Productive performance and cost/benefit ratio of West African Dwarf goats fed Gmelina leaf meal in their diets

[1]Peter-Damian C. Jiwuba*, [1]Nonye L. Azodo, [1]Amarachi A. Osuchukwu, [2]Levi E. Okoye and [3]Ikechukwu U. Obasi

[1]Department of Animal Production Technology, Federal College of Agriculture, P.M.B.7008, Ishiagu, Ebonyi State, Nigeria.

[2]Department of Animal Science, Chukwuemeka Odumegwu Ojukwu University, Igbariam Campus.

[3]Department of Animal Science and Technology, Federal University of Technology, P.M.B. 1526, Owerri, Imo State, Nigeria.

*Corresponding Author: jiwubapc@gmail.com

Citation: Jiwuba, P. D. C., Azodo, N. L., Osuchukwu, A. A., Okoye, L. E., & Obasi, I. U. (2021). Productive performance and cost/benefit ratio of West African Dwarf goats fed Gmelina leaf meal in their diets. *Zhivotnovadni Nauki*, *58*(5), 15-23 (Bg).

Abstract

The effect of feeding *Gmelina* leaf meal (GLM) diets for 82 days was investigated on productive performance and the cost-benefit ratio of West African dwarf (WAD) goats. Thirty six WAD goats of about 10 to 12-month-old were divided into four groups of nine and repeated three times in each group in this study. Four diets, A, B, C and D, were formulated in a completely randomized design to contain GLM at 0%, 12%, 24% and 36% GLM, respectively. In the morning, each goat received a specified treatment diet. The feed given was based on 3.5 percent body weight per day; in addition, a kg of wilted chopped *Pennisetum purperum* was fed to the goats later in the day as a basal diet to increase rumination and chime chewing. The GLM revealed high dry matter and energy values. The findings showed a substantial increase ($p < 0.05$) in body weight gain and feed conversion ratios for B, C, and D. Data on carcass indices indicated that dressing percentage, slaughter, warm carcass, loin and set weights showed better ($p < 0.05$) results for goats on GLM diets compared with the control. However, A produced better ($p < 0.05$) empty gut and feet weights in comparison with the treatment (B, C and D) groups. Feed cost and feed cost/weight gain were significantly ($p < 0.05$) reduced from A to D. The cost / benefit ratio was affected ($p < 0.05$) with D bucks having better revenue of N8.17 for each invested N1.00. It was concluded that GLM is rich in essential nutrients and therefore able to better results at 36 percent for use in WAD goat diets.

Key words: phytogenic plant, Leaf meal, goats, dressing percentage, meat quality and cost of production

Introduction

The West African dwarf (WAD) goat is primarily found in the warm, sub-humid and drier savannah climates below 14 °N latitude, which may have increased its adaptation in Africa's highly infected warm zones. With high productive performance recorded, the breed is resistant to trypanosomiasis, which has ensured survival and multiplication in these zones. Gall (1996) estimated that 38 percent of the 38 million goats found in the warm zone of West Africa are WAD goats. Due to their extensive adaptation, high prolificacy, and good mothering ability, this percentage and number may be higher today. In the rainforest and savanna derived areas of Nigeria, the WAD goat is the most dominant meat breed (Jiwuba and Udemba, 2019). In West Africa, goats are mainly raised for meat, provide a flexible financial reserve for rural, peri-urban and urban populations, and play important social and cultural roles, especially in southeastern Nigeria. In Nigeria, the WAD goat population is generally considered high, but still far below demand. The bucks weigh between 18 and 25 kg at maturity, but 35 kg at maturity have been recorded with good nutrition and proper management. WAD goats provide a wide variety of products and socio-economic benefits and services, considering their small body size, such as revenue from the selling of goats, as gifts, meat, milk and manure for crops. Therefore, not only do WAD goats play a vital role in ensuring the food security of a household, often the only asset owned by rural poor people, but WAD goats can be sold to provide the money to address certain emergencies when appropriate and in times of distress such as crop failure, family illness or unpredicted expenditure.

