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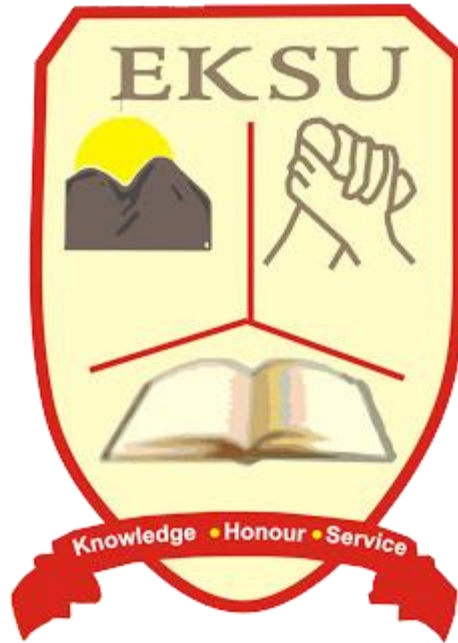
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CONTENTS

MARCH

1. Bitumen Seepage: Impact and Interaction on Heavy Metal Concentrations in Surface Water – Ogunmusa and Adeleke
2. Performance Evaluation of African Catfish (*Clarias gariepinus*) Fingerlings Fed African Locust Bean (*Parkia biglobosa*) Meal Diets – Obe et al
3. Supplemental values of Poultry litter, *Leucaena leucocephala* and Groundnut haulms on growth, nutrient digestibility, and economy of Yankasa rams' fattening
4. Comparative Evaluation of Bird Species Diversity in Different Ecosystems of Akure Forest Reserve, Ondo State – Ogunyemi
5. Boldness-aggression Syndromes in the zebrafish and the guppies – Oriyomo et al
6. Genetic Variability of some Tilapia Species from three different Reservoirs in Southwestern Nigeria - Onyeabor and Bello-Olusoji
7. Germination and Seedling Growth of African Star Apple (*Chrysophyllum albidum* G. Don Syn. *Gambeya albida*) in Soils of Ekiti State – Olayode
8. Comparative Assessment of the Avifauna Species Composition of the Beach Environment in Badagry-West Local Government, Lagos State. – Kolawole
9. Heavy Metals Concentration in African Mud Catfish (*Clarias gariepinus*) and Obscure Snakehead (*Parachanna obscura*) from River Ogbese, Ondo State, Nigeria – Abidemi-Iromini

SEPTEMBER

1. Water Physico-Chemical Parameters Inter-Relationship and Heterotrophic Fungal Count of Ureje Dam in Ekiti State, Nigeria – Akin-Obasola et al
2. Nutritional and Anti-nutritional Composition of *Parkia biglobosa* and *Adansonia digitata* in Guinea Savanna region, Taraba state, Nigeria – Sobola O.O
3. Effects of Quarry Activities on Physical and Chemical Properties of Soils in Ondo State, Nigeria – Olusola et al
4. Climate Change Impacts on Ecosystem Services and Livelihoods of Fringe Forest Communities in Ondo State, Nigeria. – Oyerinde and Adedoyin
5. Heavy Metal contents of Cocoa (*Theobroma cacao* L) Beans and Plantation Soils in Ondo State, Nigeria - Fayinmiinu et al
6. Gender Role in Decision-making among Maize Farmers in Isaga-Orile Community of Ogun State, Nigeria – Fakoya et al.
7. Evaluation of the Nutritional Qualities of Edible Portions of Two Commercially Important Prawns in Southwest Nigeria - Oghini O
8. Poaching and its impact on Wildlife Population in Ise Forest Reserve, Ekiti State. – Orimaye et al.



Supplemental values of Poultry litter, *Leucaena leucocephala* and Groundnut haulms on growth, nutrient digestibility, and economy of Yankasa rams' fattening.

