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Nutrient Digestibility and Nitrogen Retention in Yankasa Rams Fed Different Ratios of Groundnut Haulms and Concentrate in a Total Mixed Ration

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Abstract

This study evaluated the chemical composition, nutrient digestibility, and nitrogen retention in growing rams fed diets formulated with varying levels of groundnut haulms. Four treatment diets were designed, with groundnut haulms progressively replaced by concentrate-based formulations. The crude protein (CP) content of the diets ranged from 9.03% to 13.50%, meeting the maintenance requirements for ruminants. Crude fibre (CF) content decreased with increasing concentrate inclusion, while ether extract (EE) levels varied between 2.35 % and 5.2 %. Nutrient digestibility showed improved CP digestibility (33.74 - 43.73%) across treatments, with the highest fibre digestibility recorded in T2 (84.68 %). Ash digestibility increased steadily across treatments. Nitrogen intake was highest in T3 (1.84 g/day), with nitrogen retention significantly ($P<0.05$) influenced by diet, peaking in T2 (0.41 g/day). Nitrogen was more excreted in faeces than urine. The study concludes that partial replacement of groundnut haulms with concentrate-based diets can enhance nutrient utilization and nitrogen retention in growing rams, with T2 offering optimal performance.

Keywords: Nutrient digestibility, Nitrogen retention, Groundnut haulms, Alternative feed resources, Growing rams.

Introduction

Sheep population in Nigeria which is estimated to be 33.9 million, make sheep the second most important livestock species in the country (FAO, 2008). In Nigeria, sheep are kept primarily for meat production. This class of animal requires adequate nutrients for growth and productivity. This therefore helps in meeting the protein requirement of the citizenry. The use of conventional feedstuff such as maize, soybean cake, fish meal and others as supplement to low quality feed may not be cost effective in present day Nigeria to intensify production, owing to their high cost, irregular supply (Akinmutimi, 2004) and the competition both with humans and monogastric animals. It is in this respect that non-conventional energy and protein materials of farm and agro-industrial wastes origin are presently being utilized for livestock production in Nigeria (Ndubueze *et al*., 2006). Such feed resources are cheap, have high nutritive value, non-toxic, readily available, have low or no demand by both human and other livestock species and without industrial usage

(Ndubueze *et al*., 2006). The problem of dry season feeding of livestock in particular, has directed research efforts towards harnessing and enhancing the utilization of abundant arable by-products and crop residues. Recently, attention has been paid on vegetable and fruit processing residues, whey and culinary wastes. Cabbage waste (CW) and sweet potato peels (SPP) are waste generated, used by livestock but with limited information with regards to their utilization. The potential value of by-products in animal feeding depends on their nutritive characteristics. This study is therefore designed to analyse the chemical compositions, nutrient digestibility and nitrogen retention in rams fed concentrate with varying ratios of groundnut haulms.

Materials and Methods

Experimental Site

The experiment was carried out at the Livestock Teaching and Research Farm, Department of Animal Science, Faculty of Agriculture, University of Maiduguri, Borno State, Nigeria. Maiduguri is situated at latitude 11.015°N, longitude 30.05°E, and an altitude of 354 meters above sea level. The region lies within the semi-arid zone of West Africa, known for its brief rainy season and prolonged dry periods (Raji *et al*., 2014).

Experimental Animals and Design

Sixteen (16) Yankasa rams of about 10 months old with an average initial weight of 22.19kg were randomly divided into four treatment groups in a Completely Randomized Design (CRD). The rams 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 rams were dewormed with Albendazole® at the rate of 20 ml/10 kg body weight, and Long Acting Tetracycline (antibiotics) against bacterial infection before the commencement of the growth trial. They were treated against ecto and endoparasites before the commencement of the trial.

Experimental Diet and Feeding

Groundnut haulms, sweet potato peels and cabbage waste were bought from the kasuwan shanu market in Maiduguri. The sweet potato peels and cabbage waste were properly sundried for a period of seven days on a concrete floor and grounded and used in formulating the concentrate diet. The concentrate diet was formulated using 50% sweet potato peels, 30% cabbage waste, 17% cottonseed cake, 2% bone meal and 1% salt in order to get 14% CP and 10 MJ of energy. The concentrate mixture is given in graded levels of 0, 20, 40 and 60% in combination with a basal diet of Groundnut Haulms. Control group were fed 0% experimental diet + 100% groundnut haulms, T1 were fed 20% experimental diet + 80% groundnut haulms, T2 were fed 40% experimental diet + 60% groundnut haulms and T3 were fed 60% experimental diet + 40% groundnut haulms. During the feeding trial, the rams were fed at the level of 4% of their body weight in dry matter daily. Each diet was fed during a 10 day adaptation period followed by a 7 day measurement, period of faeces and urine collection. Leftover feed was weighed and recorded daily before the morning feeding.

