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# Comparative Study on Intake, Digestibility and Nitrogen Balance of Cowpea, Groundnut and Soybean Hays in a Mixed Diet Fed Red Sokoto Bucks

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**Target Audience:** Animal nutritionists, livestock farmers and Nomadic Fulani

## Abstract

*Four Red Sokoto bucks of average weight 15±2kg were fed different legumes hay in a mixed diet to evaluate their feed intake, digestibility and nitrogen balance. Using 4×4 Latin Square arrangement. The four test diets contained Maize offal, Rice husk, Salt, Bone meal and Cotton seed cake.while,20% of Soybean, groundnut and cowpea hay were included in the test diets designated T2,T3 and T4 respectively. The animals were used for digestibility and nitrogen balance studies were transferred to individual metabolism crate, for separate collection of urine and faeces. Measurements were taken for period of five consecutive days. Total faecal and urine samples collected over five days were bulked and subsampled. Urine output for 24 hours was collected with plastic buckets containing 0.1N $H_2SO_4$ acid placed under metabolic crates.. Ten percent (10%) of daily urine output were taken from each buck. The result of the nutrient intake showed that the bucks fed 20% Cowpea hay had the highest (P<0.05) DM, CP, Ash, and NFE intake. The results of nutrient digestibility and the nitrogen balance values were statistically (P<0.05) higher in the bucks fed 0% followed by 20% Cowpea hay inclusion. The result indicated that the apparent digestibility of organic matter was significantly high (P<0.05) in animals fed 0% followed by 20% Cowpea hay inclusions. The least nitrogen loss was obtained in the bucks fed 20% cowpea hay .Nitrogen retained as per cent of nitrogen intake values were statistically (P<0.05) different across the treatments. The Nitrogen retained as per cent of nitrogen intake values ranged from 66.17% for bucks fed 20% soybean hay to 76.75% for 20% cowpea hay inclusions. Nitrogen retention was positive for all treatments and significantly (P<0.05) high in the bucks fed 20% cowpea hay inclusion. It was concluded that feed intake, nutrient digestibility and nitrogen utilization of goat can be enhanced by feeding 20% of cowpea hay in the mixed diet without adverse effect.*

**Keywords:** Soybeans, Cowpea, Groundnut, hay, mixed diet

**Description of Problem**

Cost of supplementary feeding and non-availability of forage during the dry season greatly challenged efficient livestock feeding and management in Nigeria. Based on the need for adequate feeding, it is believed that about 85% of cost of livestock production is feeding, and given the poverty status of most livestock farmers and poor marketing system of farm animals, hardly could they take up supplementary feeding. This accounted for preference of extensive and semi-intensive systems of management(1).

Forage on the other hand, hardly becomes available during the dry season for consumption of the ruminant; and coupled with the declining grazing land as a result of the ever increasing land cultivation for arable crop production, alternative feed sources for the animals becomes essential. Utilization of fodder from crop residues compensates for non-availability of grasses during the off-season. (1)

The intake of these roughages by ruminants is usually too low to maintain body weight, especially during the dry season, due to their tough texture, poor digestibility and nutrient deficiency (2). The poor nutritive quality of the roughages leads to slow rates of ruminal degradation, a high rumen load, low rumen fractional outflow rates, poor growth in young stock, loss of body weight and consequent sub-optimal productive and reproductive performance (3).

Other alternative to mitigate the effect of dry season feeding was the establishment of fodder bank whereby legumes are established and properly managed in a concentrated unit. The fodder production for supplementary feeding is the only long term means for feeding the livestock. (4) Stated that the immediate intervention suitable for livestock feed production for agro pastoralist is dual-purpose legume fodder.

Forage legumes supply nutrients, especially nitrogen, that is highly degradable and digestible (5), thus providing sufficient quantities of rumen degradable nitrogen, peptides and amino acids to meet rumen microbial N requirements. This results in an increase in dry matter intake, fermentation of the roughage, fractional outflow rates and microbial protein supply from low quality roughages (6). Soybean cowpea and groundnut are one of the herbaceous legumes that can be incorporated within the smallholder farming sector to improve ruminant animal production during the dry season.

