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PERFORMANCE, APPARENT DIGESTIBILITY AND NITROGEN UTILIZATION BY WEST AFRICAN DWARF EWES FED ENSILED *ALTERNANTHERA BRASILIANA* (L.) O *KUNTZE* BASED DIETS

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ABSTRACT

The objective of this study was to evaluate the performance, apparent nutrient digestibility and nitrogen utilization by West African Dwarf (WAD) ewes fed ensiled *Alternanthera brasiliana* (AB) based diets. The chemical composition of ensiled AB was determined. Performance, apparent nutrient digestibility and nitrogen utilization by WAD ewes were also determined. Thirty (30) female WAD ewes between the ages of 1 – 1.5 years, weighing 9.18 – 11.8 kg were used for feeding trial, which lasted for 56 days. In a completely randomized design, six animals were allotted to each of five diets comprising of 0 %, 30 %, 45 %, 60 %, and 90 % ensiled AB inclusion level. Parameters measured include: dry matter intake, growth rate, feed conversion, apparent digestibility of dry matter and crude protein, nitrogen intake, urinary nitrogen, nitrogen balance and retention. Results revealed that, the dry matter of ensiled AB was 80.38 %, the crude protein and neutral detergent fibre were 18.38 % and 61.51 % respectively. The quality characteristic of ensiled AB was optimal as the aroma, colour, texture, temperature (28.0 ˚C) and pH (4.05) indicated fermentation and good keeping quality. Significant variations ($p < 0.05$) occurred in the dry matter intake, daily body weight gain and feed conversion ratio. They ranged from 793.54 – 1020.25 $g.d^{-1}$; 53.57 – 98.21 $g.d^{-1}$ and 10.39 to 14.81 $g.d^{-1}$ in ewes fed 0 % and 90 % AB inclusion level. Significant differences were observed in dry matter, crude protein, crude fibre, ether extract, ash and nitrogen free extract digestibility. The values ranged from 89.01 – 93.95 %, 92.00 – 98.11 %, 80.11 – 95.02 %, 92.10 – 99.00 %, 82.21 – 96.01 % and 51.31 – 89.02 % respectively. The nitrogen balance and nitrogen retention also differed significantly. They ranged from 18.26 – 23.69 $g.d^{-1}$ and 91.70 – 97.80 % in ewes that consumed 30 % and 90 % ensiled AB respectively. It was observed that the ewes on diet of 90 % ensiled AB performed optimally and better than ewes on other diets. It can be concluded that ruminant animals can survive and perform optimally on ensiled AB alone, especially during the off season in the tropics.

Key words: *Alternanthera brasiliana* silage; feed utilization; nutrient profile; sheep

INTRODUCTION

In Nigeria, low animal protein intake has remained a major nutritional problem, especially for low income and non-wage earners (Adeojo *et al*., 2014). Atsu (2012), reported that animal source of protein is expected to contribute 35 g per head per day but the actual amount of protein from animal source is only 15 g per head per day which is grossly inadequate. This has called for the identification of lesser known feed resources, which are capable of boosting the performance of livestock.

Nutrition in terms of quantity and quality is one of the ways to enhance the productivity of livestock to produce animal protein available for human growth and development (Babayemi,

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2007). Research into cheaper and qualitative sources of livestock feedstuff to replace the expensive conventional feedstuffs particularly those of energy and protein origin is gathering momentum. The limited supply of feed ingredients for livestock feed industry has resulted in a continuous increase in the cost of production. The long term survival of traditional livestock production system within the rapidly evolving national economy of Africa will depend on their capacity to provide products in quantities and at prices which satisfy the subsistence and income needs of livestock producers. Equally, the survival of these production systems will depend on the availability of feed materials in the right quantity and quality for animal intake.

Given the current pattern of small ruminant production, due to high cost of feeding livestock, resulting from competition between man and animals for the available feed ingredients and also the seasonal fluctuation in the availability of pasture (Babayemi, 2006), it is appropriate to consider the potential of lesser known feed materials as supplements in ruminant nutrition. The cost of feeding livestock is about 60 – 80 % of the total cost of production (Mako *et al*., 2012). The growth of livestock industry depends greatly on the progress that is made on the utilization of underutilized fodder as animal feed and the ability of these animals to convert such into animal products such as milk, meat, hides and skin.