Sample Collection

Samples of the experimental feed and that of feaces 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 (2002**)** and cell wall constituents (Van Soest *et al*., 1991). Daily urine output from each ram was collected in a plastic container (sample bottles) containing 100ml 0.1N H_2SO_4 placed under the metabolism crates. Daily, 10% of the urine was collected from each ram 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 was subjected to analysis of variance (ANOVA) using the statistical package for the social science SPSS 20.0, and means was separated using Duncan Multiple Range Test Method (Steel and Torrie, 1980)**.** The model used is as shown below:

$Y_{ij} = \mu + T_i + e_{ij}$

Where Y_{ij} = the observed response from the j^{th} replicate under the i^{th} treatment

μ = overall mean

Ti = effect of the i^{th} treatment

e = random error associated with each observation

Results and Discussion

Table 1. Chemical composition and energy content of groundnut haulms to concentrate diet mixture ratios in a total mixed rations

Parameter	Control	T1	T2	T3	SEM
DM	84.2^{b}	86.40^{ab}	88.60^{a}	89.91^{a}	0.793*
OM	75.7	76.80	77.89	78.09	0.530^{NS}
CP	9.03^{c}	11.90^{b}	12.70^{b}	13.50^{a}	0.555*
CF	29.7^{a}	27.41^{ab}	25.12^{bc}	22.82^{c}	0.891*
EE	5.2^{a}	4.9^{ab}	3.63^{ab}	2.35^{b}	0.621*
ASH	8.5	9.61	10.71	11.82	0.581^{NS}
NDF	45.3	46.93	45.43	43.92	0.549^{NS}
ADF	35.8^{a}	34.43^{a}	32.34^{ab}	30.25^{b}	0.775*
NFE	47.57^{b}	46.18^{ab}	47.84^{a}	49.51^{a}	0.693*
HEM	49.7^{a}	12.50^{b}	13.09^{b}	13.67^{b}	4.802*
ME (MJ/kg)	10.24	10.38	10.31	10.24	0.446^{NS}

Key: DM= dry matter, OM= organic matter, CP= crude protein, CF= crude fibre, EE= ether extract, NDF= neutral detergent fiber, ADF= acid detergent fibre, NFE= nitrogen free extract HEM= ME= metabolizable energy.SEM = standard error of means, a, b, c,…. means in the same column bearing different superscripts are significantly ($p<0.05$), * = significant ($p<0.05$), NS = not significant.

Table 2: Nutrient digestibility (%) and Nitrogen retention in rams fed experimental diet

Parameters	Control	T1	T2	T3	SEM
CP	36.26^{c}	33.74^{c}	40.28^{b}	43.74^{a}	1.211*
EE	78.26^{a}	62.10^{b}	62.30^{b}	43.90^{c}	3.688*
CF	78.11^{bc}	84.68^{a}	80.17^{b}	77.30^{c}	0.933*
ASH	47.06^{c}	83.34^{b}	85.81^{a}	87.98^{a}	5.091*
ADF	57.94^{b}	61.48^{a}	56.79^{b}	53.20^{c}	0.952*
NDF	31.47^{ab}	32.49^{a}	29.12^{b}	26.39^{c}	0.781*
Nitrogen Retention					
Nitrogen Intake	1.46	1.58	1.71	1.84	0.086^{NS}
Feacal Nitrogen	0.82	0.89	0.86	0.88	0.075^{NS}
Urinary Nitrogen	0.61	0.53	0.45	0.58	0.077^{NS}
Total Nitrogen Loss	1.43	1.42	1.31	1.46	0.077^{NS}
Nitrogen Balance	0.03^{b}	0.16^{b}	0.41^{a}	0.38^{a}	0.054*
% of N Intake Retained	1.92^{c}	10.38^{b}	23.34^{a}	20.91^{a}	2.683*

Key: T1= Treatment one, T2= Treatment two, T3= Treatment three, SEM = standard error of means, a, b, c, d…. means in the same row bearing different superscripts are significantly different ($p<0.05$), * = significant ($p<0.05$), NS = not significant ($p>0.05$).

