Annals of Animal and Biological Research, 2022; 2(1)

Original Article

Nutrient and Microbial Evaluation of Varied Mixtures of *Clitoria ternatea* and *Panicum maximum*

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Article Information
Keywords
Clitoria ternatea, feed, forage, *Panicum maximum,* ruminant

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Article History
Received: May 6, 2022
Accepted: July 11, 2022
Published: July 25, 2022

Article can be accessed at
www.aabrjournalaaua.org.ng

Abstract
Inadequate supply of quality feed remains one of the major challenges facing ruminant production in the tropics. Critical evaluation of the available forages will perhaps help in ameliorating this challenge. Therefore, this study aimed at determining the nutrients and microbial evaluation of varied mixtures of *Clitoria ternatea* and *Panicum maximum.* Five treatments: 100% *Panicum maximum* (100% Pm), 70% *Clitoria ternatea* + 30% *Panicum maximum* (70% Ct + 30% Pm), 50% *Clitoria ternatea* + 50% *Panicum maximum* (50% Ct + 50% Pm), 30% *Clitoria ternatea* + 70% *Panicum maximum* (30% Ct + 70% Pm) and 100% *Clitoria ternatea* (100% Ct), each replicated thrice were formulated using completely randomized design. Dry matter (DM), Crude protein (CP), Crude fibre (CF), tannin, oxalates, microbial and Ca were determined and subjected to ANOVA at 5% probability. The highest CP (18.87%) and DM (53.90%) were recorded for 100% Ct while the lowest CF content obtained was similar for 100% Ct and 50% Ct + 50% Pm at 14.35 and 16.04%, respectively. Tannin, oxalate and Ca were not affected (P>0.05). Bacterial count was similar up to 50% inclusion of *C. ternatea* while the least concentrations (2.67 x 10^5CFU/g) was observed in 100% Pm. Therefore, mixture at 50% Ct + 50% Pm lowered fiber fraction and anti-nutritional contents and thus has tendency of enhancing feed intake, digestibility and nutrient utilization for better ruminant production.

INTRODUCTION

Feeding of quality forage remains the bed rock of meeting the nutritional demand of ruminants in the tropics. Aderinola *et al.* (2007) reported that ruminants rely majorly on quality forages for their nutrition compare to any other feed materials. The core challenge of ruminants faced by herd farmers in the tropics is how to sustain quality forage supply to their animals all year round (Akinlade *et al.,* 2005; Babayemi, 2009). The low nutritive feeds are identified as a major factor responsible for significant decrease in voluntary dry

How to cite this article:
J.A. Alalade, S.T. Oyewole, O.O. Okunlola, I.A. Adebisi, O.T. Ojoawo, J.A. Akinlade, O.A. Aderinola, K.A. Adaramola and H.M. Tairu (2022). Nutrient and Microbial Evaluation of Varied Mixtures of *Clitoria ternatea* and *Panicum maximum. Annals of Anim. Bio. Res.,* 2(1): 14-23

matter intake, low rumen microbial activity and digestibility of feed by the animals which thus adversely affect growth performance (Yusuf *et al.,* 2013). Careful blend of available grasses and legumes seems to potentially mitigate challenge of quality feed facing ruminant production. Oyewole and Aderinola (2019) reported that mixture of 70% *P. maximum* and 30% *Stylosanthes hamata* in a complete diet had a better chemical composition and influenced the performance of West African Dwarf goat.

Panicum maximum is a wide spread forage in the tropics, especially in Nigeria. It is a sustainable forage grass with history of long support for ruminant feeding system (Bamikole *et al.,* 2001). It has potential nutrient enhancement if interplanted or mixed with legumes (Alalade *et al.,* 2013; Oyewole, 2021). *P. maximum* mixed with *Stylosanthes verano* enhanced dry matter intake, crude protein and organic matter digestibility (Bamikole and Babayemi, 2004). *Clitoria ternatea* (Butterfly pea) belongs to the *Fabaceae* family. Some authors attribute the origin of this legume to tropical America (Upadhyaya and Pachauri, 1983), but it is more likely that its origin is the Ternate Island in the Molluca archipelago, Indonesia (Gupta *et al.,* 2010). It is palatable and highly nutritive (AraújoFilho *et al.,* 1994). *C. ternatea* has high proximate and mineral constituent profiles that are pertinent in feed formulations (Neda *et al.,* 2013). Hence, this study aimed at evaluating the nutrients and microbial evaluation of varied mixtures of *C. ternatea* and *P. maximum.*

MATERIALS AND METHODS

Experimental Site

The experiment was carried out at the Teaching and Research Farm of Oyo State College of Agriculture and Technology, Igboora, Oyo State, Nigeria, located within 7°15' North and 3°30'East of the equator with an average rainfall of 1278mm and average annual temperature of 27°C (Alalade *et al*., 2021).

