NATIONAL AGRICULTURAL AND FOOD CENTRE
RESEARCH INSTITUTE FOR ANIMAL PRODUCTION NITRA

Slovak J. Anim. Sci., 47, 2014 (3): 157-163
© 2014 NPPC
ISSN 1337-9984

EFFECT OF FORAGE LEGUME SUPPLEMENTATION OF MAIZE COBS ON THE PERFORMANCE OF WEST AFRICAN DWARF SHEEP

O. A. FASAE[1]*, F. T. ADEDOKUN[2], T. M. BADMOS[1]

[1]Department of Animal Production and Health, Federal University of Agriculture, Abeokuta, Nigeria
[2]Department of Agricultural Extension and Management, Federal College of Forestry, Jericho, Ibadan, Nigeria

ABSTRACT

The supplementation of maize cobs with forage legumes was used to evaluate the performance of sixteen West African Dwarf sheep aged 10-15 months and average weight of 18.01 ± 0.30 kg in a complete randomized design. The basal diet of maize cob plus 100 g of palm kernel cake was offered alone (control) or supplemented with 200 g on dry matter basis of forages of *Enterolobium cyclocarpum*, *Leucaena leucocephala* and *Gliricidia sepium*, respectively. Data were taken on feed intake, body weight changes, feed conversion ratio, digestibility and haematological parameters. The result of the study showed that maize cobs supplemented with forage legume improved sheep performance with best ($p<0.05$) feed intake and weight gain observed in sheep supplemented with Leucaena (745 $g.day^{-1}$ and 33.57 $g.day^{-1}$, respectively) and Gliricidia forage (720 $g.day^{-1}$ and 30.89 $g.day^{-1}$, respectively) with best dry matter, crude protein and fibre digestibilities. Though, there were significant differences ($P<0.05$) observed in values of blood parameters with the exception of white blood cells, these values were within the normal range reported for healthy sheep production. It was therefore concluded that maize cobs supplementation with forage legumes can play an important role in improving the performance of sheep with the supplementation of Leucaena and Gliricidia forage producing the best performance.

Key words: maize cob; forage legume; sheep; intake; digestibility; haematology

INTRODUCTION

The prohibitive cost of concentrate diets for sheep production has necessitated continuous search for less expensive and high nutritive feedstuffs that could represent cost-effective supplements for sheep on poor quality crop residues.

Maize cob is a common and readily available feedstuff in Nigeria which is an underutilized by product from the processing of harvested maize. The amount of maize cob generated annually in the country increases as more people venture into the cultivation of maize, but they have low feeding value because of its poor protein content, energy, minerals and vitamins (Akinfemi *et al.*, 2009). However, supplementation is perhaps a cheaper and simpler way of improving the feeding value of crop residues in situ, involving practical methods that are realistic of small farm situations. Foliage from tree legumes and shrubs which are readily available and persist during the dry season when pasture is either scarce or of poor quality has been found to be beneficial to ruminants as they offer a cheaper alternative to supplementation of poor quality roughages (Odeyinka, 2001; Phimphachanhvongsod and Ledin, 2002), contributing protein-rich forage, digestible energy and minerals when used either as supplements or as sole feed (Abdulrazak *et al.*, 1997). There exists extensive and diverse literature on the effects of leguminous tree supplementation on the productivity of ruminants. Forage tree leaves, particularly of Leucaena and Gliricidia, have been used as supplements to a wide range of forages and agricultural by products in

***Correspondence:** E-mail: animalexp@yahoo.co.uk
Oladapo Ayokunle Fasae, Department of Animal Production and Health,
Federal University of Agriculture, P.M.B. 2240,
Abeokuta, Nigeria

Received: September 24, 2013
Accepted: January 13, 2014

ruminant nutrition (Norton, 1994).

This study therefore evaluates the effect of forage legume supplementation on the intake, digestibility, growth and haematological profile of West African Dwarf sheep fed maize cob.

MATERIAL AND METHODS

Experimental Animals and Management

Sixteen (n = 16) sheep of the West African Dwarf breed selected from the farm flock in the Small Ruminant Experimental unit of Teaching and Research Farms, Federal University of Agriculture, Abeokuta, Ogun State were used in a 56 day study. The animals aged 10-15 months with an average body weight of 18.01 ± 0.30 kg were allotted to four treatments in individual feeding pens with wooden slatted floors, balanced for weight in a complete randomized design. The animals were assigned to a basal diet of maize cob plus 100 g of palm kernel cake offered alone (control) or supplemented with 200 g on dry matter basis of forages of *Enterolobium cyclocarpum*, *Leucaena leucocephala* and *Gliricidia sepium* respectively, at 4 % of their body weight with fresh and clean water provided *ad libitum*.

