integrity Research Journals

Journal of Agricultural Science and Practice
Volume 9(1), pages 9-15, February 2024
Article Number: 39C5DD9B2
ISSN: 2536-7072
https://doi.org/10.31248/JASP2023.449
https://integrityresjournals.org/journal/JASP

Full Length Research

Apparent nutrient digestibility and nitrogen utilization of *Panicum maximum*-based diets fed to West African Dwarf (WAD) sheep

Adebayo, B. J.* and Alao, O. E.

Department of Agricultural Technology, School of Agricultural Technology, Yaba College of Technology, Lagos, Nigeria.

*Corresponding author. Email: babatunde.adebayo@yabatech.edu.ng

Received 14th November 2023; Accepted 9th January 2024

ABSTRACT: An experiment was carried out to investigate the apparent nutrient digestibility and nitrogen utilization of feed for West African Dwarf (WAD) sheep fed five selected plants in small ruminant research farm, Yaba College of Technology, Lagos. Twenty WAD sheep were subjected to five dietary treatments with four animals per treatment in a completely randomized design for an *in vivo* experiment that lasted for 84 days. The animals were fed *Anacardium occidentale, Gmelina arborea, Mangifera indica* and *Gliricidia sepium* leaves using *Panicum maximum* as a basal diet. Dry matter (DM) digestibility varied ($p<0.05$) between sheep fed *Mangifera indica* + *Panicum maximum* and *Anacardium occidentale* + *Panicum maximum* respectively. Crude protein digestibility was highest ($p<0.05$) in sheep fed *Anacardium occidentale* + *Panicum maximum* and lowest in sheep fed *Mangifera indica* + *Panicum maximum*. Nitrogen digestibility ranged from 79.64% in animals fed *Panicum maximum* (control) to 93.62% in animals fed *Anacardium occidentale* + *Panicum maximum*. Sheep fed *Anacardium occidentale* + *Panicum maximum* had highest ($p<0.05$) value (1.63 g/d) urinary nitrogen while the lowest value (0.65 g/d) was observed in animals fed *Mangifera indica* + *Panicum maximum.* Nitrogen absorbed had least value (2.36g/d) in animals fed the control diet whereas significant highest value was recorded in animals fed *Anacardium occidentale* + *Panicum maximum* (7.56g/d). The study concluded that sheep fed *Anacardium occidentale* supplemented with *Panicum maximum* had the higher values of nutrient digestibilities and nitrogen intake.

Keywords: Crude protein, microbial fermentation, forages, *in vivo* study, ruminants.

INTRODUCTION

Sheep and goats constitute a good source of family income and livelihood, assets and agricultural resources for smallholder farmers (Okafor, 2010). This makes small ruminant farming an important and secured form of agricultural investment for the Nigerian rural and urban farmers. This observation was further buttressed by Ceyhan and Karem (2010), who reported that livestock and livestock products particularly from small ruminants accounted for 56% in value terms (income) in typical smallholder mixed farming settings. This again underlines the valuable contribution of small ruminants as income generating assets among smallholder livestock farmers (Shittu *et al*., 2008; Ahaotu and Ifut, 2018). They are kept mainly as a secondary investment and require minimal input. Integration of sheep with crop agriculture usually occurs under subsistence conditions on small-scale farmers. They form an integral part of the system by providing milk, meat, manure and cash to the farm family during the time of need. Sheep and goats are efficiently reared on marginal lands and are good users of crop residues (Opara, 2010). As such, they provide the only practical means of using vast areas of natural grasslands in regions, where crop production is almost impracticable (Nlemadim, 2010). Small ruminants have been reported to be prolific and need only short gestation periods to increase flock size (Thonney and Hogue, 2007). This, therefore makes traditional small ruminant production system a low input but high output enterprise with predictable profitability and economic returns (Emokoro and Amadasun, 2012).

