Heamatological and Serum Biochemical Profile of West African Dwarf (Wad) Sheep Fed *Panicum Maximum* Supplemented with Varying Levels of Dried *Gmelina Arborea* Leaves

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Abstract

This experiment was conducted to evaluate heamatology and serum biochemical indices of West African Dwarf (WAD) sheep fed *Panicum maximum* (PM) supplemented with varying levels of *Gmelina arborea* leaves (GAL). Twenty-four (24) WAD sheep was allotted to six (6) dietary treatments in a Completely Randomized Design (CRD). The diets are; (A: 100%PM, B: 75% PM+25% GAL, C: 50% PM+50% GAL, D: 25%PM+75% GAL and E: 100% Wilted GAL and F:100%GAL**)** and replicated four times. The experiments lasted for a period of 105 days during which the feed intake and weight gain were taken. At the end of the feeding trial, blood samples were collected from the animals using standard procedure. All data collected was subjected to one-way analysis of variance (ANOVA) using SAS (2000). There was no significant different (*P>0.05*) in Packed cell volume (PCV), red blood cell (RBC), white blood cell (WBC), haemoglobin (HGB),mean corpuscular volume (MCV), mean corpuscular haemoglobin (MCH), mean corpuscular haemoglobin concentration (MCHC). The total protein, serum urea, alkaline phosphatase, creatinine, globulin, and serum glucose of the WAD sheep fed the experimental diets was significantly (*P<0.05*) different among the treatments means while mean serum albumin, aspartate aminotransferase and alanine aminotransferase of the animals assessed were not significantly affected (*P>0.05*). Thus, feeding of *G. arborea* had no adverse effects on heamatology and serum biochemical profile of WAD sheep.

Key words: Haematological, Biochemical, Blood profile, *Gmelina arborea* ,WAD sheep.

1.0 INTRODUCTION

Livestock enterprise especially small ruminant production is one of the most resourceful and rewardable ventures in agriculture all over the world. Their easy handling, adaptability to various climatic conditions, modest feed requirements and efficient conversion of limited feed resources among others favour their production both in small hold and large scale (Ajagbe *et al.*, 2019). West African Dwarf (WAD) sheep, a native breed of sheep reared in humid zone of Nigeria are fed with grasses and agricultural by-product which affect their grow rate, physiological response and performance (Aye, 2016) because, the intake of energy, protein and some essential minerals by these animals fall below their maintenance requirements resulting in 'under-nutrition' and low productivity in most animal production systems (Larbi and Olaloku, 2005). This effect of under-

feeding the animals in terms of nutrition requirement as a result of seasonal shortage of natural forages for ruminants in the tropics has been the major constraint of sheep production and this has led to the search for non-conventional feedstuffs that are cheap and not in high demand by humans (Ahamefule, 2002).

Browse plants have been reported to fed to sheep with an appreciable performance and they formed a good substitute for grasses during prolong drought to check the seasonal fluctuation in feed supply, resulting in an improved animal performance (Okpara *et al*., 2016). One of such browse plants is *Gmelina arborea,* which has been reported to enhance weight gain of small ruminants (Okagbare *et al.,* 2004) and better performance. *Gmelina arborea* is a fast-growing non-leguminous multipurpose tree that produces appreciable amount of forage even at the peak of dry season. It is commonly used as shade tree in houses, because of its canopy. Its trunk is used also in the paper industry. *Gmelina arborea* has been identified as one of the cheapest ways of reducing feed cost in ruminant production in tropic because, its leaves are relished by small ruminant animals especially sheep. It has been reported to remain green to larger part of dry season and has been fed to ruminants with appreciable results and also, researches (Ahamefule, *et al.*, 2006; Okafor, *et al.*, 2012) has proved that its leaves can be used as cheap protein supplements which can improve voluntary intake, digestibility and the general performance of animals fed low quality feeds (Okagbare *et al*.,2004).