Experimental Diets

Dried maize cobs were procured from maize sellers in a local market and the leaves of the forage legumes namely *Leucaena leucocephala*, *Enterolobium cyclocarpum* and *Gliricidia sepium* were harvested from established plots within the university campus. Maize cobs were sun-dried and grounded while the forage legumes were harvested, chopped, sun dried for 5 days.

Data Collection

The body weights of the animals were taken using a spring balance at the beginning of the experiment and on weekly basis thereafter. The feed offered and feed refusal were also taken to get the feed intake. During the last 7 days of the experiment, the animals were transferred into metabolic cages where faecal samples were collected from each sheep. Also, the faeces were weighed to get the faecal voided. The faecal sample was dried in oven to constant weight and bulked for the determination of its proximate composition.

Blood samples were also collected from each animal in ethylenediaminetetraacetic acid bottles at the end of the experiment via jugular vein puncture with a 5 ml guage syringe for the determination of haematological parameters namely packed cell volume, white blood cells, red blood cells, haemoglobin and total protein (AOAC, 1995).

Chemical Analysis

The proximate composition of the feeds and faeces was determined (AOAC, 1995). The dry matter was determined by oven drying at 65 °C for 24 hours, crude protein (CP) by Kjeldahl method and fat by Soxhlet fat extraction method. The concentration of neutral detergent fibre (NDF), acid detergent fibre (ADF) and acid detergent lignin (ADL) both in feed and faecal samples were also determined by the method of Van Soest and Robertson (1985).

Statistical Analysis

Data collected were subjected to one way analysis of variance in a completely randomized design (SAS, 1999). Significant means were separated using Duncan multiple range test (Duncan, 1955).

Table 1: Chemical composition (% DM) of experimental diets fed to sheep

Parameters	MC	EC	LL	GS	PKC
Dry matter	90.37	90.81	91.14	91.07	92.20
Crude protein	2.43	20.27	27.02	20.80	18.67
Ether Extract	0.26	6.91	3.11	2.91	6.88
Ash	1.40	5.92	9.89	9.73	5.08
Neutral detergent fibre	81.30	67.43	49.22	56.31	68.43
Acid detergent fibre	47.20	36.54	20.39	24.65	45.22
Acid detergent lignin	8.89	12.02	6.01	8.56	12.78

MC – Maize cob, EC – *Enterolobium cyclocarpum*, LL – *Leucaena leucocephala*, GS – *Gliricidia sepium*, PKC – Palm Kernel cake

RESULTS AND DISCUSSION

The chemical composition of maize cobs and forage legumes is shown in Table 1. Maize cob had a low content of crude protein (2.43 %), ether extract (0.26 %) and ash (1.40 %) with a high content of fiber fractions. The high NDF content in maize cob was consistent with previous reports where it is characterized by high NDF contents implying that the material is high in lignocelluloses component and low in nitrogen (Adebowale, 1988).

The CP contents of *Enterolobium cyclocarpum* (EC), *Leucaena leucocephala* (LL) and *Gliricidia sepium* (GS) were consistent with values reported in the literature (Odeyinka 2001, Babayemi 2006, Fasae *et al*., 2011) with Leucaena having the highest crude protein (27.02 %). The CP content of these forage legumes were above 10-12 % as recommended by Gatenby (2002) for moderate level of ruminant production suggesting the potential of these forages to provide adequate nitrogen required by rumen micro organism to maximally digest the dietary fiber components which will lead to the production o f volatile fatty acids.

The fiber contents of the plant species were similar with the report of another group of workers (Larbi *et al*. 1996). Although Meissner *et al.* (1991) reported that browse species with NDF above 60 % will reduce the intake of such fodder by ruminants, thereby reflecting the benefits of low NDF content of forage legumes used in this study in improving the DM intake of these plant species. In all, Leucaena species exhibited the lowest values of the fiber fractions.