Collection of Samples and Experimental Design

Forage samples of *C. ternatea* and *P. maximum* were harvested from an already established experimental plot at 8 weeks post planting. The samples comprise of five different varied mixtures of *P. maximum* and *C. ternatea*: 100% *P. maximum* (100% Pm), 70% *C. ternatea* + 30% *P. maximum* (70% Ct + 30% Pm), 50% *C. ternatea* + 50% *P. maximum* (50% Ct + 50% Pm), 30% *C. ternatea* + 70% *P. maximum* (30% Ct + 70% Pm) and 100% *C. ternatea* (100% Ct). The experiment was laid using a Completely Randomized Design (CRD).

Chemical Analysis and Microbial Load Determination

The forage samples were oven dried at 60°C until constant weights were achieved and ground. The finely ground samples were analyzed for proximate composition as described by AOAC (1995). Neutral detergent fibre (NDF), acid detergent fibre (ADF) and acid detergent lignin (ADL) were determined by the procedure of Van Soest *et al*. (1991). The mineral elements were analyzed according to the method of Walinga *et al*. (1989). The mineral contents (K, Ca, Mg, Fe, Zn and Cu) were determined using atomic absorption spectrophotometer while phosphorus was also determined with Vonadomehydrate spectrometer at 490mph (Fritz and Schenk, 1979). The standard procedure of Taylor *et al*. (1997) was employed in determining the microbial load of the formulated diets.

Oxalic acid was estimated quantitatively by redox titration with standard potassium permanganate according to the procedure of Day and Underwood (1986). Saponin was determined using the method similar to that of Hudson and Ei-Difrawi (1979). Tannic acid was determined in accordance with the procedure of AOAC (1990).

Statistical Analysis

Data obtained were subjected to one-way Analysis of Variance (ANOVA) procedure and the treatments significant means were separated using Duncan's multiple range test (DMRT) of SAS (2000).

RESULTS

Proximate compositions and fibre fractions of varied inclusion of *C. ternatea and P. maximum* (Table 1) were significantly (P<0.05) different across the treatments. The highest CP value (18.87%) was recorded for 100% Ct, followed by 70% Ct + 30% Pm (16.66%) while 50% Ct + 50% Pm and 30% Ct + 70% Pm had lower but similar values (14.50 and 14.10%, respectively). However, the least CP value (10.36%) was recorded for 100% Pm. Conversely, 100% Pm had the highest ash content (9.75%) while ash contents were decreasing with increasing *C. ternatea* inclusion except for 70% Ct + 30% Pm which was similar to 30% Ct + 70% Pm (9.10% and 8.75%, respectively). The least ash content was observed to be similar for 100% Ct and 50% Ct + 50% Pm (8.79 and 8.50%, respectively). Ether extract (EE) had no particular order of trend. The 30% Ct + 70% Pm recorded the highest EE (2.0%), followed by 50% Ct + 50% Pm (1.86%) that was similar to 100% Ct (1.50%) while the least value (1.10%) was recorded for 100% Pm which was also similar to 1.36% ash recorded for 70% Ct + 30% Pm. The 30% Ct + 70% Pm had lower CF compared to 100% Pm but however higher than 20.17% CF recorded for 70% Ct + 30% Pm. The lowest CF contents were similar for 100% Ct and 50% Ct + 50% Pm (14.35% and 16.04%, respectively). Dry matter ranged between

1: Proximate compositions and fibre fractions of varying inclusion of *Clitoria ternatea and Panicum maximum*

Parameters (%)	100% Ct	70% Ct + 30% Pm	50% Ct + 50% Pm	30% Ct + 70% Pm	100% Pm	SEM	P-value
Crude protein	18.87^{a}	16.66^{b}	14.50^{c}	14.10^{c}	10.36^{d}	0.76	0.01
Ash	8.79^{bc}	9.10^{b}	8.50^{c}	8.75^{b}	9.77^{a}	0.12	0.01
Ether extract	1.50^{bc}	1.36^{cd}	1.86a^{b}	2.00^{a}	1.10^{d}	0.09	0.01
Crude fibre	14.35^{d}	20.17^{c}	16.04^{d}	22.59^{b}	28.75^{a}	1.46	0.01
DM	53.90^{a}	40.10^{d}	39.03^{e}	45.19^{c}	45.89^{b}	1.41	0.01
NDF	57.49^{c}	55.70^{d}	53.10^{e}	59.60^{b}	67.53^{a}	1.31	0.01
ADF	31.63^{c}	30.40^{d}	27.90^{e}	34.10^{b}	43.15^{a}	1.40	0.01
ADL	12.69^{c}	11.10^{d}	10.30^{e}	16.10^{b}	17.21^{a}	0.73	0.01

