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ECONOMIC AND NUTRITIONAL EFFECTS OF FEEDING GROUNDNUT HAULMS WITH GRADED DRIED BREWERS' GRAIN ON RED *SOKOTO* BUCKS

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ABSTRACT
This experiment was conducted at the Adamawa State University Livestock Teaching and Research Farm, Mubi, Nigeria, to investigate the economic and nutritional effects of digestibility and haematological parameters of Red Sokoto bucks fed groundnut haulms with graded levels of brewers' grains. Bucks were blocked according to live weight into four treatment groups in a Randomised Block Designed (RBD) with four levels of concentrate at 0g, 150g, 200g and 250g which constituted the treatments designated T_1, T_2, T_3 and T_4, respectively. Treatment one had zero supplementation and served as a control. The results revealed that feed intake of 498.8g, 558.1g, and 607.4g for treatments 2, 3, and 4, and live weight gain of 43.9g, 45.0g and 46.9g for treatments 2, 3 and 4, respectively, were significantly higher ($p<0.05$) in the supplemental group than those of controlled group. Based on the results of this study, concentrate supplement is necessary to improve the performance of goats during the dry season. Further, the findings showed that dried brewers' grain at those levels had not caused any haemolysis, or its effect might have been antogonised by cholesterol present in the animal, and had no detrimental effects to animals' health and well-being and therefore, could be used to supplement bucks feeding. Based on these findings, it is recommended that dried brewers' grain can be included in the diet of goats as a cheap protein supplement during the dry season to the level of about 150-200grams without any side effects.

Keywords: Brewers grains, Nigeria, nutrients digestibility, Red Sokoto bucks.

INTRODUCTION

The essence of livestock industry in the livelihoods of several farming households in the developing economies, and particularly the sub-Saharan Africa cannot be over-emphasised. This is more evident in rural communities where the industry forms integral part of farming by contributing hugely in the process of crop production in subsistence agriculture. REYNOLDS ET AL. (2015) particularly highlighted the aspect of this industry in largely assisting in significantly providing food security for the impoverished population in the rural areas. It also serves as a source of stored wealth in time of need, and more importantly as a symbol of prestige, and providing essential manures for fertilisation of land during crop cultivation.

Assessing this industry from the broader perspective, ALEMNESH ET AL. (2018) and KENEA (2019) documented that Ethiopia benefitted economically from the export of hide and skin, placing the livestock by-products as second most earned foreign exchange to that country next to coffee. In a similar vein, the essence of this by-products was highlighted for the Kenya's economy (WUYUA AND KAGUNYU, 2012). Also, MWINYIHIJA (2014) adequately

articulated the position of this sector and particularly, its byproducts to Tanzanian economy. WANYOIKE ET AL. (2018) also expressed the huge economic gains accruable to Somaliland from this sub-sector due to livestock and its by-products. In Pakistan, AWAN *ET AL*. (2019) summarised the position of leather industry and the livestock sub-sector as impressive to country's developing economy. These studies, among several others, are indications that the livestock sub-sector plays significant function in many nations' economies, and particularly the livelihoods of their populations.

In Nigeria, ALIKWE ET AL. (2011) affirmed that, of the products derived from goats as having multipurpose uses namely, milk, meat, skin and hairs, chevon has been the main reason for goat consumption. Chevon is preferred to several other meats because of its palatability, tenderness and flavour. In fact, most of the inhabitants of southern Nigeria grossly utilised it and found same indispensable during marriages, religious rites and other forms of important festivities. In spite of the growing trend of demand of meat due to the exponential increase in population in the country, OKORUMA ET AL. (2013) noted that feeds pose some challenges in the midst of abundant crop residues and by-products that could simply be utilised as non-conventional feeds. This opinion was further upheld by YASHIM (2017) who reported that livestock feeds have been the major obstacle thwarting improved animal production in Nigeria. And since goat remain the most prolific of the ruminants, and with feeds accounting for about 85.0% of the cost of its production, sourcing for alternative feeds that would be rich in nutrients and low in terms of cost becomes imperative.