The data on feed intake, weight changes and feed conversion ratio of the experimental animals are shown in Table 2. The high DM intake of maize cobs supplemented with forage legume by the experimental sheep indicates the potential of these forages as a good supplement to low quality roughages such as maize cob. The DM intake differed significantly ($P<0.05$) among the treatments and increased with supplementation. This response could be attributed to the stimulating effect of these forages on the intake (Tolkamp, 1988) of the basal diet. In addition, the CP content of the forage legumes being able to provide the rumen microbial requirements of nitrogen (Abdulrazak *et al*., 1997) could have had an effect in increasing the microbial population thereby improving the breakdown of digesta. When the rate of breakdown of digesta is increased, there is a corresponding increase in feed intake (Ngwe and Kona, 1996). This however, reflects the ability of these forages to provide a favourable environment for microbes to grow and multiply, hence colonizing more of the cobs leading to an increase in intake.

Moreover, sheep supplemented with LL had significantly ($P<0.05$) higher feed intake of 745.0 $g.day^{-1}$ which ranked the same ($P>0.05$) with animals supplemented with GS (720.0 $g.day^{-1}$). Animals supplemented with EC had a lower ($P<0.05$) feed intake of 677.5 $g.day^{-1}$ relative to sheep on other forage legumes but higher ($P<0.05$) than the control (567.5 $g.day^{-1}$). The higher fiber fraction content of EC might explain the lower level of intake observed in the sheep compared to the other forages. Also, the low feed intake of the control treatment could be accentuated by high fiber fractions of diet to be digested. This increases the retention time in the recticulo-rumen (Orskov and Ryle, 1990) thereby depressing the intake of more feed. From this, one would expect both voluntary intake and digestibility of maize cobs to be low and an addition of supplemental

Table 2: Performance indices of West African Dwarf sheep fed maize cobs supplemented with forage legumes

Parameters	MC + EC	MC + LL	MC + GS	MC	SEM
Average feed intake ($g.day^{-1}$)	677.5^{b}	745.0^{a}	720.0^{a}	567.5^{c}	13.05
Initial weight (kg)	17.75	17.60	18.48	19.20	0.31
Final weight (kg)	19.60	19.48	20.20	20.13	0.30
Weight gain (kg)	1.55^{b}	1.88^{a}	1.73^{a}	0.93^{c}	0.12
Weight gain ($g.day^{-1}$)	27.67^{b}	33.57^{a}	30.89^{a}	16.61^{c}	2.03
Metabolic weight gain ($kgW^{0.75}$)	12.06^{b}	13.95^{a}	13.01^{a}	8.23^{c}	1.01
Feed conversion ratio	24.49^{b}	22.19^{c}	23.31^{bc}	34.17^{a}	3.73

a,b,c means with same superscripts within the same rows are not significantly different ($p>0.05$)
MC – Maize cob, EC – *Enterolobium cyclocarpum*, LL – *Leucaena leucocephala*, GS – *Gliricidia sepium*

forages would be required to support reasonable levels of production. However, the utilization of crop residues have been found to be limited because they contain a large proportion of lignocellulosic compounds and little nitrogen (Butterworth and Mosi, 1985).

Among the forage supplements, Gliricidia was the least consumed initially but was all consumed subsequently. This could not be unconnected with the presence of coumarin that triggers the offensive or repulsive odour that emanates from Gliricidia forage (Arigbede et al., 2003). This corroborates earlier reports (Fasae *et al*., 2010) of nonchalant attitude of goats initially to the consumption of Gliricidia forage.

The average daily weight gain (ADG) of the experimental sheep varied (P<0.05) among the treatments, following the same trend with feed intake and reflecting better gain in weight with forage legume supplementation. This supports earlier reports on an increasing trend in weight gain as a result of the effect of forage legume supplementation of crop residues in various species of ruminants (Nguyen, 1998; Phimphachanhvongsod and Ledin, 2002; Fasae *et al*., 2010). Sheep on LL and GS supplementation had higher (P<0.05) ADG (33.57 and 30.89 g.day^{-1}, respectively) followed by sheep on EC (27.67) and least (P<0.05) values of 16.61 observed in sheep on the control treatment. The variations in ADG of the experimental sheep could therefore be attributed to variation in nutrient supply from the diets (Oddy and Sainz, 2002). Availability of digestible protein and energy reflected by the relatively low fibre levels of the supplementary forages could have provided ready nutrients for the synthesis of body tissues in the lower gut. This could be responsible for the higher weight gains and efficiency of feed utilization of sheep on the forage supplementary treatments.

However, the ADG values in this study are higher than the range of 23.33 to 28.57 g.day^{-1} as reported by Odeyinka (2001) for WAD goats fed forages of Leucaena and Gliricidia, but lower than that of the reports of Fasae and Alokan (2006) in Yankasa sheep fed maize offals diet with varying levels of *Leucaena leucocephala* leaf residues. The metabolic weight range of 8.23 to 13.95 kgW$^{0.75}$ observed in this study is higher than 5.88 to 7.11 as reported by Yusuf *et al*. (2010) for the same breed of sheep fed forages and concentrate.

