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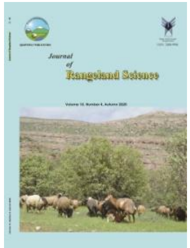

Research and Full Length Article:

Nutritional Value and Acceptability of some Selected Forages in the Derived Savanna Zone of Nigeria as Ruminant Feed

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Abstract. A study was conducted in May–July, 2019 to determine the nutritional values of selected forages consumed by ruminants in the derived Savannah zone of Nigeria. The leaves of plant species were separated, identified, washed, screened, air-dried and milled for chemical analyses and in vitro degradability measurement. Three West African Dwarf rams were used to ascertain the acceptability of these forages using cafeteria feeding trial method. Co-efficient of Preference (CoP) was then calculated. The experiment was of a completely randomized design and all data were statistically analyzed. The chemical analyses showed that the crude protein (CP) content of *Mangifera indica* (13.17%) was higher than *Pennisetum purpureum* (11.57%), *Panicum maximum* (9.57%) and *Terminalia catappa* (8.75%). The NDF of *T. catappa* (51.58%) was least compared to *P. maximum* (57.02%) which was the highest while *P. maximum* (37.10%), *P. purpureum* (54.66%) and *M. indica* (37.93%) were statistically ($P<0.05$) similar. However, *P. maximum* had the least value of ADF. The assayed macro-minerals concentrations were the highest in *T. catappa* but it had relatively high levels of phytate, saponin, alkaloids and tannin. At the end of incubation, *in vitro* gas production by *P. maximum* (5.00 ml/DM) was the highest compared to other species. Hence, rate of degradation varied. *P. maximum* was most preferred (with the highest CoP of 1.10) of the forages compared to other test forages. The relatively raised levels of antinutrients in *T. catappa* could be due to its low acceptability. It could be concluded that the forages had good nutritive value, adequate minerals composition with tolerable anti-nutrients levels and their preferential ranking from *Panicum maximum*>*Pennisetum purpureum*>*Terminalia catappa*>*Mangifera indica* indicating that they could be suitably recommended as sole or partial feed for ruminants.

Key words: Fiber fraction, Methane, Protein quality, Ruminant farmers, Short chain fatty acids, Tropics

Introduction

Ruminant production systems are based on forages with pasture grass and legumes being predominant in their diets as feed (Mohammed and Halim, 2014). However, the prohibitive cost of concentrate diets for animals in the tropics during the dry season necessitates the pressure on the utilization of non-conventional feed resources and continuous search for less expensive and high nutritive feedstuff (Babayemi and Bamikole, 2006). Multipurpose trees and shrubs commonly called browses are important components of agroforestry systems in West-Africa. Forages species have high potentials as important feed resources for ruminants during the dry season and are quite palatable. They are less susceptible to climate fluctuation (Dzowela *et al.*, 1995). The study by Babayemi *et al.* (2004) confirmed that higher percentage of the tropical browse and legumes includes seed and fruit-bearing which had been reported to be high in crude protein and other nutrients. Foliage from browse plants and fodder trees, legumes and shrubs have high protein contents ranging from 14% to 25% (Yashim *et al.*, 2013), and also provide vitamins and frequently mineral elements, which are most lacking in grassland pasture. Their year-round evergreen presentation and nutritional abundance provide for year-round provision of fodder (Oji and Isilebo, 2000). The great potential of forages feeding to animals is better noticed during the dry season, a critical period when the availability of pastures and grassland forages is low. However, Alawa and Amadi (1991) reported that some of the limiting factors associated with using forages and shrubs as animal feed include harvesting, storage, high fiber contents, toxic substances, poor digestibility and low performance when feeding the animals. Information on the preference and intake of *Mangifera indica, Terminalia catappa, Panicum maximum* and *Pennisetum purpureum* by goats is limited and such information is important since the value of any for age feed is determined by its acceptability, digestibility and eventual utilization by animals. Previous studies on these plants have concentrated on their agronomic characteristics with their potential as alternative feed sources for ruminants yet to be fully exploited. Hence, they need to make forages (abundant, nitrogen-rich source and seasonal) sole or partial basal diets to ruminants. This study has been designed to assess the nutritional potentials of these forages and their concomitant level of acceptability using i*n vitro* gas production technique.