Amidst the numerous crop residues and by-products that abound in the country and minimal trials for supplementation as feeds in the industry, this study attempted to assess the nutrient digestibility and haematological parameters of Red *Sokoto* bucks using groundnut haulms with graded dried brewers' grain. It's expected that the findings of this experiment would add to the limited existing literature the alternative cheap source of feeds for goats' production in general.

MATERIALS AND METHOD

Experimental site

The Livestock Teaching and Research Farm (LTRF) of the Adamawa State University, Mubi, Nigeria, was the experimental site. The location of the site is between latitude $10^{0}20^{'N}$ and longitude $13^{0}50^{'}E$ in the northern guinea savanna zone of Adamawa State, Nigeria, and covers an area of 24,000 km^2. The mean annual rainfall of the area ranges from 700mm – 900mm, with peak recorded in the month of August. The average minimum and maximum temperature have been 15 ^{0}C and 35.7 ^{0}C, respectively (ADEBAYO ET AL., 2020). The vegetation of the area can best be described as combretaneous woodland savanna, comprising the grasses, weeds in river valleys and weeds from dry land interspersed by woody plants and shrubs. Collectively, the combination of these weeds and grasses formed near 70.0% of the vegetation.

Materials for the research

The following materials were used for the research:

- Weighing balance;
- Feeders;
- Water throughs;
- Dewormers;

- Syringes and needles;
- Experimental diets;
- Test tubes;
- Anti-coagulants;
- Oxytetracycline long-acting (LA); and
- Experimental animals.

Collection of experimental diets

The dried brewers' grain was obtained from the local brewers within Mubi metropolis, Adamawa State, Nigeria. The sun-dried brewers' grains were sampled for analysis, and then stored in feed bags until incorporated in the test diets. The groundnut haulms were at the early seed-filling stages which were dried under shade to minimise nutrients losses. After drying, the haulms were packed in feed bags and then stored until feeding time

.

Experimental animals and their management

A total of **16** Red *Sokoto* bucks aged 15-16 months with an average weight of 18kg were randomly allotted to **4** dietary treatments, with treatment I serving as the control. On arrival, the animals (4 per pen) were housed in a well-shaded partitioned pens and all medical attention was properly given. These include treatment of endo-parasites and ecto-parasites, and were kept under intensive system of management.

The animals were fed with experimental diets over a period of **8** weeks with a trial period of **1** week. In the experiment, groundnut haulms served as the base diet supplemented with brewers' grain at graded levels of 0gm, 100gm, 150gm and 200gm for treatments 1, 2, 3, and 4, respectively. Treatment I served as control. Water was also taken to all treatment *ad-libitum.* The layout of the experimental design is shown in Table 1.

Experimental designs

Table 1: Layout of the experimental designs

Blocks	T^1	T^2	T^3	T^4
I	T^3 (200g)	T^2 (150g)	T^1 (0g)	T^4 (250g)
II	T^4 (250g)	T^1 (0g)	T^3 (200g)	T^2 (150g)
III	T^3 (200g)	T^4 (250g)	T^1 (0g)	T^2 (150g)
IV	T^1 (0g)	T^2 (150g)	T^4 (250g)	T^3 (200g)

Note: T^1 = Groundnut haulms only (control)
T^2 = Groundnut haulms + 150gms of DBG
T^3 = Groundnut haulms + 200gms of DBG
T^4 = Groundnut haulms + 250gms of DBG

Data collection

Data were collected on the following parameters:

- Feed intake;
- Nutrient's digestibility; and
- Haematological parameters.

Feed intake

- This was determined by the difference between the feed offered and feed left-over.

- Blood parameters that include PCV, RBC, WBS, Hg, Basinophils and Eosinophils were determined in the laboratory.
- Body weights were measured using weighing scale weekly.