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Abstract

Fattening of sheep by small farm holders in Nigeria entails mainly feeding with crop byproducts. There is a need to evaluate other strategies such as incorporating leguminous crops and poultry wastes. Therefore, experiment to determine the growth performance, nutrient digestibility, and economic analysis of Yankasa rams fed a basal diet of *Panicum maximum* and groundnut haulms hay, with supplemental diets of dried poultry litter and *Leucaena leucocephala* leaf meal-based concentrates designated as T1, T2 and T3 was conducted. The 12 weeks study involved fifteen (15) yearling yankasa rams with initial weights of 16-18.2 kg, randomly assigned in a completely randomized design of three treatments and five replicates. The result showed significant differences ($p < 0.05$) among the means of total weight gain, average daily metabolic weight gain, and feed conversion ratio in T1 when compared to the other two treatments. Animals on T2 and T3 had statistically similar ($p > 0.05$) values in total weight gain ($5.33 \pm 0.2\text{kg}$ and $5.17 \pm 0.2\text{kg}$), average metabolic weight gain ($23.12 \pm 0.2\text{gd}^{-1}$ and $21.17 \pm 0.2\text{gd}^{-1}$) and feed conversion ratio (15.2 ± 0.8 and 15.9 ± 0.1). These values were significantly higher ($p < 0.05$) than the values obtained for animals on T1 ($P < 0.05$). However, total feed intake in all the 3 treatments did not show any significant differences ($p > 0.05$). Animals on the groundnut haulms diet (T1) recorded significantly higher ($p < 0.05$) cost of feed per kilogram weight gain than animals on T2 and T3 diets. Crude protein digestibility and CF in T2 and T3 were similar but significantly higher than the CP digestibility of T1 ($p < 0.05$). Supplementation of sheep diets with groundnut haulms hay or with dried poultry litter and *Leucaena leucocephala* leaf meal-based concentrate enhanced utilization and reduction in the cost of feed by sheep.

Keywords- Growth, Groundnut haulms, Poultry litter, *Leucaena*, Digestibility, Economic analysis.

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Introduction

Sheep production in southwestern Nigeria is centered on the West African Dwarf (WAD) breed. Even though Yankasa as a northern breed is not traditionally managed in this area, its seeming adaptability to the area and its bigger size compared with the traditional WAD, merits its fattening by smallholder farmers in southwestern Nigeria (Fasae *et al.*, 2014)

Apart from supplying meat, sheep are important to the smallholders' livelihood because it forms an integral part of the family unit as an asset and an emergency source of fund to meet financial needs. Sheep are also featured predominantly in the socio-cultural functions like ceremonies and religious feasts. Sheep and especially rams are favorite animals, during Muslim festivals of Id el-Kabir,

because fattened rams command extremely high market prices during the festival. (Alfa *et al.*, 2016) Fattening has been defined as an intensive feeding of highly nutritious feed to promote fast growth and fat deposition to achieve desired carcass growth and quality (Alemu, 2007). The main aim of fattening is to achieve maximum growth and higher carcass in a short period with the intent to increase production per unit of land and the addition of value to the animal. Fattening can be applied to sheep because they can easily adapt to an intensive system of production under feedlots (Pasha, 2006).

Smallholder livestock fatteners/farmers especially in north and central states of Nigeria in an attempt to increase the live weight and quantity of meat in a relatively short time usually feed sheep with crop by-products and household wastes such as millet straw, cowpea hay and groundnut haulms (Ayantunde *et al.*, 2008). Groundnut haulms are one of the cherished crop residues, tradable, and highly-priced in the fodder market because of its superior nutritional benefits than other by-products (Samireddypalle *et al.*, 2017). But the sheep traders and butchers seem to be the only category of people who have better value addition from fattening because they have the resources to buy both sheep and feeds (Babale *et al.*, 2018). This category of people fatten ram for the same reason that other men operate factories, mainly to make a profit by converting raw materials which are of low value in their natural form into a product for which there is a good demand and sell for better prices (Mbanasor, 2000)