Nutrition has been described as a major factor influencing this breed's overall performance. In order to weaken this WAD in expressing their full potential, Jiwuba et al. (2017) attributed insufficient nutritional intake; to undermine WAD in showing their complete potential; thus the need for a dry season supplementation. In general, goats in the tropics are raised mainly on grasses, which is characteristically low in nutritional value, digestibility and scarce in the dry season. Enhanced performance among animals fed leaf meal from phytogenic plants have been reported by Jiwuba et al. (2016 a) and (2018 a). Jiwuba et al. (2020) attributed the recent research interest on phytogenic feed additives to their growth promoting abilities, pharmaceutical and medicinal properties.

Gmelina arborea is a multi-purpose tree with substantial fodder yield during the wet and dry seasons, indicating its possible choice for ruminants as a dry season feed resource. With tolerable amounts of anti-nutrients, the leaves are extremely palatable. It is a well-known tree due to its sapling and medicinal values. The *Gmelina* leaf is rich in bioactive compounds, protein, energy and mineral content. *G. arborea* leaves have been reported to have up to 38.4% protein (Osakwe and Udeogu, 2007) and the protein does not appear to alter with leaf maturity, except when they dry and fall on the ground (Leng et al., 1992). The leaves have also been described to have high ethno-veterinary properties for the treatment and prevention of various diseases and infections (Kumaresan et al., 2014; Deepthi et al., 2015). Therefore, this study aimed to determine the influence of *Gmelina arborea* leaf meal on the carcass and organ indices, the quality of meat and the economics of feeding WAD bucks raised intensively in South East Nigeria.

Materials and Methods

The research work was conducted at the Sheep and Goat Unit of Federal College of Agriculture, Ishiagu, Ivo, Local Government Area, Ebonyi State, Nigeria. The college is located at about three kilometers from the main town of Ishiagu. With an annual rainfall of 1000–1600 mm and a prevailing air temperature of 27–28 °C, relative humidity of approximately 88 percent respectively, the College is situated at latitude 5° 6' 0" N and longitude 7° 31' 0" E.

The Gmelina (*Gmelina arborea*) leaves were sourced within the College environs. Fresh, succulent, greenish non-over matured leaves were harvested to ensure lower lignin content and higher nutrient availability. Before milling with 10 mm hammer mill, the leaves were shade-dried in lots to around 10 percent moisture and further used in the formulating of the experimental diets. Four diets were formulated, namely, A, B, C and D. *Gmelina* leaf meal (GLM) was added in A, B, C and D at levels of 0%, 12%, 24% and 36%, respectively, as shown in Table 1.

For this experiment, thirty six WAD goats aged between 10 and 12 months and weighing an average of 9.04 ± 0.5 kg were selected from the college herd. The goats were divided randomly into four groups of nine animals, each with a replicate of three goats. The four experi-

Table 1. Composition of the experimental diets for West African Dwarf Goats

	Dietary levels			
Ingredient	A	B	C	D
Gmelina leaf meal	0.00	12.00	24.00	36.00
Cassava peel meal	45.00	45.00	45.00	45.00
Palm kernel meal	45.00	33.00	21.00	9.00
Ground nut meal	5.00	5.00	5.00	5.00
Molasses	2.00	2.00	2.00	2.00
Bone meal	2.00	2.00	2.00	2.00
Common salt	1.00	1.00	1.00	1.00
Total	100	100	100	100

mental diets (A, B, C, and D) in a completely randomized design (CRD) were randomly allocated to the goats. The animals were separately housed in well-ventilated, cement-floored pens with feeders and drinkers. A specified treatment diet was given to each animal in the morning (8 am) for 82 days. The feed offered was based on 3 percent body weight each day; later in the day (5 pm) the animals were fed 1 kg of wilted chopped *Pennisetum purpureum*. In compliance with permission and stipulated guidelines of the Federal College of Agriculture, Ishiagu (FCAI) Animal Ethics Committee, management practices and daily access to fresh drinking water were ensured.

