

Haematology and serum biochemical indices of West African dwarf sheep fed five selected plants

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Abstract

Blood profile of West African dwarf sheep was investigated. Five selected forages *Mangifera indica*, *Anacardium occidentale*, *Gmelina aborea*, *Gliricidia sepium* and *Panicum maximum* the basal diet were used for the study. Twenty West African Dwarf (WAD) male sheep of an average weight of 13.08kg and standard deviation value of 0.88 were subjected to five dietary treatments with four animals per treatment in a completely randomized design in a study that lasted for 84 days. Animals fed *P. maximum* + *Gmelina aborea* recorded significant ($p < 0.05$) highest value of PCV (32.50%) followed by animals fed *P. maximum* + *Anacardium occidentale* (32.00%) while the least PCV value (21.00%) was observed in animal fed *P. maximum* + *Gliricidia sepium*. Haemoglobin concentration value was least (6.80g/dl) in animals fed *P. maximum* + *Gliricidia sepium* while the highest ($P < 0.05$) value was recorded in animals fed *P. maximum* + *Anacardium occidentale*. Animals fed *P. maximum* + *Gmelina aborea* recorded highest ($P < 0.05$) RBC value of 13.32×10^{12} /L. Animals fed *P. maximum* + *Mangifera indica* and *P. maximum* + *Gmelina aborea* both had the lowest significant ($p < 0.05$) value of total protein (6.65 mg/dL) while the highest significant ($p < 0.05$) value was observed in animals fed *P. maximum* + *Anacardium occidentale* (7.45 mg/dL). Animals fed *P. maximum* + *Anacardium occidentale* had significant highest value of glucose (67.50 g/dL) while glucose was reduced in animals fed *P. maximum* + *Gliricidia sepium*. Significant ($P < 0.05$) highest weight gain (4.33kg) was observed in sheep fed *P. maximum* + *Anacardium occidentale* while the least value of 2.23 kg was recorded in sheep fed *P. maximum* only. The study concluded that the selected forages can be used to feed ruminants with no deleterious effects on sheep.

Keywords: White blood cell, Red blood cell, Pack cell volume, Forages, Shee

Paramètres hématologiques et indices biochimiques sériques chez des moutons nains d'Afrique de l'Ouest nourris avec cinq plantes sélectionnées.



Résumé

Le profil sanguin de moutons nains d'Afrique de l'Ouest a été étudié. Cinq fourrages sélectionnés (*Mangifera indica*, *Anacardium occidentale*, *Gmelina aborea*, *Gliricidia sepium* et *Panicum maximum*) ont été utilisés en complément du régime de base dans le cadre de cette étude. Vingt moutons mâles nains d'Afrique de l'Ouest (WAD), d'un poids moyen de 13,08 kg et d'un écart-type de 0,88, ont été soumis à cinq traitements alimentaires, à raison de quatre animaux par traitement, selon un plan d'expérimentation complètement aléatoire, dans le cadre d'une étude qui a duré 84 jours. Les animaux nourris avec *P. maximum* + *Gmelina aborea* ont présenté la valeur la plus élevée et significative ($P < 0,05$) du PCV (32,50 %), suivis par ceux nourris avec *P. maximum* + *Anacardium occidentale* (32,00 %), tandis que la valeur la plus faible du PCV (21,00 %) a été observée chez les animaux nourris avec *P. maximum* + *Gliricidia sepium*. La concentration en hémoglobine était la plus faible (6,80 g/dl) chez les animaux nourris avec *P. maximum* + *Gliricidia sepium*, tandis que la valeur la plus élevée ($P < 0,05$) a été enregistrée chez les animaux nourris avec *P. maximum* + *Anacardium occidentale*. Les animaux nourris avec *P. maximum* + *Gmelina aborea* ont présenté le nombre de globules rouges le plus élevé ($P < 0,05$), soit $13,32 \times 10^{12}$ /l. Les animaux nourris avec *P. maximum* + *Mangifera indica* et *P. maximum* + *Gmelina aborea* présentaient tous deux la valeur la plus faible et significative ($p < 0,05$) de protéines totales (6,65 mg/dL), tandis que la valeur la plus élevée et significative ($p < 0,05$) a été observée chez les animaux nourris avec *P. maximum* + *Anacardium occidentale* (7,45 mg/dL). Les animaux nourris avec *P. maximum* + *Anacardium occidentale* présentaient la valeur la plus élevée et statistiquement significative de glucose (67,50 g/dL), tandis que le taux de glucose était réduit chez les animaux nourris avec *P.*

