

Nutritional evaluation and growth response of West African dwarf (WAD) sheep fed varying levels of soybean cheese waste diets

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Abstract

Feed shortage and high cost of conventional feed ingredients in the tropics and the keen competition between man and other farm animals necessitated the need to search for alternative feed resources that are cheap, available at all times but not toxic for ruminants to enhance their productivity. Hence, this study examined the fermentation characteristics and performance of West African dwarf (WAD) sheep fed graded levels of soybean cheese waste (SBCW). Three diets were formulated at 0%, 10% and 20% levels of SBCW respectively as D1, D2 and D3. Eighteen WAD sheep averaging 14 kg were randomly allocated to the dietary treatments for 102 days. The crude protein (CP) content of the diets varied significantly ($p < 0.05$) with CP of D1 being lowest (12.18 %) and highest in D3 (17.75 %). The gas volume produced at the end of 24 hrs incubation for D3 was lower than in D1 and D2. The methane volume produced was least in D3 and highest in D1. The calculated organic matter digestibility (OMD), metabolizable energy (ME) and short chain fatty acids (SCFA) values were similar except for D3 which had higher OMD than D1 and D2. Daily dry matter intake (DDMI) of WAD sheep fed D3 was highest compared to other diets. A similar trend was observed in average daily weight gain (ADWG). D3 had the least cost per kg of diet among the others. From the results obtained, it was observed that diet D3 appeared to be the best and economically viable for sheep production.

Keywords: Soybean cheese waste, WAD sheep, growth rate, methane volume, formulated diets

Évaluation nutritionnelle et réponse de croissance des West African Dwarf (WAD) Sheep Fend des niveaux différents de régimes de déchets de fromage de soja



Résumé

La pénurie d'aliments et le coût élevé des ingrédients alimentaires conventionnels dans les tropiques et la vive concurrence entre l'homme et les autres animaux d'élevage ont nécessité la recherche de ressources alimentaires alternatives bon marché, disponibles à tout moment mais non toxiques pour les ruminants afin d'améliorer leur productivité. Par conséquent, cette étude a examiné les caractéristiques de fermentation et les performances des West African Dwarf (WAD) sheep nourris avec des niveaux gradués de déchets de fromage de soja (DFS). Trois régimes ont été formulés à des niveaux de 0 %, 10 % et 20 % de DFS respectivement en tant que D1, D2 et D3. Dix-huit moutons WAD pesant en moyenne 14 kg ont été répartis au hasard entre les traitements diététiques pendant 102 jours. La teneur en protéines brutes (PB) des régimes variait significativement ($p < 0,05$), la PB de D1 étant la

plus faible (12,18 %) et la plus élevée de D3 (17,75 %). Le volume de gaz produit au bout de 24 heures d'incubation pour J3 était inférieur à celui de D1 et D2. Le volume de méthane produit était le plus faible en D3 et le plus élevé en D1. Les valeurs calculées de digestibilité de la matière organique (DMO), d'énergie métabolisable (EM) et d'acides gras à chaîne courte (AGCC) étaient similaires, sauf pour D3 qui avait une DMO plus élevée que D1 et D2. L'apport quotidien en matière sèche (AQMS) des moutons WAD nourris au D3 était le plus élevé par rapport aux autres régimes. Une tendance similaire a été observée dans le gain de poids quotidien moyen (GPQM). D3 avait le moindre coût par kg de régime parmi les autres. D'après les résultats obtenus, il a été observé que le régime D3 apparaissait comme le meilleur et économiquement viable pour la production ovine.

Mots-clés : Déchets de fromage de soja, WAD sheep, taux de croissance, volume de méthane, régimes formulés

Introduction

Global food insecurity and hunger particularly in developing countries like Nigeria is a serious concern to individual and governments (Emaikwu *et al.*, 2011). Generally, in Africa, rearing livestock at household level is a common practice due to its socio economic role (Kosgey *et al.*, 2003). Ruminants especially, are a good source of meat, milk for human consumption and manure for crop cultivation. The intensive production of ruminant in the tropics should, however, be more practical to improve the consumption of more protein in the diets of the masses. Small ruminants have the advantages and ability to convert poor forage to useful products for human consumption such as meat and milk, even in a very hostile environment (Konlan *et al.*, 2012). Therefore, meeting the nutritional requirements of ruminants in terms of protein and energy and other nutrients throughout the year has been a difficult task (Ngele *et al.*, 2010). This is primarily because of the seasonal differences in nutritive value of the natural pastures and high competition between humans and livestock for the available conventional feeds. Feed shortage most especially during the lean period of the year has resulted to high cost of ruminant feeds arising from the high cost of conventional feed ingredients which make the production not

economical.