The feed conversion ratio (FCR) also varied (P<0.05) among the treatments. Animals supplemented with LL had the best (P<0.05), which is statistically similar with sheep on GS diets. This is largely a reflection of the highest weight gain observed in animals on these treatments. Animals on the control treatment had the worst (P<0.05) FCR, indicating that the feed was not efficiently converted by the animals.

The apparent digestibility of various dietary combinations is shown in Table 3. Results showed that digestibility values differed (P<0.05) among the treatments. High protein contents of forage supplemented treatments played a significant role in improving the digestibility of nutrients over those of the control. This supports a report that digestion of feed in ruminant animals is highly influenced by the level of protein and fibre in the diet (Peyraud and Astigarraga, 1998). Thus, the control treatment with high fibre content could have contributed to its low digestibility.

Among the treatments, MC supplemented with LL and GS had the highest (P<0.05) digestibility values. This may be due to its higher protein content and also their low fibre content of these forages which reflected high DM intake by these animals. In addition, the 200 g of forage legume offered to sheep in this study could have encouraged digestibility of MC.

Table 3: Apparent digestibility (%) of maize cobs supplemented with forage legumes in West African Dwarf sheeps

Parameters	MC + EC	MC + LL	MC + GS	MC	SEM
Dry matter	69.78^{a}	77.94^{a}	73.12^{a}	60.07^{b}	4.32
Crude protein	67.70^{b}	77.94^{a}	71.21^{a}	51.24^{c}	5.36
Ether extract	74.44^{b}	76.60^{ab}	78.31^{a}	74.97^{b}	2.86
Ash	55.13^{b}	67.73^{a}	67.88^{a}	50.03^{b}	6.22
Neutral detergent fibre	66.12^{a}	69.48^{a}	67.20^{a}	51.54^{b}	2.74
Acid detergent fibre	62.24	60.22	61.17	63.35	2.14
Acid detergent lignin	54.21	50.11	50.96	55.21	2.01

a,b,c means with some superscripts within the same rows are not significantly different (P>0.05)
MC – Maize cob, EC – *Enterolobium cyclocarpum*, LL – *Leucaena leucocephala*, GS – *Gliricidia sepium*

The optimum dietary level of fodder leguminous trees and shrubs has been reported to be 30 % to 50 % of the ratio on DM basis (Stewart and Simon, 1994). This limits the secondary components that inhibit the digestibility and reduce the acceptability to animals at higher levels of inclusion (Reed *et al*., 1990).

Table 4 presents the mean haematology parameters of WAD Sheep fed maize cobs supplemented with forage legumes. The packed cell volume (PCV) was significantly (P<0.05) higher in sheep on LL supplementation compared to the other treatments but all were within the range 20.5 - 24.9 % as reported by Olayemi *et al.* (2000) for WAD sheep.

The red blood cells (RBC) values also differed (P<0.05) among treatments. The low values reported for sheep on the control treatment could be attributed to the nutritional status. Swenson (1990) reported that nutritional status of an animal can affect the RBC count. However, the RBC counts in animals fed the experimental diets do not suggest a susceptibility to anaemia related disease condition because the values fall within the normal range for healthy sheep.

The white blood cells (WBC) values observed in this study were within the normal range of 4 to $12x10^9$.L for sheep (Jain, 1993) reflecting that the animals were healthy while the haemoglobin concentration was high and significantly (P > 0.05) influenced across treatments but fell within the normal range for sheep. High haemoglobin values have been shown to have an advantage in terms of the oxygen carrying capacity of the blood.

Table 4: Haematology of West African Dwarf sheep fed maize cobs supplemented with forage legumes

Parameters	MC + EC	MC + LL	MC + GS	MC	SEM
Packed cell volume (%)	22.50^b	26.07^a	21.75^b	22.60^b	2.52
Haemoglobin (g.dL)	9.80^b	10.65^a	10.05^a	8.13^b	1.02
Red Blood Cell (10^{12}.L)	8.58^{ab}	10.11^a	9.65^a	7.38^b	0.92
White Blood Cell ($x10^9$.L)	11.00	12.94	11.70	10.80	1.07
Total protein (g.dL)	5.22^a	5.95^a	5.40^a	4.10^b	0.43

a,b,c means in the same superscripts within the same rows are not significantly different (P>0.05)
MC – Maize cob, EC – *Enterolobium cyclocarpum*, LL – *Leucaena leucocephala*, GS – *Gliricidia sepium*

It has been reported that haematological and biochemical indices give insight into the production potential and help to monitor and evaluate incidence of diseases in animals (Orheruata and Aikhuomobhogbe, 2006). The result of haematological parameters in this study suggests that supplementation of maize cobs with forage legume do not pose health challenges.