Materials and Methods

Study area

The study was carried out in May – July, 2019 at the Nutrition Laboratory and the Teaching & Research Farm of the Animal Production and Health and Central Research Laboratory of the Federal University of Technology, Akure, Ondo state, Nigeria. The area is geographically situated between latitude 7^0 $15^"$ North of the equator and longitude 5^0 15” East (Ajibade *et al.*, 2014), Ondo State, Nigeria.

Collection and Processing of Test Ingredients

The leaves of selected forages (*M. indica*, *P. purpureum*, *P. maximum* and *T. catappa*) being the most common and cheaply available to ruminant farmers in Nigeria were collected within the University premises, and air-dried to reduce its water content until they are crispy to touch while retaining their greenish coloration. The leaves were milled (1mm sieve) using a laboratory mill to obtain a product referred to as leaf meal. The entire test ingredients were stored in an air tight container at room temperature until when needed.

Acceptability Trial

Three West African Dwarf rams were used in the feeding trial (Parlour feeding) and they were selected from the flocks or ruminant unit of Teaching and Research Farm, Federal University of Technology, Akure. The rams were managed under an intensive system and equal amount (in quadruplets) of browse species (2kg each) were offered to the rams in separate feeders, and feeders were strategically placed in the pen, changing the position of the feeders for seven days. Consumption was measured by deduction of the remains from the amount offered; CoP was then calculated as ratio between the intakes from each diet divided by average intake of the diets. A diet was inferred to be relatively acceptable provided that the CoP is greater than or equal to unity If CoP is <1, the material is poorly accepted and when is ≥1, the material is well accepted.

Chemical Analysis

The leaf meals were subjected to chemical analysis Chemical analyses was carried out on the experimental diets, faucal and urine according to AOAC (2002) method. The fiber fractions measured were Neutral detergent fiber (NDF), Acid Detergent Fiber (ADF) and Acid detergent lignin (ADL) and were determined according to Van Soest *et al.* (1991). Atomic absorption spectrophotometer was used in determining the concentration of Calcium, Potassium and Magnesium while Phosphorus was determined by Vanado-molybdate method (AOAC, 2002) as shown in Table 1.

Management of Rams for Rumen Liquor Collection

Three (3) matured West African Dwarf rams were fed with 40% concentrate feed to enact the activities of the rumen microbes and 60% *Pennisetum purpureum* for two weeks. Rumen liquor was obtained from the rams through the use of suction tube before morning feed and was collected into the thermo-flask that had been pre-warmed to a temperature of 39^0C.

Preparation of Buffer Solution

The Buffer solution prepared was the McDougall's Buffer solution which consisted of 9.8 $NaHCO_3$ + 2.77 Na_2HPO_4 + 0.57 KCl + 0.47NaCl + 2.16 $MgSO_3$ $7H_2O$ + 16 $CaCl_2$. $2H_2O$) and mixed with rumen liquor at 1:4 (v/v) under continuous flushing with CO_2 to ensure the survival of microbes and minimize changes in microbial populations.

In Vitro Gas Production

The *in vitro* gas production study involves incubation procedure that was as reported by Menke and Steingass (1988) using 50ml calibrated transparent plastic syringes with fitted silicon tube. The sample weighing 200mg (n=3) was carefully dropped into syringes and thereafter, 30ml inoculums containing cheese cloth strained rumen liquor and McDougall buffer solution under continuous flushing with CO_2 was dispensed using another 50ml plastic calibrated syringe. The syringe was tapped and pushed upward by the piston in order to completely eliminate air in the inoculum. The silicon tube in the syringe was then tightened by a metal clip so as to prevent escape of gas. Incubation was carried out at 39±1°C and the volume of gas production was measured at 3, 6, 9, 12, 15, 18, 21 and 24 hours. At post incubation period, 4ml of NaOH (10M) was introduced to estimate the methane production as reported by Fievez *et al.* (2005). The post incubation parameters such as Metabolisable energy (ME), Organic matter digestibility (OMD) and Short chain fatty acids (SCFA) were estimated at 24h post gas collection according to Menke and Steingass (1988). The average volume of gas produced from the blanks was deducted from the volume of gas produced per sample. The average of the gas volume produced from the blanks was deducted from the volume of gas produced per sample against the incubation time.

