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Growth and cost of producing Red Sokoto goats fed brewer's dried grains and malted sorghum sprouts in *Andropogon tectorum* hay meal based diet

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

Abstract

The growth and cost of producing Red Sokoto (RS) goats were evaluated using brewer's dried grains (BDG) and malted sorghum sprouts (MSP) in complete diets containing Andropogon tectorum hay meal (ATHM). The experiment was conducted using a completely randomised design (CRD). Four diets designated T1, T2, T3 and T4 were formulated to contain 40%, 30%, 20%, 10% of BDG and 10%, 20%, 30%, 40% of MSP respectively. Twenty four (24) bucks averaging 13.5±1.5 kg were randomly assigned to the four diets in a 56-day feeding trial. Data on proximate composition of BDG, MSP, ATHM and the diets, growth indices as well as the cost of production were generated. The dry matter, crude protein and gross energy of the diets were in the ranges of 91.38 – 92.23%, 15.60 – 17.09% and 1.66 – 1.70MJ/kg DM respectively. Feed utilization parameters on growth did not vary (P>0.05) across the treatments. However, these values improved numerically as the level of MSP in the diets increased from T1 – T4. Cost evaluation showed that the total feed cost (₦) and daily feed cost (₦) were statistically similar (P>0.05) for the 4 treatments while cost/kg weight gain (₦) differed significantly (P<0.05). T4 had the least cost/kg weight gain of ₦ 320.64 as against ₦ 500.69 in T1. It was concluded that increasing the levels of MSP and reducing the levels of BDG in the diets gave better performance results and also reduced cost of production in RS goats.

Keywords: Performance; Complete diets; Red Sokoto goats

Description of Problem

Overtime, it has been known that livestock farming is an important and integral component of agriculture, which forms part of the backbone of many economies. Apart from being the major source of animal protein, it offers employment opportunities to large segments of human population; in the areas of production, processing and marketing. Considering goat production in particular; it plays a very vital role in the livelihood of many rural populations as it contributes significantly to the improvement of family nutrition and health, serves as a form of food security and source of independent income for rural households and subsistent farmers (1).

At present, goat production relies mainly on forages in most parts of the world. This source of feed is unreliable as inclement weather conditions approach when forages become scarce and sometimes, highly lignified. This explains why most ruminants under the traditional system of production have poor body conditions at the peak of the dry season (2). Adegbola (3) reported that poor quality roughages when fed to ruminants without supplementation caused considerable weight loss and finally death during the dry

season. Again, the use of forages, especially; grasses as the sole source of feed for ruminants have been implicated to increase the amount of greenhouse gases emitted to the atmosphere; thereby causing global climate change and its attendant negative effects.

If the gains in goat production should be sustained, there is need to source for alternative feeds to supplement the dry season forages. These alternatives must be cheap, readily available, and non-toxic to the animals and also, not competed for by humans for both domestic and industrial uses. This is important since cereals and even the oil seed meals used as supplements have become very expensive and useful as human food, hence, the search for industrially processed by-products like brewer's dried grain (BDG) and malted sorghum sprouts (MSP).

BDG has long been fed to ruminants (4). Yaakugh and Tegbe (5) reported a crude protein (CP) and crude fibre (CF) contents in BDG to be 21% and 20% respectively. According to Adebowale and Ademosun (6), the idea of feeding BDG arose primarily from the desire to investigate cheap and alternative feeds for livestock. Earlier study by Adebowale and Ademosun (7) indicated that incorporating up to 30% BDG into the diets of goats and sheep did not affect growth rate and feed efficiency. MSP on the other hand is relatively new in the feed industry (8). It is a by-product of the sorghum malting process. Malting of sorghum like barley involves steeping or soaking, germination, drying and curing in kiln and polishing (8). Since the incorporation of sorghum as a raw material in the brewing, food and allied industries, the by-products are currently being turned out in large quantities. Consequently, the quantity of MSP available for possible use in livestock feed is constantly increasing (9). As reported by Oduguwa *et al*. (8) and Fafiolu *et al*. (10), MSP has a range of 224.3 – 226.0g/kg CP representing about 22%. This makes the by-product a suitable source of CP in diets.

