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RUMEN PARAMETERS OF WEST AFRICAN DWARF SHEEP FED *Panicum maximum* SUPPLEMENTED WITH VARYING LEVELS OF *Gmelina arborea* LEAVES

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ABSTRACT

Purpose: This experiment was carried out to assess the rumen characteristics of West African dwarf sheep fed varying level of Panicum maximum supplemented with Gmelina arborea leaves.

Methodology: Twenty (20) healthy West African Dwarf sheep with average weight of 10+0.55kg and were randomly allotted to five (5) diet with four (4) animals per treatment in a completely randomized design. The diets compared were A (100% Panicum maximum); B (75% Panicum maximum + 25% Gmelina arborea leaf); C (50% Panicum maximum + 50% Gmelina arborea leaf); D (25% Panicum maximum + 75% Gmelina arborea leaf); and E (100% Dried Gmelina arborea leaf). The diet samples were analyzed for chemical composition and anti-nutritive components. At the end of feeding trial, rumen liquor from the experimental animals were collected for rumen fermentation characteristics Data were collected on volatile fatty acids (VFAs) production rumen pH and ammonia nitrogen.

.**Findings:** The results obtained showed that the chemical composition and the anti-nutrient content in the diets were significantly (P<0.05) different. Dry matter was highest in diet E (82.50%) and lowest in diet A (36.50%). The crude protein ranged between (9.75%) in diet A and (18.33%) in diet E. the Neutral detergent fibre, Acid detergent fibre and Acid detergent lignin was highest in diet B (63.30%), A (31.50%) and C (16.60%) respectively. the anti-nutrient content of the diet showed no any negative effect on the animals. The acetic acid (5.93%), propionic acid (5.65%), butyric acid (5.40%), valeric acid (5.37%), total volatile fatty acids (34.37mmol/liter), lactic acid (7.37%) and pH (8.25) of the rumen were significantly (p<0.05) higher in animals on diet B than those on diets A, C, D and E. Animals on diet D had the highest values in terms of rumen ammonia concentration (0.53mg/100ml) followed closely was diet C and E with the value (0.48mg/100ml).

Uique contribution to theory, practice and policy: It can be concluded that feeding West African Dwarf (WAD) sheep with Panicum maximum supplemented with Gmelina arborea leaves offers potential results in supplying fermentable nutrients needed to enhance favourable rumen environment for effective microbial activities without any adverse effect on on the rumen parameters status of the animals.

KEYWORDS: *Panicum maximum, Gmelina arborea, WAD sheep, Rumen parameter*.

1.0 INTRODUCTION

Ruminant animals play an important role in the economic development of Nigeria in terms of feeding the steadily growing population and providing the investible resources for national development (Bolaji *et al.*, 2016). Most commonly reared ruminants in Nigeria include cattle, sheep and goat. The supply of adequate nutrition is germane for optimum livestock production. One of the most challenging factors in achieving this is the scarcity of feed both in quantity and quality especially during the dry periods of the year, thus resulting in animal's low productivity and even death (Ibhaze *et al.*, 2014). Feed accounts for 60 – 70% of total cost of livestock production and it's inadequacy in quality and quantity could lead to a situation of low nutritional status, poor weight gain, poor reproductive ability, poor production, poor health condition and poor conversion ratio (Fajemisin *et al*., 2015). It therefore, becomes important to supply adequate feed in quantity and quality for optimal performance by livestock.

Panicum maximum (Guinea grass) is one of the most naturally occurring grasses in the tropics and subtropics of Africa which has high yield and regenerating ability. They are very responsive to nitrogenous fertilizer and highly palatable to livestock at all stages of growth which makes it one of the best fodder grasses (Crowder and Chhenda, 1982; Eyoh *et al.*, 2019). *Panicum maximum* is considered one of the most valuable fodder plants, producing high yields of palatable fodder, but its nutritive value rapidly declines with age. There is a need to supplement *Panicum maximum* with other forages that have high nutritive value and available all year round.