Improved sheep production could be attributed to its access to a quality feed which is cheaper and available at all time. Alternative feed resources like agro-industrial by-products (AIBs) and crop residues could be a strategic measure to mitigate feed shortage and poor feeding in ruminant production. Many feed resources such as grain brans, shea nut cake (SNC), peels of root and stem tuber, soybean cheese waste (SBCW) are cheaply available where many of them constitute nuisance to the environment, resulting into environmental pollution. Most of these wastes may be integrated into crop-livestock system as feed, bio fertilizer production and bio energy generation instead of allowing them to waste and pose environmental problem to the society. In Nigeria, these wastes could be harnessed and used as supplements to low quality diets for enhanced productivity. FAO (2006) and Sultan *et al.* (2011) confirmed their utilization at various studies. Evidences have shown that feeding livestock with most of the wastes from farm and processing industries did not pose any adverse effect on their performances and health status (Mekasha *et al.*, 2007; Ogunbosoye *et al.*, 2018a and Ogunbosoye *et al.*, 2018b)

Soybean cheese waste (SBCW), rice bran and shea nut cake (SNC) are abundantly produced in the northern part of Nigeria

from the local processing industries causing environmental problems to the public. Incorporating these wastes into the diets of ruminant animals will give many benefits such as reducing environmental pollution, improved animal production, wealth generation and overall poverty alleviation of the rural livestock producers. This study is therefore aimed at investigating the effects of soybean cheese waste based diets on the fermentation characteristics, nutritive value and growth performance of West African dwarf sheep.

Materials and Methods

Processing of soyabean chesse waste

Soyabean cheese waste was obtained from a processing mill. The waste was obtained after the fermentation of soybeans for three days, ground and sieved. The leftover after sieving is the soyabean cheese waste (WBCW).

Treatment and experimental Design

Three diets were compared in a completely randomized design for eighteen (18) yearling growing sheep with an average weight of 14 ± 0.68 kg to determine their growth performance. The experimental animals were allocated to three diet groups with six (6) animals per diet. The diets were formulated (Table 1).

In vitro fermentation study

In vitro gas production was undertaken according to the procedure described by Menke and Steingass (1988) and as modified by Fievez *et al.* (2005) before the commencement of feeding trial.

Syringes preparation

Samples (200 mg) of each diet was accurately weighed into 120 mL calibrated plastic syringe fitted with plungers. The buffer solution as **described by Menke and Steingass (1988)** was prepared and made into 1 litre.

Rumen content and preparation

Rumen content was collected before morning feeding through a suction tube

from the rumen of three (WAD) sheep which were previously fed with wheat offal and guinea grass for three days. The rumen content was kept in insulated flask and taken to the laboratory. The rumen content was squeezed through a 4-layer cheese-cloth, buffered and mixed at 1:4 (v/v) flushing with CO₂. Buffered rumen fluid (30 mL) was pipetted into each syringe containing the 200mg feed samples, and the syringes were immediately placed in the pre-warmed incubator at $39 \pm 1^\circ\text{C}$ for 24 hours, gently shaken every 3 hours and gas production was recorded at 3, 6, 9, 12, 15, 18, 21 and 24 h of incubation. Total gas values were corrected for blank incubation which contains only rumen fluid and buffer in triplicates.

Methane production

At the end of incubation period, 4 mL of NaOH (10 M) was introduced using 5 mL capacity syringe as reported by Fievez *et al.* (2005). The clip was then opened while the NaOH was gradually released. The content was agitated while the plunger began to move to occupy the vacuum created by the absorption of CO₂. The volume of methane produced was read on the calibrated syringes. An average volume of gas produced from the blanks was subtracted from the volume of gas produced per sample.

