Nig. J. Anim. Prod. 2022, 49(4): 145-153. https://doi.org/10.51791/njap.v49i4.3711 *Nigerian Journal of Animal Production*

Chemical Composition of African Black Plum (*Vitex Doniana*) Leaf Ensiled with Urea and Broiler Litter

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Abstract

Inadequacy of feed resources as well as their low nutritional quality especially during the dry season subject animals to nutritional stress. The nutritive value of feed resources can be improved for enhanced utilization by rumen microbes for optimum growth by treating with non-protein nitrogen sources. Conservation of grasses and other herbage to minimize loss in their nutrient composition can be achieved through ensilage. The experiment was conducted to evaluate the nutritional potential of African black plum (Vitex doniana) leaf ensiled with broiler litter and urea. Four silages were prepared in which African Black Plum Leaf (ABPL) were ensiled alone (T_1; control), with 1% urea (T_2), 25% broiler litter (T_3) and 25% broiler litter + 1% urea (T_4) and replicated three times in bamma bottles for a period of 21 days. Physical properties, proximate and mineral composition of the silages were evaluated. Results of the physical properties of the silages showed that the silages were light brown for T_1 and T_2 and yellowish green for T_3 and T_4. The aroma and texture were pleasant and firm for T_1 and T_2 while T_3 and T_4 had very sweet aroma with a firm texture. The values obtained for pH and temperature ranged from 6.50 – 7.87 and 28.17 – 29.60^{0}C, respectively. Proximate and mineral composition showed significant ($p<0.05$) differences in the silages obtained. T_3 (25% broiler litter) had the highest CP content (17.32 %) while T_4 (25% broiler litter + 1% urea) showed higher values for EE and NFE (3.70 % and 56.19 %, respectively). Sodium, potassium and magnesium were significantly ($p<0.05$) higher in T_2 (0.61%, 1.72% and 0.83%, respectively) whereas T_3 had higher content of iron and copper (80.4 mg/kg and 12.5 mg/kg, respectively). It could be concluded that the silages possessed good physical properties and appreciable proximate and mineral composition and thus, could be a potential feed resource that could be used to supplement animal feeds during periods of feed scarcity.

Keywords: African Black Plum (*Vitex doniana*), urea, broiler litter, silage

Composition chimique de la feuille de prune noire africaine (*Vitex doniana*) Engin avec de l'urée et de la litière de poulet

Résumé

Insuffisance des ressources alimentaires ainsi que leur faible qualité nutritionnelle, en particulier pendant la saison sèche, les animaux soumettent des animaux au stress nutritionnel. La valeur nutritive des ressources alimentaires peut être améliorée pour une utilisation améliorée par les microbes du rumen pour une croissance optimale en traitant avec des sources d'azote non protéiques. La conservation des graminées et d'autres herbages pour minimiser la perte de leur composition en nutriments peut être obtenue par l'écrivain. L'expérience a été menée pour évaluer le potentiel nutritionnel de la feuille noire africaine (Vitex doniana) avec une litière de poulet et de l'urée. Quatre silages ont été préparés dans lesquels la feuille de prune noire africaine (FPNA) a été inscrite seule (T_1; contrôle), avec 1%

d'urée (T_2), 25% de litière de poulet (T_3) et 25% de litière de poulet + 1% d'urée (T_4) et reproduit trois fois dans des bouteilles de bamma pendant une période de 21 jours. Les propriétés physiques, la composition immédiate et minérale des silages ont été évaluées. Les résultats des propriétés physiques des silages ont montré que les silages étaient brun clair pour T_1 et T_2 et vert jaunâtre pour T_3 et T_4. L'arôme et la texture étaient agréables et fermes pour T_1 et T_2 tandis que T_3 et T_4 avaient un arôme très doux avec une texture ferme. Les valeurs obtenues pour le pH et la température variaient de 6,50 à 7,87 et 28,17 à 29,600 ° C, respectivement. La composition immédiate et minérale a montré des différences significatives ($p < 0,05$) dans les silages obtenus. T_3 (25% de litière de poulet) avait la teneur en CP la plus élevée (17,32%) tandis que T_4 (25% de litière de poulet + 1% d'urée) a montré des valeurs plus élevées pour EE et NFE (3,70% et 56,19%, respectivement). Le sodium, le potassium et le magnésium étaient significativement ($P < 0,05$) plus élevés en T_2 (0,61%, 1,72% et 0,83%, respectivement) tandis que T_3 avait une teneur plus élevée en fer et en cuivre (80,4 mg / kg et 12,5 mg / kg, respectivement). On pourrait conclure que les silages possédaient de bonnes propriétés physiques et une composition immédiate et minérale appréciable et pourraient donc être une ressource d'alimentation potentielle qui pourrait être utilisée pour compléter les aliments pour animaux pendant les périodes de rareté d'alimentation.