Sheep production is an important component of Nigerian livestock industry. Sheep represents about 60% of the total grazing domestic livestock in Nigeria (Ahaotu *et al*., 2009). These animals display a unique ability to adapt and survive in areas where they are found and consequently their wide geographical distribution in Nigeria (Ahaotu, 2018). Sheep supply meat, milk, wool, skin and other products. It also serves as a flexible financial reserve for the rural population as well as play other socio-cultural roles in the customs and tradition of many Nigerian societies (Alionye *et al*., 2020). It has been observed that only 8.0 gm of the 53.8 gm of protein consumption level of Nigerians per day is derived from animal sources (Gatenby, 2009; Ahaotu and Ayo-Enwerem, 2008), suggesting less than 16% contribution of animal products to protein consumption of Nigerians. This is very poor indeed when compared with countries like U.S.A with about 69% of total protein being derived from animal sources (Getachew *et al*., 2010).

Contribution of sheep to the total meat supplies in Nigeria may be related to the population of these animals in the country. Keeping of sheep also serves as an alternative investment and a source of additional income to the owners. Majority of the sheep population in the country are owned by small-holder rural livestock farmers (Ahaotu *et al*., 2017).

Sheep contribute enormously to the protein requirements of most developing countries (Ahaotu *et al*., 2009). In Sub-Saharan Africa, sheep provide almost 30% of the meat consumed and around 16% of the milk produced. Yakaka and Bashir (2012) estimated that sheep and goats contribute about 35% of the total animal meat production in Nigeria. This ranks small ruminants as the second most important suppliers of meat protein to the population after cattle (Ugwumba and Effiong, 2013). Despite the enormous contributions of the small holder farmer to the Nigeria's livestock economy and develop-ment programs, and in spite of the special attributes possessed by small ruminants, the productivity potential of these animals is yet to be fully exploited (Yakaka and Bashir, 2012). Some of these productivity attributes include the ability of small ruminants to highly adapt to a broad range of environments utilizing a wide variety of plant species (Okafor, 2010), as well as not being prone to high feed competition with other species like cattle and camels (Opara, 2010). Due to their short generation time in terms of gestation period and high fecundity (Nlemadim, 2010), sheep are generally known to have high production efficiency. During periods of unpredictable food shortage, sheep have proven very useful to human beings in the supply of meat and milk products (Madubuike, 2012).

A major constraint to small ruminants production in Nigeria is the scarcity and fluctuating quantity and quality of the year-round feed supply (Fajemisin *et al*., 2013). This has been the basic reason for poor performance of livestock. Small ruminants suffer scarcity of feed supply and pasture quality in the humid region of West Africa, especially during the dry season when the natural vegetation is of poor nutritive value (Aye and Adegun, 2010). Specifically, for small ruminant production in Nigeria, Ahamefule and Elendu (2010) identified feed shortage as a major constraint. Conventional feed resources present and accessible during the dry season are costly for animals due to competition with mankind for livelihood (Lamidi and Ologbose, 2014). This has necessitated the investigation of low-cost alternative feed sources capable of meeting the nutritional requirement of animals. During the dry season, the native rangelands and crop residues available for ruminants after crop harvest are usually fibrous and devoid of most essential nutrients including proteins, energy, minerals and vitamins. These nutrients are required for increased rumen microbial fermentation and improved performance of the host animal (Osuji *et al.*; 1995). Deficiencies will result in weight losses, low birth weights, lowered resistance to disease, and reduced animal performance (Onwuka *et al*., 1989). In response to these challenges, the usual practice has been to supplement livestock diets with protein rich ingredients such as groundnut cake (GNC), soybean meal (SBM) and cotton seed cake (CSC). Concentrate mixtures including cereal grains, cereal bran and oil seed meals have resulted in increased intake in intensive production systems, and such strategies have been the subject of several excellent reviews, including that of Bangani *et al*. (2002). Unfortunately, these supplements are often not fed due to their unavailability and their high costs (Nouala *et al*., 2006; Olomola *et al*., 2008). A cheaper alternative of enhancing utilization of low quality grass is by supplementation with the foliage of high nitrogen multipurpose trees (Norton 1994; Abdulrazak *et al*., 1997). Browse plants with high nutritive values have been successfully fed to small ruminants in alley farming systems (Fasae and Alokan, 2006). Several indigenous and exotic browse species have been investigated and evaluated for inclusion in ruminant feeding system in Nigeria (Fadiyimu *et al*., 2011). Supplementation of low quality natural grass with browse plant leaves is cheaper than the commercial concentrates (Ondiek *et al*., 2000). Multipurpose trees and shrubs have hitherto not been systematically exploited for strategic year round livestock production but they could be used to improve livestock production during dry season because of availability all year round. Multipurpose trees and shrubs are considered to be high in the production of good quality forage in terms of protein and mineral contents, palatability and digestibility (Ogunbosoye and Babayemi, 2012). Therefore, urgent attention of animal nutritionists is required in providing alternative feed resources for feeding

WAD sheep.