Gmelina aborea is a multipurpose tree, a leguminous browse plant, which has been identified as one of the cheapest way in reducing feeding cost in ruminant production in the tropics (Okpara *et al.*, 2012). It is a fast-growing deciduous tree that even though it sheds some of its leaves when the dry season is approaching, the regrowth of new leaves could serve as animal feed. The leaves are unconventional materials that can be explored for the production of feedstuff. They are high in nutrient, previous records (Ahamefule, *et al.*, 2006; Osakwe and Udeogu, 2007; Okafor, *et al.*, 2012) have shown that the leaves contain as much as 10.01-38.4% crude protein and 3.10-30.46 % crude fibre with low level of antinutritional compounds.

Ruminant animals are unique in there feeding status based on the physiology theirof rumen; it is the largest muscular organ in the fore-stomach. The rumen plays a central role in the ability of ruminants to produce human edible food from resources that are otherwise not available for consumption by mankind. The rumen is characterized as the primary site for microbial fermentation of ingested feeds. The management of microbial population in the rumen is achieved by feeds and pH control. The rumen temperature and pH are critical phenomena that depend on the fermentation of ingested feeds in the rumen. The populations of rumen microorganisms are affected by several factors like quality and quantity of feed, feeding frequency and feed additives (Hungate 1966; Varga and Kolver 1997; Vercoe *et al* 2009).Therefore, adequate feeding to meeting the nutritional need of the rumen microbes plays vital role in ruminant animal nutrition.

Ahamefule (2002) reported that Forages and feedstuffs containing less than 7 % CP are poorly digested by ruminants due to insufficient nitrogen to stimulate rumen microbial functions; although the value of CP content of *Gmelina arborea* as reported by many authors are more than the minimum protein requirement adequate for microbial functions Studies have shown that *Gmelina arborea* leaf can be used as cheap protein supplements which can improve voluntary intake, digestibility and the general performance of animals fed low quality feeds (Kakengi *et al*., 2001).

Similarly, the rumen metabolites concentration viz., volatile fatty acids and different nitrogen fractions are affected by nature and quality of feed (Santra and Karim 2001; Samanta *et al.*, 2003). Mohammed and Chaury, (2008) indicated that rumen fermentation products such as volatile fatty acids are essentials nutrients to meet the demand of rumen microbes and animals body build up. This study was carried out to evaluate rumen parameters of growing West African Dwarf goats fed *Panicum maximum* (Guinea grass) supplemented with varying levels of *Gmelina arborea leaves*

2.0 MATERIALS AND METHODS

Experimental Site.

The research was carried out at Sheep and Goat unit, Ladoke Akintola University of Technology (LAUTECH) Teaching and Research farm, Ogbomosho, Nigeria.

Sample Collection and Processing Technique

Panicum maximum (Guinea grass) was obtained from already existing pasture plot at LAUTECH Teaching and Research farm and *Gmelina arborea* was obtained from within the university premises.

The test ingredients were harvested, weighed and processed as Air-dried sample

Air-dried: A fresh sample of *Gmelina arborea* leaves was obtained and spread on a drying platform in a ventilated pasture house for five (5) days to air dried. The leaves were turned occasionally to ensure even drying. The Air-dried sample was bagged until when used.

Feeding and Housing Management of Experimental Animals

Twenty West African Dwarf (WAD) Sheep were assigned into five groups of four animals each on the basis of average body weight in a completely randomized design. Each group was offered one of these five diets. The diets offered consist of Guinea grass (*Panicum maximum*) and processed *Gmelina arborea* leaves (GAL) in the following proportion:

Treatment A: 100% of *Panicum maximum*
Treatment B: 75% *Panicum maximum* + 25% Dried GAL

Treatment C: 50% *Panicum maximum* + 50% Dried GAL
Treatment D: 25% *Panicum maximum* + 75% Dried GAL
Treatment E: 100% Dried GAL

Sheep were housed individually in pens provided with feeder and drinker. Sheep were treated against external and internal parasites using ivomec injection; vaccinated against peste-de-petit ruminant (PPR). The Sheep were subjected to 4weeks acclimatization period and 2weeks adaptation period before the commencement of the feeding trial.

