Feed Utilization, Rumen Parameters, and Microbial Profile of Goats fed Different Tropical Browse Plants with *Pennisetum purpureum* as Basal Diet.

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ABSTRACT

A feeding trial was conducted to study the effect of feeding selected browse plants as supplement to a basal diet of *Pennisetum purpureum* on the performance, digestibility, nitrogen utilization, rumen fermentation characteristics, and rumen microbial profile of West African Dwarf (WAD) goats. Thirty WAD goats in a completely randomized design were divided into five groups (6 goats per group) and were fed basal diet of *P. purpureum* and dried cassava peels which was supplemented with selected browse plants as follows: *P. purpureum only* (*Pp*)*, P. purpureum* + *Merremia aegyptia* (*Pp+Ma*)*, P. purpureum* + *Aspilia africana* (*Pp+Aa*)*, P. purpureum* + *Alchornea cordifolia* (*Pp+Ac*) *and P. purpureum* + *Newbouldia laevis* (*Pp+Nl*). The experiment lasted for 12 weeks.

Ma had the highest (p<0.05) crude protein (19.62%), dry matter (85.74%) and ash (9.43%). Supplementation increased the total crude protein intake while dry matter intake was not affected. Nutrient intake, digestibility and % Nitrogen retention were improved (p<0.05) with browse plants supplementation. Volatile fatty acids produced were highest (p<0.05) with *Ma* and *Aa* supplementation. Total viable microbial count, total yeast and lactic acid bacteria count in the rumen of the animals increased with the browse plants supplementation. Total coliform and total fungi count were lower in treatment group with browse plant supplementation. Weight gained (g/day) by the animals improved with browse plant supplementation except for *Ac*. To this effect, supplementation with selected browse plants (*A. africana, M. aegyptia, A. cordifolia,* and *N. laevis*) in the diet of WAD goat helps in increasing the utilization of poor quality forages during the dry season by increasing the population of bacteria in the rumen for better degradation and utilization of nutrients in poor quality grasses.

(Keywords: West African Dwarf goats, browse plants, feed utilization, Rumen microbial profile)

INTRODUCTION

The major limitation to ruminant production in many tropical regions of Africa, Asia, and Latin America is poor nutrition. Chemical treatment of fibrous feedstuffs, supplementation of tropical roughages with leguminous fodder trees and shrubs (FTS), low-cost nitrogenous sources and use of agricultural by-products are promising methods used to alleviate nutrient deficiencies associated with these basal diets.

Current approaches to the evaluation of digestibility and nutritive value of feed resources using conventional in vitro feed evaluation and animal studies have resulted in a large body of information about nutrient composition, digestion kinetics and digestibility. However, these techniques are unable to describe the microbial mechanisms involved in ruminal digestion and are unlikely to result in the development of rational feeding strategies. Rumen microbial ecology has been extensively researched into over half a century and many outstanding results have systematically described and characterized the predominant species of bacteria, protozoa and fungi in breeds of livestock that are not indegenous to Nigeria.

Despite the advancements made, though, more work is needed to better characterize the impact of diets on these populations of microbes, how they interact together synergistically and antagonistically, and how they are influenced by host factors. The objective of this study therefore is to evaluate the feed intake, nutrient digestibility, rumen parameters and microbial profile of WAD goats fed different browse plant with *P. purpureum* as basal diet.

MATERIALS AND METHODS

The experiment was carried out at the Small Ruminant Unit of the Teaching and Research Farm Directorate of the College of Animal Science and Livestock Production(COLANIM), University of Agriculture, Abeokuta, Ogun State which is located in the tropical rainforest zone in Nigeria within $7^0$10'N and $3^0$2'E. The area has an average rainfall of 1100mm, a mean ambient temperature of about 34^0C and an average relative humidity of 82% (Google Earth, 2011).

Thirty (30) West African Dwarf goats (Bucks) within the ages of 8-9 months with average weight of 7.5 kg±0.6 were used for this study. The animals (already adapted to the environment) were taken out of their pens and the individual pens were cleaned with soap and water, disinfected with *Asuntol* and allowed to rest for seven days. The animals were treated for mange and dewormed with *ivomec.* Antibiotics and multivitamin were also administered to the animals after which they were divided to five groups of six animals per group in a Completely Randomized Design (CRD). Animals were allowed an adaptation period of two weeks to the feed before data collection commenced. Experimental diet and water were offered to the animals' *ad Libitum* at 7.30am every day for 84 days and leftovers for the previous day were weighed and discarded. Weights of the animals were taken weekly to determine weight changes during the experiment.