AB is one of the lesser known plants that can be incorporated into the diets of ruminants. AB is a shrub, native to South America but has become naturalized in countries throughout the tropics, being found in Nigeria, Kenya, India, Ceylon, Cuba, Colombia (Sanchez-Del, 2012) and also in Laos, Vietnam and Cambodia. This study was designed to determine the chemical composition and keeping quality of ensiled AB and also to investigate the performance, apparent digestibility of nutrients and nitrogen utilization by WAD ewes fed ensiled AB.

MATERIAL AND METHODS

Experimental site

The experiment was carried out at the Tai Solarin Teaching and Research Farm, sheep and goat unit (7˚ 15' N to 7˚ 40' E). Each animal pen was made of walls of about 1 m high and each pen was about 220 cm long and 121 cm wide. The floor of the pen was made of concrete and the roof of the goat unit housing the pens was made of corrugated iron sheets. The pens were dusted and washed thoroughly with warm detergent to remove dirt. The pens were disinfected with broad spectrum insecticides, acaricides, and larvicides (diasuntol). The experimental animals were brought into the pens after 7 days of disinfection and they were allowed to acclimatize to the new environment for another 7 days before feeding trial began. Hence, there was a preparation period of 14 days.

Experimental animals

Thirty (30) adult female WAD ewes used for this experiment were randomly allotted to (five) 5 experimental diets with six (6) animals in each group. The animals were between 1 – 1.5 years of age, weighing 9.18 – 11.8 kg. The feeding trial lasted for 56 days.

Feeding trial

AB was harvested from a cultivated plot on the Teaching & Research Farm of Agricultural Science Department, Tai Solarin University of Education, Ijagun, Ijebu-Ode, Ogun State, Nigeria. The harvested plant was chopped and ensiled with wheat offal in ratio 80: 20 % w/w respectively for 42 days as per the procedure of Akinwande (2011). Polythene bags, each capable of holding at least 30 kg of AB were used as silos. Each polythene bag was then placed inside a 65 liter capacity plastic basin for reinforcement and ease of handling. Sealing of silos was effected by placing a 25 kg sand-bag on top of each polythene bag after tying carefully and timely. The ensiled AB was used to formulate five experimental diets fed to the animals.

Diet 1 = 90 % guinea grass + 0 % ensiled AB + 10 % concentrate
Diet 2 = 60 % guinea grass + 30 % ensiled AB+ 10 % concentrate
Diet 3 = 45 % guinea grass + 45 % ensiled AB + 10 % concentrate
Diet 4 = 30 % guinea grass + 60 % ensiled AB + 10 % concentrate
Diet 5 = 0 % guinea grass + 90 % ensiled AB + 10 % concentrate

Ensiled AB, Guinea grass and concentrate were fed at 0900 h each day, the refusal was weighed the following morning at 0800 h and deducted from the total amount of feed served the previous day for determination of feed intake. Daily feed was served to meet 5 % of the sheep's body weight (1 % of concentrate, 4 % of AB and Guinea

grass) and this was frequently adjusted to ensure that each animal received about 20 % of feed above its previous day's consumption. Feed refusal was sampled daily and mixed for the entire collection period on an individual basis using an air tight plastic bag. Samples from refusal were taken for proximate composition analysis. Fresh water was served each day; salt lick was placed permanently in each cage. The animals were weighed at the beginning and end of the feeding trial to determine weight gain.

Digestibility trial

Twenty (20) Ewes from the thirty (30) used for the growth study were randomly selected for determination of digestibility of the diets. The experiment lasted 14 days, for collection of feaces and urine. The animals were fed at 0900 hours daily. Feed was served at 5 % of the body weight of the animals. Water and salt lick were accessible to the animals throughout the metabolic period. Feed refused was weighed at 0800 hours every morning and deducted from the total feed offered the previous day, prior to serving new feed daily. Fresh water was also served *ad libitum*. During fourteen days of collection, total faeces was collected, weighed and 10 % aliquot was taken and stored in the freezer at -4 ˚C. After a 14-day collection period, the total faeces from daily collection were bulked, mixed and dried in the oven and kept till required for chemical analysis. Urine samples were collected and measured daily for each animal in the morning using measuring cylinder and kept in separately labeled containers. Two drops of concentrated sulfuric acid was added to each container daily after collection of each sample to prevent microbial growth and loss of the nitrogen measured. Approximately 10 % of total urine was sampled daily and stored at -4 ˚C till required for nitrogen analysis. Apparent nutrient digestibility was determined for crude protein, ether extract, crude fibre, ash and nitrogen free extract using the formula as follows:

$$\frac{\textit{Nutrient in feed} - \textit{nutrient in feaces}}{\textit{Nutrient in feed}} \times 100$$