Three goats from each treatment were randomly selected and starved of feed for 24 hours prior to slaughter. Just before slaughter, each of the randomly selected animal was weighed to get the live weight at slaughter. Subsequent weights were taken after slaughter and after dressing. Dressing percentages were calculated as the weight of dressed warm carcass in relation to live weight before slaughter.

A dressed (warm) carcass is defined as the weight of the goat after removal of the head, skin, contents of thoracic and pelvic cavities (including the diaphragm and kidney) and the limbs distal to the carpal and tarsal joints. In each case, the guts were weighed, cleansed and reweighed to get the full gut and empty gut weights respectively. The heart, liver without the gall bladder, lungs and kidney were weighed to get the organ weights. The limbs (four feet) distal to carpals and tarsals, skin, testes and guts were also be weighed to get the offal weights. Meat cuts were expressed as percentages of the warm carcass while organ/offal weights were expressed as percentages of the empty live weight. Empty live weight is defined as the live weight at slaughter minus gut content.

Using the AOAC (2000) technique, samples were analysed for proximate composition. Samples for pH were taken at the *Longissimus dorsi* of each carcass after dressing. The meat samples were refrigerated for about 24 hours after which the pH was taken. 1 g of ground meat sample was homogenized in 10 ml of distilled water and the pH was measured with the ATC pH meter, model 2000.

For the sensory evaluation, about 100 g of samples of meat from the loin of each buck in each treatment was collected, cut into chops of equal sizes and packed in a transparent double layered polythene bags and tagged for identification. Before serving ten untrained panelists, they were cooked in a water bath for 30 minutes and allowed to cool in room temperature to score each sample for taste, tenderness, juiciness and overall acceptability. Every sample was scored on a nine-point hedonic scale by the evaluators (Land and Shepard, 1988) for colour, juiciness, taste, texture and tenderness. On a three-point scale, general acceptability was evaluated (1 = least acceptable, 2 = more acceptable and 3 = most acceptable).

To estimate the unit cost of the experimental diets, the prevailing market prices of the feed ingredients at the time of the experiment were used. The cost of feeding the goats was considered variable and all other costs (i.e. labour, capital expenditure and housing) for all treatments were the same. The cost of the procurement and processing were included as the feed cost. Feed cost (N) per kilogram, daily weight gain cost per kilogram, and cost-benefit ratio have been determined accordingly. By dividing cost / kg live weight with feed cost / weight gain, the cost-benefit ratio was calculated

Both feed samples and test ingredients were analyzed using the AOAC (2000) method for their proximate composition. The formula T = 5.72Z1 + 9.50Z2 + 4.79Z3 + 4.03Z4 ± 0.9% was used to measure gross energy, where T = Gross energy, Z1 = Crude protein, Z2 = Crude fat, Z3 = Crude fibre, Z4 = Nitrogen free extract (Nehring and Haelein, 1973).

The findings were analyzed using Window 17.0 of the Statistical Package for Social Sciences one-way analysis of variance (ANOVA) to evaluate the means and standard error. Using Duncan's new multiple range test, treatment means were separated (Duncan, 1955).

Results and Discussion

The proximate composition of the test diets and *Gmelina* leaf meal are presented in Table 2. The dry matter (DM) of the experimental diets failed to maintain a regular trend. The DM ranged between 91.26 and 91.36% with diet A producing the best value (91.36%) and diet C the least value (91.26%). The crude protein (CP) improved increasingly with incremental levels of GLM with the best value of 14.88% recorded for diet D and a corresponding lowest value of 12.92% recorded for diet A. The crude fibre (CF) and ash maintained a particular trend like the CP increasing with an increasing level of GLM. The nitrogen free extract (NFE), ether extract (EE) and gross energy (GE) values failed trail a definite pattern, increasing or decreasing with increasing levels of GLM. The DM range of 91.26–91.36% recorded in this study is in comparison with the range of 91.32–91.74% and 89.95–91.44% reported by Jiwuba et al. (2018 b) for WAD goats fed yellow root cassava peel-centrosema leaf meal and Jiwuba and Udemba (2019) for WAD goats fed cassava root sieviate – cassava leaf meal based diets respectively. The CP and GE values in this study falls within the requirement for goats as recommended by NRC (1981). The CF range of 16.18–18% obtained in this study followed a particular trend, increasing with increasing levels of GLM in the diets. The values however, compared with 16.83–18.63% for WAD goats fed *Moringa oleifera* leaf meal in their diets as reported by Jiwuba et al. (2017). Adequate supply of dietary fibre tends to increase chyme chewing, salivation, reduces digestive problems, and promotes intestinal motility in ruminants (Jiwuba, 2018). The ash values of 4.22–4.98% followed a particular pattern increasing with increasing levels of