MATERIALS AND METHODS

Location of the experiment

This study was conducted at the Teaching and Research Farm of Animal Production Technology Department, Yaba College of Technology, Epe Campus, Nigeria. The farm is located on latitude 3.58ºN and longitude 6.47ºE (Google Earth, 2022).

Experimental animals

Twenty West African Dwarf growing sheep of about 5 – 7 months were used for the experiment. They were purchased from Epe and its environs. Before the commencement of the experiment, the animals were treated against both internal and external parasites using injectable Ivermectin and oxytetracycline. The animals were allowed to acclimatize for a month before the commencement of the feeding trial. The animals were fed 1 kg of the feed daily at 5% body weight and the feeding trial lasted for three months.

Experimental management and design

The animals were randomly allocated to five treatments with four animals per treatment in a Completely Randomized Design (CRD). The study was carried out during the dry season. *Panicum maximum* was harvested before flowering and the whole plant was given to the animals. According to Omoniyi (2014), the experimental diets were as follows:

T_1 - control- 100% of *Panicum maximum.*
T_2 - 40% of *Mangifera Indica* leaves with 60% *Panicum maximum.*
T_3 - 40% of *Gmelina arborea* leaves with 60% *Panicum maximum.*
T_4 - 40% of *Anacardium occidentale* leaves with 60% *Panicum maximum.*
T_5 - 40% of *Gliricidia sepium* leaves with 60% *Panicum maximum.*

Digestibility studies

Three animals per treatment were weighed and transferred into individual metabolic cages for 14 days. During the last seven days, faeces and urine excreted by each animal were collected; weighed and 10% was kept for analyses. Digestibility experiment was carried out by the total faecal and urine collection (McDonald *et al*., 1987). Weights of the sheep were measured at the beginning and at the end of the collection period. Urine samples were frozen while faecal samples were oven dried at 60°C to constant weight, ground and store in air tight container pending analysis. To avoid ammonia losses, urine was collected into bottles with few drops of concentrated H_2SO_4. Kjeldahl method was used to analyse nitrogen utilization.

Chemical analysis

Oven dried faecal samples were analysed for their proximate compositions such as crude protein, crude fibre, ether extract and ash content (AOAC, 2000). Neutral detergent fibre (NDF), acid detergent fibre (ADF) and acid detergent lignin (ADL) were determined using the Van Soest *et al*. (1991). Cellulose and hemicellulose were calculated as differences between ADF and ADL, and NDF (neutral detergent fibre) and ADF respectively.

The formulae for calculating the dry matter digestibility and crude fiber digestibility

$$\text{DM digestibility} = \frac{\text{FI (kg. M)} - \text{EO (kg. M)}}{\text{Feed Intake (kg. DM)}} \times 100$$

$$\text{CF digestibility} = \frac{\text{CF in feed } - \text{CF in excreta}}{\text{CF in feed}} \times 100$$

DM = Dry matter, and CF = Crude fiber, FI = Feed intake, EO = Excreta output.

Experimental design and statistical analysis

The experimental design was of completely randomized design. All data collected were subjected to one-way Analysis of Variance (ANOVA) while significant differences among means were compared using Duncan's Multiple Range Test using version 9.1 of SAS software (SAS, 2008).

RESULTS

Apparent nutrient digestibility coefficient (%) of the selected plants consumed by WAD sheep

Apparent nutrient digestibility coefficient (%) of WAD sheep fed selected browse plants with *Panicum maximum* as shown in Table 1. Diets showed significant differences in all the parameters measured. The DM digestibility range from 78.12 in sheep fed *Mangifera indica* + *Panicum maximum* to 87.42% in sheep fed *Anacardium occidentale*

Table 1. Apparent nutrient digestibility coefficient (%) of WAD sheep fed selected plants.

