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Comparative evaluation of cottonseed cake, poultry litter and dried cassava leaf *(Manihot esculenta cranz)* meal on growth performance of Yankasa lamb rams

[1]Abu, H.T., [2]Otaru, S.M., [1]Yashim, S.M. and [1]Musa, A.

[1]*Department of Animal Science, Ahmadu Bello University, Zaria.*
[2]*National Animal Production Research Institute, Shika- Zaria.*

Corresponding Author: *abutaiwo@gmail.com*

Targeted Audience: *Commercial feed millers, Feedstuff vendors, Livestock farmers, Animal scientists*

Abstract

A study was conducted to evaluate the dietary inclusion of cottonseed cake (CSC), sun dried poultry litter (SDPL) and dried cassava leaf meal (DCLM) on the performance of Yankasa rams. Eighteen (18) weaner rams, weighed 11.5 to 15.5 kg were randomly allotted into three dietary treatments with six animals per treatment in a completely randomized design. The concentrate diet contained CSC, SDPL or DCLM as the main sources of protein with each nitrogen source serving as a treatment designated as COSM, POUT or CASM, respectively, in the supplementary concentrate mixtures. Each group was assigned randomly to one of the three dietary treatments. The diets were formulated to be iso-nitrogenous to contain 15% CP. The result of chemical analysis showed that treatment COSM or POUT diets had higher values of crude protein than CASM diet. Feed intake were similar ($P>0.05$) across the treatments, Animals fed CASM diet had significantly ($p<0.05$) lower final weight gain (27.68 g/d), total weight gain (3.68 g/d) and average daily weight gain (40.87g/d) compared to animals fed COSM or POUT diet. Feed conversion ratio were similar ($p>0.05$) across the treatment. In conclusion, concentrate mixture of different protein sources improved the growth performance of the rams especially those fed COSM or POUT diet without adverse effect on the feed intake. It is recommended that farmers should feed their livestock at 2 % body weight of the concentrate containing CSC or SDPL.

Keywords: Cottonseed cake; poultry litter; cassava leaf meal; Yankasa rams; growth performance

Description of Problem

Ruminant animals are animals that possess four stomach compartments and have the ability to ruminate. The use of sheep and goats for religious and social ceremonies adds unquantifiable value to their economic importance in the lives of Nigerians. They fulfill a most useful task in supplying human population with meat, milk, skin, hair and other products (1). In addition, small ruminants are considered for investment and insurance due to their short generation interval, high fertility, adaptation to harsh environment and their ability to produce on limited feed resource (2). The productivity of small ruminant in many tropical countries is often poor, and has been attributed to problems of disease, nutrition, genotype and management (3). The limitations of ruminant nutrition in tropical and sub-tropical regions can partly be explained by the seasonal fluctuations in feed supply and pasture quality (4).

The green forage has long been recognized (5,6) as the cheapest and most abundant potential source of proteins because of its ability to synthesize amino acids from a wide range of virtually unlimited and readily available primary materials such as water, CO_2, atmospheric N_2 (as in legumes). For example, cassava leaves, as by-products of cassava roots harvest are (depending on the varieties), rich in proteins, (14–40% on DM basis), minerals, vitamins B_1, B_2, C and carotenes (7,8,9,10).

Recently, interest has been focused on foliage from cassava (*Manihot esculenta, Crantz*) as an animal feed. Cassava leaves have been used as a protein source when collected at the time of root harvesting. According to (11), harvesting of cassava leaves at an early growth stage (3 months) to obtain dry cassava leaf could reduce the condensed tannin content and increase the protein content resulting in a higher nutritive value. (12) attested to the significant higher performance of WAD sheep fed cassava leaves and peels in terms of feed intake, weight gain and nutrient digestibility.

The use of dried cassava leaf meal in livestock feed is yet to be fully exploited, as only a small proportion of total world production is currently being used, mainly in compounded rations for non-ruminants. It has been reported that there were no toxicity problems when cassava leaves were fed to goats (13) and cattle (14,15) when they were made to adapt gradually to the feed.