Though sheep have a way of converting poor food into desirable products, the current traditional fattening practice by smallholder farmers make sheep offered for sale to have variable size, age, and body condition (Ayantunde *et al.*, 2008). Besides, most of the crops by-products mentioned above are either in short supply or expensive in the southwest because of the cost of transportation (Adegun 2014). Because groundnut is not traditionally cultivated in southwestern Nigeria, so the haulms come at an increased cost in this area due to prohibitive transportation costs from north to southern Nigeria. Different strategies are being designed for smallholder farmers in tropics to overcome feed problems. These include further processing of the highly lignified matured pasture and crop residue, supplementing the basal diet with leguminous plants and agro-industrial by-products, and /or production

of multi-nutrient blocks (Bensalem and Smith, 2008; Adegun 2014; Adegun and Adelabu, 2016). Any strategy that must be adopted by the smallholder farmer needs to consider the cost. The high cost associated with the limited and seasonal supply of concentrates hampers their wide-scale use, especially by smallholder farmers, and as such, any strategy being considered for adoption by the livestock farmers must be relatively cheap while not compromising quality (Bello and Tsado, 2013).

Leguminous (herbaceous or tree) such as *Leucaena leucocephala* are widespread in the humid tropics and are cheap, readily available less competitive protein source for ruminants (Aye and Adegun 2013). By-product feeds such as poultry litter are other options in ruminant feeds. The high content of protein, energy, and minerals in poultry waste indicates its importance as a partial substitute for concentrates (Onimisi and Omege, 2006)).

Poultry litter is an agricultural waste from poultry farms. It is a non-conventional feed resource that can be incorporated into livestock feeds as a means of effective waste management and a low-cost protein source for animals. Studies show that it can be used as a protein supplement for ruminants. Sheep, being the most suitable ruminants for in vivo experiments, have been used in most studies involving the feeding of poultry waste (Onimisi and Omege, 2006; Agbor *et al.*, 2013; Jokthan *et al.*, 2013; Bello and Tsado, 2014). Sheep is an excellent converter not only of roughages but also of NPN sources. Poultry waste is utilized by sheep in the same manner as cattle, and because of their lower plane of nutrition, sheep can also utilize poultry manure of low quality with a higher portion of bedding, normally unsuitable for cattle under intensive feeding management (Tadele, 2015).

Trials on the response of ruminants to browse plants such as *Leucaena leucocephala* as good sources of quality food were conducted in the humid zone of West Africa. Animals' responses to levels, times, and forms of browse plants compared with their utilization as mulch for crop production have been documented (Jabbar *et al.*, 1997). Results also indicate that at any level of supplement, sheep grew twice as fast as goats. The benefits of supplementation came through increased growth, survival, and economic considerations (Longo *et al.*, 2008; Agbor *et al.*, 2013).

Fattening must provide sheep with the ingredients it needs to live and function while meeting up with the

required body weight with minimal cost and maximum profit. This study is undertaken to evaluate the growth, nutrient digestibility, and economic viability of feeding Yankasa rams with supplements containing *Leucaena leucocephala* and dried poultry manure as compared with groundnut haulms in southwestern Nigeria.

Materials and Method

Experimental Site

This study was carried out at the small ruminants' section of the Teaching and Research Farm, Ekiti State University, Ado-Ekiti southwestern Nigeria. Ado-Ekiti lies between latitude 07°37'15" N and longitude 05°13'17" E, average humidity of 72%. It experiences a tropical with temperature ranges of 20°C-28°C and a bimodal rainfall distribution between April and October with peaks in June and September and a break in August. The dry season is between November and March. The average precipitation in this area is 1367mm. The experimental period was between April and July 2018.

Experimental diet

Panicum maximum was harvested in the university premises, wilted overnight, and fed as basal diet. Groundnut haulms were sourced from the ruminant market in Lokoja and fed to the animals on the basal diet. Two concentrate diets were formulated for this experiment. Concentrate 1 and Concentrate 2 varied with the inclusion of *Leucaena leucocephala* and dried poultry manure respectively as shown in Table 1. Poultry manure was collected at the teaching and research farm of Ekiti State University by spreading nylon under the layer's battery cage overnight, sundried for 7 days, and stored in bags. *Leucaena leucocephala* leaves were harvested in the university premises sundried and milled into leaf meal. Other ingredients in the concentrate diets sourced from the local agro-allied shop in Ado Ekiti include maize, rice husk, groundnut cake, brewers' dry grain, growers' premix, and salt.