*maximum + Gliricidia sepium. Le gain de poids le plus élevé (4,33 kg), significatif ($P < 0,05$), a été observé chez les moutons nourris avec *P. maximum* + *Anacardium occidentale*, tandis que la valeur la plus faible, soit 2,23 kg, a été enregistrée chez les moutons nourris uniquement avec *P. maximum*. L'étude a conclu que les fourrages sélectionnés peuvent être utilisés pour nourrir les ruminants sans effets néfastes sur les moutons.*

Mots-clés : globules blancs, globules rouges, hématoците, fourrages, moutons

Introduction

Improved nutritional strategy is a key factor to improve the productive capacity of livestock animals. Adequate nutrition is one of the ways to enhance the productivity of WAD sheep (Yusuf *et al.*, 2010). West African Dwarf (WAD) Sheep is a predominantly indigenous breed found in southern Nigeria (Odeyinka, 2000). Small ruminants suffer scarcity of feeds supply and pasture quality in the humid region of West Africa, especially during the dry seasons when the natural vegetable is of poor nutritive value (Aye, 2007).

Blood plays an intensive role in the body of animals. It is an important index of physiological and pathological changes in animals and has been used in assessing the body's ability to respond to nutritional challenges. It has been noted that blood sampling for the assay of biochemical constituents and hematological traits is frequently employed in nutritional studies. Blood parameters are thought to be important indicators of a farm animal's physiological stage, demonstrating the link between diet and health (Jiwuba *et al.*, 2016). Blood is specialized body fluids in animals that delivers necessary substance such as nutrients and oxygen to the cells and transport metabolic waste products away from those same cells. In vertebrates, it is composed of blood cells suspended in a liquid called blood plasma. Plasma, which constitutes 55% of blood fluids, is mostly water (92% by volume) (Franklin Institute, 2009) and contains dissipated proteins, glucose, mineral ions, hormones, carbon-dioxide (Plasma being the main medium for excretory products transportation) and blood cells themselves. Blood performs many important functions within the body including: supply of oxygen to tissues (bound to hemoglobin, which is carried in red blood cells, supply nutrients such as glucose, amino acids and fatty acids (dissolved

in the blood or bound to plasma proteins e.g., blood lipids), removal of waste such as carbon dioxide, Urea and lactic acid, hydraulic functions and regulation of core body temperature (Franklin Institute, 2009).

It has reported that serum biochemical constituents are positively correlated with the quality of the diets (Adeyemi *et al.*, 2000). Hence, it is important to research on the status of blood profile of West African Dwarf Sheep fed five selected browse plants.

Materials and Methods

Experimental site

The experiment was carried out at the Teaching and Research Farm of Yaba College of Technology, Odorangunshi, Epe, campus, Lagos state, Nigeria. The farm is situated along Epe-Ijebu ode road on latitude 6.58°N, longitude 3.98°E. It lies in the low land rain forest vegetation zone within the Savannah agro ecological zones with altitude at 42m above the sea level. The average rainfall of 1694mm and temperature of 27.1°C exist during the experimental period (Google Earth, 2025).

Experimental feed materials and resources

The leaves of *Panicum maximum* (Guinea grass), *Mangifera indica* (Mango), *Anacardium occidentale* (Cashew), *Gmelina arborea* (Gmelina) and *Gliricidia sepium* (Gliricidia) were sourced for around the premises of the campus (Yaba College of Technology, School of Agriculture Odorangunshin, Epe campus) Lagos state. Fresh, succulent, tender leaves were harvested to ensure lower lignin content and higher nutrients content availability. Four diets T₁, T₂, T₃, and T₄ were formulated such that 40% each of *Mangifera indica* (Mango), *Anacardium Occidental* (Cashew), *Gmelina arborea* (Gmelina) *Gliricidia sepium* (Gliricidia) were used with *Panicum maximum* as basal diets.