Poultry litter (PL) is a byproduct of the poultry industry. They are readily available, comparatively cheaper than the conventional feedstuff such as groundnut cake, soybean cake etc and could be used to reduce the gap between feed unavailability and nutrient requirements in ruminant animal production systems (16). It contains about 25% CP on DM basis, which can be efficiently used by rumen microbes for protein production. In addition, poultry litter contributes significant amount of Ca, P, K and numerous trace minerals to the diet of animals (17). If the diet consists of at least 20% poultry litter, no additional mineral supplementation is needed (18). It has also been shown that poultry litter has a valuable role as a source of non-protein-nitrogen (NPN) for ruminants (19) provided it is processed well in order to destroy potentially harmful microorganisms (20).

(21) reported the significant effects of poultry litter on feed intake, body weight gain and feed conversion ratio in Yankasa rams. (22) also reported improved feed intake and apparent digestibility coefficient, improved feed utilization and increase live weight gain in Yankasa rams supplemented with 80 % poultry dropping compared to those that were fed lower levels of poultry dropping in the diet.

One of the major problems constraining the use of PL waste in animal diets has been the fear of health hazard arising from the presence of pathogens such as *salmonella*, and the presence of pesticide and drug residues (23). The heat treatment involved in sun drying appears to offer satisfactory control of pathogens (24).

There are problems of feed scarcity or inadequate supply during the dry season in thenorthern part of Nigeria where the largest populations of cattle, sheep, and goat are found. The crude protein contents of principal forages such as gamba (*Andropogon spp*) and guinea grass (*Panicum maximum*) fall to as low as 2% for most part of the dry season, thus affecting intake and digestibility of dry matter (25,26). The soaring costs of feed ingredients which are either imported or are keenly competed for in terms of consumption by humans (27) also have great effect on ruminant production. These result in slow rate of expansion of small ruminant production and performance of these animals in view of the non-availability and high cost of feed ingredients. Efforts to alleviate the constraints should be directed primarily towards harnessing locally available, cheap and nutritionally adequate non-conventional feed ingredients such as animal wastes and agro-industrial by products. The aim of this study was to evaluate the utilization and performance of Yankasa rams fed basal diet of *Digitarias smutsii* hay supplemented with one of the concentrate mixtures containing cottonseed cake, poultry litter or sun dried cassava leaf meal.

Materials and methods

Experimental Site

The experiment was conducted at the Experimental Unit of the Small Ruminant Research Programme of the National Animal Production Research Institute (NAPRI), Ahmadu Bello University, Shika-Zaria, Nigeria. Shika is situated in the Northern Guinea Savanna ecological zone of Nigeria between latitudes 11°8′ 19.56″N and longitudes of 7° 45′51.22″E at an elevation of 640m above sea level (28). The average annual rainfall of 1100mm starts from early-May to mid-October. The mean minimum and maximum environmental temperature ranges from 12 to 28°C during the cold (harmattan) season and 20 -36°C in the hot season. The mean relative humidity is about 72% during the rainy season. The dry season begins with a period of dry cool weather known as harmattan that lasts from October to January. The harmattan is followed by a dry hot weather from February to April. The relative humidity at this period is 21% (29).

Experimental Diets

Cottonseed cake (CSC), sun-dried poultry litter (SDPL) and dried cassava leaf meal (DCLM) were used as the main sources of protein to formulate and compound three different diets which contained, in addition, maize offal, wheat offal, bone meal and common salt. The three diets designated as COSM, POUT and CASM contained cotton seed cake, sun-dried poultry litter and dried cassava leaf meal, respectively, as the main source of protein (Table 1). The diets were iso- nitrogenous and contained 15% crude protein.

Collection and processing of cassava leaves and Poultry litter

Cassava leaves were obtained from local farmers around the study area after harvesting of cassava roots. The fresh cassava leaves were harvested and sun-dried on a flat concrete floor for 3 to 4 days depending on the intensity of the sun to reduce the hydrocyanic acid present in the leaves. It was intermittently turned to prevent scorching and fermentation as recommended by (30). Thereafter, the leaves were crushed into a meal using a mortar and a pestle. The poultry litter (Layer litter) was sourced from Poultry Research Programme NAPRI, Shika- Zaria and sun dried for 3 days to reduce the effect of pathogenic organisms, and also checked to remove metals and sharp objects. Cottonseed Cake, wheat offal, maize offal, bone meal and common salt were obtained from NAPRI and incorporated into the supplementary concentrate diets.