CONCLUSION

Based on the experimental data, the supplementation of forage legume in maize cob diets did not show any adverse effect on feed intake, digestibility and haematological parameters of sheep. However, maize cobs supplementation with Leucaena and Gliricidia forage was the best in improving the feeding value of maize cobs, producing the optimum performance in sheep. It could therefore be concluded that forage legume could play a valuable role in supplying supplemental nitrogen to sheep fed maize cobs.

REFERENCES

ADEBOWALE, E. A. 1988. An overview of recent trends and developments in the use of unconventional feed ingredients for ruminant animals: applicability to the Nigerian conditions. Proceedings of National Workshop on Alternative Formulations of Livestock Feeds in Nigeria, organized by the Economic Affairs Office, The Presidency, held at ARMTI, Ilorin, 21-25 November 1988, p. 544-578.

ABDULRAZAK, S. A. – MUINGA, R. W. – THORPE, W. – ØRSKOV, E. R. 1997. Supplementation with *Gliricidia sepium* and *Leucaena leucocephala* on voluntary food intake, digestibility, rumen fermentation and live-weight gain of crossbred steers offered Zea mays stover. *Livestock Production Science*, vol. 49, 1997, p. 53-62.

AKINFEMI, A. – ADU, O. A. – DOHERTY, F. 2009. Assessment of the nutritive value of fungi treated maize cob using *in vitro* gas production technique. *Livestock Research for Rural Development*, vol. 21, 2009, no. 11.

AOAC, 1995. Association of Analytical Chemist, 1995. Official Methods of Analysis, 15th edition. Washington, D.C., USA, 1995, p. 69-88.

ARIGBEDE, O. M. – BAMIKOLE, M. A. – BABAYEMI, O. J. 2003. Evaluation of three forms of two indigenous multipurpose tree species fed to West African Dwarf goats. *Asset Series*. vol. 3, 2003 p. 33-41.

BABAYEMI, O. J. 2006. Antinutritional Factors, Nutritive Value and *in vitro* Gas Production of Foliage and Fruit of *Enterolobium cyclocarpum*. *World Journal of Zoology*, vol. 1 (2), 2006, p.113-117.

BUTTERWORTH, M. H. – MOSI, A. K. 1985. The voluntary intake and digestibility of combinations of cereal crop residues and legume hay for sheep. *Animal Feed Science and Technology*, vol. 12 (4), 1985, p. 241-251.

DUNCAN, D. B. 1955. Multiple Range and Multiple F Tests. *Biometrics*, vol. 11 (1), 1955, p. 1-42.

FASAE, O. A. – ALOKAN, J. A. 2006. Growth performance of weaner Yankasa sheep fed varying levels of *Leucaena leucocephala* leaf residues. *Assets International Journal* (A), vol. 6 (2), p. 323-328.

FASAE, O. A. – AKINTOLA, O. S. – SORUNKE, A. O. – ADU, I. F. 2010. The effects of feeding varying levels of cassava foliage on the performance of West African Dwarf goat. *Applied Tropical Agriculture*. vol. 15 (2), 2010, p. 97-102.

FASAE, O. A. – ADESOPE, A. I. – OJO, V. O. A. 2011. The effect of Leucaena leaf supplementation to maize residues on village goat performance, *Journal of Animal and Plant Sciences*, vol. 10 (2), 2011, p. 1276- 1282.

GATENBY 2002. Sheep. Revised Edition. Tropical Agricultural Series. Macmillan Publishers Ltd., Malaysia, 2002, p. 8.

JAIN, N. C. 1993. Physiology of blood with some comments on response to disease. *International Journal of Animal Science*, vol. 8, 1993, p. 195-231.

LARBI, A. – SMITH, J. W. – ADEKUNLE, I. O. – KURDI, I. O. 1996. Studies on the multipurpose fodder trees and shrubs in West Africa: variation in the determination of forages quality in Albizia and Paraserianthes. *Agroforestry Systems*, vol. 33, 1996, p. 29-39.