Procurement of Animals

Sheep was gotten from a reputable farm within Epe and Ijebu ode axis; they were allowed to

acclimatize for a period of two weeks (14 days) before the commencement of the experiment. Twenty male sheep with an average weight of 13.08kg were bought and four sheep were allocated to each treatment.

Experimental feed materials and sources

The five forage plants selected were harvested around the premises of the campus (Yaba

College of Technology, School of Agriculture Odoragunshin, Epe campus, Lagos State) and fed fresh to the animals as supplement to grass at 5% body weight. *Panicum maximum* is the basal plant while the others are 40% replacement as shown below:

Table 1: Diet Composition

Sample	Composition
Diet I (Control)	<i>Panicum maximum</i> only (100%)
Diet II	<i>Mangifera indica</i> (40%) and <i>Panicum maximum</i> (60%)
Diet III	<i>Anacardium occidentale</i> (40%) and <i>Panicum maximum</i> (60%)
Diet IV	<i>Gmelina arborea</i> (40%) and <i>Panicum maximum</i> (60%)
Diet V	<i>Gmelina arborea</i> (40%) and <i>Panicum maximum</i> (60%)

Feeding and management of animals

Twenty growing West African dwarf sheep of an average weight of 13.08kg were randomly assigned to five dietary treatments having four replicates per diet in a completely randomized design. The pens were thoroughly washed and disinfected. Animals were de-wormed with Albendazole® 2.5% oral suspension (Anthelmintic) at 1ml/10kg body weight and treated against ectoparasites with Cypermethrin® Pour-on at 1ml/10 kg body weight before allotting them to individual pens. Weights of the animals were taken before the commencement of the experiment and thereafter weekly to monitor weight changes during the trial. A known quantity (40%) of selected forage plants with (60%) *Panicum maximum* were offered to the animals while (100%) *Panicum maximum* only were served to the control animals. Clean water was offered daily *ad libitum*. After two weeks adaptation period had been observed, leftover feed were weighed and discarded every morning. Voluntary feed intake was determined as the difference between feed offered and feed refused. The period of the experiment lasted for 84 days (12 weeks).

Hematological and serum indices

Blood sample were collected from the individual sheep at the end of the experiment. 5ml of blood samples were collected from each animal before

morning feeding via the jugular vein by using hypodermic syringe. Half of the blood collected from each animal was dropped in a well labeled bottle containing EDTA (Ethylene Diamine Tetra acetate) for the determination of packed cell volume (PCV), hemoglobin concentration (HB), red blood cell (RBC), and white blood cell (WBC), etc. The remaining half were emptied into a bottle containing no anti-coagulant for determination of total protein, glucose etc.

Serum Glutamate Oxaloacetate Transaminase and serum Glutamate Pyruvate Transaminase were determined using enzymes calorimetric method as described by Schmidt (1963).

Statistical analysis

All data collected was subjected to one-way Analysis of Variance (ANOVA) while significant differences among means were compared using Duncan's Multiple Range Test (SAS, 2005).

Statistical model

$$Y_{ij} = \mu + T_i + \epsilon_{ij}$$

Where: Y_{ij} = observation from animal j receiving diet i

μ = population mean

T_i = mean effect of selected browse plants

ϵ_{ij} =Residual error

Results

Haematological parameters of WAD sheep fed selected browse plants

Effect of different selected forages on the haematological parameters of WAD sheep are presented in Table 2. Significant variations ($P < 0.05$) were observed in PCV, Hb, RBC, neutrophil, monocyte and lymphocyte whereas diets had no significant ($P > 0.05$) variation on WBC. Animals fed *P. maximum* + *Gmelina aborea* recorded significant ($P < 0.05$) highest value of PCV (32.50%) followed by animals fed *P. maximum* + *Anacardium occidentale* (32.00%) while the least PCV value (21.00%) was observed in animal fed *P. maximum* + *Gliricidia sepium*. Haemoglobin concentration value was least (6.80g/dl) in animals fed *P. maximum* + *Gliricidia sepium* while the highest ($P < 0.05$) value was recorded in animals fed *P. maximum* + *Anacardium occidentale*. Diet had significant ($P < 0.05$) influence on the RBC;