Blood parameters

Three (3mls) mls of blood was collected from each animal from the vein following proper restraining by ADSU farm attendant. Blood collected was put into test tube containing ethylene diaminetetra-acetate (EDTA) and was transported to the ADSU animal physiology laboratory for on-ward analysis. Data that were collected include: red blood cells (RBC), white blood cells (WBC), packed cell volume, haemoglobin concentration, blood serum protein, mean corpuscular volume (MCV) and mean corpuscular haemoglobin (MCHb) were determined.

Blood Preparation:

Blood was collected through the jugular vein from all the treatments before the commencement of the experiment. It was also collected after the research for comparison. The blood which was into the labelled test tube containing ethylene diaminetetra-acetic acid (EDTA) was gently shaken to mix the samples, and were transported to the animal physiology laboratory for haematological analysis.

Manual count of WBC and RBC were carried out using haematocytometer. Packed cell volume was measured with standard technique using microhaemacrit capillary tube where samples were centrifuged at 1200G rpm for 10 minutes. Haemoglobin concentration (Hb) was also determined using cynmethohaemoglobin method. Mean corpuscular volume, MCH and MCHC were determined by calculation.

Haemoglobin Concentrations:

Haemoglobin concentrations of the samples were estimated using the acid haematin method. The blood was diluted in a solution of hydrochloric acid (HCL) which converted haemoglobin to haematin. The graduated tube was filled to the unit mark with 0.1 NHCL. About 0.2 mls of blood was added, mixed and allowed standing for 10 minutes. The Acid 0.1 N HCL was added drop by drop, while mixing between each addition until the colour matched the standard.

WBC or Leucocytes Count:

Hemacytometer was used for the determination of leucocytes counts: Blood was drawn to the 0.5 mark on the stem of WBC pipette and diluting fluid to the 11unit mark. This produced a dilution of 1:2. The WBC diluting fluid contained 1% glacial acetic acid which destroyed or lyse the erythrocytes, tinged with gentian violet 0.01% which stained the leucocytes up to half the pipette. The x10 objective and x10 eyes piece microscope was used in counting.

RBC or Erythrocytes Count:

Hematocytometer was also used in determination of erythrocytes count. Blood was drawn to 0.5 mark in RBC pipette, and diluting fluid was drawn and discarded unto the 101 mark in 2 to 3 drops fluid in the stem, which discarded up to the 1 mark by twisting the rubber tube. End of the pipette was applied at the junction of the counting chamber and cover slip so that the diluted blood flowed under the cover slip by capillary attraction. In order to facilitate easy and uniform flows, the pipette was rotated slowly with finger intact and waited for the cell to settle. Then the counting was brought at the centre which was divided into 16 small squares lowered and focused with low power objective lens. Then the RBCs in the 16 square and those lying on the two boarders were counted. The numbers of cells counted in the R squares were summed up and four zeros added to the total.

PCV Determination (Micro-Haematocrits)

Venous blood was mixed by rotating the tube. One end of the capillary tube was applied to the surface of the blood which was raised into the capillary tube by capillary attraction and surface tension. The capillary was filled to $^2/_3$. It was also removed and the end seal was freed of blood by plasticine and the capillary tube was placed into the groove centrifuge with seal end outwards from the centre. The plane cover was fastened and spun for 10 minutes (12000 G) after which the reading was then made for PCV.

Nutrients' digestibility

An animal from each treatment was randomly selected for the digestibility trial. The metabolism cages used were made of metal. The animals were weighed and caged individually and fed their treatment diets for four days adaptation period seven days measurement period. Fresh clean water and mineral salt lick were provided ad-libitum. Nutrient digestibility of the feed was calculated using the formular:

$$\text{Apparent Nutrient Digestibility (AND)} = \frac{\text{Feed consumed} - \text{Faecal output}}{\text{Feed consumed}} \times 100$$

Data analysis

The collected data were subjected to Analysis of Variance (ANOVA) as outlined by Steel and Torrie (1984) in Randomised Completely Block Design (RCBD) and the means were subsequently separated using Least Significant Different (LSD).