Mots-clés: Plum noir Africain (*Vitex doniana*), urée, litière de poulet, ensilage

Introduction

Major feed resources available to ruminants are natural grasslands or conserved forages (Shuaibu *et al*., 2020). Low nutritional quality of feeds in addition to inadequacy of feed materials during the dry season subject animals to nutritional stress, the consequences of which include inefficiency in reproduction, loss in weight and death of animals (Yohanna *et al*., 2015). Supplements such as concentrates are expensive, and as such farmers on small scale enterprises cannot afford to provide their livestock with supplements. Consequently, sourcing for alternative feed resources that are less useful or completely non-useful to man becomes a vital concern of ruminant nutritionists. One common way to improve the nutritive value of feed resources for enhanced utilization by rumen microbes to ensure optimum growth is by treating with non-protein nitrogen sources (Akinbode *et al*., 2020). Conservation of grasses and other herbage to minimize loss in their nutrient composition can be achieved through ensilage (Munza *et al*., 2020). African Black Plum (*Vitex doniana*) is a tree crop that grows in open woodland and savannah regions of tropical Africa and are commonly found in northern, eastern and western Nigeria (Adejumo *et al*., 2003). It is a perennial shrub widely distributed in tropical West Africa, extending eastward to Uganda, Kenya and Tanzania (Amah and Okogeri, 2019). It is the most common of the Vitex species in West Africa which produces fruit which is green at maturity but becomes dark brown or black when fully ripe. The fruits are plum-like, usually referred to as "Black plum" or "African olive" (Glew *et al*., 1997) and are sweet and edible (Keay, 1964). The pulp encloses a hard stone having 1-4 seeds. Odhav (2007) reported African Black Plum (*Vitex doniana*) could be grown on poor marginal soil at lower management cost. The young leaves of African Black Plum (*Vitex doniana*) has been reported to contain reasonable amount of minerals, vitamins and phytochemicals (George, 2003) and are important in the maintenance of good health and prevention of diseases (Nnamani *et al*., 2007). Multiple uses of African Black

Plum (*Vitex doniana*) has been documented (Abiw, 1990; Egbekun *et al*., 1996; Ladeji and Okoye, 1996; Ladeji *et al*., 2005; Okigbo, 2001). Despite various reports on its uses, there is scanty information on the chemical composition of African Black Plum (*Vitex doniana*) leaf ensiled with non-protein nitrogen sources (broiler litter and urea). Thus, the aim of the study is to determine the chemical potentials of African Black Plum (*Vitex doniana*) leaves ensiled with broiler litter and urea.

Materials and methods

Experimental site, collection of experimental materials and silage preparation

The experiment was conducted at Animal Science Laboratory, Department of Animal Science, Federal University Dutse, Jigawa State. African Black Plum (*Vitex doniana*) leaves were collected from trees within and around Federal University Dutse. The collected leaves were left to air-dry under shade until crispy. The dried leaves were chopped, weighed and inserted into Bamma® bottles as follows:

T_1 = 100 % African Black Plum leaves

T_2 = 100 % African Black Plum leaves + 1 % urea

T_3 = 75 % African Black Plum leaves + 25 % broiler litter

T_4 = 75 % African Black Plum leaves + 25 % broiler litter + 1 % urea

These were replicated three times to give a total of 12 replicates and ensiled for a period of 21 days. A completely randomized design was the experimental design adopted as the experimental treatments were the only source of variation. The model of analysis is:

$Xij = \mu + Ti + \Sigma ij$

where Xij = value of observation; μ = population mean; Ti = treatment effect; Σij = error term

Table 1: Description of colour and aroma rating used as indices of silage quality

Rating	Physical Properties	
	Colour	Aroma
1	Dark or deep brown	Putrid or rancid
2	Light brown	Pleasant
3	Pale yellow	Sweet
4	Yellowish green	Very sweet

Source: Muhammed *et al.* (2009)

Chemical composition

Triplicate samples were analyzed for dry matter, crude protein, crude fibre, ether extract and ash according to AOAC (2005), neutral detergent fibre and acid detergent fibre were determined by methods described by Van Soest *et al*. (1991). Mineral analysis (Na, K, Ca, Mg and Fe) were carried out after digestion using Atomic Absorption Spectrophotometer (Jenway 6405 model).