^{abcd} = Means on the same row with the same letters are not significantly different (p>0.05).

Table 2: Anti-nutritional factors and microbial loads of varying inclusion of *Clitoria ternatea and Panicum maximum*

Parameters	100%Ct	70%Ct+ 30%Pm	50%Ct+ 50%Pm	30%Ct+ 70%Pm	100%Pm	SEM	P-value
Saponin (%)	0.93^{a}	0.91^{a}	0.17^{b}	0.14^{b}	0.08^{b}	0.10	0.01
Tannin (%)	0.27	0.28	0.31	0.32	0.75	0.05	0.12
Oxalate (%)	0.20	0.19	0.20	0.20	0.19	0.02	1.00
Fungi (x10^{3}cfu/g)	2.36	2.27	2.30	2.11	2.11	0.04	0.15
Bacterial(x10^{5}cfu/g)	3.58^{a}	3.43^{a}	3.50^{a}	3.10^{b}	2.67^{c}	0.09	0.01
Protozoa(x10^{3}cfu/g)	2.08^{ab}	2.10^{a}	2.02^{ab}	1.90^{c}	1.97^{bc}	0.02	0.01

^{abc} = Means on the same row with the same letters are not significantly different (p>0.05).

39.03 and 53.90%. The highest value was recorded for 100% Ct, followed by 100% Pm while the least value was obtained for 50% Ct + 50% Pm. Fibre fractions (NDF, ADF and ADL) had similar trend. The recorded values were in the order of 100% Pm > 30% Ct + 70% Pm > 100% Ct > 70% Ct + 30% Pm > 50% Ct + 50% Pm, (p=0.01).

Table 2 reveals the anti-nutritional factors and microbial loads of varied inclusion of *C. ternatea and P. maximum.* The anti-nutritional factors were insignificant (P>0.05) across the treatments except for saponin. Saponin content was observed decrease with increase in *P. maximum* inclusion. The least saponin content (0.08%) was obtained for 100% Pm while the highest value (0.93%) was recorded for 100% Ct although similar (P>0.05) to 70% Ct + 30% Pm (0.91%). Microbial loads were significant (p<0.05) across the parameters except for fungi. Bacterial and protozoa had higher values on all the treatments compared to 30% Ct + 70% Pm and 100% Pm.

Mineral concentrations were not affected (P>0.05) by varied inclusion of *C. ternatea and P. maximum* (Table 3) except for macro-mineral contents (P<0.05). The

Table 3: Mineral concentrations of varying inclusion of *Clitoria ternatea and Panicum maximum*

Parameters	100% Ct	70% Ct + 30% Pm	50% Ct + 50% Pm	30% Ct + 70% Pm	100% Pm	SEM	P-value
P (%)	0.33	0.31	0.30	0.28	0.27	0.01	1.87
K (%)	0.64	0.63	0.50	0.57	0.48	0.03	0.44
M (%)g	0.29	0.28	0.27	0.24	0.24	0.01	0.15
Ca (%)	0.33	0.25	0.24	0.22	0.21	0.01	0.08
Fe (mg/kg)	118.79^{a}	111.03^{b}	102.89^{c}	95.30^{d}	91.85^{d}	2.71	0.01
Zn (mg/kg)	37.81^{a}	36.10^{a}	30.24^{b}	22.30^{c}	24.83^{c}	1.65	0.01
Cu (mg/kg)	5.64^{a}	5.55^{a}	3.76^{b}	4.20^{b}	3.76^{b}	0.21	0.01

^{abcd} = Means on the same column with the same letters are not significantly different (p>0.05).

100% Ct and 70% Ct + 30% Pm had similar higher (P=0.01) Zn values (37.81 and 36.10 mg/kg and Cu (5.64 and 5.55 mg/kg), respectively while highest Fe value (118.79 mg/kg) was obtained for 100%Ct. The least values for Fe and Zn were similar for 30% Ct + 70% Pm and 100% Pm while value for Cu was recorded to be similar for 50% Ct + 50% Pm, 30% Ct + 70% Pm and 100% Pm.