Experimental animals and design

Twelve (15) healthy yearling yankasa rams weighing 16 to 18.2kg were purchased from the ruminant market in Lokoja, Kogi State, a melting pot state between northern and southern Nigeria. The animals were tagged for easy identification purposes. The pen and equipment used for this experiment were thoroughly washed and disinfected to prevent any

form of infection before the arrival of the animals. The animals were held in the quarantine unit for 30 days for acclimatization. Mandatory and prophylactic medications were given to animals during this period.

The preliminary feeding period lasted for 7 days during which the animals could adjust to the experimental diets before randomly assigning them to their various treatments. The animals were allotted to three (3) treatments with five (5) replicates in a completely randomized design which lasted for 84 days. A basal diet of 3% *Panicum maximum* was fed to the animals. Rams on treatment 1 were given 400g of groundnut haulms (GHH), treatment 2 were rams fed dried poultry manure-based supplements (DPL) while treatment 3 had rams fed *Leucaena leucocephala* based supplement (LLM). The concentrates were also fed at 400g per replicate. Clean and freshwater was given *adlibitum* throughout the experiment.

Data collection

During the twelve weeks of the feeding trial, weights of sheep were taken weekly with a weighing scale. The sheep were fed weighed amount of feed and leftovers were collected and weighed to determine the amount of feed consumed by the sheep. Growth performance indices were taken by calculating the feed intake, weight gain, and feed conversion ratio. At the end of the feeding trial, three rams were selected from each treatment based on the group average weight and weighed into the metabolic units. Each animal was individually confined in a wooden metabolic cage where the animal had free access to feed, freshwater.

The first two weeks (14 days) were used as the adjustment period designed to allow the sheep to adjust to the environment. Thereafter daily feed intake was measured by offering the experimental diets to each animal and the leftover was weighed. Each animal was weighed before the commencement and the end of the digestibility trial. During the last seven days, the total feed refused, faeces and urine were collected and measured.

The total faeces voided were collected and weighed and 10% aliquot samples were taken and oven-dried for 48 hours. Urine samples were frozen while the faecal samples were dried at 65°C to a constant weight, milled using the laboratory hammer mill, to pass through 2mm sieve and stored in airtight polythene bag till required for laboratory analysis.

The milled samples were subjected to proximate analysis for dry matter (DM) crude protein (CP), ether extract (EE), crude fibre (CF), ash, nitrogen-free extract (NFE) as described by AOAC (2005). The milled faeces and aliquots of urine samples were then analyzed for nitrogen. The results obtained were used to determine the apparent digestibility of the diets. The economics of the feeds were calculated by summing up the cost of feeds per weight gain in all the treatments.

Statistical analysis

The data obtained were analyzed using analysis of variance (ANOVA), followed by Duncan's multiple range comparison at a 5% level of significance ($P <$

0.05). The computer software used to analyze is SAS.

Results

The composition of groundnut haulms hay (GHH), dried poultry litter (DPL), and *Leucaena leucocephala* leaf meal (LLM) based supplementary diets are presented in Table 1. The results showed that GHH (treatment 1) used in the study had 12.68% of CP, 1940 Kcal kg⁻¹ metabolizable energy and crude fibre of 22.62%. Treatment 2 (DPL) and treatment 3 (LLM) based concentrate diets had crude protein contents of 13.46 and 13.72%, metabolizable energy values of 2,359, and 2,249 Kcal kg⁻¹ while the CF was 20.10 and 15.46% respectively.