Although there are many studies available on the use of BDG as a source of supplementation for ruminants, there is scanty information on the incorporation of MSP, BDG and MSP or BDG and MSP in *Andropogun tectorum* hay meal (ATHM) based diets; hence the study. The objective of the study therefore centers on the assessment of the growth performance and the costs of feeding goats different proportions of these feed ingredients.

Materials and Method

Location of the study

The experiment was conducted in the Sheep and Goat Unit of the Teaching and Research Farm, Michael Okpara University of Agriculture, Umudike, Ikwuano L.G.A, Abia State, Nigeria. The area is located on latitude 05^0 29^1 north and longitude 07^0 33^1 east with an altitude of 122 meters above the sea level. It experiences an average ambient temperature of 25^0C with a range of 22^0C – 32^0C, a relative humidity range of 50 – 90% and is characterized by long rainfall duration and a short dry season. Annual rainfall reaches 2200 mm evenly distributed over 8 months (March – November) in about 148 – 155 rainy days with its peak periods in June and July (11).

Experimental animals and their management

The RS goats used for the study were sourced from the northern agro-ecological zone of Nigeria, which serves as their original habitat. On arrival, they were put in a thoroughly sanitized house for 21-day quarantine. Initially, the animals were fed some of the original feeds they were used to in their natural habitat. These comprised of groundnut vines and wheat offal. Gradually, components of the experimental diets were

introduced. Water was also provided *ad-libitum.* Prophylactic treatment of the goats included the injection of long-acting oxytetracycline intramuscularly at the rate of 0.10ml/kg body weight repeated 48 hours later. Levamisole injection was administered subcutaneously (s/c) at the rate of 1 ml per buck to control endo-parasites while ivermectin injection given s/c was used to manage common ecto-parasites. They were vaccinated against Peste des petits ruminants (PPR) at the end of the 21-day quarantine.

Experimental diets

Four diets as shown on Table 1 were formulated and mixed from the following ingredients: ATHM, BDG, MSP, palm kernel meal (PKM), molasses, bone meal and common salt. 250g of vitamin-mineral premix was added per 100kg of each diet in order to take care of the micro-nutrient needs of the goats. The grass hay used in this study was processed from *Andropogon tectorum* harvested from uncultivated pasture. The grass was cut between September – October, chopped into 3 cm length and sun dried for 5 – 7 days. The method of cutting and chopping ensured maximum reduction of the grass stems. The dried grass was later ground in a local mill to form ATHM. This was thoroughly mixed together and stored in an air proof condition until required for feed mixing. Other ingredients were procured from livestock feed dealers.

Table 1: Composition of the experimental diets

Ingredients	Experimental Diets			
	T1	T2	T3	T4
Andropogon tectorum hay meal	31	31	31	31
Brewer's Dried Grains	40	30	20	10
Malted Sorghum Sprouts	10	20	30	40
Palm Kernel Cake	10	10	10	10
Molasses	5	5	5	5
Bone Meal	3	3	3	3
Common Salt	1	1	1	1
Total	100	100	100	100

Chemical analysis

The AOAC (12) procedures for the determination of dry matter, crude protein, crude fibre, ether extract and ash were followed to establish these fractions both in the diets and the three major ingredients that constituted the diets. Nitrogen free extract (NFE) and gross energy were determined using the formulae below:

NFE% = DM% – (ash% + CF% + EE% + CP %)

Gross Energy (MJ kg-1DM) = 0.0226CP + 0.0407EE + 0.0192CF + 0.0177NFE (13). Where; DM = dry mater, CF = crude fibre, EE = ether extract and CP = crude protein.

Feeding trial

Twenty four (24) intact Red Sokoto (RS) bucks selected from the initially quarantined RS goats were used for the trial. The goats were within the age range of 09 – 11 months and averaged 13.5±1.5 kg initially. They were randomly divided into four groups of six (6) bucks per group housed in sanitized pens according to their group, with feeders and drinkers provided. The feeders and drinkers

were well fitted to prevent wastages and also contamination of the feeds or water with faeces and urine. The bucks were assigned in a completely randomized design (CRD) to the four treatment diets in three replicates with two (2) bucks per replicate. All the bucks were individually weighed once a week for the 8 weeks (56 days) feeding trial to determine the weekly weight changes and the final live weight.