Nitrogen utilization was also determined by analyzing the nitrogen content of the urine and feaces.

Chemical analysis

Crude protein, crude fibre, ether extract and total ash of experimental diets were analyzed in triplicates using standard procedure of A.O.A.C (2012). The crude protein was determined with the micro Kjeldahl distillation apparatus. Neutral detergent fibre (NDF), Acid detergent fibre (ADF) and Acid detergent lignin (ADL) were determined according to Van Soest (1995).

Shown in Table 1 is the chemical composition of ensiled AB and *Panicum maximum*. The dry matter (DM) and crude protein (CP) obtained for ensiled AB in this study are 80.81 % and 18.38 % respectively. The values here are higher than values reported for water hyacinth ensiled with different additives (19.60 – 29.74 % and 10.76 – 16.23 %) for DM and CP respectively by Akinwande *et al*. (2014). These values are also at variance with the value range of 18.36 – 30.03 % for DM and 4.52 – 5. 50 % for CP reported for elephant grass ensiled with cassava peel, (Olorunnisomo and Dada, 2011). The CP obtained here is above the recommended level of 7 – 8 % that can provide the minimum requirement for microbial activities (NRC 2002). The value of Neutral detergent fibre of ensiled AB (61.51 %) is similar to the value reported for water hyacinth ensiled with different additives (Akinwande *et al.*, 2014). The CP obtained here is within the recommended value that will enhance dry matter intake (Wanapat *et al*., 2013).

Table 1. Chemical composition (%) of *Alternanthera brasiliana* (AB) ensiled with wheat offal and *Panicum maximum* (PM)

Parameters	AB	PM
Dry matter	80.38	90.35
Crude protein	18.38	8.43
Ether extract	3.54	10.93
Ash	9.84	13.32
Neutral detergent fibre	61.51	71.21
Acid detergent fibre	46.89	48.70

Table 2 presents the quality characteristics of AB ensiled with wheat offal for 42 days. The colour, texture, odour, temperature and pH of ensiled AB are similar to the findings of Akinwande *et al.*, (2011) for water hyacinth ensiled with different

Table 2. Quality characteristics of *Alternanthera brasiliana* ensiled with wheat offal

Silage	Colour	Texture	Odour	Temperature (˚C)	pH
AB ensiled with Wheat offal	Khaki brown	Firm	Pleasant alcoholic	28.00	4.05

additives. The results obtained here indicated that fermentation occurred considering the pH value of 4.05 which could infer good quality of the silage that would be well preserved. A properly fermented silage will have a much lower pH (i.e. be more acidic) and pH is one of the simplest and quickest ways of evaluating silage (Babayemi, 2009). Any silage with pH ranges of 4.5 – 5.5 or 4.3 – 4.7 has been classified to be good (Meneses, 2007; Kung and Shaver, 2002) respectively. The temperature obtained here is in agreement with other studies elsewhere (Akinwande, 2011). This would appear to be a good operating temperature for silage fermenting organisms.

Statistical analysis

Data obtained were analyzed and subjected to analysis of variance procedure (ANOVA) of SAS (2012). Significant means were separated by Duncan's Multiple Range Test of the same statistical package.