Statistical analysis

Data generated were analyzed using SAS (2003) Statistical package and differences between means were separated using Duncan Multiple Range Test (Duncan, 1955).

Results and discussion

The physical properties of African Black Plum Leaf (ABPL) ensiled with different nitrogen sources is presented in Table 2. Silages from T_1 (100 % ABPL) and T_2 (100 % ABPL + 1 % urea) had light brown colour with a pleasant aroma while silages from T_3 (75 % ABPL + 25 % BL) and T_4 (75 % ABPL + 25 % BL + 1 % urea) had yellowish green colour with a very sweet aroma. All silages prepared had firm texture with pH and temperature values ranging from 6.50-7.87 and 28.17-29.60^{0}C, respectively. The

colour, aroma and texture of the silages produced had acceptable physical characteristics of a good silage (Odeyinka *et al*., 2021). The pleasant and very sweet aroma perceived in all the silages produced indicate normal physical characteristics of good silages (Lamidi and Akhigbe, 2018). The pH value (6.50-7.87) recorded in this study was higher than pH value (3.81-4.90) reported by Akinbode *et al*. (2017) when sugar cane top was ensiled with broiler litter but similar to the findings of Rasool *et al.* (1998) who reported an increase in pH in Sudax grass ensiled with 30 % broiler litter and 9 % molasses. The value of pH obtained fell within the range of 5.45-8.45 reported by Kadi and Muftau (2020) in their study of the chemical composition of millet panicle waste ensiled with poultry manure at graded levels.

Table 2: Silage Properties of African b lack plum (Vitex doniana) leaves ensiled with broiler litter and urea

	Treatments			
Parameters	**T_1**	**T_2**	**T_3**	**T_4**
Colour	Light brown	Light brown	Yellowish green	Yellowish green
Aroma	Pleasant	Pleasant	Very sweet	Very sweet
Texture	Firm	Firm	Firm	Firm
pH	7.87^{a}	7.03^{b}	6.50^{c}	6.73^{bc}
Temperature (^{0}C)	28.17	28.76	29.60	28.70

$^{a, b, c}$ means on the same row with different superscripts diffe r significantly ($p<0.05$), T_1 = 100 % African Black Plum leaves, T_2 = 100 %African Black Plum leaves + 1 % urea, T_3 = 75 % African Black Plum leaves + 25 % broiler litter, T_4 = 75 % African Black Plum leaves + 25 % broiler litter + 1 % urea

The proximate composition of African Black Plum leaves (ABPL) ensiled with broiler litter and urea is presented in Table 3. Ensiling ABPL with broiler litter and urea did not affect ($p>0.05$) the DM, CF, Ash, ADF and NDF contents of the silages obtained. CP was significantly ($p<0.05$) higher in the 75 % ABPL + 25 % broiler litter silage (T_3). EE was higher significantly ($p<0.05$) in T_1 (100 % ABPL) and T_4 (75 % ABPL + 25 % broiler litter +1 % urea) while NFE was significantly ($p<0.05$) lower in the silage obtained from T_4. The CP value (16.01-17.32 %) of the resultant silages obtained in this study was higher than the CP value of 3.15-4.38 % reported by Kadi and Muftau (2020) and also higher than 11.67-12.69 % reported by Lamidi *et al*. (2020). The CP value was also higher than 11.94-16.45 % reported by Odeyinka *et al*. (2021) in their study on the silage quality, growth performance and haematology of West African Dwarf goats fed *Moringa oleifera* leaves ensiled with cassava peels. The CP content of the silages obtained in the present study was above the critical limit of 7% CP below which will have adverse effect on rumen microbial activities as well as forage intake by ruminants (Norton, 2003). It is evident that the silages produced may result in the production of sufficient volatile fatty acids by the rumen micro-organisms as the silage will supply the adequate nitrogen required by the micro-organisms to maximally digest dietary fibre components (Lamidi and Ogunkunle, 2016). The values obtained for EE (3.17-3.73 %) and NFE (51.78-56.19 %) were in agreement with the reported values of 3.25-5.51 % and 20.47-72.02 %, respectively by Kadi and Muftau (2020) when they studied the chemical composition of millet panicle waste ensiled with poultry manure at graded levels.

