Haematologocal Parameters and Serum Biochemistry of Red Sokoto Goats fed Ensiled Maize Stover with or without Concentrate Supplements

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Abstract: Green and dry maize stovers were ensiled with or without ground dried cassava peels (GCP) or dried poultry litter (DPL) and fed to Red Sokoto goats to evaluate their effect on haematology and serum biochemistry of the goats. Six silage types viz: T_1= Chopped Green Maize Stover (CGMS) only (no additive), T_2 = CGMS + 5% GCP (w/w), T_3 = CGMS + 36% DPL (w/w), T_4 = Chopped Dry Maize Stover (CDMS) without additive, T_5 = CDMS + 5% GCP (w/w) and T_6 = CDMS + 36% DPL (w/w). At the end of a preliminary 112 days performance study, blood samples were collected from the jugular vein of the 24 goats (4 goats per treatment) for the analysis of haematological and serum biochemical parameters. Blood samples were collected according to standard procedure. The results showed differences ($P < 0.05$) among treatments for packed cell volume (PCV) and haemoglobin (Hb) as well as urea and alkaline phosphate. T_3 and T_6 (un-supplemented) had lower PCV and Hb values than the normal range for goats. It was concluded that maize stover silage supplemented with concentrate can serve as dry season feed for goats without compromising the health of the goats.

Key words: Haematological parameters, Serum biochemistry, Red Sokoto goats, ensiled maize stover, Concentrate supplement.

1.0 INTRODUCTION

The expression of the productive potentials of an animal is majorly determined by its plane of nutrition and health. Incidentally, health is a function of the plane of nutrition of the animal. Goat production in Nigeria is constrained by feed shortage and seasonal changes in nutritive value of fodder resources make gains in production from improved management and disease control programs unrealistic (Ahamefule and Elendu, 2010; Alli-Balogun *et al.,* 2003). Increasing human population has led to increased demand for conventional feedstuff and consequent increases in commodity prices owing to increased competition for these materials between human and livestock. The high cost of conventional feedstuffs coupled with the declining quality and quantity of forages, especially during the dry season, has necessitated the need to source for alternative feed ingredients that are cheap and readily available to replace the expensive ones Iyeghe-Erakpotobor *et al.,* 2002). Poor nutrition results in low rates of growth and reproduction as well as affecting the immune system and the ability of an animal to fight diseases which could lead to death in extreme cases (Adamu *et al.,* 2015).

The blood and serum parameters of an animal can be used to predict the health condition of the animal and blood values are affected by the nutrition of the animal (Adejumo, 2004). Variations in haematological parameters are often used to determine various status of the body and to determine stresses due to environmental, nutritional and/or pathological factors (Afolabi, *et al.,* 2010)

2.0 MATERIALS AND METHOD

2.1 Experimental site

The study was conducted at the Livestock Teaching and Research Farm of Federal University Wukari, Taraba State. Wukari is situated within lat. 7.52° 48"N to 7.87°N and long. 9.46° 38" E to 9.77° E at an altitude of 189 m above sea level; mean temperature ranges from 25.4°C in August to 29.8°C in March, with an average annual rainfall of about 1205 mm (Worldatlas, 2015; Climate-Data.Org (2015).

2.2 Experimental animal, management and experimental design

Twenty four growing male Red Sokoto goats of 9-12 months old were used for the study. They were purchased from the Livestock market of Iware in Taraba State. They were treated for endo and ecto parasites on arrival and

given prophylactic dosage of antibiotics (LA Oxytetracycline at 1 ml / 10 Kg body weight). They were also vaccinated against *Pestes des Petit Ruminante* (PPR) using a tissue culture rinderpest vaccine. A three week adaptation period was allowed the goats in individual pens measuring 1.5m^2, during which they were fed diets similar to what they were used to but gradually introduced to the experimental diets two weeks to the commencement of the feeding trial.

After the adaptation period, the goats were weighed and randomly allotted to six treatment diets in completely randomized design. Diets were offered *ad libitum* at 0800 hour. The amount offered was adjusted upwards weekly by 10% of previous week's consumption. Daily feed intake was determined by deducting the orts from the amount offered. For the experimental duration of 112 days, feed and water were supplied *ad libitum* each day while salt licks were placed permanently in each pen.