DISCUSSION

Chemical composition of a forage-based diet is an important factor determining the productivity index of ruminant animal production (Minson, 1990) and also suggests the output if consumed and utilized by animals. The significant higher crude protein value for 100% Ct compared to the mixtures and the sole *P. maximum* diet (100% Pm) agreed with the observation of Amole *et al.* (2015) who reported reduction in CP in mixed grass-legume due to dilution of grass incorporation. The CP recorded for 100% Ct in this study favourably fell within the range of 18.50 – 21.50% reported by Gomez and Kalamani (2003). However, the CP reported for 100%Pm was slightly higher than 7.07 to 9.77% reported by Jimoh *et al.* (2015) but fell within 8.51 to 12.52% reported by Muhammad (2014). The variation observed could be averred to age at harvest and location. Ajayi and Babayemi (2008) reported that age of forage at harvest has influence on their nutrient profile. Meanwhile, except for 100% Pm, the range of CP reported for this study fell within the range of 11 – 14% DM recommended by NRC (1995) for sufficient and modest livestock productivity. It is apparent from this study that grass-legume mixtures can considerably increase forage quality, thus augment the nutrient requirement of ruminant animals.

The CF value of 100% Ct was below the range of 20.4 and 21.5% reported for *C. ternatea* (Kalamani and Gomez, 2001) while significant reduction in CF contents of varied mixtures could be averred to lower fibre content in *C. ternatea.* The fibre fraction content in a diet is an important factor affecting forage utilization (Van Soest *et al*., 1994). The NDF has prominent role in the diet formulation as it affects the amount of forage that can be consumed by animals (Bingol *et al.,* 2007). It was reported by Van Soest *et al.* (1994) that an increase in NDF reduces the dry matter intake of the animals. The highest NDF, ADF and ADL in the 100% Pm could be as a result of higher CF content, lower CP content and higher structural cell wall contents. However, the range of the NDF values recorded for this study, except for 100% Pm, was within 24 – 61% reported as normal values for tropical forages by Topps (1992). Therefore, all the grass-legume mixtures in this study are within the range that will encourage dry matter intake by ruminants. The reduction in ADF and ADL contents in the grass-legume mixtures was in consonance with the observation of Oyewole (2021) that mixture of grass and legumes lower the concentration of fibre fractions. Therefore, feeding mixtures of *P. maximum* and *C. ternatea* to ruminants will not likely have negative effect on their digestibility and utilization.

The significant differences in saponnin constituents could be associated with higher ANFs in legumes (Kumar, 2011). The range of saponnin recorded in this study was higher than 0.025 – 0.041 reported by Oyewole (2021) for varied mixtures of *P. maximum* and *S. hamata*,0.81 – 1.13 mg/100g (*P. maximum*) and 0.75 7 – 5.68 mg/100g (legume/mixtures) by

Onyeonagu *et al.* (2013) except for 100% Pm. The variation observed could be associated to plant species and sapogenic fraction structures (Kumar, 2011). Since there is paucity of information validating the tolerable level of saponinin ruminants, there is need for further studies (intake, digestibility and utilization) and other animal factors to check the effect of these levels on the performance of the ruminants. However, feeding 50% Ct + 50% Pm, 30% Ct + 70% Pm and 100% Pm may not adversely affect the palatability and thus the intake of the animals. The oxalate contents in the present study were low in concentration compared to the range of 0.54 to 0.82% for forage legumes in Nigeria (Ologhobo, 2012). The recommended safe limit in ruminants is less than 2% (Sidhu *et al.,* 2014). Therefore, feeding these diets to ruminants will not likely impair feed intake or pose health challenge on ruminant animals. McMahon *et al.* (2000) reported that tannin in ruminant diets prevents bloating and suppress internal parasites (Hoste *et al.,* 2006). However, the tannin concentration should not exceed 5% for goats (Cooper and Owen-Smith, 1985) and 2% and 5% for sheep and cattle, respectively (Diagayete and Hugg, 1981). Since the observed range in this study was far below the critical tolerable level, therefore, feeding these diets to ruminants will not decrease digestibility and growth rate.