Cost evaluation

The costs of producing RS goats were evaluated to determine the following cost implications:

a) Total feed cost/goat (₦) = Total feed intake/goat × Cost/kg feed (₦)

b) Daily feed cost/goat (₦) =

$$\frac{\text{Total feed cost/goat (₦)}}{56 \text{ days}}$$

c) Cost/kg weight gain (₦) =

$$\frac{\text{Total feed cost/goat (₦)}}{\text{Total weight gain (kg)}}$$

Statistical Analysis

Data generated from the study were subjected to analysis of variance (ANOVA) appropriate for the CRD using SPSS base for windows. Treatment means showing statistical differences at a probability of 5 % were compared using the Duncan's multiple range procedures of the same package.

Results and Discussion

Proximate composition of BDG, MSP, ATHM and the experimental diets

The proximate composition of the major ingredients used in diets formulation as well as the diets is presented on Table 2. The proximate constituents of BDG varied from the values obtained elsewhere (14, 15). The dry matter (DM), crude fibre (CF), ether extract (EE) and ash contents were similar to the values obtained by Ironkwe and Bamgbose (16) while the crude protein (CP) and nitrogen free extract (NFE) levels were different from the figures given by the same authors. Jovanka *et al*. (17) explained that the nutrient content of brewer's grain will vary from plant to plant and depending upon the type of substrate (barley, wheat, corn, etc.), extent of fermentation and the type of fermentative process. Since brewer's grains used in the study was in the dried form, the method and extent of drying may also have contributed to the variations in the proximate compositions.

Table 2: Proximate composition of BDG, MSP, ATHM and the experimental diets

Parameter (%DM)	Experimental Diets				BDG	MSP	ATHM
	T1	T2	T3	T4			
Dry Matter	92.23	91.67	91.48	91.38	91.90	89.92	91.34
Crude Protein	15.60	16.10	16.59	17.09	18.22	23.20	13.27
Crude fibre	17.57	16.74	15.91	15.08	13.95	9.62	26.90
Ether extract	2.87	2.89	3.12	3.19	3.92	5.52	3.15
Nitrogen free extract	48.32	49.35	49.42	50.29	45.46	48.19	40.18
Ash	7.87	6.59	6.44	5.73	6.35	3.19	7.84
Energy (MJ/kgDM)	1.66	1.68	1.68	1.70	1.72	1.79	1.65

The MSP has higher DM content than the values reported earlier (8, 10). The CP content is similar to the CP values presented by the same authors and those of Aning *et al*. (18) and Akinola (19). A higher CF content was recorded in the present study as against

46.7g/kg and 48.1g/kg CF representing 4.67% and 4.81% obtained by Fafiolu *et al*. (10) and Oduguwa *et al*. (8) respectively. However, Oduguwa *et al*. (20) obtained 83.0g/kg (8.30%) CF close to the value obtained currently. The CF in MSP could be influenced by the amount of the lignin in the shoots and roots formed during the germination process and the rate at which the germination proceeds before drying. EE and ash values also differed from the content of these nutrients reported by the earlier workers.

The DM of ATHM was within the value of 900g/kg DM described as good (21). This was achieved through particle size reduction of the leaves, thin spread of the chopped forage under the sun and regular turning. Moreover, the processing of the hay was carried out on sunny days. The CP value was slightly higher than the values reported for the same forage (22, 23, 24). However, the CP was close to the value of 150g/kg DM representing 15.0% suggested as good (21). The CF content fell within the middle range of 24.62% and 29.30% reported by Obua *et al*. (23) and Mecha and Adegbola (24).

The EE and ash values were slightly higher in the ATHM compared to the values reported earlier while NFE value was far below 60.0% given by Aderinola (25) but close to 43.57% presented by Obua *et al*. (23). The differences in the proximate compositions of ATHM used in the study when compared to those of earlier researchers could be attributed to the methods of processing used, periods of growth (wet or dry season) or harvesting of the forage plant (26). In addition, the nutrient profile of the soil where the forage was harvested, the geographical location as well as rate of H_2O and nutrient uptake by the forage plant could contribute to the compositions.

The DM contents of the diets increased as the level of BDG increased across the diets. This was expected since the BDG had higher DM than MSP. Similarly, there was a corresponding increase in CP contents of the diets from T1–T4 as a result of proportional increase in the level of MSP. MSP had higher CP content than BDG. Similar trend was observed for the other nutrients in the diets except crude fibre and ash; though the differences were not too pronounced.