2.3 Collection and evaluation of blood samples

At the end of one hundred and twelve (112) days performance study, blood samples were collected from the jugular vein of the 24 goats for the analysis of haematological and serum biochemical parameters. Blood samples for haematology were collected into sterile vacutainer tubes containing Ethylene Diamine Tetra Acetic acid (EDTA) while a 7 ml sample for serum biochemistry was dispensed into EDTA-free vacutainer tubes to allow blood clotting such that serum can be decanted for analysis. The serum samples were stored at 20^{o}C prior to biochemical analysis.

Haematological parameters determined were Packed Cell Volume (PCV), Haemoglobin concentration (Hb), Erythrocytes count (RBC), Leucocytes count (WBC), Mean Corpuscular Volume (MCV), Mean Corpuscular Haemoglobin (MCH), Mean Corpuscular Haemoglobin Concentration (MCHC), Neutrophils, Lymphocytes, Eosinophils, Basophils and Monocytes

The serum biochemical parameters determined were: Urea, Cholesterol, Glucose, creatinine (all in mg/dL), Total protein, Albumin and Globulin (all in g/d/L) according to the method described by Ogunsanmi *et al.* (2002). Serum glutamic oxaloacetic transaminase (SGOT)/AST, serum glutamic pyruvic transaminase (SGPT)/ALT and alkaline phosphate (ALP), all in u/L, were also determined.

3.0 RESULT

3.1 Haematological Parameters and Differential White Blood Cell Count of Red Sokoto Goats fed Ensiled Maize Stover with or without Concentrate Supplements

The result of the haematological parameter is presented in Table 1. Apart from packed cell volume (PCV) and haemoglobin which were significantly ($P < 0.05$) different among the treatments, others parameters (red blood cell count, white blood cell count, mean corpuscular volume, mean corpuscular haemoglobin and mean corpuscular haemoglobin concentration) were similar ($P > 0.05$).

PCV ranged from 18.75% in both T_3 and T_6 to 30.75% in T_1. Red blood cell count (RBC) was lowest (9.20 x10^{12}/L) in T_5 and highest (12.73 x 10^{12}/L) in T_4. White blood cell count (WBC) was highest (5.10 x 10^9/L) in T_4 and lowest (3.43 x 10^9/L) in T_6. Haemolobin (Hb) ranged from 6.18 g/dL in T_6 to 9.65 g/dL in T_1. Mean corpuscular volume (MCV) ranged from 17.88 fL in T_4 to 25.79 fL in T_1. Mean corpuscular haemoglobin (MCH) was highest (8.36 fL) in T_5 and lowest (6.08 fL) in T_6. The lowest (31.56 g/dL) value of Mean corpuscular haemoglobin concentration (MCHC) was observed in T_1 and the highest (33.38 g/dL) in T_5.

Table 2 shows the differential white blood cell count of Red Sokoto goats fed the experimental diets. Lymphocytes, Neutrophils, Eosiniphils, Basophils and Monocytes are all not significantly ($P > 0.05$) different among the treatments and are generally with the normal range for goats.

Table 1: Haematological Parameters of Red Sokoto Goats fed Ensiled Maize Stover with or without Concentrate Supplements

Parameters	Experimental Treatments							
	T_1	T_2	T_3	T_4	T_5	T_6	Range	SEM
Packed Cell volume (%)	30.75^{a}	24.50^{ab}	18.75^{b}	22.25^{b}	22.75^{b}	18.75^{b}	22-38	2.54
Red blood cell Count ($x10^{12}$/L)	11.93	12.00	9.28	12.73	9.20	10.05	8-18	1.08^{ns}
White blood cell ($x10^{9}$/L)	4.53	4.13	4.10	5.10	4.40	3.43	4-13	0.65^{ns}
Haemoglobin (g/dL)	9.65^{a}	8.15^{ab}	6.25^{b}	7.43^{ab}	7.60^{ab}	6.18^{b}	8-12	0.84
MCV (fL)	25.79	23.99	21.73	17.88	25.02	18.48	10-26	4.09^{ns}
MCH (fL)	8.09	7.99	7.24	5.96	8.36	6.08	5.2-8	1.36^{ns}
MCHC (g/dL)	31.56	33.25	33.34	33.37	33.38	32.93	30-36	0.72^{ns}