Experimental design, animals and management

Eighteen (18) Yankasa rams aged 9-12 months weighing 11.5-15.5kg were randomly allotted to three dietary treatments in a completely randomized design (CRD), with six animals per treatment. The concentrate diet contained COSM, POUT or

CASM along with other ingredients in the supplementary concentrate mixtures with each nitrogen source serving as a treatment designated earlier (Table 1). Prior to the commencement of the experiment, the animals were treated against ecto and endo parasites using Acaricide and albendazole®, respectively. The animals were housed in individual pens and fed the supplementary concentrate diets at 2% of their body weight and *Digitaria smutsii*(wooly grass stent) hay was offered *ad libitum* as basal diet. The animals were weighed fortnightly and the quantities of feed offered were adjusted accordingly. Fresh clean water was provided *ad libitum*. The growth trial lasted for 90 days, excluding the adjustment period.

Table 1: Ingredient composition of the Experimental Diets

Ingredients	COSM	POUT	CASM
Maize Offal	48.88	43.65	36.44
Wheat Offal	24.07	21.50	17.95
Cotton Seed Cake	23.05	-	-
Poultry Litter	-	30.85	-
Dried cassava leaves	-	-	41.61
Bone Meal	2.5	2.5	2.5
Common Salt	1.5	1.5	1.5
Total	**100.00**	**100.00**	**100.00**

TDN= total digestible nutrient

Blood metabolite evaluation

Five millilitre of blood samples were collected from four (4) animals in each of the treatment group two times: before and 4 h after feeding using Hyperdemic Syringe at the end of the feeding trial. The collection of blood samples was done in the morning. The blood was collected through the jugular vein and decanted into anti-coagulant free bottle and used for the serum biochemical indices such as blood glucose, blood urea nitrogen (BUN), total protein and Creatinine. Total protein was determined using the procedure of (31), creatinine was analysed using the procedure of (32). Urea nitrogen level, albumin content and globulin were determined using the procedure described by Archer and Robb (33). Determination of blood glucose levels was done by the Glucose Oxidase Principle (34). All of the blood parameters were analyzed at the Clinical Pathology Laboratory, Faculty of Medicine, Ahmadu Bello University, Zaria.

Chemical Analysis

Dried cassava leaf meal, sun dried poultry litter, cotton seed cake, experimental concentrate diets and *Digitaria smutsii*hay were analyzed for dry matter (DM), crude protein (CP), crude fibre (CF), ether extract (EE), ash and nitrogen free extract (NFE), according to the Method of (35). Acid detergent fiber (ADF) and neutral detergent fibre (NDF) were determined according to the method described by Goering and Van Soest(36). Hemicellulose content could be obtained by deference between NDF and ADF values (37). The energy contents of the diets were analyzed using bomb calorimeter model e2k.

Statistical Analysis

Data collected on feed intake was subjected to repeated measures analysis using PROC MIXED (38version 9.0). The statistical model used was: $Y_{ijk} = \mu + t_i + b_j + p_k + (tp)_{ik} + e_{ijk}$, where Y_{ijk} is the response of animal j in treatment i at time k, μ is the overall mean, $t_i$is a fixed effect of i_{th} treatment (i = 1,2,3,), b_j is the random effect of the jth animal (j = 1,2,3,4,5,6) nested within the ith treatment, p_k is the fixed effect of k_{th} time (1,2,3,---------13), tp_{ik} is the interaction between the ith treatment and the kth time, e_{ijk} is the random error.

For each variable analyzed using this model, animal as a subject nested within treatment was subjected to the appropriate covariance structure which gave the smallest Akaike's Information Criterion (AIC) and met convergence criteria. Kenward – Roger correction for degree of freedom was used. The use of Kenward – Roger correction reduces the probability of type I error.

Data on final weights, live weight changes, average daily gain, feed conversion efficiency and blood metabolites were analyzed with ANOVA using General linear model procedures of (38) in accordance with the following model: $Y_{ij} = U + tj + eij$, where Y_{ij} is the response of animal j in treatment i (j = 1,2,3,4,5,6), μ = is the overall mean, ti is a fixed effect of the ith treatment (i = 1,2,3), eij = the random error. The least square means was separated using CONTRAST statement of SAS and significant differences were declared at $P<0.05$.

Results and discussion

Chemical composition of experimental diets

The result of the chemical composition of the dietary ingredients table 2. The crude protein values reported for CSC and SDPL were lower than 26 and 31 % CP reported for CSC and DPL, respectively, by (39) but comparable with 17% CP reported for DPL by (40), and fall within the ranges of 14.3 – 30 %CP by (41).