Table 2. Proximate composition Test diets and *Gmelina* leaf meal (on percentage DM)

Nutrients (%)	Treatments				
	A (0)	B (12)	C (24)	D (36)	GLM
Dry matter	91.36	91.32	91.26	91.34	93.9
Crude protein	12.93	13.66	13.88	14.88	18.32
Crude fibre	16.18	16.94	17.16	18.12	15.18
Ash	4.22	4.78	4.92	4.98	3.96
Ether Extract	3.88	3.10	3.96	4.22	1.16
Nitrogen free extract	54.15	51.84	51.34	49.14	55.28
Gross energy (MJ/kg)	4.07	4.08	4.07	4.11	4.12

GLM- Gmelina leaf meal

GLM; hence indicating that high mineral profile of GLM. The results of the chemical analysis of the GLM favourably compared with the reports of Abdu et al. (2012) and Jiwuba et al. (2016) for the same leaf meal.

The body weight changes and feed intake of West African dwarf goats fed diets containing *Gmelina* leaf meal is presented in Table 3. There were significant ($p < 0.05$) difference for final body weight, total weight gain (TWG), average daily weight gain (ADWG) and feed conversion ratio (FCR) among the experimental goats, while total feed intake (TFI) and average daily feed intake (ADFI) remained similar ($p > 0.05$). There was improvement ($p < 0.05$) in the body weight among the treatment groups (B, C, and D) in comparison with the control A. The significantly high ADWG value at 36% inclusion level could be attributed to enhanced utilization of the diets; a view corroborated by Ukanwoko and Okehielem (2016) who reported improved body weight gain and feed conversion ratio for WAD goats fed *Gmelina* leaf meal. The improved weight gain may also be attributed to the high nutrient profile of GLM. Okagbare et al. (2004) earlier reported GLM as a rich source of nutrients. This may have contributed to improving the nutritional quality of the diets, which may have supported the enhanced performance of the goats. The non-significant high feed intakes observed among the treatment groups may indicate high palatability of the diets. The superior FCR of diet D over the other diets is likened to the reported greater growth rate and enhanced feed utilization of the goats fed the individual diets.

Treatment diets had significant ($p < 0.05$) effects on slaughter weight, warm carcass weight, dressing percentage, set, loin, empty gut and feet (Table 4). Diet D had the utmost slaughter weight that differed ($p < 0.05$) significantly from other treatments. The high slaughter weight ($p < 0.05$) may be attributed to high energy and protein value of diet D which may have triggered better utilization of the diet thus resulted to higher slaughter weight of the animals fed the diet. Diet A showed lower ($p < 0.05$) warm weight in comparison to other treatments. This may be attributed to lower slaughter weight reported for diet A in this study. The warm carcass weights are nevertheless in agreement with the results of Odoemelam et al. (2014) and Jiwuba et al. (2018 a, b) who stated significant values for warm carcass weights for WAD goats. The values obtained in this study is higher than 3.73 to 6.34 kg and 4.43–7.17 kg reported by Jiwuba et al. (2018 b, c) respectively, but fell within the range of 2.9–9.81 kg reported by Marichal et al. (2003). The dressing percentage obtained in this study, fell within 32.94 to 55.35% (Odoemelam et al., 2014; Ifut et al., 2015; Ukanwoko and Okpechi, 2015; Jiwuba et al., 2018 b, c) baseline reported for WAD goats. This is a suggest that the treatment diets were nutritious and supported lean meat deposition across the treatment groups. The effect of nutrition on dressing percentage cannot be over emphasis since changes in goat diets may improve