MEISSNER, H. H. – VILJOEN, M. O. – VAN NIEKERK, W. A. 1991. Intake and digestibility by sheep of Anthephora, Panicum, Rhode and Smuts finger grass pastures: Proceeding of the IVth International Rangeland Congress, September 1991. Montipellier, France, 1991, p. 648-649.

NORTON, B. W. 1994. Tree legumes as dietary supplements for ruminants. In: Tropical Tree Legumes in Tropical Agriculture (Ed. R. C. Gutteridge and H. M. Shelton). CAB International, UK. 1994. p. 177-201.

NGUYEN THI HONG NHAN 1998. Utilisation of some forages as a protein source for growing goats by smallholder farmers. *Livestock Research for Rural Development,* vol. 10 (3), 1998. http://www.cipav.org.co/lrrd/lrrd10/3/nhan2.htm

NGWE, R. M. – KONA, B. 1996. Comparative evaluation of Stylo (*Stylosanthes guinensis*) hay and concentration as protein supplement for West African Dwarf fed basal diet of elephant grass. 1996. Small Ruminant Research and Development in Africa: Proceedings of the 3rd African Small Ruminant Research Network Conference, 1996, p. 231 -235.

ODEYINKA, S. M. 2001. Effect of feeding varying levels of *Leucaena leucocephala* and *Gliricidia sepium* on the performance of West African Dwarf goats. *Nigerian Journal of Animal Production*, vol. 28 (1), 2001, p. 61-64.

ODDY, V. H. – SAINZ, R. D. 2002. Nutrition for sheep meat production In: Sheep Nutrition (Freer, M. and Dove, H, eds). CSIRO Publishing, 2002, p. 237-262.

OLAYEMI, F. O. – FAROTIMI, J. O. – FAGBOHUN, O. A. 2000. Haematology of the West African Dwarf sheep under two different management systems in Nigeria. *African Journal of Biomedical Research*, vol. 3 (3), p. 197-198.

ORHERUATA, A. M. – AIKHUOMOBHOGBE, P. U. 2006. Haematological and blood biochemical indices of West African Dwarf goats vaccinated against pestes de petit ruminant (PPR). *African Journal of Biotechnology*, vol. 5, 2006, p. 743-748.

ORSKOV, E. R. – RYLE, M. 1990. Energy Nutrition in Ruminants. Elsevier Applied Science, London, 1990.

PEYRAUD, J. L. – ASTIGARRAGA, L. 1998. Review of the effects of Nitrogen fertilization on the intake and nutritive value of fresh herbage. Consequences on animal nutritive and nitrogen balance. *Animal Feed Science Technology*, vol. 72, 1998, p. 235-239.

PHIMPHACHANHVONGSOD, V. – LEDIN, I. 2002. Performance of growing goats fed *Panicum maximum* and leaves of *Gliricidia sepium*. *Asian-Australasian Journal of Animal Science*, vol. 15 (11), 2002, p. 1585-1590.

REED, J. D. – SOLLER, H. – WOODWARD, A. 1990.

Fodder tree and straw diets for sheep. Intake, growth, digestibility and the effects of phenolics on nitrogen utilization. *Animal Feed Science and Technology*, 1990, vol. 30, p. 39-50.

SAS, (1999). Statistical system users guide: Statistical, version 8th edition, statistical analysis system institute Inc., Cary, N.C.

STEWART, J. L. – SIMON, A. J. 1994. *Gliricidia sepium* – A multipurpose forage tree legume. In: R. C. Gutteridge and H. M. Shelton (eds). Forage tree legume in tropical Agriculture. CAB International, 1994, p. 30-48.

SWENSON, M. J. 1990. Physiological properties cellular and chemical constituents of blood;. Dukes Physiology of Domestic Animals (10th ed.) Cornell University Press, London, U.K.

TOLKAMP, B. 1988. Feed intake regulation in small ruminants. In: Goat production in humid tropics (Eds. O. B. Smith and H. G. Bosman) Pudoc, Wageningen, p. 67-75.

VAN SOEST, P. J. – ROBERTSON, J. B. 1985. Analysis of forage and fibrous feeds. A laboratory manual of Animal Science, 613. Department of Animal Science, Cornell University, Ithaca, NY 202.

YUSUF, A. O. – ADEGBENJO, F. D. – BAWALA, T. O. 2010. Effects of varying forage concentrate ration on performance of intensively managed West African dwarf sheep. Proceeding of the 15th Conference of Animal Science Association of Nigeria, 13 -15th September, 2010, University of Uyo, Nigeria, 2010, p. 679.