Chemical Analysis

The diets samples was taken, oven dried, milled, labeled and taken for dry matter, crude protein, ether extract, Ash determination according to A.O.A.C (2000) while Neutral Detergent Fibre (NDF), Acid Detergent Fibre (ADF), and Acid Detergent Lignin (ADL) analysis was determined using the procedure of Van Soest *et al.* (1991). Hemicellulose was calculated as differences between NDF and ADF while cellulose is the differences between ADF and ADL.

Antinutritional Component

Analysis was carried out to determine the presence of Tannin, Alkaloid, Saponin, Phytate, Oxalate, depicting the potential toxicity of the feed resources. The anti-nutritional factors were determined using folin ciocatteu as described by Makkar (2000), while saponin and alkaloids was determined according to A.O.A.C (2000).

Rumen Study

Rumen fluid sample (40ml) was taken at the end of feeding trial. The rumen fluid sample was collected by means of suction tube thrust into the rumen compartment. As soon as the sample was obtained, rumen fluid temperature and pH were determined within two minutes of collection by using thermometer and digital pH meter, respectively. The digital pH meter was stabilized in distilled water with specific pH recommendation before used for the reading. 20ml of the rumen fluid samples was stored in 40ml 10% formal saline prior to the direct microscopic counts of rumen bacteria. While the other 20ml sample of rumen fluid was bulked for each animal before made free of coarse particle by filtration with cheese cloth. Thereafter, 5ml sample of the filtrate was then acidified with 1ml of a 5% (v/v) orthophosporic acid solution and stored frozen in the airtight plastic bottle container for determination of volatile fatty acid concentration and its fractions. The other 15ml of the filtrate sample was added to 10% sulphuric acid solution before they were stored freeze for analysis of ammonia nitrogen concentration.

Rumen Parameters

Rumen ammonia nitrogen concentration was measured using the method of Mebrahtu and Tenaye (1997). Total volatile fatty acids production was determined by steam distillation process using

Markham micro-distillation apparatus as reported by Yusuf *et al*. (2013). Individual volatile fatty acids production was determined using gas chromatography (Mebrahtu and Tenaye, 1997).

Experimental Design and Statistical Analysis

The experimental design adopted in this study was Completely Randomized Design (CRD). Thus, data obtained from the study was subjected to one-way analysis of variance (ANOVA) and means was separated by adopting Duncan's Multiple Range test at 5% level of probability using the procedures of SAS (2000).

3.0 RESULTS

Chemical composition of *Panicum maximum* supplemented with varying level of *Gmelina arborea* leaves fed to West African Dwarf sheep

The Chemical composition of *Panicum maximum* supplemented with varying levels of *Gmelina arborea* leaves (Table 1) were significantly different ($p<0.05$) across all the diets except for Ether extract ($p>0.05$). Dry matter contents ranged between 36.50-82.50% in the study with diet A (36.50%) having the lowest ($P<0.05$) value while diet E (82.50%) had the highest. Crude protein showed that diet A (9.75%) differed significantly ($p>0.05$) from other diet and diet E (18.33%) other the other hand recorded the highest. Ash contents ranged between 12.00-16.16% with diet B (12.00%) having the lowest value while diet E (16.16%) had the highest value. Ether Extract contents ranged between 2.60-2.90%. Neutral Detergent Fibre showed 57.15% to 63.30%, diet A, B and C were similar ($P>0.005$) while Diet D and E were also similar. Acid Detergent fibre which ranged between 23.30% and 31.50%. Acid detergent lignin value was highest in diet D with the value 16.60%. The hemicellulose content varied from 27.20-36.15%, with the least value (27.20%) recorded in Treatment D while the highest value (36.15%) was recorded in Treatment B. The cellulose value ranged from 10.00% in diet E to 16.65% in diet A.