Table 3. Body weight changes and feed intake of WAD goats fed diets containing *Gmelina* leaf meal

Treatments					
Parameters	A (0%)	B (12%)	C (24%)	D (36%)	SEM
Initial body weight (kg)	9.05	8.67	9.25	9.19	2.43
Final body weight (kg)	13.70^{c}	15.80^{b}	15.65^{b}	17.85^{a}	4.44
Total weight gain (kg)	4.65^{c}	7.13^{b}	6.40^{b}	8.66^{a}	1.01
Average Daily weight gain (g/day)	56.71^{d}	86.95^{b}	78.05^{c}	105.61^{a}	32.31
Total feed intake (kg)	28.74	30.41	29.31	28.95	11.73
Average Daily feed intake (g/day)	350.49	370.85	357.44	353.05	21.71
Feed conversion ratio	6.18^{a}	4.27^{bc}	4.58^{b}	3.34^{c}	0.06

$^{a-c}$ means within a row with different superscript differ significantly ($p < 0.05$)

both the quantity and quality of the chevon as a final product. The influence of nutrition, have been reported (Odoemelam et al., 2014; Ukanwoko and Okpechi, 2015; Jiwuba et al., 2018 b, c) to positively influence dressing percentages in WAD goats. The meat cut is an important factor in evaluation of meat yield of goat (Jiwuba et al., 2018 c). Diet D showed a superior set and loin weights, which may suggests that diet D diet supported the growth of these cut parts well than other treatment groups. The improved meat cut parts at diet D may be ascribed to higher available energy of the diet. Diet A revealed superior ($p < 0.05$) empty gut value in comparison to diets C and D goats. The findings is however in disagreement with the results of Odoemelam et al. (2014) and (Jiwuba et al., 2018 b, c) who reported no diet effect on empty gut of WAD goats. Similarly, diet A showed ($p < 0.05$) improved feet weight when compared with diets B and D. This

Table 4. Carcass and Organ Evaluation of West African dwarf goat fed *Gmelina* leaf meal

Parameters	A (0%)	B (12%)	C (24%)	D (36%)	SEM
Live weight at slaughter (kg)	13.70^{c}	15.80^{b}	15.65^{b}	17.85^{a}	4.44
Warm carcass weight (kg)	6.03^{c}	7.29^{b}	7.72^{ab}	8.65^{a}	3.46
Dressing percentage (%)	44.01^{c}	46.65^{b}	49.33^{a}	48.46^{a}	7.06
Meat cuts (%)					
Set	16.36^{ab}	16.07^{b}	17.72^{ab}	18.65^{a}	3.42
Shoulder	7.44	7.84	7.30	8.35	0.23
Loin	23.66^{b}	24.31^{b}	24.51^{b}	27.14^{a}	3.44
End	4.01	4.07	4.11	4.03	0.23
Leg	18.44	18.84	18.30	19.35	4.23
Offal weights (%)					
Head	10.70	10.91	11.20	10.95	0.74
Empty gut	8.07^{a}	6.85^{ab}	6.23^{b}	6.83^{b}	0.27
Feet	2.60^{a}	2.38^{b}	2.44^{ab}	2.15^{c}	0.19
Organ weights (%)					
Liver	1.84	1.39	1.50	2.27	0.18
Kidney	0.41	0.40	0.37	0.63	0.05
Lungs	0.75	0.87	0.86	0.78	0.10
Heart	0.47	0.58	0.64	0.56	0.04
Spleen	0.20	0.17	0.16	0.25	0.04
Testicles	1.13	1.10	1.14	1.09	0.14

$^{a-c}$ *Means with similar superscripts along the same row are not significantly ($P > 0.05$) different*

Table 5. Proximate composition of meat of West African dwarf goat fed *Gmelina* leaf meal

Parameters	A (0%)	B (12%)	C (24%)	D (36%)	SEM
Dry matter (%)	31.29	30.19	28.33	31.63	1.42
Crude Protein (%)	28.99	31.42	29.76	30.21	0.38
Ether Extract (%)	2.23	2.79	2.27	2.82	0.11
Ash (%)	2.62	2.53	2.42	2.78	0.09
pH	5.05	5.42	5.29	5.28	0.06

may indicate that diet A might have supported the development of feet among the experimental animals fed the respective diet.