Table 3: Proximate Composition (%) of African Black Plum (Vitex doniana) leaves ensiled with broiler litter and urea

	Treatments				
Parameters	**T_1**	**T_2**	**T_3**	**T_4**	**SEM**
Dry matter	94.75	95.37	94.42	94.70	0.11
Crude protein	16.01[b]	16.96[b]	17.32[a]	16.89[b]	0.17
Crude fibre	23.34	24.10	22.38	20.61	0.53
Ether extract	3.73[a]	3.20[b]	3.17[b]	3.70[a]	0.09
Nitrogen Free Extract	51.78[b]	53.00[ab]	54.42[ab]	56.19[a]	0.57
Acid detergent fibre	30.67	29.81	30.19	32.65	0.21
Neutral detergent fibre	47.16	44.24	45.04	46.30	0.42
Ash	3.05	2.73	2.72	2.62	0.07

[a, b, c] means on the same row with different superscripts differ significantly ($p<0.05$), T_1 = 100 % African Black Plum leaves, T_2 = 100 % African Black Plum leaves + 1 % urea, T_3 = 75 % African Black Plum leaves + 25 % broiler litter, T_4 = 75 % African Black Plum leaves + 25 % broiler litter + 1 % urea, SEM = Standard Error of Mean

Table 4 shows the concentration of macro and micro mineral contents of silages obtained from African Black Plum (*Vitex doniana*) leaves ensiled with broiler litter and urea. Sodium (Na), potassium (K), magnesium (Mg), iron (Fe) and copper (Cu) varied significantly ($p<0.05$) among the silages obtained. Minerals are required by animals in critical amounts and balance; its deficiency reduces the efficiency of livestock production (Cheema *et al*., 2011b). Adequate levels of individual minerals are influenced by several factors such as the physical and chemical properties of the soil, water supply, climate, plant species and stage of development (Cheema *et al*., 2011b). Sodium and potassium concentration of ensiled ABPL were in agreement with the reports of Cheema *et al*. (2011a) but higher than the range 0.04-0.19 % and 0.09-1.27 % for Na and K respectively, as reported by Ghazanfar *et al*. (2011). Ruminant's requirement of magnesium varies from 0.12-0.18 % DM of diet (Anon, 1985). The magnesium content of ABPL silage obtained was higher than that recommended by earlier author but was in line with the reports of Cheema *et al*. (2011a) who reported a range of 0.72-0.96 % in fodder tree leaves. Calcium (Ca) concentration of the silages prepared from ABPL varied from 0.79-0.86%. Numerically higher value of Ca was obtained in T_4 (0.86%) followed by T_1 (0.84%), T_2 (0.81%) while the least value was obtained in T_3 (0.79%). Calcium level (0.79-0.86%) in the silages was adequate for the optimum performance of ruminants as it is higher than the calcium requirement of 0.30 % DM Ca required in the diets of ruminants for all forms of production (Khan *et al*., 2007). The Ca content of the silages was in agreement with the normal calcium (0.19-0.82%) requirement for ruminants reported by Laulloo *et al*. (2018). The silage phosphorus value (0.55-0.63%) were within the range of 0.11-0.88% reported by Ghazanfar *et al*. (2011) but higher than the reports of Cheema *et al*. (2011a). Animals require a minimum phosphorus requirement of 0.2 % DM (McDowell *et al*., 1984), thus, ensiling ABPL with broiler litter and urea must have improved the phosphorus content of the silages. Fe, Cu and Zn requirement of 50 mg/kg, 8-14 mg/kg and 30 mg/kg respectively, has been recommended as the critical level for ruminants (Anon, 1984; Khan *et al.,* 006; McDowell, 1985, Khan *et al.,* 2005). Anon (1980) recommended 12-20 mg/kg of Zn as adequate for growing ruminants. The Fe, Cu and Zn concentration in the silages were above the critical level reported by earlier authors. Silage manganese levels were

higher than 40 mg/kg critical level reported by Anon (1996). Similar higher levels of Mn concentrations have been reported by several authors (Prabowo *et al*., 1991; Khan *et al*., 2007; Velasquez-Pereira *et al*., 1997). The higher levels of Mn will thus, adequately meet the requirements of ruminant animals.