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Table 1: Chemical composition of *Panicum maximum* supplemented with varying level of *Gmelina arborea* leaves (GAL) fed to West African Dwarf sheep

PARAMETERS (%)	A	B	C	D	E	SEM
Dry matter	36.50^{e}	48.85^{d}	63.30^{c}	72.89^{b}	82.50^{a}	0.92
Crude protein	9.75^{d}	13.25^{c}	15.18^{bc}	16.60^{ab}	18.33^{a}	0.77
Ash	13.89^{b}	12.00^{c}	12.20^{c}	14.57^{b}	16.16^{a}	0.51
Ether extract	2.90	2.90	2.80	2.60	2.60	0.28
Crude fiber	35.03^{a}	27.73^{b}	26.05^{a}	25.50^{a}	21.05^{b}	0.56
NDF	62.20^{a}	63.30^{a}	61.62^{a}	57.70^{b}	57.15^{b}	1.03
ADF	31.50^{a}	27.15^{ab}	28.20^{ab}	30.50^{a}	23.30^{b}	1.41
ADL	13.85^{ab}	13.30^{b}	15.50^{ab}	16.60^{a}	13.30^{b}	0.97
Hemicellulose	31.70^{ab}	36.15^{a}	33.42^{ab}	$27.20b^{c}$	33.85^{ab}	2.13
Cellulose	16.65^{a}	13.85^{ab}	12.70^{ab}	13.90^{ab}	10.00^{b}	1.43

$^{a, b, c, d, e}$: Means on the same row with different superscripts were significantly different (P < 0.05)

SEM: standard error of mean; DM: Dry matter content; NDF: Neutral detergent fibre; ADF: acid detergent fibre; ADL: Acid detergent lignin; HEMI: Hemicellulose; CELLO: Cellulose

A: 100% *Panicum maximum*; B: 75% *Panicum maximum* + 25% Dried (GAL); C: 50% *Panicum maximum* + 50% Dried GAL D: 25% *Panicum maximum* + 75% Dried GA; E: 100% Dried GAL

Levels of Anti-nutritional factors of *Panicum maximum* supplemented with varying level of *Gmelina arborea* leaves.

The anti-nutritional content of *Panicum maximum* supplemented with varying level of *Gmelina arborea* leaves fed to West African Dwarf sheep is presented in Table 2. Significant differences (P<0.05) were observed among diet for all the parameters assessed. The tannins concentrations in the diets varied from 42.27mg/100g in diet A to 62.25mg/100g in diet E. Phytate value ranged from 53.36 mg/100g in diet A to 84.14 mg/100g in diet B. The lowest value recorded for saponin was in diet B (11.71 mg/100g) while the highest value was in diet E (20.60 mg/100g). The highest value of Oxalate was recorded in diet B (14.98 mg/100g) and the lowest value was recorded in diet E (9.17 mg/100g). Alkaloids value ranged from 3.87-7.27% with the lowest value obtained in diet E and highest value obtained in diet B. Phytate, oxalate and alkaloids decrease as inclusion of GAL increases, while Tanin and saponin increased as proportion of GAL increased.

Table 2: Levels of Anti-nutritional factors of *Panicum maximum* supplemented with varying level of *Gmelina arborea* leaves (GAL).

PARAMETER	TANNIN (mg/100g)	PHYTATE (mg/100g)	SAPONIN (mg/100g)	OXALATE (mg/100g)	ALKALOIDS (%)
A	42.27^{d}	53.36^{d}	16.65^{c}	13.39^{ab}	5.03^{c}
B	53.03^{c}	84.14^{a}	11.71^{d}	14.98^{a}	7.23^{b}
C	57.78^{b}	82.02^{a}	17.15^{c}	12.25^{b}	7.27^{b}
D	58.69^{b}	72.84^{b}	18.89^{b}	12.24^{b}	4.64^{cd}
E	62.25^{a}	63.71^{c}	20.60^{a}	9.17^{c}	3.87^{d}
SEM	0.83	1.52	0.46	0.78	0.35

$^{a, b, c, d, e}$: Means on the same row with different superscripts were significantly different (P < 0.05)

SEM: standard error of mean.