The Metabolisable energy (ME) as MJ/Kg DM and Short chain fatty acids (SCFA) were calculated as following formula:

ME=2.20 +0.136GV+0.057CP+0.0029 CF (Babayemi and Bankole, 2006; Getachew *et al*., 2002).

Where; GV, CP CF and XA are total gas volume, crude protein, crude fiber and total ash, respectively.

Statistical Analysis

Data generated were subjected to one way analysis of variance. Significant ($p<0.05$) differences among treatments means were separated using Duncan Multiple Range Test as contained in Statistical Analysis Software package (SAS, 2008).

Results and Discussion

The high DM observed in this study (Table 1) could be attributed to high content of CF and fiber fractions. The CP contents of the selected browse plant leaves ranged from 8.75% to 13.17%, above the CP requirements which provide ammonia required by rumen microbes to support optimum microbial activity (Alalade, 2012). The high CP content in the present study indicates that these forages could be efficiently utilized as potential protein supplements that will enhance the intake and utilization of low quality grass and fibrous crop residues by ruminants. The crude fiber (CF) content of the selected browse plant leaves ranged from 21.92% to 31.85% which was above the recommended range of 15% to 20% for improved intake and production in finishing ruminants (Buxton, 1996). Ash content is useful in assessing the mineral elements present in the selected browse leaves (Smart, 1996), the ash content ranged from 2.58 to 9.42% and this suggests that the sample could be an alternative or better source of essential minerals needed for good metabolism that will enhance good production. The fiber fraction contents of the plant species were generally moderate and within the limits established by NRC (1981) for ruminant animals for ensuring proper digestion and rumination. The higher NDF and ADF contents reported in this study which ranged from 51.58% to 57.02% and 37.10% to 41.71% revealed that more energy will be available to the animals if fed. The lower ADL content obtained is an indication that the animal will be able to consume and digest the leaves better. The levels of antinutrients recorded in this study (Table 2) are much below the range of 60 to 100 g/kg DM, considered to depress feed intake and growth (Mbomi *et al.*, 2011). Saponin levels in all the samples were higher than 15 to 20 g/kg DM reported for goats (Onwuka, 1983). Though, the levels reported herein are not likely to affect nutritional potentials of the browses to ruminants. The potassium (K) content of the selected browse leaves ranged from 0.04% to 0.09% in the present study. The values obtained correlates with requirement level (0.07%) by ruminants (NRC, 1981). The calcium content of the selected browse leaves ranged from 0.02% to 0.04%. The calcium content (0.04%) of *M. indica* compared favorable to 0.04% that was reported by Alikwe and Omotosho (2013). The phosphorus values obtained in this study ranged from 0.14% to 0.45% and was above the value (0.035%) reported by Alikwe and Omotosho (2013). The magnesium content of the selected browse leaves ranged from 0.03% to 0.04% and higher than the recommended requirement of 0.01% - 0.02% in the diet of ruminants (NRC, 1985).

Table 1. Chemical composition (%) of the selected forages

Nutrients (%)	*T. catappa*	*Pe. purpureum*	*Pa. maximum*	*M. indica*
Nutrients				
Dry matter	81.83±0.46	80.19±3.15	83.58±2.19	83.14±1.91
Crude protein	8.75±0.00[c]	11.57±0.58[b]	9.57±0.58[c]	13.17±0.51[a]
Crude fiber	31.85±2.22[a]	26.13±3.35[ab]	30.20±2.39[ab]	21.92±2.24[b]
Ether extract	4.20±1.44[ab]	2.11±0.75[b]	6.12±0.98[a]	6.70±0.38[a]
Ash	2.58±0.65[c]	8.25±0.86[a]	5.28v0.13[b]	9.42±0.98[a]
Nitrogen free extract	48.95±0.76	49.10±1.93	48.84±1.78	48.80±1.15
Fiber fractions				
Neutral detergent fiber	51.58±1.05[b]	54.66±1.32[ab]	57.02±1.32[a]	55.95±1.42[a]
Acid detergent fiber	41.71±0.35[a]	37.50±1.14[b]	37.10±1.38[b]	37.93±1.19[b]
Acid detergent lignin	11.70±0.66[b]	10.13±1.25[b]	13.22±0.94[b]	16.95±1.02[a]
Minerals				
Calcium	0.03±0.00[b]	0.02±0.00[c]	0.02±0.00[c]	0.04±0.00[a]
Phosphorus	0.45±0.02[a]	0.21±0.02[c]	0.29±0.02[b]	0.14±0.01[d]
Potassium	0.09±0.00[a]	0.09±0.00[a]	0.04±0.00[c]	0.06±0.00[b]
Magnesium	0.04±0.00[a]	0.03±0.00[b]	0.03±0.00[b]	0.03±0.00[b]

abc: Means of rows followed by the same letter are not significantly different (P<0.05).