animals fed *P. maximum* + *Gmelina aborea* recorded highest ($P < 0.05$) RBC value of $13.32 \times 10^{12} /l$. The WBC was drastically reduced in *P. maximum* + *Gliricidia sepium* while animals fed *P. maximum* + *Gmelina aborea* recorded highest value of $4.08 \times 10^3 /mL$

Table 2: Effects of feeds on haematological indices of WAD sheep

Parameters	<i>P. maximum</i> Only	<i>P. maximum</i> + <i>Mangifera indica</i>	<i>P. maximum</i> + <i>Gmelina aborea</i>	<i>P. maximum</i> + <i>Anacardium occidentale</i>	<i>P. maximum</i> + <i>Gliricidia sepium</i>	SEM
PCV (%)	22.50 ^b	22.50 ^b	32.50 ^a	32.00 ^a	21.00 ^b	1.41
Hb (g/dL)	7.50 ^b	7.45 ^b	10.40 ^a	10.45 ^a	6.80 ^b	0.45
RBC ($\times 10^{12}/L$)	10.73 ^b	10.68 ^b	13.32 ^a	12.75 ^a	10.57 ^b	0.36
WBC ($\times 10^3/mL$)	3.58	3.60	4.08	3.50	1.30	19.28
Eosinophil (%)	4.00	3.50	3.00	3.50	4.00	0.16
Lymphocyte (%)	46.00 ^b	44.50 ^{bc}	51.00 ^a	53.00 ^a	43.50 ^c	1.03
Neutrophil (%)	47.50 ^b	51.40 ^a	44.00 ^c	41.50 ^d	50.00 ^a	1.01
Monocyte (%)	2.50 ^a	0.50 ^b	2.00 ^a	2.00 ^a	1.50 ^{ab}	0.24

^{abcd} Means along the same column with different superscripts are significantly different ($P < 0.05$)
PCV: Packed cell volume, Hb: Haemoglobin, RBC: Red blood cell, WBC: White blood cell

SEM: Standard error of mean

Serum biochemistry of WAD sheep fed selected browse plants.

Serum biochemical parameters of WAD sheep fed selected forages are shown in Table 3. Significant variations ($P < 0.05$) were observed in all the parameters measured. Animals fed *P. maximum* + *Mangifera indica* and *P. maximum* + *Gmelina aborea* both had the lowest significant ($p < 0.05$) value of total protein (6.65 mg/dL) while the highest significant ($p < 0.05$) value was observed in animals fed *P. maximum* + *Anacardium occidentale* (7.45 mg/dL). Animals fed *P. maximum* + *Anacardium occidentale* had significant highest value of glucose (67.50 g/dL) while glucose was drastically reduced in animals fed *P. maximum* + *Gliricidia sepium*. Albumin value recorded was significantly ($p < 0.05$) highest in animals fed *P. maximum* + *Gliricidia sepium* (2.85 mg/dL) while the lowest value (2.50 mg/dl) was observed in animals fed *P. maximum* + *Mangifera indica* and *P. maximum* + *Gmelina aborea* diets. Globulin values ranged from 4.15 – 4.70 mg/dL in animals fed both *P. maximum* +