Table 4: Mineral content of African Black Plum (Vitex doniana) leaves ensiled with broiler litt er and urea

	Macro minerals (%)					Micro minerals (mg/kg)			
Treatments	**Na**	**K**	**Mg**	**Ca**	**P**	**Fe**	**Cu**	**Zn**	**Mn**
T_1	0.54^{b}	1.56^{b}	0.75^{b}	0.84	0.55	67.2^{b}	10.1^{b}	53.5	88.2
T_2	0.61^{a}	1.72^{a}	0.83^{a}	0.81	0.63	52.4^{c}	9.7^{b}	55.2	86.9
T_3	0.51^{c}	1.75^{a}	0.69^{c}	0.79	0.57	80.4^{a}	12.5^{a}	49.3	85.4
T_4	0.54^{b}	1.60^{b}	0.72^{bc}	0.86	0.60	61.2^{b}	12.2^{a}	50.1	89.6
SEM	0.12	0.10	0.19	0.23	0.09	2.63	1.95	2.06	3.15

$^{a, b, c}$ means on the same column with different superscripts differ significantly ($p<0.05$), T_1= 100 % African Black Plum leaves, T_2 = 100 % African Black Plum leaves + 1 % urea, T_3 = 75 % African Black Plum leaves + 25 % broiler litter, T_4 = 75 % African Black Plum leaves + 25% broiler litter + 1 % urea, SEM = Standard Error of Mean

Conclusion

It could be concluded that the silages possessed good physical properties and appreciable proximate and mineral composition. These silages could be potential feed resources that could be used to supplement animal feeds during periods of feed scarcity. The higher mineral contents of the silages in this study further suggests its use as a good source of feed in ruminant diets or as supplements to ruminants.

References

Abbiw, K. D. 1990. *Useful Plants of Ghana*. Intermediate Technology Publications & Royal Botanic Gardens, Kew.

Adejumo, A. A., Alaye, S. A., Ajagbe, R. O., Abi, E. A., and Adedokun, F. T. 2013. Nutritional and Anti –Nutritional Composition of Black – Plum (*Vitex doniana*). *Journal of Natural Sciences Research*, 3(12): 144-148

Akinbode, R. M., Isah, O. A., Oni, A. O., Adebayo, K. O. and Omoniyi, L. A. 2020. Rumen fermentation parameters and microbial profiles of West Africa Dwarf sheep fed sugarcane top treated with different nitrogen sources. Proceedings of the 45th Annual Conference of the Nigerian Society for Animal Production (NSAP) held at Abubakar Tafawa Balewa University, Bauchi from 15th to 19th March. Pp 1702-1706

Akinbode, R. M., Isah, O. A., Oni, A. O., Arigbede, O. M. and Ojo, V. O. A. 2017. Nutritional evaluation of sugarcane top ensiled with varying proportion of broiler liter. *Livestock Research for Rural Development,* 29(1).

Anonymous 1980. The Nutrients Requirements of Ruminant Livestock. 4th edition CAB International, Wallingford

Anonymous 1984. Nutrient Requirements of Domestic Animals. No. 4: Nutrient Requirements of Beef Cattle. 6th revised ed. (National Academy of Sciences, National Research Council, Washington DC.).

Anonymous 1996. Nutrient requirements of beef cattle (Seventh Ed.). National Academy Press, Washington, D.C.

AOAC 2005. **Association of Official Analytical Chemists**. Official

Methods of Analysis, 18th Edition, AOAC Inc, Arlington, Virginia, USA. 1094pp.