The proximate composition of meat of West African dwarf goat fed Gmelina leaf meal in their diets are presented in Table 5. Similarity in the pH and the proximate composition values observed in this study are in agreement with the earlier studies of Marichal et al. (2003) for goats slaughtered at different body weights. The non-significant difference obtained in this study for dry matter, crude protein ether extract and ash indicated that the meat is safe for human consumption.

The mean scores for the sensory characteristics of meat from WAD goats fed *Gmelina* leaf meal in their diets are presented in Table 6. The panelists rated the sensory indices of the chevon similarly ($p > 0.05$) through the treatments. This may be attributed to the positive comparison in the age of the bucks. The similarities witnessed in the overall acceptability of the chevon evidently showed that the panelists rated all of them high.

The cost/benefit of West African dwarf goat fed *Gmelina* leaf meal in their diets are presented in Table 7. All the parameters differed ($p < 0.05$) significantly through the treatments. As the level of inclusion of GLM in the diets decreased from diet A to D, cost of 100 kg of feed and cost/kilogram of feed for the treatments decreased progressively. Total (N1272.35–1423.77) feed cost was highest for diet A when compared with diets C and D. This is in agreement with earlier observation of Jiwuba et al. (2018 c) who obtained reduced feed cost when cassava root sievate-cassava leaf meal based diets were fed to WAD goats. The decrease in feed cost in this study may be attributed to the addition of unconventional feedstuff; *Gmelina* leaf meal in the diets of WAD goats. The values for feed cost/weight gain was lowest for the goats fed diet D (N1272.35) and significantly ($p < 0.05$) lower than the values recorded for goats fed other diets. Cost-benefit ra-

Table 6. Sensory evaluation of West African dwarf goat fed *Gmelina* leaf meal in their diets

Parameters	A (0%)	B (12%)	C (24%)	D (36%)	SEM
Colour	7.00	7.00	7.50	7.50	0.25
Flavour	7.50	7.50	8.00	7.50	0.27
Tenderness	7.50	7.50	8.50	6.50	0.29
Juiciness	8.00	8.50	8.50	7.50	0.29
Texture	8.00	8.00	8.50	8.50	0.18
Overall acceptability	7.50	8.00	8.50	8.50	0.19

Table 7. Economics of production of West African dwarf goats fed *Gmelina* leaf meal in their diets

Parameters	A (0%)	B (12%)	C (24%)	D (36%)	SEM
Cost of 100 kg of feed (₦)	4954.00^{a}	4796.75^{ab}	4571.89^{b}	4393.78^{c}	5.21
Cost/kg of feed (₦)	49.54^{a}	47.96^{ab}	45.71^{b}	43.93^{c}	4.3
Total feed intake (kg)	28.74	30.41	29.31	28.95	11.73
Total cost of feed (₦)	1423.77^{a}	1458.46^{a}	1339.76^{b}	1272.35^{c}	4.54
Total weight gain (kg)	4.65^{c}	7.13^{b}	6.40^{b}	8.66^{a}	1.01
Feed cost/weight gain (₦)	306.19^{a}	204.55^{b}	209.34^{b}	146.92^{c}	3.32
Cost/kg live weight (₦)	1200	1200	1200	1200	-
Cost benefit ratio	$1:3.92^{c}$	$1:5.87^{b}$	$1:5.73^{b}$	$1:8.17^{a}$	1.04

$^{a-c}$ *means within the same row with different superscripts are significantly different* ($P < 0.05$)

tio showed significant ($p < 0.05$) differences with WAD goats on diet D having the best value. This result is in agreement with the results of earlier studies by Jiwuba et al. (2018 b) for WAD goats fed yellow root cassava peel – centrosema leaf meal based diets. The result demonstrated the qualitative benefits and financial returns of using GLM diets, with diet A having the highest ratio and D the lowest value. This entails an expected benefit of N8.17 for every N1.00 in cost for diet D. This opined with the results of Jiwuba et al. (2016 b) who reported that inclusion of *Moringa oleifera* leaf meal in the diets of WAD goats enhanced the revenue of feeding WAD goats.