However, the profitability of the experiment was determined using the formular:

$$\Pi = Gr - TC$$

Where:

Π = Profit
Gr = Gross Receipts
TC = Total Cost

RESULTS

This section of the study has been segmented into findings and discussion on the proximate composition of experimental diets (% of dry matter), daily feed intake, daily weight gain, digestibility and haematological parameters, of the animals. These are explained in tables 2-4, respectively.

Proximate composition of experimental diets (% DM)

The nutrient composition and tannin concentration of the groundnut haulms and supplement are presented in Table 2. The dry matter (DM) was higher in GH (93.63%) than DBG (92.52%). However, the crude protein content was higher DBG (27.80%) than that of GH (15.60%). The crude fibre of the GH (23.30%) was higher than that of the supplement (15.80%). Similarly, the ether extract (7.40%) and nitrogen free-extract (67.60%) of the GH were higher than that of DBG with 2.30% and 51.20%, respectively. The lignin content of the GH was 10.62%, while the tannin content was 0.41%. On the other hand, in the DBG, the lignin content was 5.40%, while its tannin content was higher than GH (1.40%).

Table 2: Chemical composition of experimental diets (% DM)

Constituents	**Diets (%)**	
	GH	**DBG**
Dry matter	93.65	92.52

Ash	8.00	4.60
Crude protein	15.60	27.80
Crude fibre	23.30	15.80
Ether extract	7.40	2.30
Nitrogen free-extract	67.60	51.20
Lignin	10.62	5.40
Tannin	0.41	1.40

Note: GH = Groundnut haulms, DBG = Dried brewers' grain.

Daily feed intake of the experimental animals

The effect of feeding graded levels of DBG and GH on the performance of Red Sokoto bucks is presented in Table 3.

Table 3: ***Feed intakes, body weight gain and digestibility of bucks on different diets.***

Parameter	**Diets (T^1-T^4)**				
	T^1	**T^2**	**T^3**	**T^4**	SED
FI (g/day)	383.0^c	498.8^b	558.1^a	607.4^a	10.6^{**}
	28.2^b	43.9^a	45.0^a	46.9^a	2.01
DWG (g/day)	60.1^b	71.8^a	75.7^a	77.6^a	1.48
D (%)					

Note: FI = Feed intake, DWG = Daily weight gain, D = Digestibility.
Means bearing different superscript in the same row are significantly different ($p < 0.05$).

The DM intake on treatment diet T^2 (498.8g/day) was significantly higher than treatment diet T^1 (383.0g/day). However, treatment diet T^3 (558.1g/day) recorded a value that was not significantly different from that of treatment diet T^4 (607.4g/day) as DM intake did tend to increase with increased level of supplementation. The finding revealed that there was high significant difference ($p < 0.05$) in daily feed intake measured for eight weeks. High intake was believed to be associated with high protein contents of DBG which also confirmed the observation of Yahaya ET AL. (2001).

The low crude protein and high crude fibre in GH might have also contributed in the reduced intake. Nuwam (2015) had earlier reported that the intake of any leguminous plant depends on the relative contents of crude protein and crude fibre; whereby high intake values are obtained when crude protein is high and low crude fibre. The reduced intake of the bucks for the treatment diet T^1 was probably due to high crude fibre and lignin, which could also reduce palatability just as reported by Umar ET AL. (2020). This study also showed that DM intake was highly influenced by concentrate supplements because treatment diet T^2, T^3 and T^4 which received concentrate supplementation had similar findings.

Daily weight gain of the bucks

The mean daily weight gain (MDWG) of the bucks fed treatment are shown in Table 3. The DWG was high in bucks supplemented with high level DBG in treatment diet T^4 (46.9g/day), followed by those on treatment diets T^3 (45.0g/day) and T^2 (43.9g/day). However, the findings revealed that the control had a value is significantly lower than all the treatment means (28.2g/day).