***Justification***

The inclusion of the legume hays, which have higher levels of available nutrients, could have provided additional nutrients for microbial growth, especially fermentable N. This could have been accompanied by an increase in the attachment of rumen microbes to dietary fibre, thus increasing fibre digestion (7) through the action of surface-bound cellulase and hemicellulase enzymes secreted by rumen bacteria and fungi. The overall effect would be an increase in apparent digestibility

Groundnut haulms have widely used in animal feeding with good responses. Their high nutritive values have been reported by (8). The fodder could be fed fresh, as silage or as hay. The hay form is the most commonly used in areas of feed

shortage in the tropics. Its high crude protein content which varies from 11.4-16.7% in some cultivars (9) helps immensely in augmenting protein deficiencies in cereal residue based diets

The main by-product from cowpea is the remnants of cowpea harvest; include cowpea vines, leaves and husk. Sheep and cattle consumed in excess of 1.2% of their body weights of cowpea vines with DM digestibility of 48.8 and 78%, respectively. Although it is likely that animal consuming in excess of 2.0% of their body weight of these residues, notably cowpea leaves and shells may have maintained or even increased their weights (10)

In an earlier study by (11) residues of groundnut and bean *Phaseolus vulgaris were* evaluated as feed for indigenous Malawian goats. Nutrient in bean haulm were better digested and utilised by goats than those in groundnut haulms. The goats however, met their requirements of dry matter intake and digestible crude protein when adequate amounts of both roughages were made available

Legume hays sometimes contained less CP than anticipated based on concentrations of CP in the standing plants (12) primarily because of leaf shatters during harvest and chopping, indicating that harvest management practices that minimize such losses are critical for preserving the quality of the hays. Nevertheless, supplementation with all legume hays, increased DM and OM intake. The reticulate venation of legume leaves confers less resistance to ruminal degradation than the parallel venation of grass leaves. Consequently, legumes are degraded more easily and rapidly by ruminal microbes than grass leaves. In addition, lesser structural carbohydrate concentrations in legumes contribute to the faster degradation and passage rates of legumes (13). Collectively, these factors increase feed intake due to the decreased rumen fill resulting from faster degradation and passage rates (14).

Relative differences in DMI and digestibility among legume hay-supplemented diets reflect partly the structural fiber concentrations and morphological characteristics of the legumes. some had less crude fibre than the other legume hays; consequently, they were more digestible. While some had greater concentrations because of its thick, woody stems, which probably decreased intake and digestibility. (15; 16; 17)

However, there is a paucity of information on the extent to which these can be utilized by ruminants. Therefore, the objective of this study was to investigate the effects of supplementing poor quality feed with different legume hays on feed intake, apparent digestibility, nitrogen metabolism, in Red Sokoto bucks

## Materials and Methods

### *Experimental Site and Source of Experimental materials*

. The experiment was conducted at the Department of Animal Science Teaching and Research Farm. Ahmadu Bello University Zaria. The farm is located at an elevation of 676m, latitude $11.1623^0$ North and longitude $007.6353^0$ East (18). Chemical analysis was carried out at Biochemical Laboratory of the Department of Animal Science, A.B.U., Zaria.

Soybean, Cowpea and groundnut hays were obtained from the farmers fields, sundried milled and packed in sack and stored prior to feeding. Maize cob was purchased from Samaru market; the maize cobs were milled, packed and stored for a week prior to feeding. Other feed ingredients which include cotton seed cake, maize offal, bone meal and common salt were purchased from Labar Agriculture Enterprise, Zaria.

***Management of the Experimental Animals***

Four (4) Red Sokoto bucks of average weight 15.00 $\pm$2 Kg were used for the experiment. The animals were purchased from an open market (Yanawaki. Zaria). Each of the buck was given prophylactic treatment of Ivomectin (Ivomec®) at 0.5ml/25kg body weight subcutaneously against parasites, oxytetracycline (Tridox®) antibiotics at 1.0ml/10kg body weight intramuscularly against bacterial infections one week before the start of the experiment. Other routine management practices include; deworming against intestinal parasites using Albendazole® 10% solution which was administered in drinking water. Rhodiacides solution was sprayed on the animals using knapsack sprayer against external parasites. The animals were confined to individual metabolic crates.

***Experimental Feed and Design***

The diets consisted of legumes hay, cotton seed cake, maize cobs and bone meal. Legume hays were included at the levels of 0%, 20% soybean hay, 20% cowpea hay and 20% groundnut hay. Digestibility and nitrogen balance studies were carried out in a 4x4 Latin Square arrangement with 4 periods each has ten days adjustment period, and five days for collection samples. The animals were weighed and housed individually in clean disinfected metabolism cages, to facilitate collection of faeces and urine with free access to feed and clean water supplied *adlibitum*.