Table 1: Ingredients (%) And Calculated Composition of Diets Formulated

Ingredients	Treatment		
	1 Groundnut haulms	2 Poultry manure	3 <i>Leucaena leucocephala</i>
Maize	--	30	30
Rice Husk	--	10	10
Groundnut cake	--	2	2
BDG	--	20	20
Ground Nut Haulms	100	--	--
<i>Leucaena leucocephala</i>	--	--	36
Dried poultry manure	--	36	--
Growers Premix	--	1.5	1.5
Salt	--	0.5	0.5
Total	100	100	100
Calculated analysis			
Crude protein	12.68	13.46	13.72
Energy (kcal kg ⁻¹)	1940	2359	2249
Crude fiber (%)	22.62	20.10	15.46

Table 2 shows the proximate composition of the test ingredients used in this study. The dry matter ranged from 95.30±2.4% in Pm to 97.20±1.2% in GHH. *Leucaena leucocephala* leaf meal (LLM) recorded the highest CP (21.62 ±2.0%) and EE (7.80±0.6%) while GHH had the lowest value of 12.76±0.8 and 2.62±0.1% respectively. Crude fibre ranged from 12.50±1.4% in LLM to 23.75±1.0% in GHH. Ash Table 3 shows the growth performance of yankasa rams fed groundnut haulms, poultry manure, and *Leucaena leucocephala* based supplements. There were no significant differences ($p > 0.05$) in total feed intake (TFI) and average daily feed intakes (ADFI) in all the treatments. These values were 80.35±2.12kg, 83.93±1.12kg, and 78.51±1.02kg for T1, T2, and

content was increased in DPL (19.20±2.0%) while LLM recorded the lowest value of 10.20±0.4%. Nitrogen free extract were 48.05±2.0, 41.75±3.0 and 47.88±1.6% in GHH, DPL, and LLM, respectively. The metabolizable energy of the test ingredients ranged from 1960. 0±2.0kcal kg⁻¹ in GHH to 2537.6±3.0 kcal kg⁻¹ in LLM.

T3 respectively for TFI. The average daily intake ranged from 934.60±24.0gd⁻¹ to 999.20±32.0gd⁻¹ in T1 and T3. Significant differences ($p < 0.05$) exist among the means of total weight gain (TWG), average daily weight gain (ADWG), average daily metabolic weight gain (ADMWG), and feed conversion ratio (FCR) in all the treatments. Animals

on T2 and T3 had statistically similar ($p>0.05$) values in TWG ($5.33\pm0.2\text{kg}$ and $5.17\pm0.2\text{kg}$), ADMWG ($23.12 \pm 0.2\text{gd}^{-1}$ and $21.17\pm0.2\text{gd}^{-1}$) and FCR (15.2 ± 0.8 and 15.9 ± 0.1). These values were significantly higher ($p<0.05$) than the values obtained for animals on T1 which were $3.96\pm0.2\text{kg}$,

$18.09\pm0.3\text{gd}^{-1}$, and 20.15 ± 2.0 for TWG, ADMWG, and FCR, respectively. The result of ADWG showed significant differences ($p<0.05$) in all the treatments with animals on T2 (Pm) having the highest value of $65.87\pm3.0\text{gd}^{-1}$, followed by T3 ($61.53\pm2.0\text{gd}^{-1}$) while T1 had the lowest ADWG of $47.45\pm4.0\text{gd}^{-1}$.

Table 2: Proximate Composition of Test Ingredients

Parameters (%)	Ingredients		
	Groundnut haulms	Poultry manure	<i>Leucaena leucocephala</i>
Dry matter	97.20 $\pm$ 1.2	95.30 $\pm$ 2.4	95.50 $\pm$ 2.4
Crude protein	12.76 $\pm$ 0.8	15.72 $\pm$ 2.0	21.62 $\pm$ 2.0
Crude fibre	23.75 $\pm$ 1.0	20.52 $\pm$ 2.2	12.50 $\pm$ 1.4
Ether extract	2.62 $\pm$ 0.1	2.80 $\pm$ 0.2	7.80 $\pm$ 0.6
Ash	12.82 $\pm$ 0.6	19.20 $\pm$ 2.0	10.20 $\pm$ 0.4
Nitrogen free extract	48.05 $\pm$ 2.0	41.75 $\pm$ 3.0	47.88 $\pm$ 1.6
Energy kcal kg^{-1}	1960. 0 $\pm$ 2.0	1863.8 $\pm$ 4.0	2537.6 $\pm$ 3.0