The low level of phytate in the forages indicates the potential of the browse fodders to make minerals available to the ruminants since phytates bind minerals like Ca, Mg, Fe, and Zn, interfere with their metabolism and cause muscular weakness and paralysis.

The observed increase in cumulative gas volume during the 24 hours of incubation from the study (Table 3) of the selected browse leaves may probably be due to the comparable crude protein (CP) and fiber fractions. This corroborates what Babayemi *et al.* (2004) reported that the amount of gas to be produced during fermentation depends on the nature and level of fiber, the presence of secondary metabolites and potency of the rumen liquor for incubation.

Table 2: Antinutritional composition (%) of the selected Forages

Anti-nutrients	*T. catappa*	*Pe. purpureum*	*Pa. maximum*	*M. indica*
Phytate	13.62±0.22[a]	10.65±0.50[c]	10.10±0.34[c]	11.84±0.26[b]
Alkaloid	2.77±0.14[a]	2.92±0.92[a]	2.04±0.53[c]	2.38±0.10[b]
Saponin	9.66±0.20[a]	0.80±0.04[d]	4.58±0.17[b]	3.39±0.09[c]
Tannin	0.98±0.06[ab]	1.02±0.06[ab]	1.08±0.09[a]	0.82±0.07[b]

abc: Means of rows followed by the same letter are not significantly different (P<0.05).

Table 3: *In vitro* gas production of the selected forages

spices	**3HRS**	**6HRS**	**9HRS**	**12HRS**	**15HRS**	**18HRS**	**21HRS**	**24HRS**
T. catappa	2.00±0.00	2.33±0.33	2.33±0.33[a]	3.33±0.33[a]	4.00±0.33[ab]	4.33±0.33[a]	4.33±0.33[a]	4.33±0.33[ab]
P. purpureum	1.33±0.33	2.33±0.33	2.33±0.33[b]	2.33±0.33[b]	3.00±0.58[ab]	3.33±0.67[ab]	3.67±0.33[ab]	4.00±0.00[bc]
P. maximum	1.67±0.33	2.33±0.33	2.67±0.33[ab]	2.67±0.33[ab]	4.33±0.88	4.33±0.33[a]	4.67±0.33[a]	5.00±0.00[a]
M. indica	1.33±0.33	2.00±0.00	2.00±0.00[b]	2.00±0.00[b]	2.33±0.33[b]	2.33±0.33[b]	2.67±0.33[b]	3.33±0.33[c]

abc: Means of column followed by the same letter are not significantly different (P<0.05).

The browse leaves generally have moderate gas production potential. Many factors such as the nature and level of fiber, the presence of secondary metabolites and potency of the rumen liquor for incubation have been reported (Babayemi *et al.*, 2004) to determine the amount of gas to be produced during fermentation. The low CH_4 volume of *T. catappa* could be attributed to its high amount of saponin (Table 2). Although high methane implies an energy loss to the animal, forage with a higher degradability will lead to more intensive fermentation in the rumen (Rinne *et al.*, 1997) and thereby increase in CH_4 production. A mutual relationship exists between total gas production and ME, OMD and SCFA. The estimation of the ME values is imperative for purposes of ration formulation and to set economic value of feeds for other purposes. The values of the ME agree to that of Isah *et al*. (2013), but correspond to (3.28 to 3.83 MJ/kg) value recorded by Getachew *et al.* (2002). The highest ME of *M. indica* coupled with its high CP suggests that such fodder may enhance microbial protein synthesis as it may promote better synchronization of fermentable energy and degradable N in the rumen (Olafadehan, 2013).