***Experimental Procedure and Parameters taken***

The diets were offered to the animals daily at 0800h. 3.5 % of their body weight. Water was offered *ad libitum* and changed every morning. Animals were allowed 14 days to adjust to the new environment. Measurements were taken for a period of five consecutive days. Orts were weighed and recorded daily before the morning feeding at 0800h.

**Total fecal output** was collected daily in the morning, weighed and mixed thoroughly. The total fecal sample collected over the 5 days collection were bulked and sub-sampled. About 20% formaldehyde was added to the fecal sub-sampled to prevent further bacterial activity and the fecal samples was stored at - $4^0$C.

A total urine output for 24 hours was collected. Plastic containers containing 10mls 0.1N $H_2SO_4$, were placed under the metabolism crates. Ten percent (10%) of daily urine output were taken from each buck and stored in a refrigerator for the period of the digestibility trial. At the end of the 5 days collection period, 10% of the urine sample was taken from each of the buck, sub-sampled for analysis.

***Laboratory Analyses***

Feed samples were oven-dried at $70^0$C for 48 hours , milled through a 2.5mm

sieve and Stored in air tights bottles, prior to proximate analysis. Dry matter content of the dried feed samples and feace were determined by drying at $60^0$C for 48 hours. Nitrogen content of the feed samples, faeces and urine were determined using Kjeldahl Procedure (19). The samples were ashed by charring in Muffle Furnace at $500^0$C for about 3 hours. Ether extract and Crude fibre of the samples were analyzed according to (18) procedure. While the calculated metabolizable energy was determined using the formula as described by (20) (: ME (kcal/kg) = 37×% Cp+81.1×%EE+35.5×% NFE.

***Statistical Analysis***

All data collected on the feed intake, nutrient digestibility and nitrogen balance were calculated and subjected to statistical Analysis of Variance ANOVA using (21) Duncan Multiple Range Test (22) was used to compare the treatment means using General Linear Model (GLM).

The model used was;

$$\mathbf{Yijk = u + Ai + Bj + eijk}$$

Where:

Yijk = dependent variable

U = overall mean

Ai = effect of periods

Bj = effect of bucks

$E_{ijk}$ = effect of random error

**Results and Discussion**

Table 1 indicates the result of proximate analysis of the legumes hay. The dry matter was ranged from 89.81in groundnut hay to 93.48% in cowpea hay. The highest dry matter and crude protein were obtained in cowpea hay. The least nitrogen free extract and highest crude fibre were recorded in Soybean hay; this was probably due to the fibrous nature of the soybean.

The likely differences noticed in the chemical composition of the *legume hays* in this trial concurred with the reports of several authors on different forage legumes,(22) and (1) reported that environmental differences, site of sampling and/or proportion of foliage materials sampled, variety and soil influenced the chemical composition and digestibility of forages.

**Table 1: Proximate analysis of legume hay**

| Parameters (%) | Soybeans Hay | Cowpea Hay | Groundnut Hay |
|---|---|---|---|
| Dry matter | 93.45 | 93.48 | 89.81 |
| Crude protein | 8.04 | 12.06 | 8.51 |
| Crude fibre | 42.28 | 32.79 | 26.89 |
| Ether extract | 0.49 | 0.78 | 1.63 |
| Ash | 6.36 | 4.17 | 7.63 |
| N free extract | 43.35 | 50.20 | 55.34 |
| ME(Kcal/kg) | 1835.572 | 2267.024 | 2385.104 |

The legume *hays* in the present study had CP contents above 8%, a minimum requirement for ruminants. According to (24), feed containing less than 8% CP cannot provide the minimum ammonia levels required by rumen micro organisms to support optimum activity. Thus, legume hays are beneficial and therefore can be used for supplementing the low protein pastures and crop residues especially during the dry season

**Table 2: Chemical composition of experimental diet**

| | Levels of legume hays inclusion | | | |
|---|---|---|---|---|
| Parameters (%) | 0% | 20%SBH | 20%CH | 20%GH |
| Dry matter | 93.87 | 94.58 | 94.22 | 93.89 |
| Organic matter | 85.44 | 87.19 | 86.21 | 86.61 |
| Crude protein | 14.69 | 14.43 | 14.13 | 14.63 |
| Crude fibre | 13.87 | 16.39 | 16.08 | 16.11 |
| Eather extract | 5.56 | 4.78 | 4.12 | 4.21 |
| Ash | 8.43 | 7.39 | 8.01 | 7.28 |
| Nitrogen free extract | 42.45 | 57,01 | 57,67 | 57.66 |