Table 3. Growth Performance Of Yankasa And Balami Rams Fed Poultry Manure And *Leucaena leucocephala* Based Supplements

Ingredients	Treatment		
	1	2	3
Total feed intake (g)	80345 $\pm$ 0.0	83933 $\pm$ 112.0	78507 $\pm$ 102.0
Daily feed intake (g)	956 $\pm$ 0.0	999.20 $\pm$ 32.0	934.60 $\pm$ 24.0
Total weight gain (g)	3956 $\pm$ 0.0 ^b	5533 $\pm$ 21.0 ^a	5167 $\pm$ 24.0 ^a
ADWG (g)	47.45 $\pm$ 0.0 ^b	65.87 $\pm$ 3.0 ^a	61.53 $\pm$ 2.0 ^a
ADMWG (g)	18.09 $\pm$ 0.0 ^c	23.12 $\pm$ 2.0 ^a	21.97 $\pm$ 2.0 ^b
Feed conversion ratio	20.15 $\pm$ 0.0 ^a	15.2 $\pm$ 0.8 ^b	15.9 $\pm$ 1.0 ^b

Means with different superscripts a,b,c along the same row are significantly different.

ADWG – Average daily weight gain; ADMWG – Average daily metabolic weight gain

Table 4 depicts the economic analysis of yankasa rams fed groundnut haulms, poultry manure, and *Leucaena leucocephala* based supplements. There were significant differences ($p<0.05$) in the cost of feeds per kilogram, live weight gain, and cost of feed per live weight gain in all the treatments. The cost of feeds per kilogram was statistically similar in T2 ($\text{N}48.60\text{kg}^{-1}$) and T3 ($\text{N}50.80\text{kg}^{-1}$) but higher than that of T1 ($\text{N}43.80\text{kg}^{-1}$). Animals on the groundnut haulms diet (T1) recorded significantly lower ($p<0.05$) live weight gain of 3.96kg and significantly higher ($p<0.05$) cost of feed per kilogram weight gain Table 5 shows the nutrient digestibility of yankasa rams fed groundnut haulms or dried poultry manure and *Leucaena leucocephala* based supplemental diets. There were no significant differences ($p>0.05$) among the DM digestibility in all the treatments. The values were 82.08 ± 3.0 , 76.02 ± 2.0 , and $77.50\pm2.2\%$ in T1, T2, and T3, respectively. Crude

of $\text{N}393.76\pm15.0\text{ kg}^{-1}$ than animals on T2 and T3 diets). There were no significant differences ($p>0.05$) in the mean values of live weight gains (5.53kg and 5.16kg) and cost of feed per kilogram live weight gain ($\text{N}295\pm3.0\text{ kg}^{-1}$ and $\text{N}309 \pm 3.0\text{ kg}^{-1}$) in animals fed T2 and T3 respectively. The total feed consumed ($35.60\pm2.8\text{kg}$, $33.57\pm5.13\text{kg}$, and $31.40\pm3.65\text{ kg}$) and the cost of feeding per ram ($\text{N}1,559\pm28.0$, $\text{N}1,631\pm12.0$, and $\text{N}1,595\pm12.0$) in T1, T2, and T3 respectively did not show any significant differences ($p>0.05$).

protein digestibility in T2 and T3 were similar ($62.20\pm1.6\%$ and $64.80\pm2.0\%$) but increased significantly ($p<0.05$) than the CP digestibility of T1 (58.68 ± 2.0). The digestibility of CF also followed the same order with animals on T1 having a significantly lower ($p<0.05$) value of $60.62\pm1.6\%$ than animals on T2 ($72.06\pm2.5\%$) and T3 ($70.88\pm2.7\%$). Significant

differences ($p < 0.05$) exist in EE digestibility across the treatments. *Leucaena* based supplement (T3) recorded the highest EE digestibility ($75.77 \pm 2.8\%$), followed by T1 (69.82 ± 3.2) with animals on T2 recording the lowest EE digestibility of $65.53 \pm 3.0\%$. The utilization of ash and NFE was comparable

among the dietary treatments. Digestibility of ash were 70.02 ± 2.0 , 74.026 ± 2.7 and $72.20 \pm 2.1\%$ in T1, T2 and T3 respectively while for NFE 60.20 ± 0.8 , 58.9 and $59.6\% \pm 1.3$ % were recorded for T1, T2 and T3 respectively