RESULTS AND DISCUSSION

Table 3 presents the feed intake and performance of WAD ewes fed ensiled AB-based diets. Results revealed N dry matter increased as the test material increased. The dry matter intake ($g.d^{-1}$) ranged significantly ($P < 0.05$) from 793.24 – 1020.25 in ewes fed 0 % and 90 % AB inclusion level respectively. This result is in agreement with the findings of Adegbola *et al*., (1987), who reported a range of 624.11 – 1044.24 $g.d^{-1}$ for dry matter intake for WAD sheep fed processed cassava peel with *Gliricidia sepium*. This result is higher and at variance to the value range of 628 – 798.5 $g.d^{-1}$ reported for WAD sheep fed *Atriplex halimus* ensiled with three developed enzyme cocktails (Salem *et al*., 2015) and 573.83-715.14 $g.d^{-1}$ reported for WAD rams fed *Panicum maximum* ensiled with two cultivars of *Lablab purpureus* (Alasa, 2014). It was observed that ewes on 90 % AB

Table 3. Feed intake and performance of WAD Ewes fed ensiled *Althernanthera brasiliana* based diets

Parameters	Level of ensiled *Alternanthera brasiliana* Inclusion					SEM
	0 %	30 %	45 %	60 %	90 %	
Intake (g/DM/day)						
Concentrate	95.20^{a}	90.27^{b}	89.20^{d}	88.20^{d}	88.92^{c}	0.51
Guinea grass	698.40^{a}	259.70^{b}	210.90^{c}	166.8^{d}	-	12.70
Ensiled AB	-	488.00^{d}	541.50^{c}	706.20^{b}	931.3^{a}	10.20
Total dry matter intake ($g.d^{-1}$)	793.24^{e}	838.10^{d}	842.29^{c}	961.20^{b}	1020.5^{a}	22.10
Initial body weight (kg)	12.00	11.00	10.50	10.50	10.50	0.70
Final body weight (kg)	15.00^{c}	15.00^{c}	14.50^{d}	15.50^{b}	16.00^{a}	0.33
Body weight gain (kg)	3.00^{d}	4.00^{c}	4.50^{b}	5.00^{b}	5.50^{a}	0.25
Daily body weight gain ($g.d^{-1}$)	53.57^{d}	71.43^{c}	71.43^{c}	89.30^{b}	98.21^{a}	7.89
Feed conversion ratio	14.81^{a}	11.73^{b}	11.79^{b}	10.76^{c}	10.39^{d}	0.91

$^{a, b, c, d, e}$ = means on the same row with different superscript differed significantly ($p < 0.05$)

SEM = standard error of mean.

Formular for feed conversion ratio: $\frac{\text{Dry matter intake (g)}}{\text{Daily weight gain (g)}}$

inclusion level recorded the highest (1020.25 g.d^{-1}) dry matter intake, while the lowest dry matter intake (793.54 g.d^{-1}) was recorded for ewes fed 0 % AB inclusion level. The higher intake of silages may be dues to the sweet and pleasant acid (Lactic Acid) aroma of the plant (Babayemi, 2009). Morinson (1959) pointed out that silage even from plants with coarse stalks such as corn and sorghums are eaten practically without waste. The daily body weight gain also ranged significantly from 53.57 to 98.21 g.d^{-1} in ewes on 0 % and 90 % AB diets respectively. This result is at variance with the report elsewhere for sheep fed ensiled water hyacinth (Akinwande *et al*., 2014) but similar and in agreement with the findings of Adegbola *et al*., (1987). The higher weight gain of ewes on 60 % and 90 % AB diets could be attributed to the higher and rapid by-pass protein from the rumen and subsequent digestion and absorption in the abomasum and duodenum. The 30 % and 45 % AB diets may have stayed longer in the rumen and are utilized by the microbes for single cell formation. Belanche *et al*., (2017) reported that microbial colonization of highly lignified particles is limited. Ewes fed 60 % and 90 % AB diets consumed more than 3 % of their body weights, which agrees with the value of 3 – 5 % body weight as DMI recommended for ruminants (NRC 2002). The feed conversion ratio also ranged significantly (P < 0.05) from 10.39 to 14.81 in ewes fed 90 % and 0 % AB diets respectively. The ewes on 90 % AB diet had the best daily weight gain compared to ewes on other diets due to the least feed conversion ratio it had, this is in accordance with Smeaton (2003), who opined that the lower the feed conversion ratio value, the more efficient the animals converted the feed to meat.

