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Effects of mixed *Gmelina arborea* and *Moringa oleifera* leaf meal inclusion on growth performance and blood profile of Red Sokoto bucks fed *Digitaria smutsii* hay based diets

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Abstract

The use of browse plants as supplement have been shown to enhance intake, improve growth rate and increase reproduction in ruminants. However, most of these forage trees have not been widely used because they often contain anti-nutritional compounds that have deleterious effects on animal performance Moringa oleifera and Gmelina arborea are widely distributed in many locations in the tropics. Moringa oleifera and Gmelina arborea are promising plants which could contribute to increased intake of some essential nutrients and health-promoting phytochemicals and also provide cheaper alternative forages of high quality for ruminants. The study was carried out to investigate the effect of mixed Gmelina arborea and Moringa oleifera (GMMO) leaf meal inclusion on the growth performance and blood profile of goats fed Digitaria smutsii hay based diets. Twenty intact Red Sokoto bucks between 4-5 months of age with an average weight of 12.00 kg were used. The bucks were randomly allocated to four treatments with five animals per treatment in a completely randomized design. Gmelina arborea and Moringa oleifera leaf meals were mixed at ratio of 75 and 25% respectively and included at 0, 10, 20 and 30% in a 40% Digitaria smutsii hay base. Each level of inclusion serves as a dietary treatment. The parameters measured were feed intake, body weight gain, haematological and biochemical constituents. Feed cost and proximate analysis of GMMO were also carried out. The results showed that inclusion of GMMO leaf meal improved dry matter intake of bucks. Dry matter intake ranged from 310.28 g/d in T_1 to 372.61 g/d in T_3. Weight gain and average daily gain were significant ($P<0.05$) higher in bucks fed 20% GMMO leaf meal (4.20kg and 46.67 g/d) respectively than the other treatments. Regression analysis showed 25% inclusion as the optimal level of GMMO leaf meal inclusion in the diets of growing bucks. The haematological and biochemical parameters of Red Sokoto bucks measured were within the normal range for healthy goats. The cost-benefit analysis showed that goats fed 20% GMMO leaf meal gave more profit than those on other treatments. Net profit was highest in 20% followed by 30%, 10% and 0% inclusion (N1108.30, N 853.90, N506.20 and N485.00) respectively. This study concludes that the mixture of gmelina and moringa leaf meal can be included at 25% in the diets of Red Sokoto bucks for improved productivity.

Keywords: Red Sokoto bucks, *Gmelina aborea, Moringa oleifera*, growth and blood profile

Introduction

Forages play important role in ruminant nutrition. Ruminants are able to ruminate or regurgitate ingested high forage diets to reduce particle size for improving their digestibility (Ranjbar, 2007; Parish, *et al*., 2009). However, inadequate supply of all year-round quality forage is a major constraint to livestock production in the tropics (Ajayi*, et al.*, 2005; Ogunbosoye and Babayemi, 2010a). Most available ruminant feeds/feedstuff during the dry season are poor in nutrients which deteriorate rapidly with increasing fibre and