a, b, means with different superscripts on the same row are significantly different (P < 0.05)
T_1 = Chopped Green Maize Stover ensiled with 5% w/w GCP + concentrate supplement
T_2 = Chopped Green Maize Stover ensiled with 36% w/w DPL + concentrate supplement
T_3 = Chopped Green Maize Stover ensiled with 36% w/w DPL only
T_4 = Chopped Dry Maize Stover ensiled with 5% GCP w/w + concentrate supplement
T_5 = Chopped Dry Maize Stover ensiled with 36% w/w DPL + concentrate supplement
T_6 = Chopped Dry Maize Stover ensiled with 36% w/w DPL only
GCP = Ground Dried Cassava Peels
DPL = Dried Poultry Litter
MCV = Mean corpuscular volume
MCH = Mean corpuscular haemoglobin
MCHC = Mean corpuscular haemoglobin concentration
SEM = Standard error of mean
ns = not significantly different (P > 0.05)

Table 2: Differential White Blood Cell Count of Red Sokoto Goats Fed

Ensiled Maize Stover with or without Concentrate Supplements

Parameters	**Experimental Treatments							
	T_1	T_2	T_3	T_4	T_5	T_6	Range	SEM
Lymphocytes (%)	69.25	69.75	67.25	67.00	67.75	69.25	50 – 70	2.50^{ns}
Neutrophils (%)	26.00	22.25	27.75	26.50	24.00	24.75	17- 52	1.84^{ns}
Eosinophils (%)	1.25	3.00	2.00	2.50	2.75	2.75	1-8	0.92^{ns}
Basophils (%)	0.50	1.25	0.50	1.00	1.50	0.50	0-1	0.65^{ns}
Monocytes (%)	2.50	3.75	2.50	3.00	4.00	2.75	0-4	1.14^{ns}

**Experimental treatments T_1-T_6 as in Table 1.
GCP = Ground Dried Cassava Peels
DPL = Dried Poultry Litter
SEM = Standard error of mean
ns = not significantly different (P > 0.05)

3.2 Serum Biochemistry of Red Sokoto Goats fed Ensiled Maize Stover with or without Concentrate Supplements

The result of the serum biochemistry of Red sokoto goats fed the experimental diets is presented in Table 3. Significant differences ($P < 0.05$) were observed in serum globulin, cholesterol, urea and alkaline phosphatase (ALP). All other parameters were similar ($P > 0.05$) among the treatments. Total protein ranged from 4.35 g/dL in T_1 to 7.28 g/dL in T_6. Albumin ranged from 2.08 g/dL in T_1 to 2.38 g/dL in T_2. Globulin was also lowest (2.27 g/dL) in T_1 and highest (4.73 g/dL) in T_6.

Serum glucose (mg/dL) ranged from 55.95 in T_1 to 60.90 in T_4. Cholesterol (mg/dL) was lowest (85.00) in T_5 and highest (107.40) in T_4. Creatinine (mg/dL) had its lowest (0.25) in both T_1 and T_2 and the highest (0.88) value in T_5. Blood urea ranged from 18.23 mg/dL in T_3 to 39.33 mg/dL in T_5. Aspartate aminotransferase (AST) was lowest (6.53 u/L) in T_6 and highest (35.63 u/L) in T_2. T_3 had the lowest (26.08 u/L) alanine aminotransferase (ALT) with the highest (37.20 u/L) value in T_4. Alkaline phosphatase (ALP) was lowest (13.33 u/L) in T_3 and highest in T_6.

Table 3: Serum Biochemistry of Red Sokoto Goats fed Ensiled Maize Stover with or without Concentrate Supplements

	**Experimental treatments							
Parameters	T_1	T_2	T_3	T_4	T_5	T_6	Range	SEM
Total protein (g/dL)	4.35	4.88	5.15	4.95	6.40	7.28	6.1-7.5	0.89^{ns}
Albumin (g/dL) 2.08	2.38	2.25	2.20	2.35	2.55	2.3-3.6	0.32^{ns}	
Globulin (g/dL) 2.27^{d}	2.50^{cd}	2.90^{c}	2.75^{cd}	4.05^{b}	4.73^{a}	2.7-4.4	0.19	
Glucose (mg/dL)	55.95	56.60	60.58	60.90	60.83	55.98	48-76	3.82^{ns}
Cholesterol (mg/dL)	98.08^{ab}	88.08^{b}	96.55^{ab}	107.40^{a}	85.00^{b}	86.88^{b}	65-136	5.73
Creatinine (mg/dL)	0.25	0.25	0.68	0.50	0.88	0.45	0.7-1.5	0.25^{ns}
Urea (mg/dL)	23.05^{c}	25.63^{bc}	18.23^{c}	19.88^{c}	39.33^{a}	32.45^{ab}	13-26	3.01
AST (u/L)	34.63	35.63	22.25	11.05	25.10	6.53	12-38	9.14^{ns}
ALT (u/L)	32.28	36.63	26.08	37.20	32.08	30.43	15-52	8.03^{ns}
ALP (u/L)	26.68^{ab}	28.33^{ab}	13.33^{b}	29.38^{ab}	30.93^{a}	34.35^{a}	1.4-25.7	5.14