Table 2: Chemical composition of experimental diets

	Dietary treatment			
Parameters (%)	COSM	POUT	CASM	Digitaria smutsii
Dry matter	88.42	89.94	91.16	92.63
Organic matter	79.69	80.29	83.05	88.73
Crude protein	16.81	16.81	16.67	7.50
Crude fiber	24.11	16.09	18.93	31.17
Ether extract	14.61	16.88	14.61	7.77
Ash	8.73	9.65	8.11	3.90
NFE	35.74	40.57	41.68	42.29
ADF	22.68	19.01	28.08	39.01
NDF	38.72	41.17	36.06	73.42
TDN%	74.88	77.42	69.54	
GE MJ/kg	14.31	21.23	14.31	
ME MJ/kg	8.8722	13.1626	8.8722	

NFE=Nitrogen free extract, ADF= Acid detergent fiber, NDF= Neutral detergent fiber. ME =estimated from GE determined with bomb calorimeter following Garrett *et al.*(1959) recommendation of : 100 Mcal GE =76 Mcal DE =62 Mcal ME = 35 Mcal NE

Feed intake

The dry matter intake and growth performance of Yankasa rams fed cottonseed cake, poultry litter or dried cassava leaf meal are presented in Table 3. The DMI of the animals were similar P>0.05 for the 3 protein sources across the treatments. The result obtained in this study isin agreement with the reports of (42) .(43) also reported no difference when oil seed cakes were fed to goats.(44) reported similar result on Red Sokoto and Sahelian goats supplemented with different protein sources.

Growth Performance of weaner's rams fed COSM, POUT or DCLM

The result showed that the animals fed COSM or POUT diet had higher weight gain P<0.05 than CASM fed animals (table 3). Average daily gain and final weight gain followed the same pattern. This observation might be attributed to more efficient utilization of absorbed nutrients by the groups fed COSM or POUT diets than those fed CASM diet. The main finding of the present studies is that low serum glucose concentrations were correlated with weight gain. The association between low glucose concentrations and weight gain has earlier been reported 45; 46). The feed conversion ratio was not affected by the diet across the treatments this was an indication that the diets were well accepted by the animals and might probably be attributed to the use of concentrate and basal diet since it is well known fact that concentrate feeding stimulates rumen microbes to function more efficiently (47). The non significant effect of FCR observed in this study is in agreement with the findings of (Suleiman 48) for sheep fed different protein sources.

Table 3: Dry matter intake and growth performance of Yankasa rams fed cottonseed cake, poultry litter or dried cassava leaf meal.

	Dietary treatment			SEM	LOS
Parameters	COSM	POUT	CASM		
Conc. Intake (g/hd)	555.70	570.20	549.50	15.81	NS
Hay intake (g/hd)	448.60	534.30	463.20	42.58	NS
TDMI (g/hd)	1004.20	1104.40	1012.70	51.76	NS
TDMI/kgW$^{0.75}$	92.14	103.33	95.24	4.12	NS
Initial weight(kg)	24.33	23.83	23.80	1.77	NS
Final weight gain (kg)	30.29^{a}	30.82^{a}	27.68^{b}	0.72	*
Total weight gain(kg)	06.29^{a}	06.82^{a}	03.68^{b}	0.72	*
ADWG (kg)	69.85^{a}	75.73^{a}	40.87^{b}	7.97	*
Feed conversion ratio	15.42	14.95	29.21	10.43	NS

^{a,b} means with different superscripts along the same row differ significantly. * significant difference at (P<0.05), ADWG= Average daily weight gain, SEM=Standard error of the means, DMI= Dry matter intake, LOS= Level of significant, kg= kilogram, g/hd= gram per head, FCR=feed conversion ratio (feed intake/ weight gain).

Blood metabolites

Table 4: shows the blood metabolites of Yankasa rams fed cottonseed cake, poultry litter or dried cassava leaf meal. Total protein was significantly P<0.05 affected by the sources of nitrogen, rams fed COSM or POUT diet had higher total protein than those fed CASM diet 4 h post feeding. Serum total protein normally reflects the availability of protein in blood. Hence its concentrations decline when there is protein deficiency (49). Improvement in the concentrations of serum protein indicates that CSC or poultry liter is a good quality

protein source with high availability to ruminants. The total serum protein value 35.25 – 58.00 g/l recorded in this study was within the normal range of 23.4 – 77.3g/l reported by 50.