The gas production characteristics were estimated using the equation $Y = a + b(1 - e^{-ct})$ (as described by Ørskov and McDonald (1979). Where: Y = volume of gas produced at time 't'; a = intercept (gas produced from the soluble fraction); b = potential gas production (ml/ g DM) from the insoluble fraction; c = gas production rate constant (h^{-1}) for the insoluble fraction (b); t = incubation time. Metabolizable energy (ME, MJ/Kg DM) was calculated as $ME = 2.20 + 0.136 GV + 0.057 CP + 0.0029 CF$ (Menke and Steingass, 1988). Organic matter digestibility (OMD %) was estimated as $OMD = 14.88 + 0.889 GV +$

0.45 CP + 0.651 XA (Menke and Steingass, 1988). Short chain fatty acids (SCFA) was measured as $SCFA = 0.0239 GV - 0.0601$ (Getachew *et al.*, 1999). Where GV, CP, CF and XA are total gas volume, crude protein, crude fibre and ash respectively of the incubated samples.

Management of experimental animals

Prior to the commencement of the study, the West African dwarf sheep used for the study were given prophylactic treatments against ecto and endoparasites and bacterial infection with ivermectin and oxy-tetracycline respectively. They were also vaccinated against Pest des Petite Ruminants (PPR) disease. The animals were randomly allotted to the treatments

and balanced for weight.

Feeding trial

Following the acclimatization period of 14 days, the feeding trial was conducted for 102 days. 3% of the body weight of the animals was used to administer feed. The animals were allowed to graze freely within the school farm while the experimental diets were used as supplement. The experimental diets were offered in the morning (08:00-10:00 am) and in the evening after grazing (4:00-6.00 pm). Clean water was also provided *ad libitum* on daily basis. Daily feed intake was measured and weight gain was calculated at the end of each week.

Experimental diets

Table 1. Composition of the experimental diets at varying levels of soybean cheese waste (SBCW)

Ingredients	D 1 (0% SBCW)	D 2 (10% SBCW)	D3 (20 %SBCW)
Rice Bran	40	40	40
Corn Bran	43	33	23
Shea nut cake	10	10	10
Soy bean cheese waste (SBCW)	0	10	20
Bone meal	5	5	5
Salt	2	2	2
Total	100	100	100

Proximate analysis

The diets were analyzed for dry matter (DM), crude protein (CP), crude fibre (CF), ether extract (EE) and ash using the methods of AOAC (2000).

Cost analysis

The cost analysis of each diet was estimated using the prevailing prices of the various ingredients in the Nigerian currency (₦) at the time of the study (Mohammed *et al.*, 2007).

Data collection and statistical analysis

All data collected were subjected to analysis of variance (ANOVA) using General Linear Model procedure of statistical Analysis System (SAS, 2000). Treatment means were separated using least significant difference (LSD) method of the same package.

Results and Discussion

The nutrients analysis of the diets indicated that all the nutrients measured increased as the SBCW level increased in the diets (Table 2). Significant variations ($p < 0.05$) were observed among the parameters except the dry matter and ether extract contents which were statistically similar. The crude protein content of the diets (121.8 – 170.4g/kg) was consistent with the findings of Oni *et al.* (2010) when cassava leaves and other agro-industrial by-products were used in concentrate production to feed WAD goats. Based on the crude protein concentration of the formulated diets, it could be observed that all the diets had enough crude protein contents to meet the requirements of the animals for specific functions and to maintain efficient (delete) microbial

efficiency. The crude protein concentrations of the diet formulated were therefore far above the minimum protein (70-80 g/kg) requirements of ruminant animals for optimum rumen activities feed intake (Van Soest, 1994). Paterson *et al.* (1996) explained that feedstuffs of crude protein less than 70g/kg will need to be supplemented with high level feed to improve the intake and digestion by ruminants. It is therefore implied that the experimental diets, especially diet 3 could be a good supplement to a grazing animal under low quality feeding regime in the dry season.