Mangifera indica, *P. maximum* + *Gmelina aborea* and *P. maximum* + *Anacardium occidentale* respectively. Animals fed *P. maximum* + *Anacardium occidentale* recorded significantly ($p < 0.05$) highest value of blood urea (9.60 mg/dL) while the least value was observed in animals fed *P. maximum* + *Mangifera indica* (8.35 mg/dL). The highest significant value of creatinine was observed in animals fed both *P. maximum* + *Anacardium occidentale* and *P. maximum* + *Gliricidia sepium* (1.35 mg/dL) while the least value was observed in animals fed *P. maximum* + *Mangifera indica* (1.20 mg/dL). Animals fed *P. maximum* + *Mangifera indica* recorded the lowest ($p < 0.05$) value of ALT (27.50U/l) while the highest value was recorded in animals fed *P. maximum* + *Anacardium occidentale*. Animals fed *P. maximum* + *Gliricidia sepium* recorded significantly ($P < 0.05$) highest value of Aspartate transaminase (AST) (119.00U/l) whereas the least value (97.00U/l) was observed in animals fed *P. maximum* + *Mangifera indica*.

Table 3: Effects of feed on the Serum Chemistry of WAD sheep

Parameters	<i>P. maximum</i> only	<i>P. maximum</i> + <i>Mangifera indica</i>	<i>P. maximum</i> + <i>Gmelina aborea</i>	<i>P. maximum</i> + <i>Anacardium occidentale</i>	<i>P. maximum</i> + <i>Gliricidia sepium</i>	SEM
Total protein (mg/dL)	6.95 ^{ab}	6.65 ^b	6.65 ^b	7.45 ^a	7.40 ^a	0.12
Glucose (g/dL)	48.00 ^b	47.00 ^b	46.33 ^b	67.50 ^a	42.50 ^c	1.4
Globulin (mg/dL)	4.35 ^{ab}	4.15 ^b	4.15 ^b	4.70 ^a	4.55 ^{ab}	0.07
Albumin (mg/dL)	2.60 ^{bc}	2.50 ^c	2.50 ^c	2.75 ^{ab}	2.85 ^a	0.04
Blood urea (mg/dL)	8.85 ^b	8.35 ^c	8.43 ^c	9.60 ^a	9.50 ^a	0.04
Creatinine (mg/dL)	1.25 ^b	1.20 ^b	1.22 ^b	1.35 ^a	1.35 ^a	0.02
ALT (U/l)	29.00 ^{ab}	27.50 ^b	27.67 ^b	30.50 ^a	29.00 ^{ab}	0.39
AST (U/l)	104.50 ^b	97.00 ^c	97.67 ^c	105.00 ^b	119.00 ^a	2.21

^{abc} Means along the same column with different superscripts are significantly different ($P < 0.05$)

ALT: Alanine aminotransferase

AST: Aspartate transaminase

SEM: Standard error of mean

Performance characteristics of WAD sheep fed selected forages

As revealed in Table 4, all the data obtained were significantly ($P < 0.05$) varied. Sheep on control diet had highest (22.48kg) total grass intake while those on *P. maximum* + *G. sepium* had the least (7.33kg). *P. maximum* +

Anacardium occidentale recorded highest (13.43kg) plant intake. Diets influenced the total weight gain of the sheep, significant ($P < 0.05$) highest weight gain (4.33kg) was observed in sheep fed *P. maximum* + *Anacardium occidentale* while the least value of 2.23 kg was recorded in sheep fed *P. maximum* only.

Table 4. Growth performance of WAD sheep fed browse forages.