Growth and feed intake of Red Sokoto goats fed BDG and MSP in ATHM based diets

Growth and intake of RS goats (Table 3) fed BDG and MSP in ATHM based diets did not indicate any statistical variance ($P>0.05$) among the four treatment means. However, goats on diet 4 demonstrated numerical superiority in terms of weight gain and feed efficiency ratio among the other groups. On the other hand, goats on T1 consisting of 40% BDG and 10% MSP recorded the least performance in spite of the highest daily intake. This disparity could be as a result of better utilization of the nutrients in the diets by the goats as the level of MSP increased rather than a corresponding increase in the level of BDG. Adebowale and Ademosun (6, 7) recorded a drop in weight for goats receiving more than 30% BDG in their diets. In another study with sheep, Oduguwa *et al*. (9) reported the highest weight gain in sheep receiving 15% MSP in soybean stover based diet. This showed that MSP could be offered above 15% without affecting performance. As indicated by Augustine *et al*. (27), the malting process improves the nutrient compositions and reduces anti-nutritional factors in raw sorghum. This could have accounted for the better performance obtained as the level of MSP increased in the diets.

The total weight gains recorded in the current study are below those reported for a similar breed in earlier studies. On the average, Makun *et al*. (28) reported 4.10 kg of total weight gain for RS goats in the Guinea

Savannah ecological zone of Nigeria. Olorunnisomo *et al*. (29) recorded a gain of 3.1–7.7 kg for the same breed fed elephant grass ensiled with cassava peels at different levels and supplemented with concentrate mixture in Ibadan, Nigeria. Average daily weight gains recorded in the present study are lower than the value of 170g/day recommended by Aduku (14) for goats but similar to the value of 40–50g/day reported by Nuru (30) for West African Dwarf goats. On the other hand, feed intakes as percentage of live weights and feed efficiency ratios are higher than the values suggested by Aduku (14).

Table 3: Growth and feed intake of Red Sokoto goats fed BDG and MSP in ATHM based diets

Parameter	Experimental Diets				SEM
	T1	T2	T3	T4	
Initial body weight (kg)	13.53	13.83	13.83	14.00	0.25
Final body weight (kg)	16.00	16.33	16.75	17.17	0.32
Total weight gain (kg)	2.47	2.50	2.92	3.17	0.12
Average daily gain (g/d)	44.05	44.64	52.08	56.55	2.21
Total feed intake (kg)	30.85	28.13	28.33	29.98	1.17
Average daily intake (g/d)	553.30	505.30	506.70	536.70	0.02
Feed intake as % of LW	3.42	3.08	3.03	3.13	0.08
Feed efficiency ratio	12.58	11.35	9.73	9.49	0.55

LW: Live weight; SEM: Standard error of mean

The variations in the values obtained in the present study and the earlier studies could probably be due to the differences in duration of the study, location of the study, adaptation of the breed to a new environment, and the nutritional profile of the diets offered to the animals. The study by Makun *et al*. (28), Olorunnisomo *et al*. (29) and the present work were conducted in 5, 4 and 2 months respectively. The environment of the study according to Sylva (31) would likely exert its influence with the possibility that performance could be skewed positively to RS goats in their natural environment and would decrease as they attempt to thrive outside their local conditions. It should be noted that Makun *et al*. (28) conducted their study in the Guinea Savannah vegetation zone. On the other hand, animals that have acclimatized to a new environment outside their natural habitat would perform better than those animals newly introduced to a different environment. Olorunnisomo *et al*. (29) carried out their investigation using RS goats adapted to the humid environment of South-western Nigeria. It should be recalled that the RS goats used in this trial were sourced from the Northern Agro-ecological zone of Nigeria and used in a South-eastern humid condition. Also, depending on the composition of the various feeds used, animal responses would vary and thus performance would be better for animals on the more nutritious diets.

Linear body weight changes (kg) of RS goats fed the 4 diets between 0–8 weeks are shown on Figure 1. Initial weights of bucks on T1 were the least while those of bucks on T4 were the highest. Weights of RS goats on T2 and T3 were the same. The animals on T2 and T3 maintained similar weight gain till the 5th week when RSGs on T3 surpassed their counterparts on T2. T4 maintained the lead

from start till end while T1 grew the least. The observations, especially between T2 and T3 showed that the increasing level of MSP in the diets promoted better growth than corresponding increase in BDG.