The net gas volume produced during the 24 hours incubation of diets is presented in Figure 1. It was observed that at the end of fermentation, there was downward decreased in the net gas produced as the soybean cheese waste increased in the diets. Diet 1 recorded the highest volume gas production while diet 3 gave the lowest at the end of fermentation. From the diet composition, Diet 1 contained the highest percentage of corn bran and diet 3 had the highest concentration of protein source. The proportions of corn bran and soybean cheese waste in the experimental diets may be the contributing factor to the low level of gas volume produced among the diets. Blummel *et al.* (1993) reported that more gas volume is generated from the feed with high carbohydrates than diet of protein source during fermentation. Fievez *et al.* (2005) affirmed that *in vitro* gas fermentation of any diet could be likened to digestibility of such feed. The fermentation characteristics, metabolizable energy (ME), short chain fatty acids (SCFA) and organic matter digestibility (OMD) of the formulated diets were depicted in Table 3. The soluble fractions 'a', the insoluble but degradable fractions 'b' and potential gas production 'a+b' were not also significantly

different among the diets but diet 3 took higher time for its degradation. The reason for D3 to take longer time in digestion might be due to the fact that it contains more soybean waste than the other diets which may take longer time to be attacked by the rumen microbes. There will be more escaped protein into the abomasum which is located in the lower GIT of the animals. This fact could be linked with the better growth rate observed among the group of sheep fed D3. The OMD, SCFA and ME were observed to be statistically similar among the diets but numerically highest in diet 3. Similar observations were reported elsewhere (Babayemi and Bamikole, 2006) when guinea grass was replaced with *Tephrosia candida*, a plant with high protein content in diet of ruminants using *in vitro* fermentation. These values were rather at variance with the report of Kanber *et al.* (2018) during the *in vitro* fermentation of barley-based feed of beef cattle.

The methane production was also significantly different for the three diet groups with diet 1 exhibited the highest methane volume production (Figure 2). Methane volume produced among the diets decreased with increased level of soybean cheese waste. However, the volume of methane produced in this study was higher than the value obtained when a barley-based diet was evaluated *in vitro* Kanber *et al.* (2018). The same reasons stated above may be responsible for the low methane production in diet 3. Methane production during rumen degradation is a colossal loss to the animal and its contribution to global warming is not over-emphasized. Therefore, every effort must be made to reduce methane emission into the atmosphere. So, diet 3 having lowest methane volume could be used as a means of reducing greenhouse emission and at the same time improve sheep' performance.

Table 2: Nutrients analysis (g/kg DM) of the formulated diets at graded levels of SBCW inclusion

Parameters	Diets			SEM
	D1 (0% SBCW)	D2 (10% SBCW)	D3 (20% SBCW)	
Dry matter	920.3	915.3	912.5	1.38
Crude protein	121.8c	156.5b	177.5a	0.59
Crude fiber	170.4a	146.5b	182.3b	0.56
Ash	129.0b	131.0b	169.0a	0.83
Ether extract	50.5	70.4	74.7	0.99

^{a,b,c} Means with the different superscripts along the row are significantly different (P<0.05)

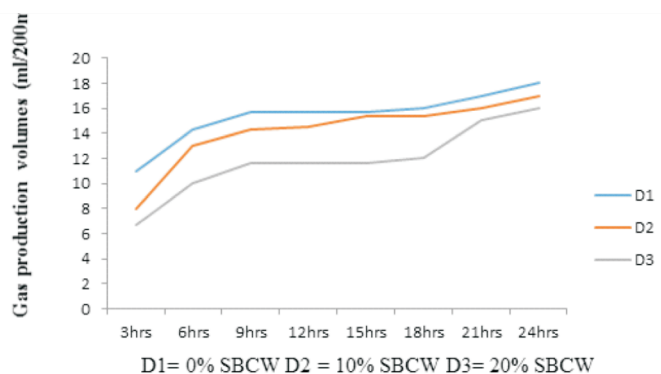


Figure 1: Gas production volume (mL/200mgDM) of the experimental diets over a 24 hr incubation

Table 3: Gas production characteristics and metabolizable energy (ME, MJ/kg DM), organic matter digestibility (OMD %) and short chain fatty acids (μ mol) of the experimental diets.