Experimental diets consisted of a basal diet of *P. purpureum* and dried cassava peels supplemented with or without browse supplement. Browses and *P. purpureum* were collected around the premises of the University farm. They were air dried over night before feeding them to the goats. Cassava peels were sourced and bought from neighboring villages around the premises of the University and dried before feeding. The control diet consisted of only *P. purpureum* and Cassava peels while browses were fed to animals with other treatments.

Diet 1: *P. purpureum* + cassava peel

Diet 2: *P. purpureum* + cassava peel + *M. aegyptia*

Diet 3: *P. purpureum* + cassava peel + *A. africana*

Diet 4: *P. purpureum* + cassava peel+ *A. cordifolia*

Diet 5: *P. purpureum* + cassava peel + *N. Laevis*

The proximate composition of the grass, browse plants and cassava peel was determined according to the method described by AOAC **(**2000**),** while the anti – nutritional factor determination was according to the procedures outlined by Harbourne (1973), Trease and Evans (1989). At the end of the experiment, rumen content was collected via stomach tube and kept in different bottles and then taken to the laboratory for microbial and rumen parameter analysis.Total VFA concentrations of rumen content were measured by steam distillation technique according to Eadie et al.,(1967) while molar percentages of propionic, acetic and butyric acids were determined by using Gas- liquid chromatography (Samuel *et al*., 1997). Rumen NH_3-N concentration was measured by spectrophotometry according to Chaney & Marbach (1962).

Isolation and Enumeration of Rumen Microorganisms

One gram (g) of samples were homogenized in 9mls of distilled water to obtain a ratio of 1:9. Further dilution and the second diluents of each sample was plated using pour plate technique. Swab of packaging material was also taken and cultured on nutrient agar (LAB M) and Sabouraud dextrose agar (LAB M).The nutrient agar plate was incubated aerobically at 37^OC for 24hrs and that of sabouraud dextrose agar was incubated at 28±2 ^{O}C for 3-5days. The bacteria isolated were then identified using morphological culture characteristics i.e. color, consistency, shape, size, elevation, edge, opacity and biochemical test (such as oxalate, citrase, and catalase). Bacteria were identified based on the result obtained from biochemical characterization.

Statistical Analysis

Data collected were subjected to one way Analysis of Variance (ANOVA) using SAS (1990) Procedure in a Completely Randomized Design (CRD). The mean significance was compared using Duncan's New Multiple Ranged Test (Duncan, 1995).

RESULTS

Table 1 shows the proximate composition of feed, cassava peels and the forage plants (%DM) used in this study. Table 2 shows the nutrient intake, while nutrient digestibility, nitrogen utilization and growth rate of WAD goats fed basal diet of *P. purpureum* supplemented with various selected browse plants were shown in Tables 3, 4, and 5, respectively.

Table 1: Proximate Composition of Cassava Peel, Elephant Grass (*Pennisetum purpureum*), and Browse Plants (%DM).

PARAMETERS	*Pp*	CP	*Ma*	*Aa*	*Ac*	*Nl*	SEM
Dry Matter	85.34^{abc}	86.43^{abc}	85.74^{abc}	87.31^{ab}	82.58^{c}	84.47^{bc}	0.61
Ether Extract	10.98^{c}	5.19^{d}	13.72^{bc}	16.15^{ab}	11.38^{c}	16.30^{ab}	1.04
Crude Protein	11.24^{b}	5.67^{c}	19.62^{a}	19.37^{a}	11.33^{b}	12.26^{b}	1.21
Crude Fiber	23.85	17.72	20.58	18.34	16.97	15.60	0.98
Ash	11.47^{ab}	12.96^{a}	9.43^{ab}	8.30^{ab}	5.20^{b}	4.27^{b}	0.97
Organic Matter	88.53^{ab}	87.04^{b}	90.57^{ab}	91.70^{ab}	94.80^{ab}	95.73^{a}	0.99
NFE	27.81^{c}	44.89^{a}	22.40^{c}	25.16^{c}	37.7^{b}	36.03^{b}	1.78
Saponins			+	+++	++	++	
Phenol			_	CT+	CT+	CT+	
Steroids			+	+	-	+++	