A significantly ($p < 0.05$) higher live-weight changes were observed among the treatment means. The high daily life-weight gained might be attributed to the high feed intake and apparent digestibility observed in animals fed diet T^4 (607.4 g/d) and 77.6%, respectively. However, the reduced daily live-weight changes seen in animals fed only groundnut haulms might be due to the low digestibility (60.0%) and dry matter intake (383.0 g/d) of the animals fed control diet T^1. This could also be associated with the high content of lignin and tannins present in the basal diet since it was fed sole to the animals. This is in conformity with Ng'ambi ET AL. (2018) report which indicated presence of lignin and tannins in feeds that have propensity of binding protein with indigestible fibre, thereby limiting its availability to goats. As noted by Babale ET AL. (2019b), this indicated that there is negative effect of tannins presence in dried brewers' grain on goats' performance
.

Digestibility of feeds by goats

The effect of dried brewers' grain supplement on the DMD of the goats fed groundnut haulms are shown in Table 3. Those goats that were fed diet D indicated higher DMD of 77.6%. In descending order, the DMD of 75.7% and 72.8% were attained by goats fed diets T^3 and T^2, respectively. However, the lowest value of 60.0% was obtained for control diet T^1.

Going by the means, there was a highly significance difference at $p < 0.05$. The high apparent digestibility observed in diet T^4 might be attributed to high level of dried brewers' grain inclusion and high percentage of crude protein associated with low crude fibre. The Prescence of lignin and high crude fibre in the control diet might have been responsible for the reduced DMD. The report of Olafadehan and Okoye (2017) which documented that there was a remarkably high correlation between digestibility with lignin and fibre contents, but very low values were found with fibrous species. Further, this might be connected to presence tannins in brewers' grain. The findings of this research are also similar to that of Okafor ET AL. (2012) which stated that high level of tannins inhibit digestibility of both crude protein and dry matter.

The recent report of Mayulu ET AL. (2020) revealed a similarity with this work by showing that digestibility of crude protein, dry matter, organic matter, crude fibre, ether extracts and nitrogen free extracts increased significantly ($p < 0.05$) as dietary energy supplementation increased. Another finding of Babale ET AL. (2018) also showed that an increase in dietary protein intake caused depressed digestibility of fibre in African dwarf goats.

Haematological parameters of the bucks

The findings on haematological parameters of the bucks fed diets with graded levels of dried brewers' grain are shown in Table 4. The PVC, MCH, RBC, MCV, MCHC and Hb values revealed no significant effects ($p < 0.05$) in animals in T^2, T^3, and T^4 compared with bucks in T^1. However, a significant difference ($p < 0.05$) was observed with regards to WBC values across the four treatments. The bucks in T^3 showed highest values in comparison to bucks in T^1. With regards to the differential counts, the reticulocytes, monocytes and eosinophils were within normal range for
adult bucks. But there was a significant increase in neutrophils observed from T^1 to T^2. Further, there was a significant increase observed in neutrophils from diet T^1 to T^2, and values T^2 and ^{T3} were seen to be higher than T^1.

Also observed in Table 4, the PCV values obtained for all dietary levels were similar to those reported for healthy bucks as earlier advanced by BABALE ET AL. (2019a), but varied with findings of NG'AMBI ET AL. (2018) which in comparison revealed lower values. The values for PCV, HB, MCHC and MCV were similar for the three levels of diets since the

test diets did not produce any notable effect but marginal increase, it may be suggested that dried brewers' grain at those levels have not caused any haemolysis or its effect might have been antogonised by cholesterol present in the animals, as stated in a similar documentation by SHUA ET AL. (2021). Similarly, leukocytes values obtained in this study agreed with values reported by BALA ET AL. (2021) for normal healthy goats. Since the findings from diet T^2 and T^3 compared well with those of the control diet T^1, it could be inferred that the method of preparation of groundnut haulms must have removed some of its toxic effects in the bucks. This assertion was further strengthened by earlier report of OKAFOR ET AL. (2012) which revealed that sun-curing or heat treatment could be a proper means of treating materials with toxic substances to eliminate toxicity. OZUNG ET AL. (2011) also reported similar results.