Treatment	a (ml)	b (ml)	a+b (ml)	c (ml)	t(h ⁻¹)	Y (ml)	OMD	ME	SCFA
D1	7.0	11.0	18.0	0.145	6	14.33	37.0	5.34	0.32
D2	8.0	9.0	17.0	0.13	6	13.0	37.2	5.39	0.35
D3	6.67	9.33	16.0	0.12	7	12.67	39.08	5.58	0.37
SEM	NS	NS	NS	NS	NS	NS	NS	NS	NS

Y = volume of gas produced (ml/200 mg DM) at time t, a = gas production (ml) from the soluble fraction, b = gas production (ml) from insoluble fraction, c = gas production rate (h⁻¹) constant from insoluble fraction b, a + b = potential gas production (ml), t = incubation time; D1= 0% SBCW D2 = 10% SBCW D3= 20% SBCW NS= Not significant

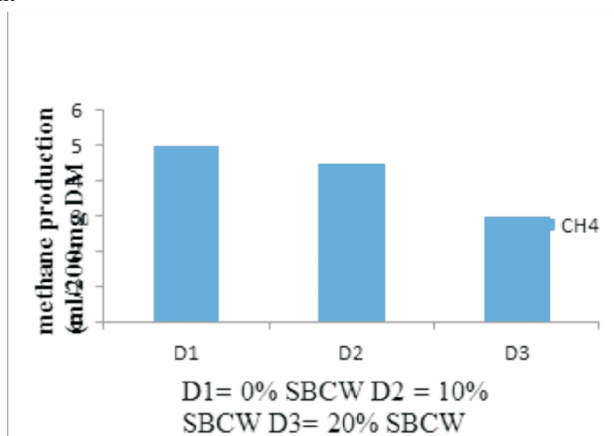


Figure 2: Methane production (mL/200mgDM) of the experimental diets

Table 4: The growth performance of West African dwarf sheep fed soybean cheese waste based diets

Parameters	D1 (0 % SBCW)	D2 (10 % SBCW)	D3 (20 % SBCW)	SEM
Average initial Weight (kg)	13.75	14.0	13.75	0.68
Average final Weight (kg)	16.50 ^b	17.88 ^a	18.90 ^a	0.40
Total weight gain	2.75 ^c	3.88 ^b	5.15 ^a	0.23
Average daily weight gain (g)	26.96 ^b	38.03 ^{ab}	50.49 ^a	1.09
Total feed Intake (kg)	30.13 ^b	33.57 ^{ab}	35.23 ^a	1.47
Daily dry matter intake (g)	295.39 ^b	329.11 ^a	345.39 ^a	6.04
Feed conversion ratio (gDM/gADWG)	10.47 ^a	8.65 ^{ab}	6.84 ^b	1.29
Cost of diet/kg (₦)	28.1	24.3	20.3	NA
Cost of diet/unit weight gain (₦/kg)	10.22	6.26	3.94	NA

^{a,b,c} Means with the different superscripts along the the row are significantly different (P<0.05)

The growth performance indices from the study revealed that there were significant differences in the parameters measured among the diet groups (Table 4). There was progressive increase in both average feed intake and average weight gain as the level of soybean cheese waste increased in the formulated diets. Feed conversion ratio (FCR) was highest for the group of sheep fed at 0% soybean cheese waste. There were significant variations ($p < 0.05$) in all the growth parameters measured in this study. The increase in the daily weight gain of the sheep down the diets may be as a result of the improved taste and texture of the diets. This may not be unconnected with the high concentration of protein in the diets, suggesting the increased palatability of the diets. However, the daily dry matter intakes of the animals in this study were lower than what was reported elsewhere (Oni *et al.*, 2010) when West African dwarf goats were fed cassava leave-based concentrate diets. The lower intake in this study might be attributed to the fact that the animals were on grazing and the intake during grazing could not be quantified. However, the results compared favorably to the findings of Tona *et al.* (2014) when moringa leaves were included in the diet of goats. Both final weight gain and daily feed intake obtained here were consistent with Oni *et al.* (2010), higher than that of Tona *et al.* (2014) with WAD goats but lower than the results obtained when Djallonke sheep were fed supplemented