The higher bacterial and protozoa counts observed for 100% legume to 50% inclusion in this study could be as a result of high nutrients profile. Jeffrey *et al.* (1998) reported that protein ingredients served as vehicle for microbial contamination. Omojasola and Kayode (2015) reported that the presence of microbes in the feed suggests sufficient nutrients to support proliferation of bacterial, protozoa and fungi. However, half a million microbial load is recommended as safe level for ruminants' consumption (Wilson and Sperber, 1981) while 300,000 cfu/g for older animals and 500,000CFU/g for younger animals were recommended according to International Microbiological Standard (Omojasola and Kayode, 2015). All the feeds in this study aligned with the microbial counts recommended safe levels for animals except on the account of bacterial counts recorded for 100%Ct and all the varied legume/grass mixtures in this study. This suggests that legume and legume inclusive diets are contaminated with bacteria. This could be averred to storage during processing and protein level as reported by Jeffrey *et al.* (1998). Only 100% Pm is below 300,000 cfu/g, thus makes it safe for older animals' consumption. However, all these diets will be adequate in feeding young animal since they were below 500,000 cfu/g of fungi, bacteria and protozoa recommended for younger animals.

The Ca concentration recorded in this study fell within 0.20 and 0.54g/100gDM reported for legume and mixtures by Bamikole and Babayemi (2009). All the Ca contents observed in this study could furnish required Ca (0.20 – 0.82 mg/kg) recommended for goats and sheep without supplementation (NRC, 1985). Phosphorous is vital for differentiation as a component of RNA and formation of bone matrix in farm animals (NRC, 2000); hence, its contents recorded in the present study were higher than 0.15%P recommended for ruminants (NRC, 1985). The Mg requirement of ruminant animals will likely be adequately met considering the values

(1-2 and 2-2.5 g/kg) required by beef and dairy cattle, respectively and 1.2 g/kg recommended for gestation cow (NRC, 1996). Adequate Mg in diets helps in enhancing metabolic activities and controlling of muscle cells (Kubkomawa *et al.,* 2015).

Potassium is the third most abundant mineral in the body of ruminant animals (NRC, 2000). However, the recorded amount in this present study is far below the range (1.8 – 2.5 g/kg) recommended for goat and sheep (NRC, 1981). Therefore, K supplementation is required when these diets are fed to the ruminants. Zinc is essential for some biological processes and hormonal activities (Alves *et al.,* 2012). About 30 mg/kg has been reported by NRC (2000) as a critical dietary level for ruminants while 12 – 20 mg/kg was reported adequate for growing ruminants (Anonymous, 1980). The range observed in this study will likely furnish ruminants with sufficient Zn without adverse effect on biological and hormonal processes. Iron (Fe) value was higher than 30 – 50 mg/kg but Cu was lower to 7 – 11 mg/kg recommended by NRC (1985) for sheep.

Dietary supplementation of Cu is required when feeding these diets to the ruminants. Copper deficiency can reduce growth rate and cause fatal disease in lamb. The observed significant differences within the treatments for Fe, Zn and Cu could be averred to differences in mineral concentrations in grass and legume, and as well the mixture ratio effect. Minson (1988) reported that legume contains higher mineral concentrations than grass.

CONCLUSION AND RECOMMENDATION

1. 100% Ct had highest CP, DM and Fe while 50%Ct+50%Pm had least NDF, ADF and ADL.
2. *Clitoria ternatea* at 100% and 70% inclusion had similar Zn and Cu contents.
3. Inclusion of *P. maximum* up to 50% decreases the saponin concentrations while 100% Pm had least count of bacteria. The least protozoa counts were recorded for 30% Ct + 70 Pm.
4. Mixture of *C. ternatea* and *P. maximum* at 1:1 (50% Ct + 50% Pm) will lower the fibre fraction and anti-nutritional contents thus enhanced feed intake, digestibility and nutrient utilization for improved productivity.
5. Further study is recommended on growth performance, digestibility and blood assay of ruminants fed these formulated diets.

Conflict of interest: All authors indicated that there was no conflict of interest that could inappropriately or possibly influence this work after publication.

REFERENCES

Aderinola, O.A., Akinlade, J.A., Akingbade, A.A., Babajide, P.A., Akinwunmi, A.O. and Rafiu, T.A. (2007). Effect of varying inter-row spacing of *Lablab purpureus* on biomass yield and chemical composition of *Andropogon tectorum* in the derived savanna zone of Nigeria. *Tropical Journal of Animal Science*, 10(1): 505 – 509.