[a,b,c,d]Mean values in the same row with different superscripts differ significantly (P< 0.05)
+ = Present; ++ = strongly present; +++ = very strongly present; and - = absent.***Pp* –** *Pennisetum purpureum,* ***Ma* –** *Merremia aegyptia,* ***Aa* –** *Aspilia africana,* ***Ac*** *– Alchornea cordifolia,* ***Nl****– Newbouldia laevis,* **CT** – Condensed Tannin, **NFE** – Nitrogen Free Extract, **SEM –** Standard Error of Mean

Table 2: Feed Intake of WAD Goats fed *Pennisetum purpureum* Supplemented with Selected Browse Plants.

PARAMETERS	*Pp*	*Pp+Ma*	*Pp+Aa*	*Pp+Ac*	*Pp+Nl*	SEM
Dry matter Intake (g/day)	787.32	799.21	793.91	792.36	801.69	3.15
Crude Fiber Intake (g/day)	176.17^{a}	173.81^{ab}	170.50^{b}	149.58^{d}	162.19^{c}	2.66
Ether Extract intake (g/day)	89.04^{b}	94.64^{a}	96.32^{a}	78.32^{c}	97.60^{a}	1.92
Crude Protein Intake (g/day)	90.86^{c}	105.66^{a}	102.05^{b}	93.40^{c}	100.10^{b}	1.52

[a,b,c,d]Mean values in the same row with different superscripts differ significantly (P< 0.05)
Pp* –** *Pennisetum purpureum,* ***Ma* –** *Merremia aegyptia,* ***Aa* –** *Aspilia africana,* ***Ac *– Alchorne acordifolia,* ***Nl****– Newbouldia laevis,* **CT** – Condensed Tannin, **NFE** – Nitrogen Free Extract, **SEM –** Standard Error of Mean

Table 3: Nutrient Digestibility of WAD Goats fed *Pennisetum purpureum* Supplemented with Selected Browse Plants.

PARAMETERS	*Pp*	*Pp+Ma*	*Pp+Aa*	*Pp+Ac*	*Pp+Nl*	SEM
Dry Matter Digestibility (%)	79.14^{c}	86.20^{a}	82.65^{b}	86.58^{a}	86.18^{a}	0.79
Crude Protein Digestibility (%)	70.60^{c}	82.83^{a}	80.64^{ab}	79.56^{b}	81.32^{ab}	1.21
Ether Extract Digestibility (%)	64.21^{c}	80.50^{a}	75.58^{b}	74.92^{b}	74.93^{b}	1.51
Crude Fiber Digestibility (%)	77.07^{b}	79.83^{a}	72.06^{c}	75.16^{b}	75.92^{b}	0.72
NFE Digestibility (%)	87.38^{d}	94.57^{b}	92.83^{c}	98.15^{a}	92.43^{c}	0.95

[a,b,c,d]Mean values in the same row with different superscripts differ significantly (P< 0.05). ***Pp* –** *Pennisetum purpureum,* ***Ma* –** *Merremia aegyptia,* ***Aa* –** *Aspilia africana,* ***Ac*** *– Alchornea cordifolia,* ***Nl****– Newbouldia laevis,***NFE** – Nitrogen Free Extract, **SEM –** Standard Error of Mean

Table 4: Nitrogen Utilization of WAD Goats fed *Pennisetum purpureum* Supplemented with Selected Browse Plants.