Table 4. Economic Analysis Of Yankasa And Balami Rams Fed Poultry Manure And *Leucaena Leucocephala* Based Supplement

Ingredients	Treatment		
	1	2	3
Cost/kg feed (₦)	43.80 $\pm$ 0.0	48.60 $\pm$ 0.0	50.80 $\pm$ 0.0
Total feed consumed (kg)	35.60 $\pm$ 2.8	33.57 $\pm$ 5.1	31.40 $\pm$ 365.4
Cost of feeding (₦ /ram)	10599 $\pm$ 28	1,631 $\pm$ 12.0	1,595 $\pm$ 12.0
Live weight gain (kg)	3.96 $\pm$ 0.02 ^b	5.53 $\pm$ 2.1 ^a	5.16 $\pm$ 2.4 ^a
Cost of feed/weight gain (₦kg ⁻¹)	393.76 $\pm$ 0.0 ^a	295 $\pm$ 3.00 ^b	309 $\pm$ 3.0 ^b

Means with different superscripts a,b, along the same row are significantly different.

Table 5. Apparent Digestibility (%) of Yankasa Rams fed Groundnut Haulms or Poultry Manure and *Leucaena*-based Supplemental Diets.

Ingredients	Treatment		
	1	2	3
Dry Matter	82.02 $\pm$ 3.0	76.02 $\pm$ 2.0	77.50 $\pm$ 2.2
Crude Protein	58.68 $\pm$ 2.0 ^b	62.20 $\pm$ 1.6 ^a	64.80 $\pm$ 2.0 ^a
Ash	70.02 $\pm$ 2.0	74.02 $\pm$ 2.7	72.20 $\pm$ 2.1
Ether Extract	69.82 $\pm$ 3.2 ^b	65.53 $\pm$ 3.0 ^b	75.77 $\pm$ 2.8 ^a
CF	60.62 $\pm$ 1.6 ^b	72.06 $\pm$ 2.5 ^a	70.88 $\pm$ 2.7 ^a
NFE	60.20 $\pm$ 0.8	58.90 $\pm$ 0.7	59.60 $\pm$ 1.2

Means with different superscripts a,b, along the same row are significantly different.

Discussion

The result of the CP of DPL used in this study was like the CP of 15.4% reported by Lanyasunya *et al.* (2006) but lower than 21.88% by Bello and Tsado (2013). This could be due to the nature of bedding, age of bedding, processing, type of bird, level of feeding, presence of feather in the droppings used (Ogunsipe, 2014). The CP of GHH used in this study is lower than for 14.4% and 14.12% reported by Tekle and Gebre (2018) and Nuwan (2015). The CP of LLM used in this study is like 21.88% reported by Adedeji *et al.* (2013) but lower than 33% for LLM dried for 72 hours by Agbo *et al.* (2012). Lower NFE of 33.67% was observed for LLM (Agbo *et al.*, 2012). The differences in the proximate analysis could be due to the age of plant and processing methods.