Table 4: Haematological parameters of Red Sokoto bucks fed various levels of DBG with GH.

Parameters	T^1	T^2	T^3	T^4
PVC (%)	20.25	25.03	25.74	25.30
RBC ($x10^{12}$/l)	9.35	11.42	12.85	11.25
Hg (g/dl)	6.12	6.28	6.14	6.80
MCH (pg.)	5.41	6.22	6.35	7.09
MCV (FL)	24.65	25.43	22.23	30.88
MCHC (g/dl)	21.66	22.73	24.25	25.02
WBC ($x10^9$/L)	6.39	8.59	11.50	9.07
Reticulocytes(%)	1.09	1.20	0.70	0.20
Monocytes (%)	0.20	0.30	0.40	0.20
Lymphocytes(%)	21.20	56.40	19.50	48.00
Eosinophils (%)	0.30	0.40	0.30	0.50
Neutrophils (%)	40.50	43.70	46.80	48.00
Basophils (%)	0.60	1.00	1.04	1.04

Note: All parameters are as defined in text.

Analysis of profitability of feeding bucks with brewers' grain and groundnut haulms

The analysis of profitability of feeding RSB with brewers' grain and groundnut haulms is shown in Table 5. It could be observed that the TVC of the entire experiment accounted for 79.66% of the TC. The FC which was far negligible recorded only 23.66% of the total cost of the production. Going by these values obtained, it could be seen that the profit for the entire experiment was put at N41100.00. And on the average, a total of N2568.75 only was realised per buck, which was considered profitable. Therefore, it can be stated that feeding supplementation using brewers' grain and groundnut haulms to goats would be cheaper compared to the application of conventional feeds. Similar but lower values of profit margin of between N1590.12 and N1795.60 were reported by BABALE ET AL. (2018) in which West African Dwarf (WAD) goats were fed groundnut haulms and cowpea husk supplemented with brewers' dried grain.

Table 5: Profitability Analysis of Feeding Red Sokoto Bucks (RSB) Dried Brewers' Grain and Groundnut Haulms

Gross receipts (Gr)				
RSB	6500	16	104000	100.00

Variable costs				
G/nut haulms	500	30	15000	23.85
Brewers' bran	600	15	9000	14.31
Water			8100	12.88
Transportation			5000	7.95
Medication			4500	7.15
labour			8500	13.52
TVC			**50100**	**79.66**
Fixed costs				
Watering trough	400 (Dep.)	16 pieces	6400	10.17
Feeding trough	400 (Dep.)	16 pieces	6400	10.17
TFC			**12800**	**23.66**
TC (TFC+TVC)			**62900**	**100.00**
Π = Gr - TC			**41100**	

Note: TVC = Total Variable Cost; TFC= Total Fixed Cost; TC = Total Cost, Π = Profit, Dep. = Depreciation on assets, US$1 = N550.

DISCUSSION

Based on the findings of this study, it can be stated that bucks fed experimented diet with supplement had better performance than those fed control diet only, which was groundnut haulms. This indicated that the supplement had enhanced performance of the bucks by efficiently improving rumen fermentation digestion, thus providing a better balanced of nutrients to the bucks for absorption. Further, the haematological results indicated that dried brewers' grain at those levels had not caused any haemolysis or its effects might have been antogonised by the presence of cholesterol in the animals, and had no detrimental effects to their health and well-being. Therefore, it could be used to supplement bucks' feeding.

Considering these results, it can be recommended that dried brewers' grain could be included in the diet of goats as cheap protein supplement during the dry season to the level of about 150 – 200 grammes without any side effects.

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