decreasing protein (Babayemi, 2007). Sources of cheaper alternative forages of high quality for ruminants have been a subject of research in recent years (Alan*, et al.*, 2013) especially for farmers in the tropics. Browse plants have great potential as source of high quality nutrient for ruminants, being high in protein, minerals and vitamins (Babayemi*, et al.,* 2003). They are available all year round because of their drought resistance, persistence, vigorous growth, re-growth and palatability (Reynolds and Atta-Krah, 2006). The use of browse plants as supplement have been shown to enhance intake, improve growth rate and increase reproduction in ruminants (Lamidi*, et al.,* 2009; Okafor*, et al.*, 2012). However, most of these forage trees have not been widely used because they often contain anti-nutritional compounds that have deleterious effects on animal performance (Ghosh*, et al.*, 2007). *Moringa oleifera* Lamarck which originated from India is widely distributed and has become naturalized in many locations in the tropics (Fahey, 2005). It is a non-leguminous multipurpose tree and one of the fastest growing trees of the world. *Moringa* is one of the promising plants which could contribute to increased intake of some essential nutrients and health-promoting phytochemicals (Alikwe and Omotosho, 2013; Nweze and Nwafor, 2014). It has a high crude protein content ranging from 20-26% CP in leaves (Asaolu*, et al.,* 2011) with negligible contents of anti-nutrients (Makkar and Becker, 1996). *Gmelina arborea* Roxb. (Family Verbenanceae) is a fast-growing deciduous tree that even though it sheds some of its leaves when the dry season is approaching, the regrowth of new leaves could serve as animal feed. The leaves are high in nutrient, previous records (Ahamefule*, et al.*, 2006; Osakwe and Udeogu, 2007; Okafor*, et al.,* 2012) have shown that the leaves contain as much as 10.01-38.4% crude protein and 3.10-30.46 % crude fibre with low level of anti-nutritional compounds. The objective of this study was to ascertain the effect of mixed Gmelina and Moringa leaf meal inclusion levels on growth and blood parameters of Red Sokoto bucks fed *Digitaria smutsii* hay-based diets.

Materials and methods

Experimental site

The experiments were conducted in the Experimental Unit of the Small Ruminant Research Programme of the National Animal Production Research Institute (NAPRI), Shika, Zaria, Nigeria. The location of Shika has been described in detail elsewhere by (Okafor*, et al.*, 2017).

Feed preparation

Fresh *Gmelina arborea* (GM) leaves were harvested within the Ahmadu Bello University Main Campus. Leaves were allowed to air-dry for three days and then removed by carefully beating the branches with sticks. Dried Moringa leaves were sourced from Sabon-Gari market, Zaria. The *Digitaria smutsii* hay was sourced from NAPRI. The dried leaves and *D. smutsii* hay were ground with hammer mill fitted with 2cm screen for easy mixing with other feed ingredients. The ground ingredients were packed in sacks and stored in a well-ventilated room.

Dietary treatments

Four isonitrogenous complete diets were formulated, with 40% *D. smutsii* hay base. The diets were compounded to contain 13% CP. *Gmelina arborea and Moringa oleifera* leaf meals were mixed at ratio of 75 and 25% respectively and included at 0, 10, 20 and 30%. Each level of inclusion served as a treatment. Other ingredients are maize offal, cotton seed cake, salt and bone meal (Table 1).

Table 1: Ingredient composition of experimental diets (%) fed to growing Red Sokoto bucks

Ingredients	Level of GMMO leaf meal inclusion (%)			
	0	10	20	30
75GM:25MO	0	10	20	30
Cottonseed cake	23.40	20.00	16.00	12.30
Maize offal	34.60	28.00	22.20	15.80
Bone meal	1.5	1.5	1.5	1.5
Common salt	0.5	0.5	0.5	0.5
D.smutsii hay	40	40	40	40
Total	100	100	100	100
Calculated analysis				
% Crude Protein	13.01	13.06	13.02	13.00
Cost/kg feed (₦)	44.14	40.63	37.12	33.52

75 GM: 25 MO= 3:1 mixture of Gmelina and Moringa leaf meal.

Table 1: Chemical composition (%) of experimental diets fed to growing Red Sokoto goats

Parameters	Levels of GMMO leaf meal inclusion (%)			
	0	10	20	30
Dry matter	94.44	94.10	93.90	94.08
OM	87.59	87.63	87.19	87.23
Crude protein	13.09	13.00	13.15	13.25
Crude fibre	27.43	25.26	23.27	28.23
Ash	6.85	6.47	6.71	6.85
Ether Extract	7.91	5.66	5.08	5.88
NDF	41.59	46.22	45.71	43.51
ADF	22.56	26.94	26.41	24.51

OM= organic matter; NDF=neutral detergent fibre; ADF=acid detergent fibre.