In this study, the co-efficient of preference and preference ranking table shows that *Panicum maximum* was the most accepted forage with an average CoP value of (1.10) and it is relatively rich in nitrogen and minerals when compared with other forages and this could be responsible for higher intake. Meanwhile, *Terminalia catappa* leaf is succulent, rich in tannin, and could serve as anti-inflammatory, analgesic, modulatory, and anti-oxidant activities. The reduced intake of *Mangifera indica* leaves could be a result of the non-succulent nature of the leaves.

Table 4: *In vitro* characteristics of the selected forages species for Methane (CH_4), Carbon (IV) oxide (CO_2), Organic Matter Digestibility (OMD), Short Chain Fatty Acid (SCFA), Metabolizable Energy (ME)

Species	CH_4	CO_2	OMD (%)	SCFA (µm)	ME (Kcal/g)
T. catappa	1.00 ± 0.00^{b}	2.33 ± 0.33^{ab}	29.85 ± 2.96^{c}	0.02 ± 0.01^{c}	3.24 ± 0.05^{c}
P. purpureum	2.33 ± 0.33^{a}	1.67 ± 0.33^{b}	35.77 ± 0.01^{bc}	$0.04\pm0.00b^{c}$	3.48 ± 0.04^{b}
P. maximum	2.00 ± 0.00^{a}	2.33 ± 0.33^{ab}	38.76 ± 2.96^{ab}	0.04 ± 0.01^{bc}	3.42 ± 0.06^{b}
M. indica	2.00 ± 0.00^{a}	3.00 ± 0.00^{a}	44.70 ± 0.00^{a}	0.06 ± 0.00^{a}	3.69 ± 0.02^{a}

abc: Means of column followed by the same letter are not significantly different (P<0.05).

Table 5: Co-efficient of preference and Preference ranking of the selected forages in West African dwarf ram

Species	Acceptability parameters		
	Average daily intakes (kg)	Coefficient of preference	Preference ranking
Terminalia catappa	0.72^{c}	0.62	4
Pennisetum purpureum	1.10^{b}	0.92	2
Panicum maximum	1.30^{a}	1.10	1
Mangifera indica	0.82^{c}	0.68	3

[a,b,c,d=] Means of column followed by the same letter are not significantly different (P<0.05), n=3,

Conclusion

This study showed that all the selected browses have high nutritive potential as alternative low cost sources of good protein supplements to poor quality roughages for ruminant feeding especially during the dry season. The browse species are thus promising fodders that can be used for sustainable ruminant production in the tropics. The study further established the suitability of the browse forages as ruminant feeds in terms of nutrients compositions. The acceptability based on coefficient of preference was higher than one in only forage (*P. maximum*). The ranking for the forages was *Panicum maximum>Pennisetum purpureum>Terminalia catappa>Mangifera indica* suggesting the order of the suitability of forages.

References

Ajibade, F. O., Adewumi, J. R. and Oguntuase, A. M., 2014. Design of improved storm water management system for the Federal University of Technology, Akure. Nigerian Journal of Technology, 33 (4): 470-481.

Alalade, J.A., 2012. Effect of legumes intercropping and application of manure on herbage yield and nutritive value of *P. maximum.* PhD Thesis, Department of Animal Production and Health, Ladoke Akintola University of Technology, Ogbomoso.

Alawa, J. P. and Amadi, C., 1991. Voluntary feed intake and digestibility of diets containing corncobs, brewer's dried grain and wheat bran by rabbits. *Nigerian Journal of Animal Production*, 11:9-20

Alikwe, P. C. N. and Omotosho, M. S., 2013. An evaluation of the proximate and phytochemical composition of *Moringa oleifera* leaf meal as potential foodstuff for non-ruminant livestock. *Agro-search*, 13 (1): 17-27.

AOAC, 2002. Association of official analytical chemists. Official Methods of Analysis, 17th ed. Published by association of official Analytical Chemists, Washington, D.C.ARC 1980. The nutrients Requirements of Ruminant Livestock. 4th edition, 73-310. *CAB International, Wallingford.*

Babayemi, O. J. and Bamikole, M. A., 2006. Effects of *Tephrosia candida* leaf and its mixture with Guinea grass on *in-vitro* fermentation changes as feed for ruminants in *Pakistan Journal of Nutrition,* 5(1):14-18.

Babayemi, O. J., Demeyer, D. and Fievez, V., 2004. *In vitro* fermentation of tropical browse seeds in relation to their secondary metabolites. *Journal of Animal Science Technology*. 13 suppl. 1:31-34.