Blood tests via haematology and serum biochemistry can be used to assess the health status and the state of organs of farm animals. It has been noted that blood sampling is frequently employed in nutritional studies (Ajagbe *et al*., 2019), heamatology and serum biochemical values have been considered useful for evaluation of body condition, nutrition and immune status in the animals where other tissue related measurement are not available (Anurudu and Ewuola, 2010). As the quest for unconventional and cheap sources of feedstuffs for livestock continues, it becomes imperative to always investigate the health and physiological implications of such materials on the animals. As reported by Isaac *et al.* (2013), animals with good blood composition are likely to show good performance.

This study is therefore designed to determine the heamatology and serum biochemical indices of West Africa Dwarf (WAD) sheep fed *Panicum maximum* (PM) supplemented with varying levels of *Gmelina arborea* leaves (GAL).

2.0 MATERIALS AND METTHOD

Experimental site

The study was carried out at sheep and goat unit, Ladoke Akintola University of Technology (LAUTECH) Teaching and Research Farm Ogbomoso, it lies on $8^{0}10^{1}$ North of the equator and longitude $4^{0}10^{1}$ East of the Greenwich Meridian within the derived savannah region of Nigeria.

The altitude is between 300m and 600m above sea level while the mean temperature and rainfall are 27°C and 1247mm respectively (Ayinla and Adetoye, 2015).

Collection of test ingredient

Panicum maximum (PM) was gotten from already existing paddock at LAUTECH Teaching and Research Farm. *Gmelina arborea* leaves (GAL) was harvested within the university campus premises. The harvested leaves were separated from the stalk and processed as air dried. The leaves were spread on a drying platform and kept in a well-ventilated pasture house, it was occasionally turned to ensure even drying for 5 days. The leaves were packed after 5^{th} day and bagged until use.

Experimental diets

Five (5) experimental diets were formulated as follows, A: (100% *Panicum maximum*) which also served as control experiment, B: (75% *Panicum maximum* + 25% *Gmelina arborea* leaves), C: (50% *Panicum maximum* + 50% *Gmelina arborea* leaves), D: (25% *Panicum maximum* + 75% *Gmelina arborea* leaves) and E: (100% *Gmelina arborea* leaves).

Experimental animals and management

Twenty-four (24) clinically healthy yearling WAD rams was purchased in the local markets around Ogbomosho Nigeria. They were stratified by BW, such that the animals in each treatment group had similar average initial BW, and randomly allocated to one of three experimental treatment groups (n = 4). Two weeks prior to the procurement of the experimental rams, the pens and the surrounding environment were thoroughly cleaned and disinfected with anti-septic (Morigad). The rams were given prophylactic treatment consisting of intramuscular injection of antibiotics (oxytetracycline LA) at the rate of 1 ml/10 kg BW, dewormed with levamisole at the dosage of 1 ml/10 kg BW and dipped against ectoparasite with diazintol. They were kept in open well- ventilated pens; The animals were housed in individual pen made of concrete floor and cover with wood shavings to prevent the animals from coming in contact with their feaces. Feed was given once daily *ad libitum* at 09:00 h. The feeding trial lasted for 12 weeks including two weeks adjustment period after which blood samples were collected for haematological and biochemical analysis.

Blood sample collection

On the last day of the experimental feeding trial period, Blood samples were collected in two sets from the four rams in each treatment via jugular venipuncture using a 5m1 syringe. 5 ml blood sample was collected into labelled sterile universal bottles containing 1.0 mg/ml ethylenediamine tetraacetic acid (EDTA) as anticoagulant for the determination of haematological parameters. Another 5ml was blood samples for serum analysis were collected into anticoagulant free bottles, allowed to coagulate at room temperature and centrifuged at 1500 x g for 10 minutes. The supernatant sera were then collected and stored in a freezer

for subsequent biochemical analysis. Serum biochemical analysis such as determination of total protein, albumin, triglyceride, urea and creatinine were done using the methods according to (Opara *et al.,* 2010). Globulin was calculated as the difference between total protein and albumin.