Parameters	<i>P. maximum</i> only	<i>P. maximum</i> + <i>Mangifera indica</i>	<i>P. maximum</i> + <i>Gmelina aborea</i>	<i>P. maximum</i> + <i>Anacardium occidentale</i>	<i>P. maximum</i> + <i>Gliricidia sepium</i>	P value	SEM
Average Total grass intake (kg)	22.48 ^a	9.03 ^b	8.20 ^b	9.97 ^b	7.33 ^b	0.0001	1.53
Average Total browse intake (kg)	0.00 ^d	9.43 ^b	7.90 ^c	13.43 ^a	12.60 ^a	0.0001	1.29
Average Total feed intake (kg)	22.48 ^{ab}	18.47 ^{cd}	16.10 ^d	23.39 ^a	19.93 ^{bc}	0.0001	0.80
Average Daily grass intake (g/day)	267.66 ^a	107.54 ^b	97.62 ^b	118.65 ^b	87.30 ^b	0.0001	18.27
Average Daily browse intake (g/day)	0.00 ^d	112.30 ^b	94.05 ^c	159.84 ^a	150.00 ^a	0.0001	15.30
Average Total daily feed intake (g/day)	267.66 ^{ab}	219.84 ^{cd}	191.66 ^d	278.49 ^a	237.30 ^{bc}	0.0001	9.56
Average Total weight gain (kg)	2.23 ^b	2.33 ^b	2.77 ^b	4.33 ^a	2.33 ^b	0.0001	0.17
Average Daily weight gain (g/day)	26.59 ^b	33.73 ^b	32.93 ^b	51.59 ^a	27.70 ^b	0.0001	1.98
Feed conversion ratio (FCR)	10.20 ^a	8.09 ^a	5.82 ^b	5.41 ^b	8.62 ^a	0.0001	0.12

^{a,b,c,d} means on the same row with different superscripts are significantly different ($p < 0.05$).

Discussion

The comparison of an animal's hematologic and biochemical values with a reference interval provides evidence for numerous conditions such as infection, malnutrition and stress (Clifford

and Briggs, 2007). Hence, laboratory tests on blood are very vital tools to detect any deviation from the normal in the animal body (Alemede *et al.*, 2010).

The PVC of this study was lower compared to those of goats reported by Kalio *et al.*, (2014). This range fell within the mean PCV value of 25.7% in Red Sokoto goats (Tambuwei *et al.*, 2002) and the range of 21 – 35% PCV value reported for goats by Daramola *et al.*, (2005). Oni (2009) reported highest PCV value of 25.5 in goats fed with graded level of dried cassava leaves which was lower to the values recorded in sheep fed with *P. maximum* + *Gmelina aborea* and *P. maximum* + *Anacardium occidentale*

The haemoglobin concentration in the blood of the studied animals (sheep) showed a similar pattern of variation as observed in PCV. The same trend as observed in PCV was noticed in the haemoglobin (Hb) concentration value of sheep fed with *P. maximum* + *Anacardium occidentale* as the best value was recorded. The least value was observed in sheep fed with *P. maximum* + *Gliricidia sepium* was similar to the values obtained by Belewu and Ogunsola (2010) for goats fed treated *Jatropha curcas* kernel cake rations but lower than the reported values in Sudan desert lambs fed untreated or urea treated groundnut hull supplemented with different protein sources (Abdel Hameed *et al.* 2013), The haemoglobin range however fell within the reported values for sheep fed with selected forages (Omoniyi, 2014). The highest haemoglobin value (10.45g/dl) observed in sheep fed with *P. maximum* + *Anacardium occidentale* was lower compared to the range of reported values (11.8 and 12.5 g/dl) by Oduguwa *et al.* (2013) on WAD sheep. Babayemi *et al* (2003) submitted that lower value of Hb concentration in any animal could be used as an assay of nutritional anaemia.

The values of RBC counts observed in the present finding fell within the range reported by Tambuwei *et al.* (2002), Taiwo and Ogunsanmi (2003), Ajala *et al.* (2000) and Omoniyi (2010) respectively. The highest RBC counts observed in sheep fed with *P. maximum* + *Gmelina aborea* could be linked to the high CP content of the forage. This observation is in conformity with the report of Adeyemi *et al.* (2008) who observed that red blood cells and haemoglobin are positively correlated with protein quality and protein level in the diet and that decreased in red

blood cell counts are associated with low protein deficiency in the diet.