Experimental design

Twenty Red Sokoto bucks between 4-5 months of age with an average weight of 12.00 kg were used. The animals were obtained from the Small Ruminant Research flock in NAPRI and were given prophylactic treatment, consisting of Ivermectin ® at 200µg/kg body weight (BWT) against endo and ectoparasites and Terramycin long lasting (LA) ® at 20mg/kg BWT against bacterial diseases 7 days before the experiment. Routine health checkups were performed on the flock by animal health personnel on a regular basis in line with management protocols at the Experimental Unit. The animals were randomly allocated to four dietary treatments with five animals, each serving as a replicate in a completely randomized design. At 8.00 hours, the animals were offered their daily allowance (4% of body weight) of the experimental diets. The bucks were weighed weekly and weight changes were recorded as the difference between weight of the previous week and the current. Weekly weights of the bucks were used to adjust the quantities of feeds offered in order to maintain the pre-determined level. The animals have free access to clean drinking water. The duration of the experiments was 90 days after 14 days adjustment period. Daily feed intake and weekly body weight of the animals were recorded throughout the experiment.

Feed cost analysis

Market prices in Zaria and its environs were used for determining the cost of bucks and feeds as at the time of research. The costs of harvesting and transportation of *Gmelina* leaves were estimated. Feed consumed by the animals was multiplied by the cost of feed per kilogram to obtain the cost of feed consumed. The market cost was used to

work out total cost of feed consumed per treatment, value of gain, and net benefit.

Haematological analysis and evaluation of blood biochemical constituents

Blood samples (5ml) were collected from three randomly selected bucks per treatment at the beginning, middle and end of the experiment through the jugular vein using a 5 mL syringe. Two mL of the blood sample was collected and transferred into a sampling bottle containing ethylene diamine tetra acetic acid (EDTA) as anticoagulant and was rocked gently to ensure easy mixing of blood with the anticoagulant. The blood samples were used to determine the haematological parameters (packed cell volume, haemoglobin, red blood cells and white blood cells) at the Veterinary Teaching Hospital of Ahmadu Bello University, Samaru, Zaria using Abbott haematological analyser (Cell-Dyn 1700®, Abbott Park, Illinois, U.S.A.). The remaining blood sample (3ml) was poured into plain bottle and allowed to clot at room temperature within 3 hours of collection. Plasma was separated by centrifugation at 3500 rpm for 15 minutes and frozen at -20 ºC for the determination of total protein, albumin, total cholesterol, glucose, creatinine, urea nitrogen using Elisa multiplex commercial kits (Pfizer Animal Health, New York, NY) following the steps as described by the manufacturers. The globulin values were obtained by subtracting the values of albumin from the corresponding values of total protein (Coles, 1974).

Proximate chemical analysis

The feeds samples were analyzed for dry matter (DM), crude protein (CP), ether extract (EE), crude fibre (CF), and ash using the procedures outlined by the Association of Official Analytical Chemists (A. O. A. C., 2005). acid detergent fibre (ADF) and neutral detergent fibre (NDF) were determined according to Van Soest*, et al.,* (1991) procedures.

Statistical analysis

Data generated on dry matter intake, weight changes, and blood profile was analyzed statistically using the General Linear Model (GLM) procedure of SAS, (2005). Significant differences between treatment means were determined according to Duncan's Multiple Range Test of SAS, (2005).

Results

The growth performance parameters of Red Sokoto bucks fed *D. smutsii* hay-based diets containing levels of GMMO leaf meal are presented in Table 3. Dry matter intake was significantly higher ($P<0.05$) in animals fed 30% GMMO leaf meal compared to those on 0%. It ranged from 237.79g/d in 0% to 330.17g/d in animals on diet containing 30% leaf meal. Weight gain and average daily gain increased with increasing level of mixed GMMO leaf meal inclusion up to 20% and then declined. Weight gain varied from 2.86 to 4.20kg while average daily weight gain ranged from 31.78 to 46.67 g/d in animals fed diets with 0% and 20% leaf meal respectively. Feed conversion ratio was significantly ($P>0.05$) across the treatments. Feed conversion ratio was better in animals fed 10% and 20% GMMO leaf meal inclusion levels.