Parameters (%)	*P. maximum* only	*P. maximum + Mangifera indica*	*P. maximum + Gmelina aborea*	*P. maximum + Anacardium occidentale*	*P. maximum + Gliricidia sepium*	SEM	P value
Dry matter	80.88 ^{ab}	78.12 ^{b}	78.58 ^{b}	87.42 ^{a}	84.04 ^{ab}	1.26	0.0001
Crude protein	92.11 ^{ab}	90.60 ^{b}	92.12 ^{ab}	95.12 ^{a}	94.94 ^{a}	0.66	0.0001
Ether extract	89.37 ^{ab}	84.54 ^{b}	82.91 ^{b}	95.16 ^{a}	88.03 ^{b}	1.38	0.0001
Organic matter	93.28 ^{ab}	90.87 ^{b}	89.69 ^{b}	95.60 ^{a}	93.95 ^{ab}	0.75	0.0001
NDF	92.44 ^{ab}	88.80 ^{bc}	87.09 ^{c}	95.32 ^{a}	92.41 ^{ab}	0.97	0.0001
ADF	93.10 ^{ab}	88.47 ^{bc}	87.63 ^{c}	95.45 ^{a}	92.12 ^{abc}	0.95	0.0001
ADL	92.92 ^{a}	87.36 ^{c}	88.27 ^{bc}	95.93 ^{a}	92.08 ^{abc}	1.00	0.0001
Crude fibre	92.42 ^{ab}	86.90 ^{bc}	84.34 ^{c}	94.74 ^{a}	90.26 ^{ab}	1.20	0.0001

^{abc} Means along the same column with different superscripts are significantly different (p<0.05). **Key:** NDF = Neutral detergent fibre, ADF= Acid detergent fibre, ADL = Acid detergent lignin, SEM = Standard error of means.

Table 2. Nitrogen utilization of WAD sheep fed selected plants.

Parameters	*P. maximum* only	*P. maximum + Mangifera indica*	*P. maximum + Gmelina aborea*	*P. maximum + Anarcadium occidentale*	*P. maximum + Gliricidia sepium*	SEM	p-value
Nitrogen intake (g/d)	2.95 ^{c}	3.08 ^{c}	2.96 ^{c}	8.08 ^{a}	5.36 ^{b}	0.54	0.0001
Faecal nitrogen (FN) g/d	0.60	0.57	0.56	0.52	0.52	0.02	0.0001
Urinary nitrogen (UN) g/d	1.15 ^{b}	0.65 ^{c}	1.00 ^{b}	1.63 ^{a}	1.20 ^{b}	0.09	0.0001
Total (FN+UN)	1.74 ^{b}	1.22 ^{c}	1.56 ^{b}	2.15 ^{a}	1.73 ^{b}	0.09	0.0001
Nitrogen absorbed (g/d)	2.36 ^{c}	2.51 ^{c}	2.39 ^{c}	7.56 ^{a}	4.84 ^{b}	0.55	0.0001
Nitrogen balance (g/d)	1.21 ^{c}	1.86 ^{c}	1.39 ^{c}	5.93 ^{a}	3.63 ^{b}	3.84	0.0001
Nitrogen balance (%)	40.66 ^{c}	60.07 ^{ab}	45.95 ^{bc}	73.37 ^{a}	67.55 ^{a}	3.84	0.0001
Nitrogen digestibility (%)	79.64 ^{b}	81.28 ^{b}	80.63 ^{b}	93.62 ^{a}	90.16 ^{a}	1.68	0.0001

^{abc} Means along the same column with different superscripts are significantly different (p<0.05). SEM = Standard error of mean.

