastures	96.26	2.76	7.02	0.78	50.29	80.27	11.5

Calculated analysis of the experimental r ations

	Ration A	Ration B	Ration C
CP (%)	17.05	9.82	10.85
ME (MJ /kg DM)	11.17	10.29	10.17

The ME values of the experimental rations were calculated as per Alderman (1985) as follows:

$$ME\ (MJ/kg\ DM) = 11.78 + 0.00654CP + (0.000665EE)^2 - CF(0.00414EE) - 0.0118A$$

where CP = Crude Protein, EE = Ether Extract, CF = Crude Fibre, A = Ash

Table 4 Mean nutrient intake, apparent digestibility coefficients and cost of the experimental diets

Ration	1A	2A	1B	2B	1C	2C	D	SEM
Nutrient intake (kg/day)								
DMI	0.24^{b}	0.47^{a}	0.21^{bc}	0.30^{ab}	0.23^{b}	0.42^{a}	0.15^{c}	± 0.02
CPI	0.044^{a}	0.087^{a}	0.012^{b}	0.017^{b}	0.032^{a}	0.072^{a}	0.009^{b}	± 0.01
Apparent digestibility of nutrients (%)								
DM	84.3^{a}	83.0^{a}	62.5^{d}	60.5^{e}	75.8^{b}	67.8^{c}	56.4^{f}	± 2.84
CP	90.6^{a}	89.2^{a}	69.5^{d}	65.5^{e}	82.7^{b}	78.1^{c}	48.4^{f}	± 3.07
NDF	69.5^{a}	66.6^{b}	$62.1c^{d}$	61.9^{d}	65.9^{b}	63.7^{c}	60.1^{e}	± 3.23
ADF	51.7^{a}	49.8^{a}	43.9^{bc}	42.8^{c}	46.1^{b}	44.4^{bc}	42.3^{bc}	± 5.01
Economic analysis of the feeds (Naira)*								
Cost of feed consumed per animal per day	2.19^{b}	4.42^{a}	0.50^{e}	1.06^{d}	$0.83d^{e}$	1.55^{c}	-	± 0.15

a,b,c,d,e,f means within the same row bearing different superscript letters differ significantly ($P<0.05$)
Naira = Nigerian currency (100 kobo make 1 naira and current exchange rate is 1US$ = 140 Naira)