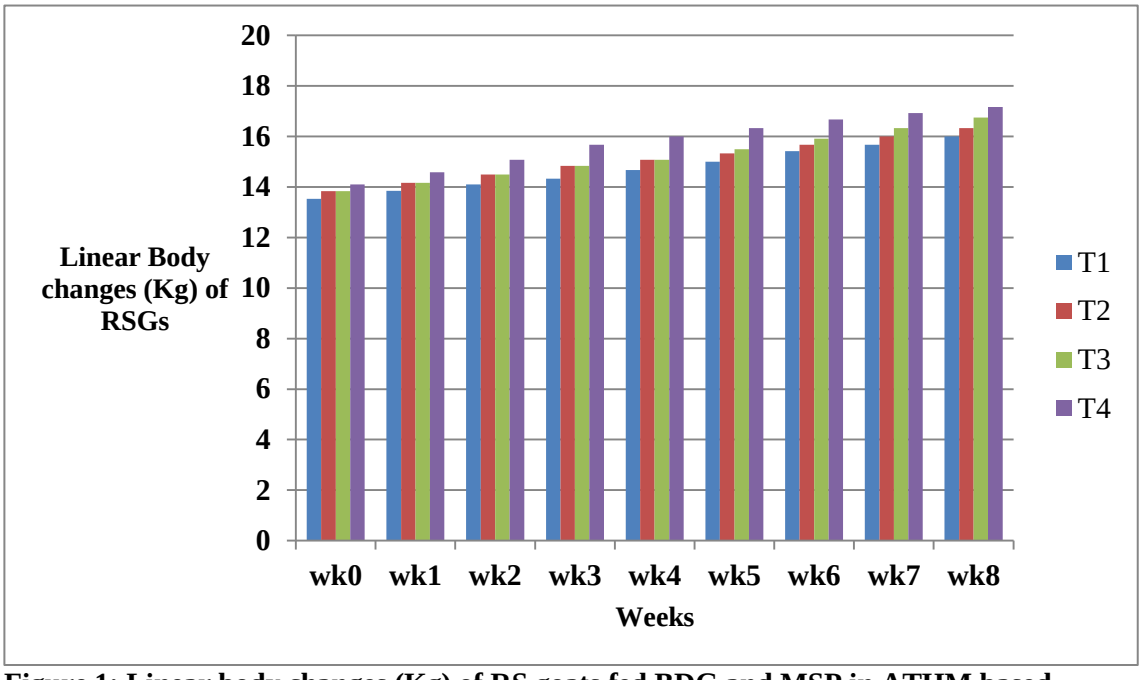

Figure 1: Linear body changes (Kg) of RS goats fed BDG and MSP in ATHM based diets across weeks 0 to 8

Cost of producing Red Sokoto goats fed BDG and MSP in ATHM based diets

Table 4 shows the cost estimates of producing RS goats fed BDG and MSP in ATHM based diets. The total feed intake (kg) (TFI), total weight gain (kg) (TWG), total feed cost (₦) (TFC) and daily feed cost (₦) (DFC) were all statistically similar (P>0.05) across the four treatment means while the cost/kg weight gain (₦) differed (P<0.05). T1 varied statistically (P<0.05) from T3 and T4 but similar to T2. T2 recorded similar (P>0.05) cost/kg weight gain (₦) with T3 and T4.

The TFI and TFC though statistically similar (P>0.05), numerically increased as the level of inclusion of BDG in the diets increased with an inverse increase in the TWG across the treatments. Adebowale and Ademosun (6, 7) had earlier reported reduction in weight gain in goats and sheep receiving more than 30% BDG in their diets while Oduguwa *et al*. (8) recorded significantly higher weight gain in sheep receiving 15% MSP in soya bean stover based ration. MSP as a relatively new and unconventional feed resource in the livestock feed industry was generally cheaper than BDG during the period of the study. It was therefore expected that increasing levels of MSP in the diets could reduce cost of producing RS goats as the level of supplementation increased since this produced appreciable weight gain in the animals.