A: 100% *Panicum maximum*; B: 75% *Panicum maximum* + 25% Dried (GAL); C: 50% *Panicum maximum* + 50% Dried GAL D: 25% *Panicum maximum* + 75% Dried GA; E: 100% Dried GAL

Rumen volatile fatty acid (VFAs) parameters of West African Dwarf sheep fed *Panicum maximum* supplemented with varying levels of *Gmelina arborea* leaves

Presented in Table 3 are the rumen volatile fatty acid (VFAs), lactic acid, pH and Ammonia Nitrogen (NH_3-N) parameters of West African dwarf sheep fed *Panicum maximum* supplemented with varying levels of *Gmelina arborea* leaves. No Significant differences (P>0.05) were observed among diet for all the VFAs assessed. The molar proportion of acetic acid values observed ranged from 3.57 to 5.93% with the highest value recorded in diet B and lowest in diet E. The propionic, butyric, valeric acid, lactic acid and the rumen total volatile fatty followed the same trend as obtained in acetic acid.

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Table 3: Rumen volatile fatty acid (VFAs) of West African Dwarf sheep fed *Panicum maximum* supplemented with varying levels of *Gmelina arborea* leaves

PARAMETERS	A	B	C	D	E	SEM
Acetic acid (%)	5.21	5.93	5.60	5.09	3.57	0.70
Propionic acid (%)	4.97	5.65	5.34	4.86	3.40	0.66
Butyric acid (%)	4.75	5.40	5.10	4.64	3.25	0.63
Valeric acid (%)	4.73	5.37	5.07	4.62	3.24	0.63
Total volatile fatty acid (mmol/litre)	31.22	34.37	30.01	28.31	23.69	3.32

$^{a, b, c, d}$: means with different superscript along the same row differ significantly (p<0.05)

SEM: Standard error of mean

A: 100% *Panicum maximum*; B: 75% *Panicum maximum* + 25% Dried (GAL); C: 50% *Panicum maximum* + 50% Dried GAL D: 25% *Panicum maximum* + 75% Dried GA; E: 100% Dried GAL

Lactic acid, pH and Ammonia Nitrogen (NH_3-N) parameters of West African Dwarf sheep fed *Panicum maximum* supplemented with varying levels of *Gmelina arborea* leaves

Presented in Table 4 are Lactic acid, pH and Ammonia Nitrogen (NH_3-N) parameters of West African dwarf sheep fed *Panicum maximum* supplemented with varying levels of *Gmelina arborea* leaves. No Significant differences (P>0.05) were observed among diet for all the VFAs assessed.

The molar proportion of acetic acid values observed ranged from 4.44 to 7.37% with the highest value recorded in diet B and lowest in diet E. The pH of the rumen fluid was observed to be significant (P<0.05) and the values were 8.70, 8.59, 8.25, 7.95 and 7.86 for diets A, B, C, D and E respectively. Apparent rumen ammonia nitrogen concentration levels in sheep ranged from 0.42-0.53mg/100ml with animals on diet E (0.53mg/100ml) being the highest, diet B (0.42 mg/100ml) recorded the least.

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Table 4: Lactic acid, pH and Ammonia Nitrogen (NH_3-N) parameters of West African Dwarf sheep fed *Panicum maximum* supplemented with varying levels of *Gmelina arborea* leaves

PARAMETERS	A	B	C	D	E	SEM
Lactic acid (%)	6.48	7.37	6.97	6.34	4.44	0.87
pH	8.70^{a}	8.59^{a}	8.25^{ab}	7.86^{b}	7.95^{b}	0.15
NH_3-N (mg/100ml)	0.45	0.42	0.48	0.48	0.53	0.05

$^{a, b, c, d}$: means with different superscript along the same row differ significantly ($p<0.05$)

SEM: Standard error of mean

A: 100% *Panicum maximum*; B: 75% *Panicum maximum* + 25% Dried (GAL); C: 50% *Panicum maximum* + 50% Dried GAL D: 25% *Panicum maximum* + 75% Dried GA; E: 100% Dried GAL