PARAMETERS	*Pp*	*Pp+Ma*	*Pp+Aa*	*Pp+Ac*	*Pp+Nl*	SEM
Nitrogen Intake (g/day)	14.54[c]	16.91[a]	16.33[b]	14.94[c]	16.02[b]	0.24
Fecal Nitrogen (g/day)	4.27[a]	2.90[b]	3.19[b]	3.05[b]	2.99[b]	0.14
Urine Nitrogen (g/day)	1.27[c]	1.91[a]	1.99[a]	1.67[b]	1.87[a]	0.07
Nitrogen Output (g/day)	5.54[a]	4.81[bc]	5.18[ab]	4.72[c]	4.86[bc]	0.09
Nitrogen Retained(g/day)	9.00[d]	12.09[a]	11.15[b]	10.22[c]	11.16[b]	0.29
% Nitrogen Retained	61.90[c]	71.53[a]	68.25[b]	68.39[b]	69.67[ab]	0.93
PER	0.22[b]	0.28[a]	0.24[ab]	0.16[c]	0.26[a]	0.02

[a,b,c,d]Mean values in the same row with different superscripts differ significantly (P< 0.05).***Pp*** **–** *Pennisetum purpureum,* ***Ma*** **–** *Merremia aegyptia,* ***Aa*** **–** *Aspilia africana,* ***Ac*** – *Alchornea cordifolia,* ***Nl***– *Newbouldia laevis,* **PER** – Protein Efficiency Ratio, **SEM –** Standard Error of Mean

Table 5: Weight Gain and Feed Conversion Ratio of WAD Goats fed *Pennisetum purpureum* Supplemented with Selected Browse Plants.

PARAMETERS	*Pp*	*Pp+Ma*	*Pp+Aa*	*Pp+Ac*	*Pp+Nl*	SEM
Dry matter Intake (g/day)	904.80	929.91	903.06	915.82	935.30	3.85
Initial Weight (Kg)	7.53	7.60	7.77	7.57	7.63	0.11
Final Weight (Kg)	9.20[ab]	10.10[a]	9.80[ab]	8.80[b]	9.80[ab]	0.18
Weight Gain (g/day)	19.88[c]	29.16[a]	24.17[b]	14.64[d]	25.83[b]	1.75
FCR	45.51[b]	31.89[c]	37.36[c]	62.56[a]	36.21[c]	2.17

[a,b,c,d]Meanvalues in the same row with different superscripts differ significantly (P< 0.05), ***Pp*** **–** *Pennisetum purpureum,***Ma** **–** *Merriemia aegyptia,* ***Aa*** **–** *Aspilia africana,* ***Ac*** – *Alchonea cordifolia,* ***Nl***– *Newbouldia laevis*, **FCR** - Feed Conversion Ratio, **SEM –** Standard Error of Mean.

Weight gain and FCR differed significantly (P<0.05) with *Pp+Ma* group having the greatest daily weight gain of (29.16g/day) while *Pp+Ac* had a daily weight gain value (14.64g/day) which was less than that of the control group (19.88g/day). Intake of crude fiber, crude protein and ether extract all differed significantly (P<0.05). Animals on *Pp* group had the highest crude fiber intake of 176.17g/day and *Pp+Ma* group had a comparable value of 173.81g/day while lower values were recorded in *Pp+Ac, Pp+Aa* and *Pp+Nl* groups, (149.58g/day, 170.50g/day and 162.19g/day, respectively). Diet supplemented with *Ma* showed greater (p<0.05) digestibility values. Animals on *Pp+Ac* and *Pp+Nl* had crude fibre digestibility values (75.16% and 75.92% respectively) comparable to that of the animals on *Pp* (77.07%) and greater than that of *Pp+Aa* (72.06%). Nitrogen intake of animals on *Pp* group is comparable to that of *Pp+Ac* group and less than that of the remaining treatment groups.

The positive values for nitrogen retained by the animals in this study are supported by the fact that none of the animals experienced weight loss during the experiment. Rumen NH_3-N produced by animals on browse supplements were similar but higher than that of animals on *Pp* treatment group. Volatile fatty acids production of animals on *Pp+Ma* and *Pp+Aa* groups recorded highest values. Least value for the volatile fatty acids production was recorded in *Pp+Nl* group. Supplementation with the various selected browse plants increased the total viable count of bacteria, the total yeast count and total lactic acid bacteria count (Table 7). Highest values of total coliform count and total fungi count were recorded in animals on *Pp.*

DISCUSSION

There are many different species of trees and shrubs available in the rural areas, many of which are eaten by ruminants. However, not all of them are nutritious. The CP contents of *M. aegyptia* and *A. africana* (19.62 and 19.37% respectively) are higher than that of *P.purpureum* (11.24%) and *Panicum maximum* (8.37%: Isah and Babayemi, 2010), the most important grass species of natural grassland in Nigeria.