Chemical Analysis

Samples of experimental diets were weighed and oven dried at 105 °C for 24 hours. The dried samples were weighed and ground to pass through a 2mm sieve and subjected to proximate analysis (CP, CF, EE and ASH) using the outline of A. O. A. C, (2005). Fiber components of the diets; neutral detergent fiber (NDE), acid detergent fiber (ADF) and acid detergent lignin (ADL) was determined according to (Van Soest *et al.* 1991). Cellulose was calculated from the difference between ADF and ADL while hemicellulose was calculated from difference between NDF and ADF.

Tannins were determined by the methods of Makkar (2003). The Spectrophotometric method (Brunner, 1984) was used for saponin analysis. While Oxalate and Phytate contents was determined as described by (Oke, 1969) and (Maga, 1983) respectively. Alkaloids and flavoids was determined according to A. O. A. C. (2005)

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Experimental Design and Statistical Analysis

The experimental design adopted in this study was Completely Randomized Design (CRD). Thus, data collected was subjected to one-way analysis of variance (ANOVA) using SAS (2002). Significant differences among means was separated using the Duncan's Multiple Range Test (5% probability) of the same package.

3.0 RESULTS

Chemical composition of *Panicum maximum* supplemented with varying levels of *Gmelina arborea* leaves

Present in Table 1 are the chemical composition of *Panicum maximum* supplemented with varying level of GAL, all the parameters assessed in the study are significantly different ($P < 0.05$) except ether extract. Dry matter values ranged between 36.50% in Treatment A and 82.50% in Treatment E. The crude protein values ranged between (9.75-18.33%) with treatment E (18.33%) recorded the highest while the lowest value was recorded in A (9.75%), the ash contents was highest ($P < 0.05$) in treatment E (16.16%) and lowest in B (12.00%). Neutral detergent fiber was highest ($P < 0.05$) in treatment B (63.30%) and lowest in E (57.15%), acid detergent fiber was ranged between (23.30-63.30%), while acid detergent lignin was recorded the lowest value in treatment B (13.30%) which is similar to E (13.30%) and highest in C (16.60%).

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

PARAMETRS (%)	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
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 Means with significant superscript on the same row differ significantly (P<0.05). SEM: Standard error of mean, NDF: Neutral detergent fiber; ADF: Acid detergent fiber; ADL: Acid detergent lignin.
A:100% PM, B:75%PM+25%GAL, C:50%PM+50%GAL, D:25%PM+75%GAL and E:100% GAL. PM: *Panicum maximum*, GAL: *Gmelina arborea* leaf.

Levels of anti-nutritional component of *Panicum maximum* supplemented with varying level of *Gmelina arborea*

The level of anti-nutritional components of experimental diets are presented in the table 2. There was significant different ($P < 0.05$) in the mean values of tannin ranging between 42.27mg/100g in treatment A and 62.25mg/100g in treatment E, saponin also shows significant different across the treatments and range between 11.71mg/100g and 20.60mg/100g in both treatment D and E respectively. Oxalate and alkaloids were significant different ($P < 0.05$) and ranged between (9.17-14.98mg/100g) and (3.87-7.27%) respectively.

Table 2: Levels of anti-nutritional component of *Panicum maximum* supplemented with varying level of *Gmelina arborea*

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

a,b,c Means with significant superscript on the same column differ significantly (P<0.05). SEM: Standard error of mean.
A:100% PM, B:75%PM+25%GAL, C:50%PM+50%GAL, D:25%PM+75%GAL and E:100% GAL. PM: *Panicum* maximum, GAL: *Gmelina arborea* leaf.