Figure 1 shows the trend analysis of the inclusion of mixed GMMO leaf meal in the diets of Red Sokoto bucks. The optimum level of inclusion of GMMO in the diets of growing Red Sokoto bucks was 21.95% as obtained by regression equation.

Table 3: Effect of GMMO leaf meal inclusion levels on dry matter intake and growth performance of Red Sokoto bucks fed *D. smutsii* hay-based diets

	Levels of GMMO leaf meal inclusion (%)				
Parameters	0	10	20	30	SEM
Feed intake (g/d)	237.79^{b}	260.11^{b}	296.86^{ab}	330.17^{a}	29.58
Initial weight (kg)	11.80	12.00	11.80	11.90	1.04
Final weight (kg)	14.66	15.20	16.00	15.60	1.14
Weight Gain (kg)	2.86^{b}	3.20^{ab}	4.20^{a}	3.70^{ab}	0.53
ADG (g/d)	31.78^{b}	35.56^{ab}	46.67^{a}	41.11^{ab}	5.91
FCR	7.48^{b}	7.31^{ab}	6.36^{a}	8.03^{b}	0.52

a,b, Mean values with different superscripts within a row differed significantly (P<0.05) SEM standard error of mean; DMI=dry matter intake; ADG=average daily gain; FCR= feed conversion ratio.

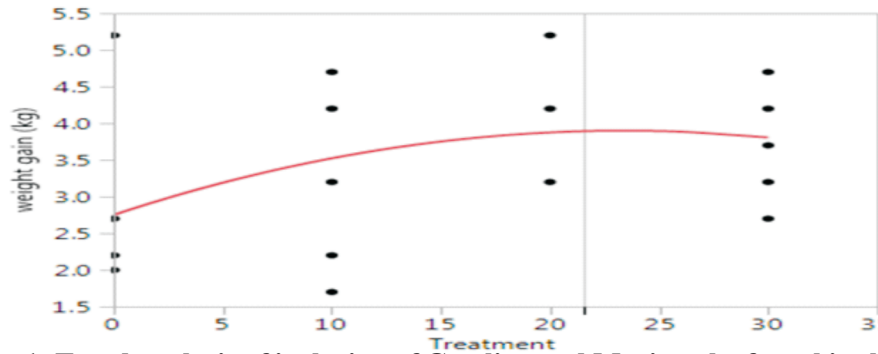

Figure 1: Trend analysis of inclusion of Gmelina and Moringa leaf meal in the diets of Red Sokoto bucks.

The feed cost analysis of inclusion of Gmelina and Moringa leaf meal in the diets of Red Sokoto bucks is shown on Table 4. The result showed that the net profit increased with increasing GMMO leaf meal inclusion in the diets. The analysis indicated that treatment group fed 20% GMMO leaf meal had the highest net profit of N1108.30 followed by treatment group fed 30% (N 853.90). The treatment group fed 10% had net profit of N506.20 while the control treatment group had the least net profit of N485.00. Reduction in feed cost/kg gain was 34.79% in treatment group fed 20% and 22.30% in treatment group fed 30%.

Table 4: Effect of GMMO inclusion on feed cost benefit in Red Sokoto bucks fed *D. smutsii* hay-based diets

Parameters (₦)*	Levels of GMMO leaf meal inclusion (%)			
	0	10	20	30
Total feed intake (kg)	21.41	23.41	26.72	29.72
Feed cost/kg	44.14	40.63	37.12	33.52
Total cost of feed	944.60	951.10	991.70	996.10
Cost/kg Gain	353.99	328.18	230.84	275.04
Value of gain	1430.00	1600.00	2100.00	1850.00
Net Profit	485.00	648.90	1108.30	853.90
% Reduction in feed cost/kg gain	-	7.29	34.79	22.30

* Naira = Nigerian currency (100 kobo= 1 naira); Net profit=value of gain minus feed cost.