Table 4 shows the apparent digestibility of nutrients by WAD ewes fed ensiled AB. The digestibility values differed significantly (P < 0.05) among the treatment means. The digestibility for dry matter ranged from 89.01 to 93.95 % in ewes fed 0 % and 90 % ensiled AB respectively. This result is lower and at variance with the value range of 54.67 – 68.00 % reported for Red Sokoto goats fed elephant grass ensiled with cassava peel (Olorunnisomo and Dada, 2011). The crude protein digestibility value for ewes on 90 % AB diets was significantly higher (P < 0.05) than those on 0 % AB diet (96.10 %) and 60 % AB diet (97.20 %) whose values differ significantly (P < 0.05) from each other and this is an index of microbial protein made available to the ewes daily (Kissada *et al*., 2010). This result is higher than the values reported for goats fed elephant grass ensiled with cassava peel (Olorunnisomo and Dada 2011). The crude fibre digestibility followed the same trend with crude protein digestibility. However, the digestibility of DM, CP and CF are in agreement with the digestibility obtained for goats fed sun-cured water hyacinth (Mako, 2009).

Presented in Table 5 are nitrogen utilization, nitrogen balance and retention. These are functions of nitrogen ingested and digested; they varied significantly (P < 0.05) among treatment means with ewes on 90 % AB diet recording the highest (23.69 g.d^{-1} and 97.80 %), while ewes on 30 % AB diet recorded the lowest (18.26 g.d^{-1} and 91.70 %). The nitrogen retention values obtained in this study are similar to value range reported for kids

Table 4. Apparent digestibility (%) by WAD Ewes fed ensiled *Alternanthera brasiliana*

Parameters	Level of ensiled *Alternanthera brasiliana* Inclusion					SEM
	0 %	30 %	45 %	60 %	90 %	
Dry matter	89.01^{e}	90.21^{d}	90.35^{c}	92.51^{b}	93.95^{a}	1.01
Crude protein	96.10^{c}	92.00^{d}	92.10^{d}	97.20^{b}	98.11^{a}	2.11
Ether extract	95.01^{d}	99.00^{a}	92.10^{d}	96.10^{c}	98.12^{b}	2.35
Crude fibre	89.12^{c}	80.11^{d}	80.11^{d}	92.01^{b}	95.02^{a}	2.04
Ash	91.01^{c}	82.21^{e}	83.21^{d}	93.02^{b}	96.01^{a}	1.00
Nitrogen free extract	72.11^{c}	51.31^{e}	53.21^{d}	82.11^{b}	89.02^{a}	1.15

$^{a, b, c, d, e}$ = means on the same row with different superscript differed significantly (p < 0.05)
SEM = standard error of mean.

Table 5. Nitrogen utilization by WAD Ewes fed ensiled *Alternanthera brasiliana*

Parameters	Level of ensiled *Alternanthera brasiliana* Inclusion					SEM
	0 %	30 %	45 %	60 %	90 %	
Nitrogen intake ($g.d^{-1}$)	19.050^{e}	19.910^{d}	20.010^{c}	22.840^{b}	24.230^{a}	0.050
Feacal nitrogen ($g.d^{-1}$)	0.580^{c}	1.600^{b}	1.650^{a}	0.740^{d}	0.540^{e}	0.020
Urinary nitrogen ($g.d^{-1}$)	0.034^{b}	0.050^{a}	0.014^{c}	0.010^{d}	0.004^{e}	0.001
Total nitrogen excreted ($g.d^{-1}$)	0.614^{c}	1.650^{a}	1.660^{a}	0.750^{b}	0.544^{d}	0.001
Nitrogen balance ($g.d^{-1}$)	18.440^{c}	18.260^{d}	18.350^{e}	22.090^{b}	23.690^{a}	0.020
Nitrogen retention (%)	95.700^{c}	91.700^{d}	91.700^{d}	96.720^{b}	97.800^{a}	2.010

$^{a, b, c, d}$ = means on the same row with different superscript differed significantly ($p < 0.05$)
SEM = standard error of mean.

fed varying proportions of Zinc (Osineye, 2011), however, these value ranges are higher and at variance with the range (9.86 – 29.80 %) reported for Red Sokoto goats fed varying levels of energy source (Otaru *et al*., 2011), also higher than 62.5 – 74.4 % reported for goats fed ensiled maize stover and supplemented with *Bobgunnia madagascariensis* (Kanyinji *et al*, 2017). The positive nitrogen balance obtained may be indicative of proper utilization of the silage.