4.0 DISCUSSION

The dry matter contents of the experimental diet ranged between 36.50 and 82.50%, the dry matter content recorded in diet C, D and E were relatively high but similar to 70% to 80% reported by Okoruwa (2015) suggesting the feeds can be stored for a longer period of time without spoilage. The crude protein content of a browse fodders is an indication of their nutritional quality since crude protein content is a very important index of nutritional quality of a feed (Okunade *et al.,* 2014). The crude protein value of the experimental feedstuffs ranged between 9.75% and 18.33%. Crude protein values increased with decrease ratio of GAL supplementation. The crude protein level of all the experimental diet except diet A which is slightly low exceed the 10% crude protein level recommended by Bengaky *et al*. (2007) for maximum growth in ruminant animals. The lower value of crude protein observed in diet A is in agreement with Leng (1997) who stated that roughages such as grasses contain greater quantities of structural components and therefore more fibre than other livestock feed resources. The CP contents of these browses were higher than the minimum of 7- 8% necessary to provide the minimum ammonia levels required by rumen micro-organisms to support optimum rumen activity Norton (1994). This implies that the feedstuffs are adequate to provide nitrogen requirement for rumen microbes to maximally digest the components of dietary fibre leading to the production of volatile fatty acids (Okoruwa and Igene, 2014).

The ash contents were considerably different in values, ranging from 12.00% to 16.16%. Diet E having the highest value of ash implies that the mineral content present in the diet is highest compared to the rest of the experimental diets. Also the fibre fraction level obtained in this study was within the safe upper limit of 60% reported by Oni *et al.,* (2010) for NDF (57.70%-63.30%), but relatively low in ADF

(23%-31%) and ADL (13%-16%) for guaranteed forage intake by ruminant. Meissner *et al*. (1991) observed that NDF level of forage above 65% can limit feed intake.

The result of the fibre fractions obtained in this study was also lower than the value reported by (Fasae *et al.,* 2014). The fibre fractions showed that the diets have the potentials to support intestinal movement and proper rumen function. This may imply that the fibre fractions of the diet have the potential to improve fermentation in the fore stomach of the animals (Ajagbe *et al.,* 2020). Adegbola *et al.* (1990) stated that excess fibre fractions especially NDF reduces the rate of fermentation and feed intake, but little fibre leads to rapid rumen fermentation. The hemicellulose value ranged between 27.20% and 36.15% in this study. The value was higher than the 14% - 26% reported by Okunade *et al*. (2014) who quoted Humphreys (1991) who opined that the higher the hemicellulose fraction, the higher is the feed value. The range of cellulose concentration from this study 10%-16.65% was within the 11% to 26% reported by Okunade *et al. (*2014) who opined that fodders of this range have the potentials to support intestinal movement, proper rumen function and promote dietary efficiency. Variation in nutrient composition of experimental diets might be attributed to different feed ingredients, processing methods of feed ingredients, soil condition on which the feed materials used was harvested and other factors such as climatic factors of the location etc.

Anti-Nutritive Factors are compounds which are produced by different mechanisms and affect the utilization of nutrients. These are produced by inactivation of some nutrients and through normal metabolism and affect the utilization of nutrients and digestion of feed. These anti-nutrients also play role in defense mechanism in plants by producing tannin. Levels of antinutrients reported in this study was lower compared with the study of Abegunde *et al*. (2021) whose value were below the threshold levels permissible in ruminant animals (Umar *et al.,* 2014).

A threshold concentration of 5% tannin had been reported above which there is rejection of browse plants (Ologhobo 1989). Min and Hart (2003) also reported that the action of condensed tannins in forages markedly reduced rumen proteolytics bacterial growth and some bacteolytic populations measured *in vivo*. However, ruminants are known to tolerate a threshold level of about 9% dietary tannin.

Phytates is considered as a most effective anti-nutrient in foods, and a cause of mineral ions deficiencies in animal and human nutrition. Phytate is actually the organically bounded form of phosphorus. Phytate binds with various minerals such as magnesium, calcium, zinc and iron and thus cause increase in the mineral deficiency in digestive tract of animals (Bello *et al*., 2008). The concentration of phytate in this study varied from 53.836-84.14mg/100g. The values observed in this study are similar to the values of 0.84-1.14mg/g reported elsewhere for dried *Gmelina arborea* as substitute for groundnut haulms (Okafor *et al*., 2012). The low level of phytate in the diets indicates the potential of the experimental diets to make mineral available for the animals since phytates bind minerals like Ca, Mg, Fe and Zn

(Bakare *et al*., 2019). The low phytate value recorded from this study is an indication of a good diet as reported by Abegunde *et al*. (2021) that high concentration of phytate greatly lowers the ability of intake of minerals in animals.