The effect of GMMO inclusion on hematological parameters of growing Red Sokoto bucks fed *Digitaria smutsii* hay-based diets is presented in Table 5. The dietary treatments significantly (P<0.05) affected the Packed Cell Volume (PCV), Haemoglobin (Hbg) and Red Blood Cell (RBC). The PCV, Hbg and RBC were statistically higher (P<0.05) in treatment groups with GMMO leaf meal than the control group. The PCV and haemoglobin varied from 31.33 to 38.56% and 8.37 to 10.82×10g/L in treatment group fed 0% and 20%, respectively. The RBC count in this study ranged from 5.23 to 6.31×10^{12}/L in dietary treatment with 30% and 20% leaf meal inclusion respectively.

Table 5: Effect of GMMO leaf meal inclusion on hematological parameters of growing Red Sokoto bucks fed *D. smutsii* hay-based diets

	Levels of GMMO leaf meal inclusion (%)				
Parameters	0	10	20	30	SEM
PCV (HCT) (%)	31.33^{b}	36.56^{a}	38.56^{a}	36.55^{a}	2.12
Hb (g/dl)	8.37^{b}	10.74^{a}	10.82^{a}	10.46^{a}	0.85
RBC ($\times10^{12}$/L)	10.21^{b}	11.54^{a}	11.47^{a}	11.41^{a}	0.45
WBC ($\times10^{12}$/L)	5.54	5.81	6.31	5.23	0.60

a,b, Mean values with different superscripts within a row differed significantly (P<0.05), SEM= Standard Error of Means .WBC = White blood cells; RBC = Red blood cells; Hb = Haemoglobin; PCV (HCT) = Packed cell volume (Haematocrit).

Dietary treatments did not affect the total protein, albumin, globulin, urea nitrogen, glucose and creatinine as shown in Table 6. The cholesterol concentration decreased with increasing level of GMMO leaf meal. It was significantly higher (P<0.05) in animals fed dietary treatments with 0% and 10% (106.61 and 106.50 mg/dL respectively) than those fed 20% and 30% leaf meal.

Table 6: Effect of feeding of Gmelina and Moringa leaf meal on biochemistry of growing Red Sokoto bucks fed *D. smutsii* hay based diets

Parameters	Levels of GMMO leaf meal (%)				SEM	Ranges
	0	10	20	30		
Total protein	69.22	68.44	64.78	67.78	3.06	64-70g/l
Albumin	33.11	32.78	35.56	31.89	2.64	27-39g/l
Globulin	36.11	35.67	29.22	35.89	4.02	27-41g/l
Glucose	61.44	59.22	59.67	56.44	6.81	50-75mg/dl
Creatinine	105.67	105.22	97.67	113.33	8.59	88.40-159
BUN	5.48	5.80	6.21	6.00	0.89	3.60-7.10 mmol/L
Cholesterol	106.61^{a}	106.50^{a}	84.22^{b}	82.91^{b}	5.67	80-130mg/dl

a,b, Mean values with different superscripts within a row differ significantly (P<0.05), BUN= Blood Urea Nitrogen; SEM= standard error of mean.

Discussion

Result showed that GMMO leaf meal inclusion improved feed intake of growing Red Sokoto bucks. This similar with the work of Asaolu*, et al.*, (2011) who reported feed intake of 278-289 g/d when Moringa leaves were fed as sole forage or combined with legume tree leaves to growing goats. However, Abdu*, et al.* (2012) reported higher intake of 498.28 to 562.89g/d when they fed complete diets with varying levels of Gmelina leaf meal. The overall result showed that GMMO leaf meal inclusion improved performance in terms of body weight, average body weight and feed conversion ratio. This finding agrees with the works of Murro*, et al.*, (2003); Fasae*, et al.* (2011) and Fasae*, et al.* (2010) in small