diets (Ansah *et al.* 2012 and Ogunbosoye and Babayemi, 2012) where pregnant WAD goats were fed five tropical forages. The variations in the reported results when compared with this study may be due to some factors like feed composition, the health status of the animals at the time of the experiments, the various ingredients used and management system the animals are subjected to. The feed conversion ratio (FCR) was least in the group sheep fed diet at 20% SBCW inclusion and highest at 0% inclusion. This is indicating that sheep on D3 were able to utilize feed more efficiently than the other animals fed diets D1 and D2. The least cost of feed/kg was recorded for diet 3 (N20.3) and the lowest cost/unit weight gain was also observed from the same group of animals fed 20% SBCW diet. The cost of each diet and cost/unit weight gain decreased progressively with the increasing level of soybean cheese waste in diets. Esonu *et al.* (1997) and Anyanwu *et al.* (2003) observed similar trend when soybean hulls and Bambara groundnut were used to partially replace maize in broiler diets respectively. The result was also in consistent to the finding of Maigandi *et al.* (2002) using fore stomach digesta in the diet of sheep. This is an indication that feeding ruminant animals with the locally available wastes could increase ruminant productivity at a low cost of production. In conclusion, the results of this study reveal that ruminant productivity could be enhanced with the introduction of diet

containing 20% soybean cheese waste to WAD sheep. Locally available agro-industrial by-products if well formulated could improve ruminant performance at the least cost.

References

- A.O.A.C. 2000.** Association of Official Analytical Chemists: *Official Methods of Analysis*. 17th Edition. Washington DC, USA.
- Ansar, T., Konlan, S.P., Ofori, D.K. and Awudza, H.A. 2012.** Effect of agro-industrial by-products supplementation on the growth performance and hematology of Djallonke sheep. *Ghanian Journal of Animal Science*, 6(1), 96-99.
- Anyanwu, G.A., Esonu, B.O., Iwuala, E., Okorie, and Etuk, C.B. 2003.** Bambara Groundnut (*Voandzeia severance (L) Thours* offal as Partial substitute for maize in broiler diets. *Tropical Animal Production Investigation* 6: 55-61.
- Babayemi, O.J and Bamikole, M.A. 2006.** Effects of Tephrosia candida DC leaf and its mixture with Guinea grass on *in vitro* changes as feed for ruminants in Nigeria. *Pakistan Journal of Nutrition*, 14-16.
- Blummel, M and Ørskov, E.R. 1993.** Comparison of *in vitro* gas production and nylon bag degradability of roughages in predicting feed intake in cattle. *Animal Feed Science Technology* 40:109-119.
- Emaikwu, K. K., Chikwendu, D. O. and Sani, A. S. 2011.** Determinants of flock size in broiler production in Kaduna State of Nigeria. *Journal of Agricultural Extension and Rural Development* Vol. 3(11), pp. 202-211.
- Esonu, B.O., Etuk, E.B., and Ezigbo, O.C. 1997.** Determination of optimal dietary level of soybean hulls for broilers. *JOTEN*, 2 (1&2): 76-84.
- FAO. 2006.** Food and Agricultural Organization of the United Nations (Suttie, J.M). Retrieved June 2014, from www.fao.org
- Fievez, V., Babayemi, O. J and Demeyer, D. 2005.** Estimation of direct and indirect gas in syringes. A tool to estimate short chain fatty acid production that requires minimal laboratory facilities. *Animal Feed Science and Technology* 123 -124: 197-21.
- Food and Agricultural Organization. 2003.** State of Food and Agriculture, Rome, Italy.
- Getachew, G., Makkar, H. P. S and Becker, K. 1999.** Stoichiometric relationship between short chain fatty acid and *in vitro* gas production in presence and absence of polyethylene glycol for tannin containing browse. EAAP Satellite Symposium, Gas production fermentation kinetics for feed evaluation and to assess microbial activity. August 18-19. Wageningen, Netherlands.
- Kanber Kara., Serkan Özkaya., Sabri Erbaş and Erol Baytok. 2018.** Effect of dietary formic acid on the *in vitro* ruminal fermentation parameters of barley-based concentrated mix feed of beef cattle. *Journal of Applied Animal Research*, 46:1, 178-183.
- Konlan, S.P., Karikari, P.K. and Ansah, T. 2012.** Productive and Blood Indices of Dwarf Rams Fed a Mixture of Rice Straw and Groundnut Haulms Alone or Supplemented with Concentrates Containing Different Levels of Shea Nut Cake. *Pakistan Journal*