Higher live weight was expected in COSM fed animals than in CASM fed animals due to greater serum total protein level observed in COSM fed treatments. Increase in body weight was attributed to the increase in serum total proteins (51). It also implied that protein synthesis was efficient because the animals were in good health condition and were not stressed by nutrition or environment.

The glucose levels of the rams were significantly (P<0.05) higher in rams fed CASM diet. Blood glucose production through gluconeogenesis in the liver was not impaired. The lower blood glucose in animals fed COSM or POUT diet may be due to efficient utilization of the diets as apparent in the higher weight gain they have compared to the rams fed the CASM diet which exhibited higher blood glucose concentrations. Although glucose homeostasis has made blood glucose responses to dietary treatments to be inconsistent, the result of this study is consistent with that of (52) who observed that feedlot Buffaloes fed concentrate supplements grew better and had lower blood sugar levels than their counterparts fed grass only.

Table 4: Blood Metabolites of Yankasa rams fed cottonseed cake, poultry litter or dried cassava leaf meal.

	Dietary treatment			SEM	LOS
Parameters	COSM	POUT	CASM		
Total protein (g/l)					
0h	38.25	44.25	49.00	3.94	NS
4h	58.00[a]	50.73[ab]	41.00[b]	4.93	*
BUN(mmol/l)					
0h	13.50	13.25	13.25	1.98	NS
4h	13.75	14.25	12.00	1.78	NS
Creatinine (mg/dl)					
0h	1.48	0.95	1.80	0.92	NS
Glucose (mg/dl)					
0h	152.50[b]	133.50[b]	194.75[a]	11.96	*
4h	143.50[ab]	114.00[b]	150.75[a]	09.60	*

[a,b] means with different superscript along the same row differ significantly. * significant difference at (P<0.05) ,SEM= Standard error of the mean, NS= not significant at 5%, BUN= Blood urea nitrogen, NS= not significant.

Economic analysis

Value of gain was highest ₦ 5,115 in animals fed POULT diet and lowest ₦ 2, 760 in animals fed CASM diet (Table 5). The high cost of feed per kg diet obtained in COSM diet ₦ 63.99 could be attributed to the high cost per kilogram of the supplement compared to the price of the other protein supplements used (POULT ₦ 35.86 or CASM ₦ 30.50). The lower cost of CASM containing diet in this study is similar to the report of (53) who reported that the lowest feed cost per unit weight gain was at the 60 % inclusion level of dried cassava leaves. The higher value of gain observed in animals fed POUT containing diet is consistent with the report of (54) who reported economical increases in live weight gain when beef steers grazing endophyte-infected tall fescue were fed a 50:50 (on dry matter basis) broiler litter-ground corn mixture. POUT containing diet from this study was found to be more economical and has the net benefit (value of gain) of ₦ 5,115 in feeding growing rams to obtain better performance in terms of average daily gain than other protein supplements.

Table 5: Cost benefits analysis of feeding rams with diets containing cottonseed cake, poultry litter or dried cassava leaf meal

	Dietary treatment (%)			
Parameters	**COSM**	**POULT**	**CASM**	**SEM**
Cost/kg feed (₦)	63.99	35.86	30.50	1.00
Total feed consumed (g/d)	1004.20	1104.40	1012.70	19.75
Cost of feeding (₦/Ram)	64, 258.76	39, 603.78		2.34
Weight gain (kg)	06.29	06.82	03.68	4.84
Cost of feed/kg gain (₦/kg)	10, 216.02	5, 807.01	8, 393.30	1.87
Value of gain (₦)	4,717.5	5,115	2, 760	1.01
Cost over gain (₦)	2.17	1.14	3.04	

₦ = Naira, Kg = Kilogram, cost per kg liveweight = ₦ 750.

Conclusion and Applications

1. It is concluded from the results of this study that concentrate mixture containing 23.05 % cottonseed cake or 30.85 % SDPL (on as- fed basis) and fed at 2.0 % of body weight supported similar weight response by Yankasa rams while outperforming the mixture containing 41.61 % sun dried cassava leaf meal.
2. In terms of cost, however, concentrate mixture containing poultry litter was the most economical.

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