Ajayi, F.T. and Babayemi, O.J. (2008). Comparative *in vitro* evaluation of mixtures of *Panicum maximum* cv Ntchisi with stylo (*Stylosanthes guianensis*), Lablab (*Lablab purpureus*), Centro (*Centrosema pubescens*) and Histrix (*Aeschynomene histrix*). *Livestock Research for Rural Development,* 20 (83). Retrieved

May 27, 2022, from http://www.lrrd.org/lrrd20/6/ajay20083.htm

Akinlade, J.A., Farinu, G.O., Olujide, A.M., Ojebiyi, O.O., Aderinola, O.A. and Togun, V.A. (2005). Evaluation of shrubby legumes (*Stylosanthes guianensis* and *Stylosanthes scabra*) and cotton seed cake on the performance of West African Dwarf sheep. *Proceedings of 10th Annual Conference of Animal Science Association of Nigeria (ASAN). University of Ado-Ekiti, Nigeria. September, 12-15. pp.184-186.*

Alalade, J.A., Akinlade, J.A., Aderinola, O.A., Amao, S.R. and Adaramola, K.A. (2013). Effect of number of *Stylosanthes hamata* rows on herbage yield, nutritive quality and performance of WAD sheep fed native *Panicum maximum. Journal of Biology, Agriculture and Healthcare*, 3(10): 73 - 80.

Alalade, J.A., Adaramola, K.A., Okunlola, O.O., Tairu, H.M., Adelodun, O.B., Adebisi, I.A. and Muraina, T.O. (2021). Haematological and biochemical indices of White Fulani cattle grazed on natural pasture in four locations. *Nigeria Journal of Animal Science and Technology,* 4 (3):82-92.

Alves, C.X., Helena, S., Vale, L., Marilia, M., Dantas, G., Maia, A., Franca, M.C., Marchini, J.S., Leite, L.D. and Brandao-Neto, J. (2012). Positive effects of zinc supplementation on growth, GH, IGFI and IGFBP3 in eutrophic children. *Journal of Pediatric Endocrinology and Metabolism,*25: 881 – 887.

Amole, T.A., Oduguwa, B.O., Onifade, S.O., Jolaosho, A.O., Amodu, J.T. and Arigbede, M.O. (2015). Effect of planting patterns and age at harvest of two cultivars of *Lablab purpureus* in *Andropogon gayanus* on agronomic characteristic and quality of grass/legume mixtures. *Pertanika Journal of Tropical Agricultural Science*, 38(3): 329 – 346.

Anonymous (1980). The nutrients requirements of ruminant livestock, CABI Publishing: Wallingford, UK.

AOAC (1990). Official methods of analysis. *Association Official Analytical Chemists.* (15th Ed.). Arlington Virginia USA, 2, 910 - 928.Http://dx.doi.org/103923/pjn.2009.120 4.1208

AOAC (1995). Official methods of analysis. *Association of Official Analytical Chemists Methods*, AOAC 16th Edition. Washington, D.C.

AraújoFilho, J.A., Gadelha, J.A., Silva, N.L. and Pereira, R.M.A. (1994). Efeito da alturaeintervalo de cortenaprodução de forragem da cunhã (*Clitoria ternatea*, L.) *Pesq Agropec Brasilia*, 29: 979 - 982.

Babayemi, O.J. (2009). Silage quality, dry matter intake and digestibility by West African Dwarf sheep of *Panicum maximum* (*Panicum maximum* cv Ntchisi) harvested at 4 and 12 week regrowths. *African Journal of Biotechnology,* 8(16): 3983 - 3988.

Bamikole, M.A. and Babayemi, O.J. (2004). Feeding goats with Guinea grass-Verano stylo and Nitrogen fertilized grass with energy concentrate. *Archivos de Zootecnia,* 53: 13 - 23.

Bamikole, M.A. and Babayemi, O.J. (2009). Macro-mineral utilization in West African Dwarf goats fed combinations of fertilized and unfertilized Guinea grass (*Panicum maximum* cv. Ntchisi), Veranostylo (*Stylosanthes hamata* cv Verano) and a concentrate mix. *Livestock Research for Rural Development*, 21(140). Retrieved May 27, 2022, from http://www.lrrd.org/lrrd21/9/bami21140.htm

Bamikole, M.A., Ezenwa, I.A., Akinsoyinu, A.O., Arigbede, M.O. and Babayemi, O.J. (2001). Performance of West African Dwarf goats fed Guinea grass-Verano stylo mixture, N-fertilized and unfertilized Guinea grass. *Small Ruminant Research,* 39 (2): 145 - 152.