Conclusion

In conclusion, this study showed that *Gmelina* leaf meal improved the body weight gain, feed conversion ratio, dressing percentage, loin, cost benefit ratio and decreased feed cost of the WAD goats and therefore could be added in the diets of WAD goats up to 36% without any detrimental effect on the productive performances and financial returns.

References

Abdu, S. B., Hassan, M. R., Jokthan, G. E., Adamu, H. Y., Yashim, S. M., & Yusuf, K. (2012). Effect of varied inclusion levels of Gmelia (*Gmelina arborea*) leaf meal on intake, digestibility and nitrogen in Red Sokoto bucks fed on sorghum glum based complete diets. *Advances in Agriculture, Sciences and Engineering Research*, *2*(2), 79-84.

Deepthi, P., Harini, A., & Prakash, L. H. (2015). A Review on Gambhari (*Gmelina Arborea* Roxb.). *Journal of Pharmacognosy and Phytochemistry* 4: 127-132.

Duncan, D. B. (1955). Multiple range and multiple F tests. *Biometrics*, *11*(1), 1-42.

Gall, C. (1996). *Goat breeds of the world*. Technical Centre for Agricultural and Rural Cooperation (CTA). Wageningen, The Netherlands.

Ifut, O. J., Inyang, U. A., Akpan, U. B., & Ekanem, N. J. (2015). Influence of feeding *Panicum Maximum* Supplemented with wheat offal on the carcass characteristicsWest African dwarf goat. *Global Advanced Research Journal of Food Science and Technology, 4*(1), 010-013.

Jiwuba, P. D. C., & Udemba, F. O. (2019). Productive and physiological characteristics of West African dwarf goats fed cassava root sievate-cassava leaf meal based diet. *Acta fytotechn zootechn*, *22*(3), 64-70. doi.org/10.15414/afz.2019.22.03.64-70

Jiwuba, P. C. (2018). Effect of pawpaw (Carica papaya) leaf meal on productive parameters of growing rabbits. *Agricultural science and technology*, *10*(2), 102-106.

Jiwuba, P. C., Ahamefule, F. O., Ogbuewu, I. P., & Ikwunze, K. (2017). Blood chemistry and haematology of West African Dwarf goats fed Moringa oleifera leaf meal (MOLM) in their diet. *Comparative Clinical Pathology*, *26*(3), 621-624.

Jiwuba, P. C., Ikwunze, K., Ume, S. I., & Nsidinanya, N. O. (2016). Performance, apparent nutrient digestibility and cost benefit of West African dwarf goats fed dietary levels of Moringa oleifera leaf meal. *Journal of Advances in Biology & Biotechnology*, *8*(3),1-9.

Jiwuba, P. C., Ogbuewu, I. P., & Nwachukwuguru, K. (2018). Performance and economy of production of broilers fed Siam weed (*Chromolaena odorata*) leaf meal (SWLM). *Tropical animal health and production*, *50*(6), 1305-1311. https://doi.org/10.1007/s11250-018-1559-x.

Jiwuba, P. D. C., Onunka, B. N., & JC Nweke, J. C. (2018). Influence of supplemental cassava root sieviate-cassava leaf meal based diets on carcass and economics of production of West African dwarf goats. *Sustainability, Agri, Food and Environmental Research*, *6*(4). 40-54.

Jiwuba, P. C., Onwujiariri, E. B., & Kadurumba, O. E. (2018). Carcass yield, organ response and cost/benefit evaluation of West African dwarf goats fed yellow root Cassava Peel-Centrosema leaf meal based diets. *Nigerian Journal of Animal Production*, *45*(2), 342-351.