SBH=Soybean hay, CH= Cowpea hay and GH= Groundnut hay

The chemical compositions of the experimental diets are presented in Table 2. The dry matter (DM) content of the diets ranged from 93.87% to 94.58%. The experimental diets are isonitrogenous diets since their CP contents were all around 14%. Results on proximate composition showed that crude protein content (14.13-14.69%) of the experimental diet were within the values of 13-15% CP requirements for goat stated by (25)

Table 3 indicates the result of feed intake. The inclusion of different legume hays showed significant ($P<0.05$) differences in feed intake. The highest Dry Matter intake recorded in the bucks fed diet contains 20% groundnut hay may be as a result of the inclusion of groundnut haulm in the diet. The increased DMI of the bucks fed diet containing 20% groundnut hay could be an indication of increased palatability of groundnut haulm to the red Sokoto buck. This observation is in conformity with earlier works reported by (26) who reported that groundnut haulms supplementation improved palatability.

**Table 3: Nutrients intake of Red Sokoto bucks fed different legume hays in a mixed diet**

| | Level of legume hays inclusion | | | | |
|---|---|---|---|---|---|
| Parameters(g/d) | 0% | 20%SBH | 20% CH | 20%GH | SEM |
| Dry Matter | $340.75^{d}$ | $388.72^{b}$ | $364.67^{c}$ | $397.15^{a}$ | 1.25* |
| Organic Matter | $310.14^{c}$ | $333.72^{b}$ | $360.68^{a}$ | $344.4b^{a}$ | 1.15* |
| Crude Protein | $70.46^{a}$ | $55.22^{c}$ | $59.95^{a}$ | $58.18^{b}$ | 1.15* |
| Crude Fibre | $50.93^{d}$ | $62.72^{c}$ | $65.91^{a}$ | $64.07^{b}$ | 0.25* |
| Ether Extract | $20.41^{a}$ | $18.29^{b}$ | $17.42^{c}$ | $16.47^{d}$ | 0.05* |
| Ash | $30.59^{b}$ | $28.28^{c}$ | $33.17^{a}$ | $29.91^{b}$ | 0.11* |
| N Free Extract | $154.09^{d}$ | $218.20^{c}$ | $243.94^{a}$ | $229.27^{b}$ | 0.82* |

$^{a\,b\,c;}$ Means within row with different superscripts were significantly different ($P< 0.05$), SEM= Standard Error of means, * significant ,SBH = Soybean hay, CH = Cowpea hay and GH= Groundnut hay

The result of nutrients intake by the bucks fed different legume hays is presented in table 3. The result showed statistical differences across the treatments. The highest Organic matter (360.68 %), crude fibre (65.91%) and nitrogen free extract intakes (243.94) were obtained in bucks fed 20% Cowpea hay of inclusion and were statistically differed ($P<0.05$) . Bucks fed 20% soybean hay had the lowest of almost all nutrients intake. It is noteworthy that the improvement of nutrient intake due to inclusion of Cowpea Hay may be related to the increase of the CP content of the diets and likely less anti-nutritive factors. This apparent effect of dietary Crude Protein agreed with earlier report of (27). (28) However, stated that in some case the used of legume supplement at between 10-20% had increased animal performance without significant increase in intake.

Calculated nutrient digestibility coefficient is presented in table 4. The dry matter digestibility was significantly ($P<0.05$) different across the dietary treatments, Crude fibre digestibility was statistically ($P<0.05$) higher in bucks fed 20% inclusion level of cowpea hay, followed by 20%, groundnut haulm level of inclusion. The significant ($p<0.05$) increase in the apparent digestibility of Dry matter, Organic matter, Crude Protein Ether extract and NFE, as a result of cowpea haulm supplementation is in agreement with the findings of (29). This can be attributed to an increasing level of the Crude protein that was ingested. It agrees with the previous study on the effect of increasing dietary Crude protein level on Nitrogen or Crude protein digestibility (30) .Thus, the inclusion of cowpea hay had significant ($P<0.05$) effect on apparent digestibility of CP and other nutrients. Perhaps, due to less fibre and anti nutritive factors content, such as tannins. The low apparent nutrients digestibility in the bucks fed 20% soybean hay and 20% groundnut hay measured in this experiment was as a result of the high CF content and tannins which are associated with their ability to bind proteins, structural carbohydrate polymers and minerals with an overall effect of lowering the bioavailability of the nutrients at specific sites in the gastro-intestinal tract. Similar results have been reported elsewhere in ***A auriculate*** (23). Relative differences in digestibility among legume hay-supplemented diets reflect partly the structural fibre concentrations and morphological characteristics of the legumes hay. Some had less Crude fibre than the other legume hays; consequently, they were more digestible. While some had greater concentrations because of its thick, woody stems, as it was observed in 20% Soya bean inclusion, which probably decreased its intake and digestibility. As in other studies (16; 17)