Table 6: Rumen pH, Rumen Ammonia-Nitrogen and Volatile Fatty Acid Production of WAD Goats fed *Pennisetum purpureum* Supplemented with Selected Browse Plants.

PARAMETERS	*Pp*	*Pp+Ma*	*Pp+Aa*	*Pp+Ac*	*Pp+Nl*	SEM
pH	7.00^{b}	7.14^{a}	6.20^{c}	5.77^{d}	6.27^{c}	0.14
Rumen (NH_3-N) (%)	5.27^{b}	6.33^{a}	6.13^{a}	5.92^{a}	6.27^{a}	0.12
Propionic Acid (%)	20.67^{ab}	23.33^{a}	23.33^{a}	19.33^{b}	11.73^{c}	1.20
Lactic Acid (%)	47.27^{ab}	52.5^{a}	51.77^{a}	43.50^{b}	23.97^{c}	2.91
Acetic Acid (%)	31.50^{ab}	35.00^{a}	34.50^{a}	29.00^{b}	17.83^{c}	1.77
Butyric Acid (%)	32.02^{ab}	35.58^{a}	35.05^{a}	29.48^{b}	16.68^{c}	1.92

^{a,b,c,d}Meanvaluesin the same row with different superscripts differ significantly ($P< 0.05$),
Pp **–** *Pennisetum purpureum,* ***Ma*** **–** *Merriemia aegyptia,* ***Aa*** **–** *Aspilia africana,* ***Ac*** – *Alchonea cordifolia,* ***Nl***– *Newbouldia laevis*, **NH_3-N** - Ammonia-Nitrogen, **SEM –** Standard Error of Mean.

Table 7: Rumen Microbial Count and Identification (cfug^{-1}) of WAD Goats fed *Pennisetumpurpureum* Supplemented with Selected Browse Plants.

PARAMETERS	*Pp*	*Pp+Ma*	*Pp+Aa*	*Pp+Ac*	*Pp+Nl*
Total Viable Count	7.6×10^5	10.6×10^5	11.6×10^5	9.8×10^5	12.6×10^5
Total Coliform Count	0.8×10^5	0.4×10^5	0.4×10^5	0.5×10^5	0.5×10^5
Total Fungi Count	0.7×10^5	0.6×10^5	0.5×10^5	0.4×10^5	0.4×10^5
Total Yeast Count	0.6×10^5	1.4×10^5	1.0×10^5	1.6×10^5	1.1×10^5
Lactic Acid Bacteria Count	0.5×10^5	1.2×10^5	1.6×10^5	1.4×10^5	1.8×10^5
Micro-Organisms Isolated	*Staphylococcus aureus, Streptococcus faecum, Bacillus cereus, Micrococcus acidophilus, Lactobacillus lactis, Protecusvulgaricus, Bacillus macerans, Pseudomonas aureginosa, Saccharomyces cervisae, Aspergillusniger.*	*Micrococcus acidophilus, Streptococcus lacis, Bacillus cereus, Bacillus subtilis, Aspergillusniger, Saccharomyces cervisae, Serratiamacecences, Protecusvulgaricus, Lactobacillus fermentum.*	*Micrococcus acidophilus, Protecusvulgaricus, Streptococcus lacis, Lactobacillus lactis, Bacillus macerans, Pseudomonas aureginosa, Micrococcus luteus, Clostridium welchii, Penicillumchrysogenium, Saccharomyces cervisae.*	*Micrococcus luteus, Bacillus subtilis, Streptococcus lacis, Pseudomonas fragii, Saccharomyces cervisae, Lactobacillus fermentum, Protecusvulgaricus.*	*Lactobacillus lactis, Micrococcus acidophilus, Bacillus subtilis, Proteus morganii, Streptococcus lacis, Saccharomyces cervisae, Aspergillusterreus.*

Pp **–** *Pennisetum purpureum,* ***Ma*****–** *Merriemia aegyptia,* ***Aa*** **–** *Aspilia africana,* ***Ac*** – *Alchonea cordifolia,* ***Nl***– *Newbouldia laevis*

The CP content are also higher than rice bran (13%), but close to wheat bran (17 %) and Palm Kernel cake (15 %) [Aduku and Olukosi,1990]. Percentage DM composition of *Pp* in this study correspond with reported values of Osakwe *et al,* (2007). This might be due to the soil nitrogen of the location where the *Pp* used in this study was harvested. The *Pp* used in this study was harvested around places where poultry litter was deposited on the farm. This might contribute to the high crude protein of *Pp* observed in this study.