The higher WBCs count recorded in the sheep fed with *P. maximum* + *Gmelina aborea* may be as a result of the response of the animals to protect themselves against invading pathogens which could be resulted from secondary metabolite in the plant. Hence it is probable that the higher WBCs observed were a response to possible threat of these pathogens to the animals' immune system. This finding was corroborated with the report of Kalio *et al.*, (2014) as well as Aiello, (2000). The WBCs or leucocytes are the mobile unit of the body's protecting system (Aiello, 2000). Consequently, no deleterious conditions were observed among the animals in all the treatment groups in this experiment, since their WBC values fell within the normal range (Aiello, 2000) for healthy sheep.

The lymphocytes which is one of the WBC precursors ranged from 43.50 – 53.00% fell below the reported mean values of 58.00 to 69.25% observed in goats fed with some leaves (Ajayi *et al.*, 2005). The lymphocytes values recorded by the WAD sheep in this study fell within the reported ranged 49.8 – 53.7 % reported for WAD goats by Belewu and Ojo-Alokomaro (2007). The variations in the lymphocytes values recorded in this study as compared to those reported by the cited authors may be due to differences in diets. Lymphocytes play an important role of impacting immunity (Sembulingam and Sembulingam, 2002).

Serum glucose observed in this study fell within the reported value range of (Ohiomah, 2012). These values also compared favourably with the glucose value reported for Naemi sheep by Abdel rahman and Aljumah (2012). The blood glucose values exhibited by the WAD sheep in this study were indicative of their nutrient status. Turner *et al.* (2005) observed that blood glucose has been used to monitor the nutrient status in goats. The high level of serum glucose recorded in sheep fed with *P. maximum* + *Anacardium occidentale* could be attributed to the high level of blood sugar as a result of increased digestibility of nutrients resulted in the proportion of propionate which is a major precursor of glucose that supplies about 27 –

55% of the glycogenic material as reported by Matras and Preston (1989) by so doing enough glucose is present in the system of the sheep. The range of serum protein observed in this finding is within 6.65 – 7.45g/dl. Daramola *et al.* (2005) reported range values of 6.3 – 8.5 g/100ml in WAD goats. Abdel Hameed *et al.*, 2013 and Omoniyi, 2014 were in opinion that serum protein concentration at any given time in turn is a function of hormonal balance, nutritional status, water balance and other factors affecting health. Improvement in the total protein of the sheep could also be ascribed to the nutrient status of the forages fed to the sheep as supported by Akinmumi and Oke, 2002 and Babayemi *et al.* (2003) that the higher the values of the total protein the better the quality of the ingredients and that total protein of an animal is a reflection of the state of the animal. Kalio *et al.*, 2014 reported similar creatinine levels for some WAD bucks. The creatinine levels in blood and urine may be used to calculate the creatinine clearance (CrCl), which reflects the glomerular filtration rate (GFR). The GFR is clinically important because it is a measurement of renal or kidney function (Nabili and Shiel, 2010). The range observed in this study implies that the animals have properly functioning kidneys.

The levels of blood urea recorded in this study fell within the reference values reported by Aiello, (2000). The blood urea levels in the study were within the recommended limits which suggest that the kidneys and liver in the body of the animals were functioning well. Evaluation of the blood profile of animals may give some insight as to the potentials of a dietary treatment to meet the metabolic needs of the animals. ALT and AST values were influenced by the dietary treatments. The AST obtained in this study was higher than the reported values of 41.05 – 59.00 by Ikhimoya and Imasuen (2007). Normal enzyme level in serum is a reflection of a balance between synthesis and their release, as a result of the different physiological processes in the body.

The best feed conversion ratio (FCR) observed in sheep fed with *P. maximum* + *Anacardium occidentale* was lower compared with the range reported by Wuanor *et al.* (2013) when WAD

goats were fed forages and cassava processing by products. The highest live weight gain and best feed conversion ratio obtained in goats fed with *P. maximum* + *Anacardium occidentale* indicated better performance in terms of weight gain with addition of browse forages in the present study.

Conclusion

The results of the hematology and serum biochemistry of the sheep fed with *P. maximum* + *Mangifera indica*, *P. maximum* + *Gmelina aborea* and *P. maximum* + *Anacardium occidentale* revealed that the plants can be used to feed ruminants with no deleterious effects on sheep.

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