Table 4: Costs of producing Red Sokoto goats fed BDG and MSP in ATHM based diets

Parameter	Experimental diets				SEM
	T1	T2	T3	T4	
Total feed intake (kg)	30.85	28.13	28.33	29.98	1.17
Total weight gain (kg)	2.47	2.50	2.92	3.17	0.12
Total feed cost (₦)	1227.70	1063.19	1014.33	1013.44	51.27
Daily feed cost (₦)	21.92	18.99	18.11	18.0	0.91
Cost/kg weight gain (₦)	500.69[a]	429.13[ab]	348.20[b]	320.64[b]	26.55

SEM: Standard error of mean, [a,b] means on the same row with different superscripts are significant (P<0.05)

Conclusion and Applications

1. The incorporation of different proportions of BDG and MSP into ATHM based diets did not produce significant effects on the performance indices evaluated except in the cost per kilogram weight gain which depreciated significantly with increasing levels of MSP.
2. However, the linear body weight changes of the RS goats observed within 8 (eight) weeks duration depicted superiority of increasing levels of MSP over BDG.
3. It is therefore recommended that stakeholders in the livestock industry and farmers should be incorporating BDG and MSP into feeds in order to meet the nutrient needs of goats for improve production during periods of fodder shortage.

References

1. Ahamefule, F.O., Odilinye, O. and Nwachukwu, E.N. (2012). Milk yield 288 and composition of Red Sokoto and West African Dwarf does raised intensively in a hot humid environment. *Iranian Journal of Applied Animal Science* 2, 143–149.
2. Rosiji, O.G. and Iposu, S.O. (2002). Potentials of oil palm (*Elaeis guineensis*) leaves as ruminant feed resource: Proximate composition. In: Proc. 27th Ann. Conf., NSAP, FUT, Akure, March 17 - 21, pp.185 –187.
3. Adegbola, A.A. (2002). Nutrient intake, digestibility and rumen metabolites in bulls fed rice straw with or without supplements. *Nigeria Journal of Animal Production* 29, 40 – 46.
4. Murdock, F.R., Hodgson, A.S. and Riley, R.E. (1981). Nutritive value of wet brewer's grains for lactating dairy cows. *Journal of Dairy Science* 64, 1826 – 1832.
5. Yaakugh, I.D.I. and Tegbe, T.S.B. (1990). Performance and carcass characteristics of grower and finisher pigs fed diets containing brewers' dry grains. *Nigerian Agricultural Journal* 24, 31–40.
6. Adebowale, E.A. and Ademosun, A.A. (1981a). The carcass characteristics and chemical composition of the organs and muscles of sheep and goats fed brewers' dried grains-based rations. *Tropical Animal Production* 6, 133 – 137.
7. Adebowale, E.A. and Ademosun, A.A. (1981b). Studies on the utilisation of brewers dried grains by sheep and goats: 1. Growth studies. *Bulletin of Animal Health and Production in Africa* 4, 365 – 370.
8. Oduguwa, B.O., Jolaosho, A.O., Babayemi, O.J., Aina, A.B.J. and Adu, I.F. (2006). Nutritive value of Malted Sorghum Sprout in West African Dwarf sheep fed Soybean Stover based diets. *Journal of Animal and Veterinary Advances* 5, 901 – 906.