- of Nutrition* 11 (6): 566-571.
- Kosgey, I. S., Van Arendok, J. A. M., and Baker, R. L. 2003.** Economic values for traits of meat sheep in areas of the tropics with medium to high production potential. *Small Ruminant Research*, 50, 187-202.
- Maigandi, A. H., Tukur, M and Daneji, A.I. 2002.** Fore-stomach digesta in the diet of growing sheep 1. Performance and economics of production. *Sokoto Journal of Veterinary Sciences*, 4(2): 16-21.
- Mekasha, Y., Tegegne, A and Rodriguez-Martinez, H. 2007.** Effect of supplementation with agro-industrial by-products and Khat (*Catha edulis*) leftovers on testicular growth and sperm production in Ogaden bucks. *Journal of Veterinary Medicine* 54, 147-155.
- Menke, K.H and Steingass, H. 1988.** Estimation of the energetic feed value from chemical analysis and in vitro gas production using rumen fluid. *Animal Research Development*, 28:7-55.
- Mohammed, I.D., Baulube, M. and Adeyinka, I.A. 2007.** Multi-nutrient blocks: Formulation and production under a semi-arid environment Of North East Nigeria. *Journal of Biological Science* 7(2): 389-392.
- Ngele, M.B., Adegbola, T.A., Bogoro, S. E. F., Abubakar, M. and Kalla, D. J. U. 2010.** Nutrient intake, digestibility and growth performance of Yankasa sheep fed urea -treated or untreated rice straw with supplement. *Nigeria Journal of Animal Production*, 37(1), 61-70.
- Ogunbosoye, D.O and Babayemi, O.J. 2012.** The utilization of some tropical browse plants by pregnant West African Dwarf goats in southern Nigeria. *International Journal of Environmental Sciences*, Vol. 1 No. 4. Pp. 224-229.
- Ogunbosoye, D.O., Akinfemi, A and Ajayi, D.A. 2018a.** Blood profiles of West African dwarf (WAD) growing bucks fed varying levels of shea nut cake based rations in Nigeria. *Cogent Food & Agriculture* (2018), 4: 1-9.
- Ogunbosoye, D.O., Akinfemi, A and Otukoya, F.K. 2018b.** The efficacy of multinutrients feed block using shea nut cake with other agro industrial by-products and its acceptability by West African dwarf goats in Nigeria. *Wayamba Journal of Animal Science* pg. 1630- 1635.
- Oni, A.O., Arigbede, O.M., Oni, O.O., Onwuka, C.F.I., Anele, U.Y., Oduguwa, B.O. and Yusuf, K.O. 2010.** Effects of feeding different levels of dried cassava leaves (*Manihot esculenta*, Crantz) based concentrates with *Panicum maximum* basal on the performance of growing West African dwarf goats. *Livestock Science* 129, 24-30.
- Orskov, E.R. and McDonald, I. 1979.** The estimation of protein degradability in rumen from incubation measurements weighted according to the rate of passage. *Journal of Agricultural Science Cambridge*. 92: 449- 503.
- Paterson, A.H., Lan, T.H., Reischmann, K.P., Chang, C., Lin, Y.R., Liu, S.C., Burow, M.D., Kowalski, S.P., Katsa, C.S., DelMonte, T.A., Feldmann, K.A., Schertz, K.F. and Wendel, J.F.I 1996.** Toward a unified genetic map of higher plants, transcending the monocot-

- dicot divergence. *Nature Genetics*. 14:380-382.
- Statistical Analysis Systems (SAS) Institute Inc. 2000.** SAS/ STAT. User's guide version 6. 3rd Ed. Cary. North Carolina, USA.
- Sultan, S., Kushwaha, B. P., Nagl, S. K., Mishra, A. K., Bhattacharya, S., Gupta, P. K., and Singh, A. 2011.** In vitro methane emission from Indian dry roughages in relation to chemical composition. *Current Science*, 101.
- Tona, G.O., Ogunbosoye, D.O. and Bakare, B.A. 2014.** Growth performance and nutrient digestibility of West African Dwarf goats fed graded levels of *Moringa oleifera* leaf meal. *International Journal of microbiology and Applied Sciences* 3 (8) 99-106.
- Van Soest, P.J. 1994.** Nutritional ecology of the ruminant. 2nd. ed. Cornell University Press.
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