ruminant. The reduction in body weight gain in treatment group fed 30% GMMO leaf meal was similar to the findings of Bamikole and Babayemi (2004) and Okpara*, et al.* (2014) who stressed the negative effect of high level of browse leaves in goats' diets. It is more profitable to feed browse leaves as supplements at a reduced level of inclusion in livestock diets. The feed conversion ratio in this study showed that GMMO leaf meal inclusion improved feed utilization. This finding is similar to the reports of Nagalakshmi ,*et al.* (2010) observed that complete diets increased nutrient utilization, palatability and reduced cost of feeding in ruminants. The trend obtained showed that the inclusion of GMMO leaf meal improved weight of the bucks to the optimal level and then decreased. The reduction in weight after the optimal level maybe as a result of reduced digestibility at higher level of inclusion. The result of this work indicated that GMMO leaf meal inclusion in the experimental diets were more profitable than the control diet due to improved feed utilization. Okafor*, et al.,* (2012) stated that inclusion of *Gmelina arborea* leaves in goats' diet reduced the cost of feed because of its availability. Similarly, Njidda and Ikhimioya (2010) revealed that diet supplemented with *Ziziphus mauritiana* had the best in terms of feed cost per kg gain and percent reduction in feed cost (53.04%). Supplementation is economically feasible and is necessary to ensure farm viability because of large difference in term of average daily gain between supplemented and non-supplemented animals. The parameters were within normal range for healthy goats (Latimer*, et al.* 2010). This result suggested that the bucks were not negatively affected by the GMMO leaf meal inclusion in their diets. Results of Clifford and Briggs (2007) reported that the comparison of an animal's haematological and biochemical values with reference interval provides evidence for numerous conditions such as reflection, malnutrition and stress. Haemoglobin values within normal range imply that the dietary proteins fed to animals were of high quality and adequate. All the serum blood parameters measured in this study were within the normal ranges for clinically healthy goats (Kankeo*, et al.* 2008). Significantly lower cholesterol obtained in this work corroborated the result of **Aderinola, *et al.*, (2013) who observed** low cholesterol and triglyceride content in the birds with MOLM. Moringa leaves contain phytosterol (beta-sitosterol) which is a plant substance similar to cholesterol. Beta-sitosterol was reported to reduce cholesterol levels by limiting the amount of cholesterol that is absorbed in the digestive tract (Longe, 2008). The beta-sitosterol in *Moringa oleifera* leaf was also reported to be responsible for its hypolipidaemic and antioxidant properties (Rajanandh and Kavitha, 2010). This means that inclusion of GMMO leaf meal in the diets of goats can help in the regulation of blood cholesterol level.

Conclusion

The study showed that Gmelina and Moringa leaf meal inclusion in the diets of Red Sokoto goats improved feed intake, average daily gain and weight gain. Also Gmelina and Moringa leaf meal inclusion did not have adverse effect on the haematological and biochemical parameters of Red Sokoto goats. The cost-benefit analysis showed that bucks fed diets with Gmelina and Moringa leaf meal reduced cost of feed/kg gain up to 34.79%. It is recommended that Gmelina and Moringa leaf meal be incorporated into the diet of growing bucks at 21.95%.

References

Abdu, S. B., Hassan, M. R., Jokthan, G. E., Adamu, H. Y., Yashim, S. M. and 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): 7 9 – 8 4 .* http://www.ejournal.sedinst.com

Aderinola, O. A., Rufiu, T. A., Akinwumi, A. O. Alabi, T. A. and Adeagbo, O. A. 2013. Utilization of *Moringa oleifera* leaf as feed supplement in broiler diets. *International Journal of food, Agricultural and veterinary Sciences, 3 (3): 94-102.*

Ahamefule, F. O., Obua, B. E., Ibeawuchi, J. A. and Udesen, N. R. 2006. The Nutritive Value of Some Plants Browsed by Cattle in Umudike, Southeastern Nigeria. *Pakistan Journal of Nutrition,* 5 (5): 40-409.

Ajayi, D. A., Adeneye, J. A. and Ajayi, F. T. 2005. Intake and nutrient utilization of West African Dwarf goats fed mango (*Mangifera indica*), ficus (*Ficus thionningii*), Gliricidia *(Gliricidia sepium)* foliages and concentrates to basal diet of guinea grass (*Panicum maximum*). *World Journal of Agricultural Science,* 1:184-189 .