9. Okoye, F.C., Ugwuene, M.C. and Ubaeduonu, L.C. (2006). Effect of the replacement of maize with graded levels of sorghum malt (*Sorghum bicolor*) on the performance of broiler chicks. *Agriculture Journal* 1, 77 – 80.
10. Fafiolu, A.O., Oduguwa, O.O., Ikeobi, C.O.N. and Onwuka, C.F.I. (2006). Utilization of malted sorghum sprouts in the diet of rearing pullets and laying hens. *Archivos de Zootechnics Technology* 55, 361 – 371.
11. National Root Crop Research Institute, (NRCRI, 1999). Meteorological Data
12. AOAC (2006). American Official Methods of Analysis. 17th edition, Association of Analytical Chemists International, Gaithersburg, MD.
13. MAFF (1977). Energy allowances and feeding system for ruminants. Technology Bulletin Number 33, Ministry of Agriculture, Fisheries and Food, London.
14. Aduku, A.O. (1993). Tropical feedstuff analysis table. Department of Animal Science, Faculty of Agriculture, Ahmadu Bello University, Samaru-Zaria, Nigeria.
15. Keshab, K.B. and Randy, D.S. (1998). In situ dry matter, crude protein, and starch degradabilities of selected grains and by-product feeds. *Animal Feed Science and Technology* 71, 165 – 176.
16. Ironkwe, M.O. and Bamgbose, A.M. (2012). Effect of replacing maize with brewer's dried grain in broiler finisher diet. *Bulletin of Environment, Pharmacology and Life Sciences* 1, 17–20.
17. Jovanka, L., Olivera, D. and Slavica, S. (2010). Use of new feed from brewery by-products for breeding layers. *Romanian Biotechnological Letters* 15, 5559 – 5565.
18. Aning, K.G., Ologun, A,G,, Onifade, A., Alokan, J.A., Adekola, A.I. and Aletor, V,A, (1998). Effect of replacing dried brewers' grain with sorghum rootlet on growth, nutrient utilization and some blood constituents in the rat. *Animal Feed Science and Technology* 71, 185 – 190.
19. Akinola, A. A. (2002). The utilization of fermented and alkaline treated malted sorghum sprouts (MSP) in the diets of broilers. M. Agric. thesis, department of Animal Production and Health, University of Agriculture, Abeokuta, Nigeria.
20. Oduguwa, O.O., Fanimo, A.O., Oduguwa, B.O., Iyayi, E.A. and Oyadotun, A.I. (2001). Effect of enzyme supplementation on the nutritive value of MSP in the rat. *Tropical Journal of Animal Science* 4, 189 – 195.
21. Frame, J. (1992). Improved grassland management. Farming press books Uk.
22. Aderinola, O.A., Akinlade, J.A. and Akingbade, A.A. (2013). Agronomic performance and nutrient composition of *Andropogon tectorum* as influenced by varied inter-row spacing of *Lablab purpureus* during a minor wet season in the derived Savannah zone of Nigeria. *Journal of Biology, Agriculture and Healthcare* 3, 6 – 10.
23. Obua, B.E., Okocha, C.N. and Nwaoha, L.E. (2012). Proximate composition and anti-nutritional factors of some forage species used in feeding rabbits in Umudike humid south eastern Nigeria. *International Journal of Agriculture and Rural Development* 15, 1275 – 1286.
24. Mecha, I. and Adegbola, T.A. (1980). Chemical composition of some Southern Nigeria forage eaten by goats. In: Browse in Africa: The current state of knowledge. Le Houérou HN ed., International Livestock Centre for Africa, ILCA.
25. Aderinola, O.A. (2011). Agronomic

performance and nutrient composition of *Andropogon tectorum* as influenced by varied inter-row spacing of *Lablab purpureus* during a minor wet season in the derived savannah zone of Nigeria. In: Proceedings of the conference on international research on food security, natural resource management and rural development. Tropentag.

26. Ajayi, F.T. (2012). Dry matter yield, mineral contents and proximate composition of *Panicum maximum* (Jacq var Ntchisi) sown with forage legumes. *Nigeria Journal of Animal Production* 39, 180 – 189.
27. Augustine, C.O., Christian, I.A., Ekaette, O. and Ukpong, S.U. (2012). Effect of malting conditions on the nutritional and anti-nutritional factors of sorghum grist. *AUDJG – Food Technology* 36, 64 – 72.
28. Makun, H.J., Ajanusi, J.O., Ehoche, O.W., Lakpini, C.A.M. and Otaru, S.M. (2008). Growth Rates and Milk Production Potential of Sahelian and Red Sokoto Breeds of Goats in Northern Guinea Savannah. *Pakistan Journal of Biological Sciences* 11, 601 – 606.
29. Olorunnisomo, O.A., Ewuola, E.O. and Lawal, T.T. (2012). Intake and Blood Metabolites in red Sokoto Goats fed Elephant Grass and Cassava Peel Silage. *Journal of Animal Production Advances* 2, 420 – 428.
30. Nuru, S. (1985). Small ruminant production in Nigeria. keynote address at the National conference on small ruminant production in Nigeria, NAPRI Zaria. Pg. 2.
31. Sylva, I.N. (2013). Performance of Red Sokoto goats fed grass forages supplemented with diets formulated from Bambara groundnut (*Vigna subterranean*) offal and PKC. M.Sc. Thesis, Department of Animal Production and Livestock Management, Michael Okpara University of Agriculture, Umudike, Nigeria.