The Proximate composition of cassava peels reported by Ifut, (2007) is similar to values obtained in this study, dry matter value of 86.43%, crude protein (5.29%), crude fiber (9.87-14.5%), ether extract (0.7-0.78%) and ash (5.5-6.17%) were reported. Slight variations observed in the values reported by this author and those obtained in this study may be attributed to differences in location, growth rate of forage plants and processing methods of cassava peels.

The crude protein (11.33-19.62%) value obtained for the browse plants is sufficient to serve as nutritious browse leaves for ruminants in the tropic (Onwuka, 1980) and also higher than the 10% recommendation for growth/maintenance of goats (Ranjah, 1980). The most important aspect of browse plants is that, unlike grasses during dry season, they are usually protein-rich (Simbaya, 2002). It is this characteristic which gives value to the lesser-utilized and non-conventional plant resources and justifies evaluating them as animal feeds. These species can be used as supplements to low quality grass-based diets for ruminants, especially those in extensive production systems such as practiced by rural smallholder crop – livestock farmers.

The effects of using multipurpose trees as supplement to basal grass diets on growth and survival of WAD sheep and goats have been reported (ILCA, 1988). Higher CP intake recorded in *Pp+Ma, Pp+Aa,* and *Pp+Nl* groups could be as a result of complementation of intake of *Pp* by the browse plants as a result of their high protein content and the importance of protein intake as the determinant of performance and intake in ruminants has been strongly emphasized (Preston and Leng, 1987).

The results indicated that supplementation with *M. aegyptia*, *Aspilia africana* and *N. laevis* forages increased crude protein, ether extract, but not fibre intake, possibly for two reasons: firstly, the palatability of the diet was increased; and secondly, its high CP content improved the rumen environment and hence the digestibility of the diet. It is likely that the *M. aegyptia, A. Africana* and *N laevis* increased the supply of soluble nitrogen to the rumen microbes, thereby increasing rumen microbial activity.

Animals fed with diets supplemented with *A. Cordifolia* did not increase their dry matter intake possibly because of its lower protein content (11.33%). It is recognized that rumen degradable protein content increases microbial biomass yield and hence digestibility and feed intake (Parvez, 2001). The higher crude fiber intake of control *Pp* could be due to the fact that grasses during the dry season are higher in fiber and this is in line with report of Adegbola and Mecha (1980), who reported that as tropical grasses mature, palatability and digestibility declines and the grasses become dry, coarse, fibrous and less digestible during the dry season resulting in reduced feed intake and weight losses of the animals.

Mean dry matter intake in this study is higher than 212.05-236.59g/day reported by Akinyemi *et al,* (2010) and lower than (915.4g/day) reported by Olomola *et al,* (2008). Digestibility values recorded in this study are similar to those earlier reported in literatures (Isah and Babayemi, 2010). Significant improvement in the digestibility of DM, CP and EE, as observed in supplementation with browse plants might be due to their high protein content which improved the growth of the rumen microbes, and thus improving digestion in the rumen.

Better protein utilization than that of the control *Pp diet* were recorded in *Pp+Ma* and *Pp+Nl* groups (0.28 and 0.26, respectively) and this could be as a result of higher cell wall content of grasses during the dry season which tend to reduce digestibility and utilization of the nutrients. Despite this, positive nitrogen balance was recorded in all the treatments. The high value of protein efficiency ratio observed in diet supplemented with M. *aegyptia* might be due to the high crude protein content of the plant. Supplementation with the various browse plants resulted in increased rumen NH_3-N concentration. Ranjah, (1980) had observed that the concentration of ammonia and hence nitrogen in the rumen depends on the quantity and solubility of protein fed to the animals.