Saponins have been found to be detrimental to protozoa and have been identified as defaunating agents in the rumen (Newbold *et al* 1997). The saponins contents from this study ranged from 11-21mg/100g in all diet. These values were slightly similar to 9-13mg/100g reported by Abegunde *et al*. (2021). The concentration of saponin in this study is still within tolerable level of 1.5 - 2% (Onwuka, 1983). Tannins and saponins have been reported to be a critical factor in ruminant nutrition. They are important ingredients in feed for ruminants, particularly for methane mitigation strategy owing to their natural origin as opposed to chemical additives (Wanapat *et al*., 2013). Evidence from experiments have shown suggests that tannins bind to proteins, forming a tannin coating of the protein through a surface adsorption mechanism, and this can lead to precipitation of the tannin-protein complex (Dobreva *et al*., 2011). This undermines the importance of ensuring that the secondary metabolites, particularly tannin, are consistent with the threshold levels recommended for ruminant.

The value 42-62mg/100g observed from this study was lower compare the range of 60 to100g Kg DM that is considered to depress feed intake and growth (Barry and Duncan, 1984). However, in ruminants, dietary condensed tannins of 2 to 3% have been shown to have beneficial effects because they reduce the protein degradation in the rumen by the formation of a protein-tannin complex (Barry, 1987).

It was observed that ruminants can consumed certain quantity of feeds with a high level of oxalate without any deleterious effect [Oke, 1969]. The concentration of alkaloid ranges from 3-7% in all the experimental diet. Some types of alkaloids show very dangerous effects on animals. Development of fetal in sheep could be affected by alkaloids and sometime it leads to the death of fetal (Zafar *et al.*, 2015).

The values of acetic obtained in this study (3.57-5.93%) were highest for diet 2. The values were however similar to 42.03mol/100ml- 46.65mol/100ml reported by Okoruwa *et al.* (2016). Butyric acid values were higher than 8.80-12.47mol/100ml reported by Adebayo *et al.* (2017) for their study on rumen fermentation characteristics of West

The acetic acid production value recorded from this experiment was within the range of. The values was very low compared to the (42-47%) recorded by Okoruwa *et al.* (2016). There were differences in acetic acid value across all the diets. These differences observed in acetic acid values might be due to the varying level of the diets (Okoruwa *et al.,* 2016). Propionic acid has been classified as the major precursors of glycogenic fatty acid in ruminants (Vasta *et al.*, 2009). The propionic acid values recorded from this study was within the range of (3.40-5.65%). Values of propionic acid obtained were lower than 21.6mol/100ml -28.8mol/100ml reported by Suarez *et al* (2006) in their study on effects of different levels of roughage- concentrate dietary treatments on rumen fermentation characteristics of sheep. Butyric acid values were lower than 16.77mol/100ml-18mol/100ml reported by Puga *et al.* (2001) for sheep fed controlled release urea supplements. Variations in the values might be attributed to physical fibrousness, levels of starch content and carbohydrate solubility of the different dietary treatments used in different studies conducted. The highest proportion of propionic and butyric acids was recorded in diets E which revealed the better rumen fermentation of the diets by the microbial activity and good nutrient utilization to yield energy (Okoruwa *et al.*, 2016). Acetic acids obtained indicate that acetic acid predominates the volatile fatty acid production followed by propionic and butyric acid.