a, b, c, means with different superscripts on the same row are significantly different ($P < 0.05$)
**Experimental treatments T_1-T_6 as in Table 1. AST = Aspartate aminotransferase, ALT = Alanine aminotransferase, ALP = Alkaline phosphatase,
SEM = Standard error of mean, ns = not significantly different ($P > 0.05$)

4.0 DISCUSSION

4.1 Haematological Parameters of Red Sokoto Goats Fed Ensiled Maize Stover with or without Concentrate Supplements

Packed cell volume (PCV) was higher in T_1 than in T_3 - T_6 while that of T_2 was similar to T_1. In general, supplemented treatments groups had higher PCV than the un-supplemented groups. Also, the PCV of the supplemented treatment groups fall within the normal range (22 - 38%) of PCV for goats and similar to the range of 22.50 – 30.33% reported by Amuda (2013) for WAD sheep fed similar diets while T_3 and T_6 were lower than the normal range (Merck manual, 2010). Since PCV is involved in transport of oxygen and absorbed nutrients (Etim *et al.,* 2014), it is logical to suggest that the low PCV was contributory to the poor growth performance observed in the un-supplemented treatments (T_3 and T_6) as PCV has been reported to be highly correlated with the nutritional status of the animal (Adejumo, 2004). Although T_2, T_4 and T_5 are statistically similar to T_3 and T_6, the former group had their PCV within the normal range for goats while the latter had PCV below the normal range for goats. Differences in PCV between the treatment groups therefore consist in whether they are or not within the normal range of values for goats.

The PCV values for T_1, T_2, T_4 and T_5 (supplemented treatments) are similar to the 22.6 – 28.8% (25.7 ± 3.1%) reported by Tambuwal *et al.* (2002) for healthy Red Sokoto goats but lower than the (36.1 ± 2.24%) reported by Njidda *et al.* (2013) for Red Sokoto goats fed on natural grazing rangeland in Northern Nigeria. The higher value of PCV (in T_1) observed in this study falls within the 29.25-32.75% reported by Okunlola *et al.* (2015) but lower than

the 36.1% reported by Njidda *et al.* (2013) for Red Sokoto goats. The variation may be attributed to the differences in the diets fed and the consequent nutritional status of the animals (Adejumo, 2004).

The red blood cell count (RBC) obtained in this study falls within the 8 - 18 x 10^{12}/L normal range of RBC for goats. The values observed in this study are within the 8.8 – 13.0 x 10^{12}/L (10.9 ± 2.1 x 10^{12}/L) reported by Tambuwal *et al.* (2002) for healthy Red Sokoto goats, similar to the 12.01 – 13.79 x 10^{6}/µL reported by Ngi (2012) for WAD goats and the 13.58 x 10^{6}/µL reported by Amosu *et al.* (2017) for Red Sokoto goats.

Haemoglobin (Hb) was significantly higher in T_1 than T_3 and T_6. The lower values were observed in T_3 and T_6. T_1 and T_2 were within the 8 – 12 g/dL normal range for goats (Merck manual, 2010) while other treatments had lower Hb than the normal range. The implication of this is that such animals would have reduced capacity to transport oxygen to the tissues of the animals for oxidation of ingested food and the transport of carbon dioxide from the tissues to the lungs. Hb values for T_1 and T_2 are similar to the 8.50 – 9.25 g/dL reported by Ngi (2012), 9.8 g/dL by Daramola *et al.* (2005) and 8.6 – 10.45 g/dL by Ocheja *et al.* (2016). Hb values for T_1, T_2, T_4 and T_5 are also similar to the range of 7.71 – 8.29 g/dL reported by Njidda *et al.* (2013) for Red Sokoto goats fed on natural grazing rangeland in Northern Nigeria. The result agrees with the findings of Adejumo (2004) and Addass *et al.* (2012) that nutrition affects the blood values of animals.