The result of the chemical composition of the basal and supplemental diets used in this study revealed that groundnut haulms, dried poultry manure, and

Leucaena leucocephala based concentrate have crude protein values above 7% which is the optimum value for microbial growth in the rumen. These values were also adequate for the 10 to 12% CP recommended for growing sheep and goats (Gatemby, 2002). The CP of GHH is like the CP of the 2 concentrate diets but the energy is probably reduced in GHH due to other ingredients included in the concentrate diets. The intake of poultry manure-based diet obtained in this result was slightly higher to the value reported by Hadjipanayiotou *et al.*, (1993) who also compared Poultry manure to other diets. The slightly lower but insignificant response of yankasa rams to *Leucaena* based supplements compared to DPL in terms of intake may be due to palatability problems, presence of the toxic amino acid mimosine and its breakdown products and lignification which may affect both intake, digestibility, and growth (Kayouli *et al* 1993; Agbor

et al., 2013). The significant increase in weight in T3 over T1 could be due to the condensed tannin in LLM, which may have promoted higher protein escape due to tannin binding at the rumen that protects the protein from excessive microbial degradation and make them more available posterior to the site of absorption (Longo *et al.*, 2008). The significant weight gain T2 compared with T1 could also be because of urea present in DPM. It is high in urea, a source of nitrogen, which improves the rumen environment making the feed more efficiently utilized and the animal better nourished with whatever feed that is made available. Uric acid present in DPL is also a major component of poultry excretions that can be efficiently utilized by rumen microbes for protein production. It is not easily dissolved in the rumen fluid and so the ammonia that is gradually and slowly released is efficiently utilized even more than other non-protein nitrogenous feed sources (Adegbola *et al.*, 2010). Agbor *et al.* (2013) also recorded the highest intake of DPM compared with LLM when WAD goats were fed with these feed ingredients, but higher weight gain was obtained with LLM based diet compared with DPM in their trial. The work of Jokthan *et al.* (2013) revealed that 30% of broiler litter improved weight gain and feed cost in yankasa rams with CP and EE digestibility of 62.09 and 69.44%. However, the positive growth rate in all the treatment groups is in line with the need for supplementation of ruminants' diet with fodder crops and agro-industrial waste as a panacea for improved productivity of ruminants especially during the dry season (Lamidi and Ologbose 2014; Adegun, 2014). This result implies that the protein and energy levels of the feeds in all the treatment groups were above the maintenance level. The result obtained in this study from T1 confirms that GHH supplementation support moderate live weight and has a positive linear effect on DM, fibre digestibility, live weight gain, and feed conversion efficiency (Abdou *et al.*, 2014; Addah *et al.*, 2019). The similar feed intake in the basal diet and the concentrate diets of T2 and T3 despite the lower weight gain in T1 could be because energy

concentration is being compensated for in T1 (Bello and Tsado 2013). Higher CP digestibility in DPL and LLM based treatments could be due to the presence of NPN present in DPM and bypass protein present in LL. Reduced CP digestibility in groundnut haulms could be due to a decrease in caloric density of the diet coupled with increased dietary fibre in the diet (Bawa *et al.*, 2008). The result obtained in this study aligns with the one obtained by Agbor *et al.* (2013) that dry matter digestibility of CP and CF of the concentrate group was significantly higher than that of the control.

The reduction in the cost of feed per weight gain in rams fed DPM (T2) is in line with the result obtained by Mahmoud (2004) who reported reduced feeding costs when DPM was used as supplements in all trials involving Sudanese desert sheep. The reduced cost of feeding at positive weight gain supports the findings of other authors that the use of non-conventional feed sources such as DPM and LLM minimize feed costs and maximize productivity (Amata, 2014; Beigh *et al.*, 2017). The increased cost of feed per weight gain in animals on T1 diet is as a result of the lower growth rate of the animals compared with those on concentrate diets and the high cost incurred in the purchase of groundnut haulms coupled with a transportation cost of the byproduct from the market to the farm.

Conclusion

This study shows that groundnut haulms hay and *Leucaena leucocephala* meal or dry poultry litter (DPL) based concentrates have similar nutritive values. These nonconventional feeds improved sheep performance and are potential sources of readily available energy and protein which would fill the gap in feed available to ruminant during the dry season. However, rams DPL and LLM based supplements had better weight gain, feed conversion, and feed cost per weight gain than those fed GHH. Supplementation with DPL or LLM enhanced utilization and reduced feed cost and can be used at 36% in concentrate diets for sheep fattening.

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