Animals supplemented with browse plant had higher NH_3-N in the rumen and this could be as a result of the quantity and solubility of the protein in the browse plants. Although *A. cordifolia supplementation* did not improve feed intake, the crude protein content was digested better than the unsupplemented diet and it has high ammonia nitrogen concentration, which encourage good microbial proliferation as seen in the result of total viable microbial count. There is reduction in total coliform as well as total fungi count.

The result of weight gain (14.64 – 29.19 g/day) obtained in this research is lower than the result (84.9-94g/day) obtained by Isah and Babayemi, (2010) for WAD goats fed rumen epithelial wastes and soybean cake based diets but similar to (7.74-27.38g/day) obtained by Babayemi and Bamikole, (2007) for goats fed different concentrate diets as supplement after daily grazing on natural grassland. Supplementation with *M. aegyptia* increased weight gain of the goats, probably because its protein content and PER maintained a favourable rumen environment for optimum nutrient digestibility.

Daily live-weight gains of kids receiving *M. aegyptia, A. africana and N. laevis* leaves were 29.16g/day, 24.17 g/day and 25.83 g/day respectively, which is higher than those animals on grass only. Increase in rumen NH_3-N with browse supplementation has been reported by Getachew *et al,* (1994) to be a function of the degradability of the nitrogen in the forage legume. Leng, (1990) suggested that the beneficial effects of the incorporation of highly digestible forage in an otherwise low digestible basal diet could be that it exerts a large effect on digestibility by providing a high protein source to seed bacteria in the utilization of the less digestible fiber. Supplementation with *A. cordifolia* and *N. Laevis* reduced volatile fatty acid concentration in the rumen probably because of presence of anti – nutritional factors in the plants (Singh, 2011).

Getachew et al. (2008) reported lower VFA production by adding CT in batch culture of mixed rumen microorganisms. The variability in VFA and its molar proportion with different tannin sources might be due to variations in the type and concentration of tannins present in the test materials. Increased total viable microbial count observed in supplemented diets might be due to avalability of nutrient in the rumen which triggers microbial proliferation, while reduction in total coliform and fungi count might be as a result of anti – nutritional factor present in the browse plants especially *A. cordifolia* and *N.laevis.* CT could cause reductions in the numbers of protozoa (Patra *et al,* 2006). Makkar et al. (1995) reported lower protozoa numbers by feeding *L. leucocephala* and leucaena hybrid KX2 tannins at the levels of 7.3 and 11.6%. According to McSweeney et al. (1999) rumen protozoa, fungi and some of the bacteria are more resistant to condensed tannin as compared to other microbial populations, but Monforte et al. (2005) reported that with some condensed tannins rich plants protozoa numbers were negatively correlated.

The presence of Clostridium species in goats consuming *A. africana* revealed that the microbe is resistant to the anti- nutritional factors present in the browse plant. While *streptococcus lacis* was found in the animals supplemented with the different browse plants, *Streptococcus faecum* was found only in animal fed grass alone indicating that *S. faecum* is not resistant to anti-nutritional component of the various browse plant. Nelson *et al.* (1998) has studied six strains of tannin tolerant bacteria and observed that some, not all ruminal Streptococci, Proteobacteria and Clostridia genus can tolerate high levels of hydrolyzable and condensed tannins. This is confimed by Jakhesara *et al,*(2010). O'donovan and Brooker (2001) reported that Streptococcus gallolyticus (*S. caprinus*) and S. bovis was resistant in vitro to at least 7% (w/v) tannic acid and 4% (w/v) acacia condensed tannin.

CONCLUSION

In conclusion, the results of this study shows that supplementation with the selected browse plants (*Aspilia africana, Merremia aegyptia,* and *Newbouldia laevis*) in the diet of WAD goat helps in increasing the utilization of poor quality forages during dry season by increasing the population of microbes in the rumen for better degradation and utilization of nutrients in poor quality grasses. The four forages selected for this study are all lesser-utilized and non conventional forages generally available in South western Nigeria. These four species are not, at present, being used by farmers for feeding livestock although the results of this study suggest they could be. Although *Merriemia aegyptia* gave the largest positive responses, *A.africana* and *N. laevis* forages could also be considered worthy of investigation for on-farm experiment except *A. cordifolia*.

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