**Table 4: Nutrient Digestibility by Red Sokoto buck fed different legume hays in a mixed diet**

| Parameters (%) | Level of legume hays inclusion | | | | SEM |
|---|---|---|---|---|---|
| | 0% | 20%SBH | 20%CH | 20%GH | |
| Dry Matter | 70.46[a] | 57.09[b] | 48.59[b] | 59.41[b] | 1.24* |
| Organic matter | 50.38[c] | 66.15[a] | 58.22[b] | 48.15[b] | 1.33* |
| Crude Protein | 85.56[a] | 69.65[c] | 78.80[b] | 77.30[b] | 0.78* |
| Crude Fibre | 78.48[b] | 70.91[c] | 84.10[a] | 83.28[c] | 1.32* |
| Ether Extract | 92.38[b] | 93.79[b] | 93.85[a] | 90.40[c] | 0.26* |
| N Free Extract | 50.98[c] | 51.46[a] | 51.51[a] | 46.43[b] | 1.34* |

[a b c;] Means within row with different superscripts were significantly different (P<0.05), SEM= Standard Error of means , * = significant ,SBH = Soybean hay, CH = Cowpea hay and GH= Groundnut hay

The result of Nitrogen balance study is presented in table 5 .There was a significant difference (p<0.05) in the urinary nitrogen in animal fed diet 0% (1.88g) being the highest and 20% cowpea hay had the lowest value (1.16g). The significant (p<0.05) high urinary N observed in 0% compared to 20% Cowpea hay can be explained by the fact that excess ruminal ammonia is absorbed and excreted in the urine in the form of urea (31)

The significant high N absorbed (47.56d) N balance (46.39d) and Nretained as percent of intale (76.75%) obtained bucks fed diet containing 20% cowpea hay and statistically (p<0.05) higher compared to the group of bucks on the diet 20% Soya bean hay and groundnut hay. This is as a result of better digestibility of nutrients. It is in agreement with the report of (23) that N utilization depends on good digestibility of nutrients and /or utilization. In some cases this effect is sufficient to maintain an adequate N balance. The observed constituent increases in nitrogen retention with increasing crude protein intake support earlier report by (26).

**Table 5. Nitrogen retention by Red Sokoto bucks fed different legume hays in a mixed diet**

| Parameters | Level of legume hays Inclusion | | | | SEM |
|---|---|---|---|---|---|
| | 0% | 20%SBH | 20%CH | 20%GH | |
| N intake g/d | 70.96[a] | 55.22[c] | 59.95[b] | 58.18[b] | 0.25* |
| N losses in faeces g/d | 15.54[a] | 16.34[a] | 12.39[c] | 13.63[b] | 0.44* |
| N losses in urine g/d | 1.88[a] | 1.75[b] | 1.16[d] | 1.22[c] | 0.04* |
| Total N losses g/d | 17.46[b] | 18.09[a] | 13.56[d] | 14.86[c] | 0.4* |
| N balance | 53.40[a] | 37.13[d] | 46.39[b] | 43.32[c] | 0.45* |
| N absorbed g/d | 55.42[a] | 38.88[d] | 47.56[b] | 44.56[c] | 0.48* |
| N R as % of intake g/d | 75.59[a] | 66.39[d] | 76.75[a] | 74.10[c] | 0.74* |

[a b c;] Means within row with different superscripts are significantly different (P<0.05), SEM= Standard Errorof mean , * = significant, SBH = Soybean hay, CH = Cowpea hay and GH= Groundnut hay

**Conclusion and Application**

This study revealed that:

1. Inclusion of 20 % cowpea hay in a mixed diet could successfully improve the performance of Red Sokoto bucks.
2. At this level feed intake crude, protein digestibility and nitrogen retention values observed were better than those of other diets.
3. It was therefore concluded that 20% cowpea inclusion in a mixed diet for Red Sokoto bucks can increase organic matter intake, crude fibre digestibility and high nitrogen retained

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