Heamatological indices of West African Dwarf Sheep (WAD) fed *Panicum maximum* supplemented with varying levels of *Gmelina arborea* leaves

The heamatological profile of sheep fed *Panicum maximum* with varying level *Gmelina arborea* was presented in Table 3. There was significant different (*P>0.05*) in haemoglobin (Hb), red blood cell (RBC), white blood cell (WBC), mean corpuscular volume (MCV), mean corpuscular heamoglobin (MCH), mean corpuscular heamoglobin concentration (MCHC), packed cell volume (PCV),. The PCV, RBC counts, WBC counts and the Hb concentration ranged between (24.10-33.70%), (2.76-3.8 x10^6/ul), (12.30-37.20x10^3/ul) and (8.50-9.70g/dl) respectively. Mean corpuscular volume (MCV) range from 41.45-43.50fl to 43.450fl. Mean corpuscular heamoglobin (MCH) content ranged between 24.75pg in animals fed treatment B and in those on treatment C (35.5pg). Mean corpuscular heamoglobin concentration (MCHC) recorded the highest value of 81.65% in animals fed treatment C and lowest in animals fed treatment B (56.95%).

Table 3: Heamatological indices of West African Dwarf Sheep fed with *Panicum maximum* with varying level *Gmelina arborea*

Parameter	A	B	C	D	E	SEM	Range **
PCV (%)	24.10	25.60	27.90	32.40	33.70	1.54	27-45
RBC (x10^6/ul)	3.23^{ab}	3.86^{a}	2.76^{b}	2.99^{ab}	3.65^{ab}	0.36	9-15
WBC (x10^3/ul)	12.3^{b}	16.78^{b}	22.4^{ab}	36.55^{a}	37.20^{a}	4.67	4-12
Hb (g/dl)	8.50	8.50	9.25	9.60	9.70	0.49	9-15
MCV (fl)	42.6^{bc}	43.5^{ab}	43.5^{ab}	41.45^{c}	44.35^{a}	0.64	28-40
MCH (pg)	26.15^{b}	24.75b	35.5^{a}	28.8^{b}	27.30^{b}	1.99	8-12
MCHC (%)	60.6^{b}	56.95^{b}	81.65^{a}	67.00^{b}	61.80^{b}	4.35	31-34

a,b,c means with significant superscript on the same row differ significantly (p<0.5).
SEM: Standard error of mean, PCV: packed cell volume; RBC: Red Blood Cell; WBC: White Blood Cell; HGB: Haemoglobin; MCH: Mean Corpuscular Haemoglobin; MCV: Mean Corpuscular Volume; A: 100% PM, B:75%PM+25%GAL, C:50%PM+50%GAL, D:25%PM+75%GAL and E:100% GAL. PM: *Panicum* maximum, GAL: *Gmelina arborea* leaf.
Source: * Radostits *et al.*, 2000.

Serum biochemistry of West African dwarf sheep fed *Panicum maximum* supplemented with varying levels of *Gmelina arborea* leaves

The serum Biochemistry of West African Dwarf Sheep fed *Panicum maximum* supplemented with varying levels of *Gmelina arborea* leaves are presented in Table 4. The total protein of the WAD sheep fed the experimental diets was significantly (*P < 0.05*) different among the

treatments means. The lowest serum protein values obtained in animals fed diets B(7.25g/dL) and E (7.32g/dL) while those on diet A(8.43g/dL) was significantly ($P < 0.05$) the highest between the dietary treatments and similar to those on diets C and D. The mean serum albumin, ASTand ALT of the animals assessed in this study, were not significantly influenced by the dietary treatments. However, serum urea, ALP, Creatinine and Serum glucose were significantly ($P < 0.05$) affected. The mean serum urea of animals fed diet E (34.10mg/dL) was significantly ($P < 0.05$) highest across the treatments and similar to those on diets A, C and D, the lowest serum urea value was obtained in animals on diet B (21.69mg/dL). The mean serum glucose of animals fed diets B, E, A and D were similar and significantly ($P < 0.05$) higher than animals fed diet C (88.36mg/dL). Alkaline phosphatase was significant ($P<0.05$), such that it was highest in diet C (26.95 iu/L) and lowest in diet E (18.69 iu/L).