+ *Panicum maximum* respectively. The crude protein digestibility significantly (p<0.05) higher value of 95.12% was observed in sheep fed *Anacardium occidentale* + *Panicum maximum* while the lower value of 90.60% was observed in sheep fed *Mangifera indica* + *Panicum maximum* (P<0.05). Sheep fed *Anacardium occidentale* + *Panicum maximum* indicated the higher ether extract and organic matter digestibility while the lower values were noticed in animals fed with *Gmelina aborea* + *Panicum maximum*. Sheep fed *Anacardium occidentale* + *Panicum maximum* had the highest values for NDF (neutral detergent fibre) (95.32%) and ADF (95.45%) digestibility. *Gmelina aborea* recorded the least value for crude fibre digestibility (84.34%) across the selected plants.

Nitrogen utilization of WAD sheep fed the selected plants

Presented in Table 2 is nitrogen utilization of WAD sheep fed browse plants with *Panicum maximum.* No statistically significant (p>0.05) differences were observed in the values of the faecal nitrogen parameters. Sheep fed a combination of *Panicum maximum* + *Anacardium occidentale* had a significantly higher nitrogen intake value (8.08 g/d) compared to the control group with *Panicum maximum* (2.95 g/d). Nitrogen digestibility percentage ranged from 79.64% in sheep fed *Panicum maximum* (control) to 93.62% in sheep fed *Panicum maximum* + *Anacardium occidentale*. Sheep fed *Panicum maximum* + *Anacardium occidentale* had highest (p<0.05) value (1.63g/d) in urinary nitrogen while the lowest value (0.65 g/d) was observed in animals fed *Panicum maximum* + *Mangifera indica*. Nitrogen absorption was least in animals fed the control diet while animals fed *Panicum maximum* + *Anacardium occidentale* had the higher value (7.56 g/d). Sheep fed *Panicum maximum* (control) recorded lowest nitrogen balance (1.21 g/d) while the highest value (5.93 g/d) was observed in animals fed *Panicum maximum* + *Anacardium occidentale.* The highest nitrogen balance (73.39%) was obtained in animals fed *Panicum maximum*+ *Anacardium occidentale* while the least value (40.66%) was recorded in animals fed the control diet.

DISCUSSION

Addition of browse plants to the basal diet of *Panicum maximum* improved the digestibility of sheep. The least dry matter (DM) and crude protein (CP) digestibility observed in sheep supplemented with *Mangifera indica* could be attributed to the least intake of the plant by sheep. The CP digestibility values observed in this study were higher than the reported range in goats fed with *Moringa oleifera* and some browse forages (Asaolu *et al.,* 2011). Higher organic matter (OM) digestibility range values (89.69 – 95.60%) were recorded in this finding when compared with the reported values by Wada *et al.* (2014) when graded levels of *Parkia biglobosa* was used in a concentrate diet fed to Yankasa rams. The high digestibility values obtained for the nutrient in *Gmelina aborea, Anacardium occidentale and Gliricidia sepium* browse plants suggest that the plants were highly degraded in the rumen.

Effects of the selected browse forages were observed in the nitrogen utilisation of the sheep. The highest nitrogen intake in this study was obtained in sheep fed with *Panicum maximum* + *Anacardium occidentale* while the least was recorded in *Panicum maximum* (control). The highest nitrogen intake observed in *Panicum maximum* + *Anacardium occidentale* was higher than the highest nitrogen intake observed in WAD goats fed with Mango leaves + *Panicum maximum* + concentrate (Ajayi *et al*., 2005). The range of nitrogen intake observed in the current study was higher than the range observed in WAD goats fed with Elephant grass and different proportion of plantain and mango peels (Okoruwa *et al*., 2013). Wada *et al.* (2014) reported higher values of nitrogen intake when graded levels of *Parkia biglobosa* was used in a concentrate diet fed to Yankasa rams, however, the least nitrogen intake observed in this study which was observed in sheep fed with *Panicum maximum* (control) was lower when compared with the reported values by Okoruwa *et al*. (2013) who reported a value of 18.67 g/d when WAD goats were fed elephant grass with concentrate diet and Wada *et al*. (2014) with a reported value of 23.72 g/d when Yankasa rams were fed graded level of *Parkia biglobosa* with concentrate diet.