Volatile fatty acids contribute about 70% of the energy requirement for ruminants; hence they are classified as one of the universal end-product of anaerobic microbial fermentation of carbohydrates in the rumen and the proportion of major partials of volatile fatty acid concentration in the rumen depends largely on the type of feed consumed by the animals (Dung *et al.*, 2011). The total volatile fatty acid values of 23.69-34.37 mol/litre recorded from this experiment was lower than the 66.00-72.00 mmol/litre recorded by Okoruwa *et al.* (2016). Okoruwa (2015) reported that, if volatile fatty acids production rate exceeds the clearance rate, they will accumulate in the rumen and this may lower the rumen pH and cause metabolic disturbance known as rumen acidosis. The lactic acid values recorded from this experiment were between the range of 4.44% and 7.37%, these was lower than 5-21mol/100ml reported by Suarez *et al.* (2006). Aside from lactic acid, values acetic acids obtained indicate that acetic acid predominates the volatile fatty acid production followed by propionic and butyric acid. The difference in values obtained by different authors might be attributed to nature of the diets fed to the animals as well as the chemical composition

Rumen pH is an important factor that measure the acidity and alkalinity of rumen content in ruminants and an acceptable physiological pH for maintaining a well-balanced rumen population is between 5.8 and 6.4 (Ishler *et al.*, 1996; McDonald *et al.*, 2002). The values of rumen pH (7.86-8.70) were above the reported values (6.00-7.20 pH) suitable to facilitate optimum growth and activities of rumen microbes (Kamra, 2005; Jallow and Hsia, 2011; Petrovski, 2017). This was also higher than 5.92-6.60 reported by Okoruwa *et al.* (2016) on rumen metabolites of WAD sheep. The higher rumen pH observed in animals on the experimental diets could probably be due to less fermentable feed components that were consumed by the animals. The implication of these higher rumen fluid pH values observed was that ciliate protozoa population might established well in such rumen environment and encourage fauna and faunation in the rumen. Ranjhnan (2001) reported that diets which are very high in protein also give alkaline reaction which brings about high pH in the rumen. Factors affecting rumen pH are salivary buffer secretion, the endogenous buffering capacity of feeds or digestion and volatile fatty acid (VFA) synthesis and absorption rates (Allen, 1997).

The NH3-N levels of animals in this study were in the normal range of the optimum ammonia level for growth and microbial activity (5-25 mg/dL), according to Preston and Leng (1987). The rumen ammonia concentration levels were highest (0.53 mg/100ml) in animals on diet E. This could be a reflection of the extent of crude protein degradability and nitrogen uptake by the rumen microbes in preference to amino acid in the animals. Cabrita *et al*. (2006) stated that one of the most intriguing problems in rumen ecology is the extent to which ammonia serves as nitrogenous materials for synthesis of microbial cells. The minimum ammonia-nitrogen level of 2–5mg/100ml rumen fluid has been suggested to maximize rumen microbial synthesis, 15mg/100ml to maximize fibre digestion and 20mg/100ml to maximize intake (Yashim *et al.,* 2014). Nonetheless, the rumen ammonia levels obtained in this study were within the normal ranged of 0 to 130mg/100ml reported by Yusuf *et al*. (2013).

These findings suggested that an increase in nutrient intake, especially CP intake, of sheep fed with *P. Maximum* with varying level of GAL may provide a better environment for rumen bacterial activity. Previous studies have reported that dietary CP is important to promote nutrient digestibility and ruminal fermentation. An Increase in CP intake tends to improve apparent digestibility. Animals receiving a high CP level diet produce a significantly higher bacterial population and microbial protein synthesis in rumen fluid, thus resulting in an improved ruminal fermentation (Norrapoke *et al*., 2012; Kang *et al*., 2015; Xia *et al*., 2018).

5.0 CONCLUSION AND RECOMMENDATION

The study revealed that feeding varying level of *P. maximum* supplemented with *Gmelina arborea* leaf (GAL) to WAD sheep posed no negative effects on rumen ecology of the animals. The result of rumen parameters obtained was in harmony with optimum characteristics of the rumen ecology. Based on the results obtained in this study, supplementing the diets of growing West African Dwarf sheep with *Gmelina arborea* leaf has the potentials of meeting the nutritional needs of the animals without adverse effects on the rumen parameter.

Gmelina arborea leaf has the nutritive potential as a supplements to poor quality roughages for ruminant feeding.

Therefore, farmers can incorporate *Gmelina arborea* leaf in the diets of their sheep to help alleviate the challenge of feed availability all the year round.

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