Table 4: Serum biochemical indices of West African Dwarf sheep fed *Panicum maximum* supplemented with varying levels of *Gmelina arborea* leaves

PARAMETERS	A	B	C	D	E	SEM	Range*
T. protein (g/dL)	7.32^{b}	7.25^{b}	7.77^{ab}	8.11^{a}	8.43^{a}	0.22	6.0-7.9
Serum Gl.(mg/dL)	107.88^{ab}	123.29^{a}	88.36^{ab}	101.71^{ab}	112.33^{ab}	13.49	50-80
Urea (mg/dL)	32.18^{a}	21.69^{ab}	29.15^{ab}	27.84^{ab}	34.10^{a}	5.07	0-35
Albumin (g/dL)	3.13	3.81	3.47	3.89	3.8	0.24	2.4-30
Creatinine(mg/dL)	0.88^{b}	1.63^{a}	1.08^{b}	0.90^{b}	0.58^{b}	0.18	1.2-1.9
Alkaline P (iu/L)	26.18^{a}	26.31^{a}	26.95^{a}	19.88^{bc}	18.69^{c}	1.38	70-390
AST (iu/L)	59.5	62.83	66.94	54.77	48.52	5.87	60-280
ALT (iu/L)	14.69	20.41	16.04	17.72	13.01	2.37	22-38

a,b,c Means with significant superscript on the same row differ significantly (P<0.05). SEM: Standard error of mean, ALT: Alanine aminotransferase, AST: Aspartate aminotransferase, ALP: Alkaline phosphatase, Bi: Bilirubin.

A:100% PM, B:75%PM+25%GAL, C:50%PM+50%GAL, D:25%PM+75%GAL and E:100% GAL. PM: *Panicum* maximum, GAL: *Gmelina arborea* leaf. Source: * Radostits *et al.*, 2000.

4.0 DISCUSSION

Chemical composition of *Panicum maximum* supplemented with varying level of GAL, showed significant different ($P < 0.05$) except ether extract (Table 1). Dry matter (DM) content of dried GAL containing diets (B, C, D and E) were higher compared to the control diet A and tends to increase by increasing levels of dried GAL. However, the dry matter values reported in the present study is lower than 84.35% and 71.57% reported by Aye, (2016) for *Panicum maximum* and *Gmelina arborea* multi-nutrients block respectively and 90.95-93.29% reported for the same leaf by Jiwuba *et al.* (2016). The differences in the values obtained in this study and those of other researchers might be due to the stage of harvest of the crops, the amount of edible part and

the geographical location, processing methods (such as; wilting, air drying) and the length of storage (Aye, 2016). Crude protein was highest for the 100% level (Treatment E) of GAL (18.33%) and least for the 0% level of inclusion. These imply that increasing the inclusion level of *Gmelina arborea* leaves increases the crude protein of the diet. This agrees with the work reports of Okagbare *et al.* (2004) and Njidda (2011) that browse forage species have moderate to high crude protein content which remains all year round. The crude protein percentage recorded in this study fell within the range of 16.09-18.92% which is well above the values of 10.25 and 13.73% reported by Abdu *et al.* (2012) and Okafor *et al.* (2012), respectively for sheep and goat production .The CP contents of all the dietary treatments is higher than the recommended 8% value for normal functioning of rumen micro-organisms and the range of 11.0 – 13.05% known to be capable of supplying adequate protein for maintenance and moderate growth in goats (NRC, 2002).

Ether extract content reported in this study (2.60-2.90%) was higher when compared to the EE content of 1.62% reported by Lamidi and Ogunkunle (2015) but lower than 3.50-5.15% reported by Aye and Tawose (2016), and 4.73-13.77% reported by Okpara *et al.* (2016).The percentage ash (12.00-16.16%) was higher than 6.0% reported for GAL by Augustine *et al.* (2018) but comparable with 13.26% and 11.20% reported for both the *Panicum maximum* and GAL by Aye (2016).

The neutral detergent fiber also varied from 56.05-63.30% across the treatments. These values are within the recommend limit of 60.00% guaranteed for forage intake by ruminants (Meissner *et al.,* 1991). Acid detergent fiber range between 23.30% and 31.50%, this value is in line with 31.48% reported for fresh GAL from the report of Okpara *et al.* (2016) while the acid detergent lignin obtained ranged between 13.30% and 16.60% which is in line with the report of Augustine *et al.* (2018).