Cheema, U. B., Sultan, J. I., Javaid, A., Akhtar, P. and Shahid, M. 2011a. Chemical composition, mineral profile and *in situ* digestion kinetics of fodder leaves of four native trees. *Pakistan Journal of Botany*, 43(1): 397-404

Cheema, U. B., Younas, M., Sultan, J. I., Virk, M. R. and Waheed, A. 2011b. Fodder tree leaves: An alternative source of livestock feeding. *Advances in Agricultural Biotechnology*, 2: 22-33

Duncan, D. B. 1955. Multiple range and multiple F- test. *Biometrics* 11:1-42.

Egbekun, M. K., Akowe, J. I. and Ede, R. J. 1996. Physico-chemical Properties and Sensory Properties of Formulated Syrup from Black-plum (*Vitex doniana*) Fruit. *Plant Foods for Human Nutrition*; 49(4): 301-306.

George, A. U. 2003. Proximate and mineral composition of hairy indigo leaves. *Electronic Journal of Environmental, Agricultural and Food Chemistry,* 10(3): 207-213.

Ghazanfar, S., Latif, A., Mirza, I. H. and Nadeem, M. A. 2011. Macro-minerals concentrations of major fodder tree leaves and shrubs of District Chakwah, Pakistan. *Pakistan Journal of Nutrition*, 10(5): 480-484

Glew, R. H., Vanderjagt, D. J., Lockett, C., Grivetti, L. E., Smith, G. C., Pastuszyn, A. and Millson, M. 1997. Amino Acid and Mineral Composition of 24 Indigenous Plants in Burkina Faso. *Journal of Food Composition and Analysis,* 10(3): 205-217.

Kadi, N. and Muftau, M.A. 2020. Chemical composition of millet panicle waste ensiled with poultry manure at graded levels. Proceedings of the 45th Annual Conference of the Nigerian Society of Animal Production held at Abubakar Tafawa Balewa University, Bauchi on 15th-19th March. Pp 1630-1632.

Keay, R. W. J. 1964. **Nigerian Trees** In: Keay RWJ, Onochie CFA and DP Stanfield (Eds). FRIN, Ibadan, Vol. II, 1964.

Khan, Z. I., Ashraf, M., Hussain, A. and McDowell, L. R. 2005. Seasonal variation of trace elements in a semiarid veld pasture. Communications in soil science and plant analysis, 37: 1471-1484

Khan, Z. I., Ashraf, M., Valeem, E. E., Ahmad, K. and Danish, M. 2007. Pasture concentration of minerals in relation to the nutrient requirements of farm livestock. *Pakistan Journal of Botany*, 39(6): 2183-2191

Khan, Z. I., Hussain, A., Ashraf, M. and McDowell, L. R. 2006. Mineral Status of Soil and Forages in South Western Punjab, Pakistan. Asian-Australian Journal of Animal Sciences, 19(8): 1139-1147

Khan, Z. I., Hussain, A., Ashraf, M., Ashraf, M. Y., McDowell, L. R. and Huchzermeyer, B. 2007. Copper nutrition of goats grazing native and improved pasture with seasonal variation in a semi-arid region of Pakistan. *Small Ruminant Research*, 67: 138-148.

Ladeji, O. and Okoye, Z.S.C. 1996. Anti-hepatotoxic properties of *Vitex doniana* bark extract. *International Journal of Pharmacology.* 34(5): 355-358.

Ladeji, O., Udo, F. V. and Okoye, Z. S. C.

2005. Activity of aqueous extract of the bark of *Vitex doniana* on some uterine muscle response to drugs. *Phytotherapy Research*, 19: 804-806.

Lamidi, A. A. and Akhigbe, J. 2018. Quality of ensiled Guinea grass (*Panicum maximum*) at varying proportions with sweet potato peels for ruminant production in Niger Delta, Nigeria. *Nigerian Journal of Animal Production*, 48(2): 184-191.

Lamidi, A. A. and Ogunkunle, T. 2016. Nutritional potential of poultry dropping meal as feed resources for ruminant production in Niger Delta, Nigeria. *Global Agricultural Science and Technology*, 1: 1-11

Lamidi, A. A., Etela, I., Ukanwoko, A. I., Ingweye, J. N., Ologbose, F. and Oruene, I. 2020. Physical features and chemical composition of ensiled maize stover and groundnut haulms for sustainable ruminant production. Proceedings of the 45th Annual Conference of the Nigerian Society for Animal Production held at Abubakar Tafawa Balewa University, Bauchi on 15th-19th March. Pp 1761-1765

McDowell, L. R. 1985. In: Nutrition of Grazing Ruminants in Warm Climates. Academic Press New York, pp-443

Muhammed, I. R., Abdu, M. 1., Iyeghe-Erakpotobor, G. T. and Sulaiman, K. A. 2009. Ensiling quality of Gamba fortified with tropical legumes and its preferences by rabbits. *Research Journal of Applied Sciences,* 4(1): 20-25.