CONCLUSION

Ensiling AB with wheat offal had beneficial effects on silage qualities, intake and performance of WAD ewes. AB is a shrub that is readily available in the tropics especially during the rainy season. It can be preserved to feed animals during the dry season. It can then be concluded from the result of this study that ruminant animals can survive and perform optimally on ensiled AB alone.

REFERENCES

Adegbola, A. A., Smith, O. B. & Asaolu, V. O. 1987. *Response of West African Dwarf Sheep to diets based on processed cassava peel and Gliricidia sepium*. FAO Corporate document Repository. Produced by ILRI. www.fao.org/wairdocs/ilri/x5490e/x5490e0m.htm

Adeojo, P. E., Mohammed, I. A. & Alus, F. S. 2014. Analyzing consumer's preference for snails to other meats in Kabsba/Bunu L.G.A of kogi state Nigeria. *American Journal of Food Science and Health*, 2(4), 82–87.

Akinwande, V. O. 2011. *Utilization of ensiled water hyacinth* (*Eichhornia crassipes* Mart. Solms-Laubach) *by West African Dwarf Sheep*. PhD Thesis. Department of Animal Science University of Ibadan.

Akinwande, V. O., Mako, A. A. & Babayemi, O. J. 2011. *Silage quality, voluntary feed intake (VFI), Nutrient digestibility and Nitrogen Balance in WAD sheep fed ensiled water hyscinth (WH) in Nigeri*a. Proceedings of the 36th Animal Production (NSAP) held at Development of Animal Science, Faculty of Agriculture University of Abuja between 13th – 16th March, 509–512.

Akinwande, V. O., Mako, A. A. & Babayemi, O. J. 2014. *Performance characteristics of WAD sheep fed water hyacinth silage fermented with different Agro-industrial additive*s. Proceedings of the 39th Annual conference of Nigerian society for Animal Production (NSAP) held at Babcock University ilishan between 16th and 19th March, 384–387.

Alasa, M. C. 2014. *Nutritional Assessment of Panicum maximum* (Jacq.) *ensiled with two* cultivars of *Lablab purpureus* (*Lablab purpureus* L.) *for West African Dwarf Ram*. PhD Thesis. Department of Animal Science. University of Ibadan.

AOAC. 2012. *Official methods of Analysis*, 19th ed. Association of Officials Analytical Chemists, Arlington, VA.

Atsu, D. W. 2012. Contributory role of Animal production in National Development Process of the 17th Annual Conference of Animal Science Association of Nigeria. September 16th–19th 2012.

Babayemi, O. J. 2006. Evalution of the nutritive value and free choice intake of two aquatic weeds (*Nephrolepis biserratha* and *Spirodels polyrhiza*) by West African Dwarf goats. *Tropical and Subtropical Agroecosystems*, 6 (1), 15–22.

Babayemi, O. J. 2007. *In Vitro* Fermentation Characteristics and Acceptability by West African dwarf Goats of some Dry Season Forages. *African Journal of Biotechnology*, 6(10), 1260 –1265.

Babayemi, O. J. 2009. Silage quality, dry matter intake and digestibility by West African dwarf sheep of Guinea grass (*Panicum maximum* cv Ntchisi) harvested at 4 and 12 week re-growths.*African Journal of Biotechnology*, 8, 3983–3988.

Belanche, A., Newbold, C. J., Lin, W., Ree-Stevens, P. & Kingston-Smith, A. H. 2017. A systems Biology approach reveals differences in the dynamics of colonization and degradation of grass Vs Hay by rumen microbes with minor effects of vitamin supplementation. *Front Microbiology*, 8, 1458.

Kanyinji, F., Nguni, M. & Mulenga, A. 2017. Intake, digestibility and nitrogen retention in goats fed ensiled maize stover and supplemented with snake bean (*Bobgunnia madagascariensis*) pod meal. *Journal of Advanced Veterinary and Animal Research*, 4(2), 168–174.

Kissada, B., Metha, W. & Chainarong, N. 2010. Replacement of soybean meal by yeast fermented-cassava chip protein (YEFECAP) in concentrate diets fed on rumen fermentation, microbial population and nutrient digestibility in ruminants. *Journal of Animal and Veterinary Advances*, 9, 1727–1734.