Alan, J. L., Gavin, D. K., Robert, G. D., Gavin, J. P. and Hayley, C. N. 2013. The potential of a salt-tolerant plant *(Distichlis spicata* cv. NyPa Forage) to treat effluent from inland saline aquaculture and provide livestock feed on salt-affected farmland. *Science of the Total Environment,* 445: 192-201.

Alikwe, P. C. N. and Omotosho, M. S. 2013. An Evaluation of the Proximate and Phytochemical Composition of *Moringa oleifera* Leaf Meal as Potential Feedstuff for Non-Ruminant Livestock. *Agrosearch, 13 (1): 17-27.*

Asaolu, V. O., Binuomote, R., Akinlade, J. A., Oyelami, O. S. and Kolapo, K. O. 2011. Utilization of *Moringa oliefera* fodder combinations with *Leucaena leucocephala,* and *Gliricidia sepium* fodders by West African Dwarf Goats. *International Journal of Agricultural Research ISSN 1816-4897/ DOI:IO. 3923/ ijar.*

Association of Official Analytical Chemist (AOAC), 2005. Official Methods of Analysis, 18th ed. Association of Analytical Chemists. Washington, DC.

Babayemi, O. J. 2007. In- vitro fermentation characteristics and acceptability by West African Dwarf goats of some dry season forages. *African Journal of Biotechnology* 9 (18): 2720-2726.

Babayemi, O. J., Bamikole, M. A., Daniel, I. O., Ogungbesan, A. and Babatunde, A. 2003. Growth, nutritive value and dry matter degradability of three *Tephrosia* species. *Nigerian Journal of Animal Production, 30 (1 and 2): 62-70.*

Bamikole, M. A. and Babayemi, O. J. 2004. Feeding goats with Guinea grass-verano stylo and nitrogen - fertilized grass with energy concentrate. *Archivos de Zootecnea, 53: 13-23.*

Clifford, G. R. and Briggs, H. 2007. Hematologic and Biochemical Reference Intervals for Mountain Goats (*Oreamnos americanus*): Effects of Capture Conditions.

North West Science, 81 (3): 206 – 214.

Coles, E. H. 1974. *Liver function*. In: Saunders, W.B. (Editor) *veterinary clinical pathology* Second Edition. company Philadelphia. pp 202-215.

Fahey, J. W. 2005. *Moringa oleifera*: A review of the medical evidence for its nutritional, therapeutic, and prophylactic properties, Part 1, *Trees of Life Journal,* 1: 5.

Fasae, O. A., Adesope, A. I. and Ojo, V. O. A. 2011. The effect of Leuaena leaf supplementation to maize residues on village goats' performance. *Journal of Animal and Plant Science, 10 (2) 1276-1282.*

Fasae, O. A., Sowande, O. S. and Popoola, A. A. 2010. Evaluation of Selected Leaves of Trees and Foliage of Shrubs as Fodder in Ruminant Production. *Journal of Agricultural Science and Environment, 10(2):36-44.*

Ghosh, M. K., Atreja, P.P., Buragohain, R. and Bandyopadhyay, S. 2007. Influence of short-term Leucaena feeding on milk yield and its composition, thyroid hormones, enzyme activity, and secretion of mimosine and its metabolites in milk of cattle. *Journal of Agricultural Science Cambridge,* 145:407-414.

Kaneko, J., Harvey, J. and Bruss, M. 2008. *Clinical Biochemistry of Domestic Animals*. 5th Ed. Academic Press, New York, Pp 932.

Lamidi, A. A., Aina, A. B. J., Sowande, S. O., and Johosho, A. O., 2009. Assessment of *Panicum maximum* (Jacq), *Gliricidia sepiuma* (Jacq) and *Gmelina arborea* (Roxb)-based diets as all year round for West Africa Dwarf goat. *Proceedings of 14th Annual conference of Animal Science Association of Nigeria (ASAN). Sept. 14th -17th LAUTECH Ogbomoso, Nigeria, 582-584.*

Latimer, K. S. 2010. Duncan and Prasse's Veterinary Laboratory Medicine: Clinical Pathology, 5th ed., Chichester (UK), **Wiley-Blackwell**, Pp 509**.**

Longe, L. J. 2008. The Gale Encyclopedia of Diets: A Guide to Health and Nutrition. New York: Thomson Gale.