Munza, B. M., Hassan, M. R., Tanko, R. J., Yashim, S. M., Zakka, T., and Adewumi, A. E. 2020. Physicochemical characteristics of grain sorghum (Sorghum bicolor L.) silage as influenced by variety and planting date. Proceedings of the 45th Annual Conference of the Nigerian Society for Animal Production (NSAP) held at Abubakar Tafawa Balewa University, Bauchi from 15th to 19th March. Pp 1671-1674

Nnamani C. V., Oselebe H. O. and Okporie E. O. 2007. Ethnobotany of Indigenous Leafy Vegetables of Izzi Clan, in Ebonyi State, Nigeria. In: Proceedings of 20th Annual National Conference of Biotechnology Society of Nigeria held at Abakaliki from 14th -17th November. Pp.111-114.

Norton, B. W. 2003. The nutritive value of tree legumes as dietary supplement for ruminants. In: Forage tree legumes in tropical agriculture. Gutterridge R.C. and Shelton, H.M. (Eds), pp 171-191

Odeyinka, S. M., Abegunde, T. O., Ofoegbu, M. O. and Apanisile, O. J. 2021. Silage quality, growth performance and haematology of West African Dwarf goats fed *Moringa oleifera* leaves ensiled with cassava peels. *Nigerian Journal of Animal Production*, 48(2): 183-190.

Odhav, R. G. 2007. Proximate and mineral composition African Black Plum leaves. *Journal of Environmental, Agricultural and Food Chemistry,* 12(5): 310-316

Okigbo, R. N. 2001. Mycoflora within Black-plum (*Vitex doniana* Sweet). *Fruits* 56: 85-92.

Prabowo, A., McDowell, L. R., Wilkinson, N. S., Wilcox, C. J. and Conrad, J. H. 1991. Mineral status of grazing Cattle in South Sulawasi, Indonesia. 2-

Microminerals. *Asian-Australian Journal of Animal Science*, 4: 121-130

Rasool, S., Sali, M.A., Ahsan-ul-Haq and Jamil, A. 1998. Chemical changes during ensiling of Sudax fodder with broiler. *Animal Feed Science and Technology*, 72: 347-352

SAS 2003. *Statistical Analysis System SAS/STAT*. Guided for Personal Computers. 6th Edition, Cary N.C., USA. Pp 967 – 978.

Shuaibu, A. Y., Fasae, O. A., Adeleye, O. O., Oluwatosin, B. O. and Olugbokiki, A. 2020. Yield and proximate composition of *Brachiaria ruziziensis* fertilized with goat manure as potential dry season forage for ruminants. Proceedings of the 45th Annual Conference of the Nigerian Society for Animal Production (NSAP) held at Abubakar Tafawa Balewa University, Bauchi from 15th to 19th March. Pp 1679-1683.

Van Soest, P. J., Rebortson, B. and Lewis, B. A. 1991. Method for dietary fiber, neutral detergent fiber and non-starch poly saccharides in relation to animal nutrition. *Journal of Dairy Science*, 74: 3583- 3597.

Velasquez-Pereira, J. B., McDowell, L. R., Conrad, J. H., Wilkinson, N.S. and Martin, F. G. 1997. Mineral status of soils, forages and cattle in Nicaragua. I. Microminerals. *Reviews in Fac. Agron.*, 14: 73-89.

Yohanna, B. I., Nyako, H. D., Hyeladi, M. I., Yohanna, A. H., and Mohammed, I. D. 2015. Formulation and nutrient composition of dry season rations for ruminants using crop residues and their rumen degradation characteristics in semi- arid region of Nigeria. *Annal. Bio. Res*., 6(7): 1- 6.

Date received 11th February, 2022
Date accepted 3rd July, 2022