Jiwuba, P. C., Onwujiariri, E. B., & Azodo, L. N. (2020). Effect of diets with iron tree (*Prosopis africana*) pulp on performance and blood characteristics of growing rabbits. *Asian J. Anim. Sci.,* DOI: 10.3923/ajas.2020.

Jiwuba, P. C., Ugwu, D. O., Kadurumba, O. E., & Dauda, E. (2016). Haematological and serum biochemical indices of weaner rabbits fed varying levels of dried Gmelina arborea leaf meal. *International Blood Research & Reviews*, *6* 1-8.

Kumaresan, P., Jeyanthi, K. A., & Kalaivani, R. (2014). Biochemical evaluation of anti diabetic activity of aqueous extract of *Gmelina arborea* in Alloxan induced albino rats. *International Journal of Herbal Medicine*, *2*(2), 90-94.

Land, D. G., & Shepherd, R. (1988). Scaling and Ranking Methods. In: Piggott, J.R., Ed., Sensory Analysis of Foods, Elsevier Applied Science, London, 155-185.

Leng, R. A., Bird, S. H., Klieve, A., Choo, B. S., Ball, F. M., Asefa, G., Brumby, P., Mudgal, V. D., Chaudhry, U. B., Haryono, S. U., & Hendratno, N. (1992). The potential for tree forage supplements to manipulate rumen protozoa to enhance protein to energy ratios in ruminants fed on poor quality forages. *Legumes trees and other trees as protein sources for livestock. Proceedings of the Food and Agriculture Organization expert Consultation held at the malaysian Agricultural Research and Development Institute (mARDI) in Kuala Lumpur, malaysia*, 177-191.

Marichal, A., Castro, N., Capote, J., Zamorano, M. J., & Argüello, A. (2003). Effects of live weight at slaughter (6, 10 and 25 kg) on kid carcass and meat quality. *Livestock Production Science*, *83*(2-3), 247-256.

Nehring, K., & Haenlein, G. F. W. (1973). Feed evaluation and ration calculation based on net energyFAT. *Journal of Animal Science*, *36*(5), 949-964.

Odoemelam, V. U., Ahamefule, F. O., Ahiwe, E. U., Ekwe, C. C., & Obi, J. I. (2014). Carcass yield, organ characteristics and economics of West African dwarf bucks fed *Panicum maximum* supplemented concentrate containing Bambara nut (*Vigna subterranea*) meal. *Nigerian Journal of Agriculture, Food and Environment, 10,* 18-24.

Okagbare, G. O., Akpodiete, O. J., Esiekpe, O., & Onagbesan, O. M. (2004). Evaluation of *Gmelina arborea* leaves supplemented with grasses (*Panicum maximum* and *Pennisetum purpureum*) as feed for West African Dwarf goats. *Tropical animal health and production*, *36*(6), 593-598.

Osakwe, I. I., & Udeogu, R. N. (2007). Feed intake and nutrient digestibility of West African Dwarf (WAD) goat fed *Pennisetum purpureum* supplemented with *Gmelina arborea*. *Animal Research International*, *4*(3) 724-727.

Ukanwoko, A. I., & Okpechi, J. I. (2016). Evaluation of the carcass characteristics of West African dwarf (WAD) goats fed *Gliricidia sepium*, cassava and *Leucaena leucocephala* leaf meals in a cassava peel based diets. *Int'l Journal of Agric. and Rural Dev*, *19*(1), 2497-2500.

Ukanwoko, A. I., & Okehielem, O. V. (2016). Effect of Gmelina (*Gmelina arborea*) leaf meal based diets on growth performance of West African dwarf bucks. *Asian Journal of Animal Sciences, 10: 154-158. DOI: 10.3923/ajas.2016.154.158.*

AOAC (2000). Animal feed. In AOAC Official Methods of Analysis (6th Edition) 5 -15. AOAC International, Washington DC, USA.

NATIONAL RESEARCH COUNCIL, & Nutrient, N. R. C. (1981). Requirements of goats: angora, dairy, and meat goats in tempera tropical countries. Washington: National Research Council; National Academy of Science Press, Washington DC.