Chemical Composition of the Experimental Diet

The chemical composition of the experimental diet is presented in Table 1. Crude protein (CP) content of the diet (9.03 to 13.50%) tends to increase as the level of the concentrate increases and is above the minimum requirement of a ruminant animal for maintenance as reported by NRC (2007). The CP content of T2 and T3 is comparable to the value of 12.8 % reported by Asaolu *et al*. (2010). The crude fibre (CF) 29.70, 27.41, 25.12 and 22.82 for control, T1, T2 and T3 respectively decreases as the level of groundnut haulms decreases. The CF values obtained in this study was higher than the values (19.20 to 21.30) obtained by Kwaido *et al*., (2020). The ether extract (EE) level ranged from 5.2% to 2.35%. The higher EE in the diets indicates fats content which could give rise to a high concentration of volatile fatty acids (VFAs). However higher levels of EE may depress fiber digestion.

Nutrient Digestibility of Rams Influenced by Levels of Groundnut Haulms Inclusion

The results of the nutrient digestibility of rams fed with the formulated ration is shown in Table 2. The crude protein (CP) content ranged from 33.74 to 43.73 %. Crude fibre digestibility is highest in T2 (84.68 %) while T3 had the lowest (77.30 %). Nastis and Liacos (1992) reported lower crude fibre digestibility of 48.62 % in sheep. Ash digestibility in the treatments were 47.06, 83.34, 85.81 and 87.98 % for control, T1, T2 and T3, respectively which increases across the treatments. Nutrient digestibility in ruminants have been reported by Okoruwa *et al*. (2014) as the direct method for estimating feed digestion by ruminants, hence studies on nutrient digestibility of ruminant feeds are very important as they allow for the estimation of nutrient actually available for ruminant animals.

Nitrogen Retention in Rams Influenced by levels of Groundnut Haulms Inclusion

Table 2 showed the results of the nitrogen balance in rams fed experimental diet. Nitrogen intake (g/day) values of 1.58, 1.71, 1.84 and 1.48 % were obtained for T1, T2, T3 and control, respectively. The intake for T3 was the highest (1.84%) as compared with control which recorded the lowest (1.48%). However,

nitrogen intake among the treatment groups did not differ ($p > 0.05$) significantly. The increase in nitrogen intake is associated with the increase of the urea production in the liver and consequently, of it secretion in urine, while a decreased nitrogen intake leads to a reduction in the excretion of urea in urine for maintenance of the pool of urea in the plasma, which is under homoeostatic physiological control (Vansoest, 1994). Nitrogen excretion in faeces was higher than in urine. Nitrogen balance and retention were reported by Tripathi and Karim (2010) to be proportion of nitrogen utilized by ruminants from the total nitrogen intake for body process. Thus, the more the nitrogen consumed and digested the more the nitrogen retained and vice versa. However, nitrogen balance was significantly ($P<0.05$) affected by the dietary diets with sheep in treatment T2(0.41g/day) and T3(0.38g/day) are higher than those fed on treatments T1(0.16g/day) and control (0.03g/day). Nitrogen absorbed almost followed the same trend as observed in nitrogen balance.

Conclusion

The results of this study revealed that replacing groundnut haulms with graded levels of concentrate-based formulations significantly improved the nutrient digestibility and nitrogen retention in growing rams. Higher levels of concentrate increased crude protein content and reduced crude fibre, which positively influenced feed digestibility, particularly for crude fibre and ash. Nitrogen balance was significantly higher in rams fed T2 and T3 diets, suggesting better utilization of dietary nitrogen. Overall, the diet in T2 (40% concentrate to 60% groundnut haulms) proved most effective in enhancing nutrient availability and nitrogen retention. These findings support the potential of formulating cost-effective grower diets using alternative feed resources for improved performance in small ruminants during the dry season in semi-arid environment of Borno State.

Recommendation

The following recommendations were observed in this research:

i. It is recommended that groundnut haulms be partially replaced with concentrate-based diets, particularly at the level used in Treatment 2 (40% concentrate to 60% groundnut haulms) to improve nutrient utilization and nitrogen retention in growing rams.

ii. Further studies should investigate the long-term effects of these dietary treatments on growth rate, feed conversion efficiency, and carcass characteristics in larger flocks.

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