The level of anti-nutritional components of experimental diets showed the level of tannin, oxalate, saponin and alkaloids ranged from (42.27-62.25mg/100g), (9.17-14.98mg/100g), (9.28-20.60ng/100g) and (3.87-9.36%) respectively. This finding is in line with the report of Amata (2012) who observed similar anti-nutritional factors in ripe Gmelina fruit. These toxic factors may be harmful to livestock when consumed beyond certain thresh hold and in addition may limit nutrient utilization and consequently affect animal performance (Augustine *et al.*, 2018). Tannins are plants anti-nutrient that have the ability to form complexes with metal ions and with macro-molecules such as proteins and polysaccharides in the rumen and remain indigestible due to high pH and invariably dissociates in the abomasum at a lower pH for proper digestion (Barry and McNabb, 1999), the values obtained in this study is lower than 1.20g/100g reported for *Gmelina arborea* leaves by (Augustine *et al.*, 2018). Saponin will suppress methanogenesis which is major energy loss and oxalate can form complexes with most essential trace elements, thereby making them unavailable for enzymatic activities and other metabolic processes

(Eneobong, 2001), the result of both saponin and oxalate are lower than the values obtained by (Augustine *et al.*, 2018). The alkaloids contents of this study is comparable to those of some medicinal plants (Soetan and Oyewale, 2009), except in treatment E (100% GAL) which maybe as a results of drying on the treatments, its presence indicated that the treatments are adequate for the animals as alkaloids possessed significant pharmacological properties.

Haematological components are valuable in monitoring feed toxicity especially with feed constituents that affect the blood as well as the health status of farm animals. Mean PCV was highest in treatment E and lowest in the control diet. The values obtained were but comparable to 22 – 38% given by Krammer (2000) and within the normal range for healthy sheep (Njidda *et al*., 2014), a sign that the experimental diet promote animals' healthy conditions. The higher PCV values in the rams fed higher percentage of GAL in this study is an indication of a better nutritional status of the diets

Defense of the body against invasion by pathogens and foreign bodies are the major functions of WBC therefore animals with very low white blood cell are usually exposed to higher risk of disease and infection, but those with normal WBC counts are capable of generating antibodies in the process of phagocytisis and more capable of fighting diseases, which further enhances adaptability to local environment (Isaac *et al* 2013). White Blood Cell count is also associated with microbial infection or the presence of foreign body or antigen in the circulating medium (Ahamefule *et al.*, 2005). White blood cells (WBC) ranged from 12.30 $x10^3$/ul T1 to 37.20 x103/uL in T5. WBC of animals from Treatment C, D and E were above normal range of 4-13×10^3/µl reported by Radostitis *et al.* (2000) for clinically healthy sheep. High WBC count is usually associated with microbial infection or the presence of foreign body or antigen in the circulating system.

Red blood Cells (RBC) was also significantly ($P<0.05$) affected by diets. Observed RBC values (2.76 – 3.86×10^6/µl) were within the range of (2.39-3.51×10^6/µl) reported by Amuda and Okunlola *et al.* (2018) and (2.40-.20×10^6/µl) reported by Sowande *et al.* (2008). The hemoglobin concentration ranged between 8.50-9.70g/dl and were within the normal physiological range of 8 - 16 g/dL for sheep (RAR 2009) indicating that the ram had sufficient blood pigment for proper transportation of oxygen, thus healthy living.

The mean corpuscular volume (MCV) ranged from 41.45-to 43.450fl and are within 23-48 fl reported by RAR (2009) but higher than 25fl and 31fl reported for WAD sheep under extensive and intensive managements system (Olayemi *et al.*, 2000). The mean corpuscular haemoglobin (MCH) values of animals ranged from 24.75- 35.50 pg and were above normal range (8-12pg) reported by RAR (2009). Mean corpuscular haemoglobin concentration (MCHC) values ranged between 60.6 - 81.65 % and were higher than the normal reference range of 31 -38g/dl reported

by RAR. (2009) for healthy sheep. The values obtained in this study for both MCH and MCHC is lowered than the reported of Olayemi *et al.,* (2000).