The range (0.65 – 1.63 g/d) of urinary nitrogen observed in this study fell below the reported values by Okoruwa *et al*. (2013). The range of faecal nitrogen observed in this current study was lower than the reported values in WAD goats fed with some selected browse forages (Isah *et al*., 2013) while the percentage nitrogen retained observed in the present study fell within the reported values by Isah *et al*. (2013). The positive nitrogen balance values obtained in all the treatments indicated that the maintenance requirements of the experimental animals were adequately met by the rations they consumed; this could also be explained by the fact that none of the experimental animals lost weight during the study.

Conclusion

The present study extends the frontiers of knowledge on the potentials of browse plants. Nutrient digestibility and nitrogen utilization of WAD sheep were high and comparable through supplementation with *Gmelina aborea, Anacardium occidentale,* and *Gliricidia sepium*. High organic matter digestibility in *Anacardium occidentale* and *Gliricidia sepium* showed that the diets would be a better source of protein and energy to support the growth performance of ruminants especially during the period of feed scarcity.

Recommendation

Selected forages can be included in the diet of ruminants when fed high or low quality forage grass to improve the nutrient intake of ruminants.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

REFERENCES

Abdulrazak, S. A., Muinga, R. W., Thorpe, W., & Ørskov, E. R. (1997). Supplementation with Gliricidia sepium and Leucaena leucocephala on voluntary food intake, digestibility, rumen fermentation and live weight of crossbred steers offered Zea mays stover. *Livestock Production Science*, *49*(1), 53-62.

Ahamefule, F. O., & Elendu, C. (2010). Intake and digestibility of WAD Bucks fed cassava leaf-maize offal based diets. *Journal of Agricultural Veterinary Advances*, 9(3), 535-539.

Ahaotu, E. O., Ayo-Enwerem, C. M., Onu, P. N., & Ifut, O. J. (2009). Sheep production and grazing management. Jeolas Publishers, Owerri, Nigeria. 141p.

Ahaotu, E. O. (2018). Characteristics of small holder sheep production at selected communities in Ohafia and Arochukwu Areas of Abia State, Nigeria. *Veterinary Research International*, *6*(1), 19-24.

Ahaotu, E. O., & Ayo- Enwerem, C. M. (2008). Goat Production and Management Practices. Jeolas Press, Owerri, Nigeria. 132p.

Ahaotu, E. O., & Ifut, O. J. (2018). Consequences of heat tolerance in West African Dwarf Sheep. *Livestock Research International*, *6*(1), 1-7.

Ahaotu, E. O., Ifut, O. J., & Akinfemi, A. (2017). Characteristics of small holder sheep production from selected Local Government Councils and States in Nigeria. *Proceedings of the 20th Biennial Conference, Ghana Society of Animal Production* (GSAP), 1-5 August, 2017 Sasakawa Centre, University of Cape Coast, Ghana. Pp. 64-72.

Ajayi, O. A., Adeneye, J. A., & Ajayi, F. T. (2005). Intake and nutrient utilization of West African Dwarf goats fed mango, Ficus, Gliricidia foliages and concentrate as supplement to basal diet of guinea grass. IDOSI publication. *World Journal of Agricultural Sciences*, *1*(2), 184-189.

Alionye, E. B., Ahaotu, E. O., Ihenacho, R. O., & Chukwu, A. O. (2020). Comparative evaluation of swine production with other domestic livestock in Mbaitolu Local Government Area of Imo State, Nigeria. *Sustainability, Agriculture, Food and Environmental Research, 8*(4), 222-244.

Association of Official Analytical Chemists (AOAC) (2000). Official Methods of Analysis. 6th Edition. Washington DC, USA.

Asaolu, V. O., Binuomote, R. T., Akinlade, J. A., Oyelami, O. S., & Kolapo, K. O. (2011). Utilization of *Moringa oleifera* fodder combinations with *Leucaena leucocephala* and *Gliricidia sepium* fodders by West African Dwarf goats. *International Journal of Agricultural Research,* 6(8), 607-619.

Aye, P. A., & Adegun, M. K. (2010). Digestibility and growth in West African dwarf sheep fed *gliricidia* based multi-nutrient block supplements. *Agriculture and Biology Journal of North America, 1*(6), 1133-1139

Bangani, N. M., Botha, J. A., Muller, C. J. C., & Cruywagen, C. W. (2000). The production performance of lactating Jersey cows receiving varying levels of Lucerne hay and oat silage as roughage sources. *South African Journal of Animal Science*, *30*(Supplement1), 6-7.