Bingol, N.T., Karsli, M.A., Yilmaz, I.H. and d Bolat, D. (2007). The effects of planting time and combination on the nutrient composition and digestible dry matter yield of four mixtures of vetch varieties intercropped with barley. *Journal of Veterinary Animal Science, 31:* 297–302.

Cooper, S.M. and Owen-Smith, N. (1985). Condensed tannins deter feeding by browsing ruminants in a South African Savannah. *Oecologia* (Berlin), 67: 142 – 146.

Day, R.A. and Underwood, A.L. (1986) *Quantitative Analysis*.5th Edition, Prentice Hall Publication, Upper Saddle River, 701.

Diagayete, M. and Hugg, W. (1981). Tannin contents of African pasture plants: Effects on analytical data and *in vitro* digestibility.

Animal Res. and Development, 15: 79-90.

Fritz, J. S. and Schenk, G. H. (1979). Quantitative Analytical Chemistry. 4th Ed., Boston, Massachusetts: Allyn and Bacon, Inc.

Gomez, S.M. and Kalamani, A. (2003). Butterfly pea (*Clitoria ternatea*): A nutritive multipurpose forage legume for the tropics – An Overview. *Pakistan Journal of Nutrition,* 2(6): 374 – 379.

Gupta, G.K., Chalal, J. and Bhatia, M. (2010). *Clitoria ternatea* (L.): Old and new aspects. *Journal of Pharmaceutical Research International*, 3: 2610–2614.

Hoste, H., Jackson, F., Athanasiadou, S., Thamsborg, S. M. and Hoskin, S. O. (2006). The effects of tannin-rich plants on parasitic nematodes in ruminants. *Trends in Parasitology Research, 22*: 253-261.

Hudson, B.J.F. and Ei-Difrawi, E.A. (1979). The sapogenins of the seeds of four *Lupin species*. *Journal of Plant Foods*, 3 (3): 181-186.

Jeffrey, J.S., Kirk, J.H. Atwill, E.R. and Cullor, J. S. (1998). Prevalence of selected microbial pathogens in processed poultry waste used as dairy cattle feed. *Poultry Science,*77: 808-811.

Jimoh, S.O., Olanite, J.A., Mustapha, S.O., Oladepo, O., Amisu, A.A. and Sotimehin O.A. (2015). Proximate composition of the morphological fractions of *Panicum maximum* varieties as affected by age in the derived savanna of Nigeria. *First Biennial Conference of the Society for Grassland Research and Development in Nigeria. December, 6-9. Federal University of Agriculture, Abeokuta, Nigeria. pp. 82 -85.*

Kalamani, A. and Gomez, S.M. (2001). Genetic variability in *Clitoria* spp. *Annals of Agricultural and Research*, 22(2): 243 – 245.

Kubkomawa, H., Olawuye, H.U., Krumah, L. J., Etuk, E. B. and Okoli, I. C. (2015). Nutrient requirements and feed resource availability for pastoral cattle in the tropical Africa: a review. *Journal of Agricultural and Crop Research,* 3: 100 – 116.

Kumar, R. (2011). Anti-nutritional factors. The potential risks of toxicity and methods to alleviate them.www.irrd.org/Ag/AGA/AGAP/FRG/A4pp102/102-145. Retrieved on 23/01/2012.

McMahon, L.R., McAllister, T.A., Berg, B.P., Majak, W., Acharya, S.N., Popp. J.D, Coulman, B.E., Wang, Y. and Cheng, J.K. (2000). A review of the effects of forage condensed tannins on ruminal fermentation and bloat in grazing cattle. *Canadian Journal of Plant Science,* 80 (3): 469-485.

Minson D.J. (1988). Chemical composition and nutritive value of tropical legumes. In: *Tropical Legumes*. P.J. Skerman, D.G. Cameron and F. Riveros (eds.). Food and Agriculture Organization of the United Nations, Rome, FAO *Plant Production and Protection Series,* No. 2. pp. 18 – 193.

Minson, D.J. (1990). *Forage in Ruminant Nutrition*. Harcourt Brace Jovanovich, London: Academic press, Inc., pp. 208 - 221

Muhammad, R. (2014). Dry matter yield and nutritional quality of *Panicum maximum-Centrosema pubescens* mixtures at different plant proportions and cutting intervals. *International Journal of Science, Environment and Technology*, 3(6): 2231 – 2241.

Neda, G.D., Rabeta, M.S. and Ong, M.T. (2013). Chemical composition and anti-proliferative properties of flowers of *Clitoria ternatea. International Food Research Journal,* 20(3): 1229-1234.