The lowest serum protein values were obtained in animals fed diets B (7.25g/dL) and A (7.32g/dL) while animals fed diet E (8.43g/dL) was significantly ($P < 0.05$) the highest between the dietary treatments and similar to the diets C and D. The value range of 7.25-8.43g/dL obtained in this study fall within the range of 6–7.9 g/dL recommended by (Radostits *et al.,* 2000; Merck, 2012) for normal healthy sheep; and 9.40±0.023 g/dL reported for ouda rams by Njidda *et al.* (2014). The result suggests that there was no muscle wastage in the sheep and that the animals did not survive at the expense of body reserves since protein synthesis is related to the amount of dietary protein (Jiwuba *et al.,* 2016). This entails better utilization of the dietary proteins by the animals within each treatment thereby facilitating total protein availability.

The serum Glucose is one of the metabolites measured as an indicator of the energy status of the animal. When glucose is lower than the normal range, is an indicator of hypoglycemia while higher levels are indicator of hyperglycemia (Olorunnisomo *et al.,* 2012). The increase in the glucose concentration is probably a reflection of the energy status of the diets which obviously would increase with increasing concentration proportion in the diets. Serum glucose fell within the range 70.89 and 123.29mg/dL. The levels obtained across the dietary treatments suggest that feed was adequate in energy supply for the animals. A high level of serum urea has been attributed to excessive tissues protein catabolism associated with protein deficiency. The values of serum urea in this study fall within the range of 10-35 mg/dL reported by Radostits *et al.* (2000).

Serum albumin level in this study (3.13-3.89 g/dL) were higher than 2.4-3.0g/dL reported for healthy sheep by (Radostits *et al.,* 2000). The creatinine values (0.58-1.63mg/dL) in this study were within the value (1.1-1.9 mg/dl) reported by Abdul and Daniel (2013) on Yankassa ram. It was observed from this study that the creatinine value decreases with inclusion of GAL and the diets with sole GAL having the lowest values.

Alkaline phosphatase was significantly different ($P < 0.05$) across the treatments, the low values (18.69 -26.31 iu/L)obtained in this study is in contrast to 30.73-79.18iu/L recorded by Ikhimioya and Imasuen, (2007) and 63.2iu/L reported by (Opara *et al.,* 2010).The serum alanine phosphatase (ALP) concentration in all the rams fell within that reported by Binuomote and Babayemi (2017) for sheep. The comparative values of alkaline phosphatase was reported to be influenced by pregnancy, disease and blood pH. Animal's age also have been reported to affect the value of alkaline phosphatase (Opara, *et al.,* 2010). The animals in this study were apparently healthy, not diseased, nor pregnant as they are males and also yearling animals of approximately the same age.

Serum transaminase, aspartate aminotransferase (AST) and alanine aminotransferase (ALT) are fluid found in the serum and their level in the serum are reliable test for liver damage. Values obtained for both AST and ALT were not significant different (*P>0.05*) across the treatments. The values obtained for Aspartate aminotransferase was lower than 82.67-128.33iu/L reported for sheep fed Moringa leaf meal supplement by Sanwo *et al.* (2015) and 66-230 iu/L reported by Merck (2012). Alanine aminotransferase across the treatments fall within the value of 14.33-20.33iu/L reported by Sanwo *et al.*(2015) but lower in value compare to the recommendation of (Radostits *et al.,* 2000) for healthy sheep.

CONCLUSION

The haematological and biochemical levels in the study were within recommendation. This implies that *Panicum maximum* supplemented with varying levels of GAL were not harmful and posed no health challenges to the animals. This implies that *Panicum maximum* supplemented with varying levels of GAL supplied nutrients needed by the animals therefore, GAL should be used as supplement during the extended dry season so as to overcome dry season weight losses or poor performances.

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