Kung, L. & Shaver, R. 2002. *Interpretation and use of silage fermentation analyses reports*. Department of Animal and Food Science, University of Delware Newark, DE 19717.

Mako, A. A 2009. *Evaluation of water hyacinth* (*Eichhornia crassipes* Mart. Solms-Laubach) *as a potential feed for the West African Dwarf goats.* PhD Thesis. Department of Animal Science. University of Ibadan.

Mako, A. A., Akinwande, V. O., Abiola-Olagunju, O. I., Babayemi, O. J. & Akinsoyinu, A. O. 2012. Variations in Chemical Nutrients and Mineral Concentrations of Water Hyacinth (*Eichhornia crassipes* Mart. Solms-Laubach). *Nigerian Journal of Animal Production*, 39(1), 199–205.

Meneses, M. D., Megias, J., Madrid, A., Martinez-Teruel, F., Hernadez, J. & Oliva, J. 2007. Evaluation of the Phytosanitary, Fermentative and nutritive characteristics of silages made from crude artichoke (*Cynara scolymus* L.) by- Product feeding for ruminants. *Small Ruminant Research*, 70, 292–296.

Morrison, F. B 1959. *Feeds and feeding*. Morrison Publishing Company, New York.

NRC. 2002. *National Research council. Publicity Funded Agricultural Reseach and the changing structure of U.S Agriculture*. Washington, DC: The National Academic Press. http.//doi.org/10.17226/10211

Olorunnisomo, O. A. & Dada, O. A. 2011. *Digestibility and intake of elephant grass ensiled with cassava peels by Red Sokoto goats in Ibadan*. Proceedings of the 36th Annual conference of Nigeria Society for Animal Production. Held between 13-16th March 2011 at Merit House/ Raw Materials Research and Development Council, Abuja, pp. 584–586.

Osineye, O. M. 2011. *Zinc on energy and nitrogen utilization in West African Dwarf Kids.* Proceedings of the 36th Annual conference of Nigeria Society for Animal Production. Held between 13-16th March 2011 at Merit House/ Raw Materials Research and Development Council, Abuja, pp. 587–590.

Otaru, S. M., Adamu, A. M., Ehoche, O. W. & Makun, H. J. 2011. *Effect of varying the level of energy source on digestibility of nutrients and nitrogen retention in Red Sokoto goats.* Proceedings of the 36th Annual conference of Nigeria Society for Animal Production. Held between 13-16th March 2011 at Merit House/ Raw Materials Research and Development Council, Abuja, pp. 591–594.

Salem, A. Z. M., Alsersy, H., Camacho, L. M., EL -Adawy M. M., Elghandour, M. M. Y., Kholif, A. E., Rivero, N., Alonso, M. U. & Zaragoza, A. 2015. Feed intake nutrient digestibility, nitrogen utilization, and ruminant fermentation activities in sheep fed Atriplex halimus ensiled with three developed enzyme cocktails. *Czech Journal of Animal Science*, 4, 185–194.

SAS. 2012. *Statistical Analytical Systems*. SAS Version 9.2 user's guide. Carry, NY: SAS Institute.

Sanchez-Del, P. 2012. Molecular phytogenetics of *Alternanthera* (Gomphrenoidae, Amaranthaceae): resolving complex taxonomic history caused by different interpretations of morphological characters

in a lineage with C_4 and C_3-C_4 intermediate species. *Botanical Journal of the Linnean Society*, 169(3), 493–517.

Smeaton, D. C. 2003. *Profitable Beef Production: A Guide to Beef Production in New Zealand.* Published by the New Zealand Beef Council.

Van Soest, P. J. 1994. Nutritional Ecology of Ruminants, 2nd ed. Cornell University Press.

Wanapat, M., Pilajun, R., Polyorach, S., Cherdthrong, A., Khejornsart, P. & Rowlinson, P. 2013. Effect of Carbohydrate sources and Cotton- seed meal level on feed intake, nutrient digestibility, Rumen fermentation and Microbial Protein Synthesis in swamp Buffaloes. *Asian Australas Journal of Animal Science*, 26(7), 952–960.