Makkar, H. P. S. and Becker, K. 1996. Nutritional value and anti-nutritional components of whole and ethanol extracted *Moringa oleifera* leaves. *Animal Feed Science Technology*, 63: 211-228.

Murro, J., Muhikambele, V. and Sarwatt, S. 2003. *Moringa oleifera* leaf meal can replace cottonseed cake in the concentrate mix fed with Rhodes grass (*Chloris gayana*) hay for growing sheep. *Livestock Research Rural Development 15(11).*

Nagalakshmi, D., Nalini Kumari ,N. and Srinivasa , R . D. 2010. Feed Processing: Effect on nutrient availability. *In Proceedings of Animal Nutrition Strategies for Environment Protection and Poverty Alleviation,* College of Veterinary Science and Animal Husbandry, Bhubaneswar, India. (1) 76- 83.

Njidda, A. A. and Ikhimioya, I. 2010. Nutritional evaluation of some semi-arid Browse forages leaves as feed for goats. *European Journal of Applied Sciences*, *2*(3), 108-115.

Nweze, N. O. and Nwafor, F. I. 2014. Phytochemical, Proximate and Mineral Composition of Leaf

Extracts of *Moringa oleifera* Lam. from Nsukka, South-Eastern Nigeria, *Journal of Pharmacy and Biological Sciences, 9 (6): 99-103.*

Ogunbosoye, D. O. and Babayemi, O. J. 2010. Potential values of some non-leguminous browse plants as dry season feed for ruminants in Nigeria. *African Journal of Biotechnology, 9 (18):* 2720-2726. Parish, A., Daniel Rivera, J. and Hlly, T.B. (2009). Understanding the Ruminant Animal's Digestive System. Mississippi State University Extension Service report.

Okafor, E. C., Lakpini, C. A. M. and Fayomi, A. 2012. Dried gmelina *(Gmelina arborea roxb) l*eaves as replacement forage to groundnut haulms in the diet of fattening Red Sokoto bucks. *International Journal of Agriculture and Biosciences*, 1(1): 5-10.

Okafor, E. C., Lakpini, C. A. M., Abdu, S. B. and Lamidi, O. S. 2017. Effects of *Gmelina arborea* and *Moringa oleifera* leaf meal inclusion on intake, digestibility and nitrogen balance of Red Sokoto bucks fed *Digitaria smutsii* hay based diets. *Journal of Animal Production Research, 29 (1):335-346.*

Okpara, O., Akporhuarho, P. O. and Okagbare, G. O. 2014. Determination of Browse Intake and Nutrient Digestibility of Grazing West African Dwarf (WAD) Goats Fed Varying Levels of *Gmelina arborea* Leaves as Supplements in Delta State Nigeria**.** *International Journal of Animal and Veterinary Advances 6(2): 52-57.*

Osakwe, I. I. and 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.*

Rajanandh, M. G. and Kavitha, J. 2010. Quantitative Estimation of β-Sitosterol, Total Phenolic and Flavonoid Compounds in the Leaves of *Moringa oleifera*. *International Journal of PharmTech Research,* 2**:**1409-1414.

Ranjbar, G. A. 2007. Forage and hay yield performance of different berseem clover (*Trifolium alexandinum* L.) genotypes in mazandaran conditions. *Asian Journal of Plant Science,* 6: 1006-1011.

Reynolds, L. and Atta-Krah, A. W. 2006. Alley farming with livestock. *Paper presented at the International Workshop on Alley Farming for Sub-humid Region of Tropical Africa*, IITA, Ibadan, Nigeria.

SAS 2005. Institute Inc. SAS/STAT user's guide. 6.03 Ed, Gray NC. USA.

Van Soest, P. J., Robertson, J. B. and Lewis, B. A. 1991. Methods for dietary Fibric, NDR and Starch Polysaccharides in relation to animal nutrition. *Journal of Dairy Science, 74:3583-3542.*

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