Buxton, D. R., 1996. Quality-related characteristics of forages as influenced by plant environment and agronomic factors. *Animal Feed Science and Technology*, 59(1-3): 37-49. https://doi.org/10.1016/0377-8401(95)00885-3

Dzowela, B. H., Hove, I., Topps, A. J. H., and Matongoya, P. L., 1995. Nutritional and anti-nutritional characters and rumen degradability of dry matter and nitrogen for some multipurpose tree species with potential for agroforestry in Zimbabwe. *Animal Feed Science Technology,* 55: 207-214.

Fievez, V., Babayemi, O. J. and Demeyer, D., 2005. Estimation of direct and indirect gas production in syringes: a tool to estimate short chain fatty acid production requiring minimal laboratory facilities. *Animal Feed Science Technology*; 123-124:197-210.

Getachew, G., Makkar, H. P. S. and Becker, K., 2002. Tropical browses: Contents of phenolic compounds, *in vitro* gas production and stoichiometric relationship between short chain fatty acid and *in vitro* gas production. *Journal of Agricultural Science*. 139 (3): 341- 352.

Isah, O.A., Omorogiuwa, L.E. and Okunade, S.A., 2013. Chemical evaluation of some browse plants eaten by local breeds of goats in Edo State, Nigeria. *Pacific Journal of Science and Technology*. 14 (1):406-412.

Mbomi, S.E., Ogungbesan, A.M., Babayemi, O.J. and Nchinda, V.P., 2011. Chemical composition, acceptability of three tephrosia species and use of *Tephrosia purperea* as supplement for grazing animals in the western highlands of Cameroon. *Journal of Environmental Issues and Agriculture in Developing Countries*. 3(3):132-137

Menke, K. H. and Steingass, H., 1988. Estimation of the Energetic Fed Value from Chemical Analysis and *In Vitro* Gas Production Using Rumen Fluid. *Animal Resource Development*, 28: 7-55.

Mohammed, B. M. and Halim, R. A., 2014. Productivity quality and volatile fatty acid production from guinea grass-legume mixtures. *Nigerian Journal of Animal Science*, 16 (1):133-143

NRC. 1981. Nutrient requirements for goats angora, dairy and meat goat in temperate and tropical countries. National Research Council, *National Academic of Press, Washington D. C., U.S.A.*

NRC. 1985. National Research Council Recommended Dietary Allowance, *National Academic of Press, Washington D. C., U.S.A.*

Oji, U. I., and Isilebo, J. O., 2000. Nutrient characteristics of selected forages of humid tropics. Proceedings of the 25th Annual Conference of NSAP, 19-23rd March 2000, Umudike, Nigeria; 54-56.

Olafadehan, O. A., 2013. Feeding value of *Pterocarpus erinaceus* for growing goats. *Animal Feed Science Technology*, 185, 1–8.

Onwuka, C. F., 1983. Nutritional evaluation of some Nigerian forages in the humid tropics. PhD. Thesis. University of Ibadan: Ibadan, Nigeria.

Rinne, M., Jaakkola, S. and Huhtanen, P., 1997. Grass maturity effects on cattle fed silage-based diets. 1. Organic matter digestion, rumen fermentation and nitrogen utilization. *Animal Feed Science Technology*. 67, 1–17

SAS. 2008. Statistical Analytical Systems. SAS/STAT User's guide, version 17, Cary, North Carolina, USA.

Smart, J., 1996. Canavalia gladiate (Jacq) D. C. (Sword bean). Tropical pulses. *Longman group Ltd., London,* Pp 58

Van Soest, P.J., Robertson, J.B. and Lewis, B.A., 1991. Method for dietary fiber, neutral detergent fiber and non-starch polysaccharides in relation to animal nutrition. Journal of Dairy Science, 3583-3597.

Yashim, S. M., Abdu, S. B., Achi, N. P., Yakubu, R. L., Adamu, H. Y., Joktan, G. E. and Goje, B. J., 2013. Effects of levels of dried milled *Gmelina arborea* leaves supplementation on voluntary feed intake and growth performance of Red Sokoto bucks. *Proceedings of 18th Annual Conference, 2nd ASAN-NIAS Joint Annual Meeting, Abuja. Pp*. 423-426.