NRC (1981). Nutrient requirement of goats: Angora, dairy and meat goats in temperate tropical countries. *Nutrient Requirement of Domestic Animals*. No 15, National Research Council, Washington. Dc USA: National Academies Press.

NRC (1985). Nutrient Requirements of Sheep, Sixth Revised Edition (1985), Subcommittee on Sheep Nutrition, Committee on Animal Nutrition, Board on Agriculture, Nation Research Council. Washington, D.C: National Academies Press. .

NRC (1995). National Research Council. Nutrient Requirements of Sheep (6th Edition). National Academy Press, Washington D. C.

NRC (1996). Nutrient requirements of beef cattle.7th edition. Washington. DC: National Academies Press. .

NRC (2000). Nutrient Requirements of Beef Cattle. Seventh revised edition, Washington D C : The National Academies Press.

Ologhobo, A.D. (2012). Mineral and anti-nutritional contents of forage legumes consumed by goats in Nigeria www.fao.or/wairdocs/ILRI/x548913/

x5489b0o.htm. Retrieved 14/08/12.

Omojasola, P.F and Kayode, R.M. (2015). Microbiological quality assessment and physicochemical properties of selected poultry feeds from commercial feed millers in Ilorin, Nigeria. *International Journal of Applied Agricultural and Apicultural Research,* 11 (1&2): 60-66.

Onyeonagu, C. C., Obute, P. N. and Eze, S. M. (2013). Seasonal variation in the anti-nutrient and mineral components of some forage legumes and grasses. *African Journal of Biotechnology,* 12(2): 142 - 149.

Oyewole, S. and Aderinola, O. (2019). Growth performance and bio-economic indices of varying mixtures of grass-legume pellets fed to West African Dwarf (WAD) goats. *Journal of Biology, Agriculture and Healthcare*, 9(24): 55 - 62.

Oyewole, S.T. (2021). Performance of West African Dwarf sheep fed *Panicum maximum* and *Stylosanthes hamata* harvested at different age and seasons. PhD Thesis (Unpublished), Ladoke Akintola University of Technology, Ogbomoso, Nigeria. 227pp.

SAS (2000). Statistical Analysis Systems, Institute Inc., SAS/ STAT. User's Guide. 3rd Edition. Cary, North Carolina, USA.

Sidhu, P.K., Lamba, J.S., Kumbhar, G., Sekhon, G.S., Verma, S. and Gupta, M.P. (2014). Role of epidemiological factors in accumulation of oxalates in forage crops. *American International Journal of Research,* 7(1): 48 - 52.

Taylor, D.J., Green, N.P.O. and Stout, G.W. (1997). *Biological Science 1 and 2.* Third edition (Cambridge University Press), 1997.

Topps, J.H. (1992). Potential composition and use of legume shrubs and trees as fodder for livestock in the tropics. *Journal of Agricultural Science,* 118: 1 - 8.

Upadhyaya, R.S, and Pachauri, V.C. (1983). Nutritive value of *Clitoria ternatea* L. hay for Barbari goats. *Indian Journal of Animal Science,* 53:1032–1033.

Van Soest, P.J., Robertson, J.B. and Lewis, B.A. (1991).Methods for dietary fibre, neutral detergent fibre and nonstarch polysaccharides determination in relation to animal nutrition. *Journal of Dairy Science,* 74: 3583 – 3597.

Van Soest, P.J. (1994). Nutritional ecology of the ruminants. In P.J. Van Soest *Fiber and Physiochemical Properties of Feeds* (2nd ed.). Ithaca and London: Cornell University Press. pp. 140–155.

Walinga, I., Van-Veak, V.W. Houba, V.I.G. and Van-derlee. J.J. (1989). *Plant Analysis, Procedures* (Soil and Plant Analysis, Part 7). Wagenningen, Netherland, 18.

Wilson, D. and Sperber, D. (1981). On grice's theory of conversation. In P. Werth (ed.) Conversation and Discourse. London: Croom Helm. 155-178. Reprinted in Kasher (ed.) 1998, 4: 347 - 368.

Yusuf, K.O., Isah, O.A., Arigbede, O.M., Oni, A.O. and Onwuka, C.F.I. (2013). Chemical composition, secondary metabolites, *in vitro* gas production characteristics and acceptability study of some forage for ruminant feeding in South-Western Nigeria. *Nigerian Journal of Animal Production,* 40(1): 179- 190.