Ceyhan, V., & Karem, H. (2010). economic efficiency of cattle fattening farms in Amarya Province, Turkey. *Journal of Animal and Veterinary Advances*, *9*(1), 60-69.

Emokoro, C. C., & Amadasun, O. J. (2012). Analsis of beef marketing in Benin City, Nigeria. *Nigerian sJournal of Agriculture, Food and Environment, 8*(3), 26-31.

Fadiyimu, A. A., Fajemisin, A. N., & Alokan, J. A. (2011). Chemical composition of selected browse plants and their acceptability by West African Dwarf sheep. *Livestock Research for Rural Development, 23*(12), 129-133.

Fajemisin, A. N., Olomola, O. A., Fadiyimu, A. A., Alokan, J. A. (2013). Nutrient digestibility and nitrogen retention of WAD goats fed cassava peels, *Cajanas cajan* hay and concentrate supplements. In: Oruwari, B. M., Alawa, J. P., Oji, U. I., Owen, O. J., & George, O. S. (ed.). *Proceedings of the 38th Annual Conference and 48th Anniversary of Nigerian Society for Animal Production. March 17-20. Rivers State University of Science and Technology, Port Harcourt.* Pp. 354-356.

Fasae, O. A., & Alokan, J. A. (2006). Growth performance of weaner Yankasa sheep fed varying levels of Leucaena leucocephala leaf residues. *Asses Series A*, *6*, 323-328.

Gatenby, R. M. (2009). Sheep – The Tropical Agriculturist series. Revised Edition. Macmillan Press, London. 178p.

Getachew, T. Haile, A, Tibbo, M, Sharma, A.K, Sölkner, J., & Wurzinger, M. (2010). Herd management and breeding practices of sheep owners in a mixed crop-livestock and a pastoral system of Ethiopia. *African Journal of Agricultural Research*, 5(8), 685-691.

Google Earth (2022). Google earth. Retrieved from https://www.google.com/earth.

Isah, O. A., Omoniyi, L. A., Taiwo, O. O., Afolabi, A. D., & Fernandez, A. J. (2013). Dry matter and crude protein digestibility of WAD sheep fed *Newbouldia laevis, Ficus thonnigii* and *Mangifera indica* as supplement to *Panicum maximum* during the dry season. *Proceedings of the British Society of Animal Science and the Association of Veterinary Teaching and Research Work includes papers from the Rare Breeds Survival Trust. 40th Anniversary Seminar and the Colloquium for Equine Reproduction.* Nottingham, U.K (16 – 17 April, 2013).

Lamidi, A. A., & Ologbose, F. I. (2014). Dry season feeds and feeding: A threat to sustainable ruminant animal production in Nigeria. *Journal of Agriculture and Animal Production and Social Research*, 14(1): 17-30.

Madubuike, F. N. (2012). Bridging the animal protein supply and demand gap in Nigeria. Imo State University, Owerri, Nigeria. Inaugural Lecture Series No. 7. Imo State University Owerri.

McDonald, P., Edward, R. A., & Greenhalgh, J.F.D. (1987). Animal Nutrition. 4th Edition. Longman Group (FE) Ltd., Hong Kong.

Nlemadim, H. C. (2010). The causes of low productivity of sheep and Goats in Ohaji Local Government Area of Imo State, Nigeria. ND II Project, Imo State Polytechnic, Umuagwo, Ohaji.

Norton, B. W. (1994). The nutritive value of tree legumes. In: Gutteridge, R. C., & Shelton, H. M. (eds.). *Forage tree legumes in tropical agriculture*. CAB International, UK. Pp. 177-191.

Nouala, F. S., Akinbamijo, O. O., Adewumi, A., Hoffman, E., Muetzel, S., & Becker, K. (2006). The influence of Moringa oleifera leaves as substitute to conventional concentrate on the in vitro gas production and digestibility of groundnut hay. *Livestock Research for Rural Development*, *18*(9), 121.

Ogunbosoye, D. O., & 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*, *1*(4), 224.229.

Okafor, I. C. (2010). Development of pasture for small ruminants: A case study of Obowo Local Government Area of Imo-State, Nigeria. ND II Project, Imo State Polytechnic, Umuagwo, Ohaji, Nigeria. Pp. 6-10.

Okoruwa, M. I., Adewumi, M. K., & Njidda, A. A. (2013). Nutrient utilization and growth performance of West African dwarf goats fed with elephant grass at different proportions of plantain and mango peels. *World Journal of Agricultural Sciences, 1*(6), 194-202.

Olomola, O. O., Babayemi, O. J., & Akinsoyinu, A. O. (2008). Performance characteristics and nutrient utilization of pregnant West African Dwarf gosts fed groundnut cake, urea and rumen epithelia wastes in cassava flour and citrus pulp-based diets. *Tropical and Subtropical Agroecosystems*, *8*(1), 61- 67.

Omoniyi, L. A. (2014). Nutritional assessment of selected forages and their effects on ruminal bacteria and blood parameters of West African dwarf sheep. Ph.D Thesis, Department of Animal Nutrition, Federal University of Agriculture, Abeokuta Nigeria.

Ondiek, J. O., Tuitoek, J. K., Abdulrazak, S. A., Bareeba, F. B., & Fujihara, T. (2000). Use of *Leucaena leucocephala* and *Gliricidia sepium* as nitrogen sources in supplementary concentrates for dairy goats offered Rhodes grass hay. *Asian-Australasian Journal of Animal Sciences*, *13*(9), 1249-1254.

Onwuka, C. F. I., Akinsoyinu, A. O., & Tewe, O. O. (1989). Feed value of some Nigerian browse plants: chemical composition and in vitro digestibility of leaves. *East African Agriculture and Forestry Journal*, *54*(3), 157-163.

Opara, J. C. (2010). *Sheep and goat management practices: A case study of Ohaji District, Imo State, Nigeria*. ND II Project, Imo State Polytechnic, Umuagwo, Ohaji, Nigeria. Pp. 32-39.

Osuji, P. O., Fernandez-Rivera, S., & Odenyo, A. (1995). Improving fibre utilization and protein supply in animals fed poor-quality roughages: ILRI nutrition research and plans. In: Rumen Ecology Research Planning. Wallace, R. J., & Lahlou-Kassi, A. (eds.). *Proceedings of a workshop held at ILRI*, Addis Ababa. Pp. 1-22.

SAS (2008). Statistical Analytical Systems, 9.4 for Windows x64 Based Systems. SAS Institute Inc., Cary, NC 27513, USA.

Shittu, A., Chafe, U. M., Buhari, S., Junaidu, A. U., Mgaji, A. A., Salihu, M. D., Lawal, M. D., & Jibril, A. (2008). An overview of mastitis in Sokoto red goat, Nigeria. *Sokoto Journal of Veterinary Sciences*, *7*(1), 65-70.

Thonney, M. L., & Hogue, D. E. (2007). Formulation of ruminant diets using potentially-fermentable NDF and nonstructural carbohydrates. In: *Proceedings of the Cornell Nutrition Conference, Ithaca*, NY. Pp. 113-123.

Ugwumba, C. O. A., & Effiong, J. A. L. (2013). Analysis of household demand for beef in Owerri Metropolis of Imo State, Nigeria. *Nigerian Journal of Chemical Biological and Physical Science*, *3*(2), 1201-1205.

Van Soest, P. J., Robertson, J. B., & Lewis, B. (1991). Method of dietary fibre, neutral detergent fibre and non-starch polysaccharides in relation to animal nutrition. *Journal of Dairy Science*, *74*, 3583-3597.

Wada, N. I., Njidda, A. A., Olafadehan, O. A., & Bello, B. (2014). Effect of graded levels of *Parkia biglobosa* in a concentrate diet on growth, performance, digestibility and nitrogen utilization of Yankasa rams. *Global Journal of Biological and Allied Health Sciences, 3*(4), 65-70.

Yakaka, B. M., & Bashir, A. B. (2012). Determinants of ruminants meat demand in Maiduguri, Borno State, Nigeria. *Greener Journal of Agricultural Science*, *2*(8), 381-385.