The white blood cell (WBC) values of the goats in the treatment groups are similar and within the normal range of 4.0 – 13.0 x 10^{9}/L (MERCK, 2010) except for T_6 that was lower than the normal range. The WBC values in this study are close to the 4.85 – 7.77 x 10^{3} /µL reported by Odoemelam *et al.* (2014) for WAD goats fed *Panicum maximum* supplemented with Bambara nut meal based concentrate diets but lower than the 13.5 x 10^{3} /µL reported by Daramola *et al.* (2005) for WAD goats for WAD goats fed *Panicum maximum* supplemented with kitchen waste and dried cassava peels. It is also lower than the 5.30 – 7.40 x 10^{3} /µL reported by Ngi (2012) for WAD goats fed composite sweet orange peel. The variation may be attributed to difference in both diets and breed of animal (Etim *et al.,* 2014; Addass *et al.,* 2012). The lower than normal range WBC count in T_6 could result to high risk of disease infection since WBC functions to fight infections (Etim *et al.,* 2014). Although no serious clinical infection was observed other than occasional diarrhea in T_3 and T_6, the lower than normal WBC in T_6 could be due to the poor nutritional status owing to the lack of supplementation.

Mean Corpuscular Volume (MCV) values in this study are within the 10 – 26 fL normal range for goats reported by Merck manual (2010). The range of values observed is similar to the 20.75 – 22.52 fL reported by Ngi (2012). Mean Corpuscular Haemoglobin (MCH) and Mean Corpuscular Haemoglobin Concentration (MCHC) values were also within the 5.2-8.0 fL and 30.36 g/dL normal ranges respectively for goats. The MCHC values obtained are similar to the 32.81-33.33 g/dL and 33.1 ± 0.1 g/dL reported by Ngi (2012) and Daramola *et al.* (2005) respectively for WAD goats. The MCHC values observed, being within the normal range, seem to suggest that there was no anaemia resulting from the treatments (Njidda *et al.,* 2013)

The white blood cell differentials are similar among the treatments and all within their respective normal ranges for goats. Lymphocytes values are similar to the range of 69.1 - 72.9% (71.0 ± 1.90%) reported by Njidda *et al.* (2013) for Red Sokoto goats fed on natural grazing rangeland of Northern Nigeria but higher than the range of 48.6-54.6% (51.6 ± 3.0%) reported by Tambuwal *et al.* (2002) for healthy Red Sokoto goats. Since the values were within the normal range, it is suggestive of the good health condition of the animals.

Neutrophils, noted to be effective killing machine (Ganong, 2005), had lower values than lymphocytes; a corroboration of the report of Olusanya *et al.* (1976). Observed values are similar to the range of 22.33 - 28.71% reported by Njidda *et al.* (2013) for Red Sokoto and Kano brown bucks goats fed on natural grazing rangeland of Northern Nigeria and also within the normal range of 17.00 – 52.00% reported by Daramola *et al.* (2005) for WAD goats. Eosinophils, which functions like neutrophils in protecting the body against bacteria and parasites, had similar values across the treatments and are within the normal range for goats (Merck manual, 2010).

Basophils, which are about 1% of the entire white blood cells (WBC), also had similar values across the treatments which were also within the normal range for goats. Monocytes as the biggest type of WBC, which fight bacteria, viruses and fungi, had similar values across the treatments and within the normal reference range for goats. They were however lower than the 7.4 ± 1.7% reported by Tambuwal *et al.* (2002). The absence of significant differences in the differential white blood count may be an indication that the treatments did not have pronounced adverse effect on the immune system of the animals in the various treatment groups.

4.2 Serum Biochemistry of Red Sokoto Goats Fed Ensiled Maize Stover with or without Concentrate Supplements

Total protein was similar across the treatments. The values observed for T_1 – T_4 are within 2.90 – 5.90 g/dL (4.4 ± 1.5 g/dL) reported by Tambuwal *et al.* (2002) for apparently healthy Red Sokoto goats and within the 3.33 – 5.52 g/dL reported by Odoemelam *et al.* (2014) for WAD goats fed *Panicum maximum* supplemented with Bambara nut meal based concentrate diets. They were however lower than the 6.1 – 7.5g/dL normal reference range for goats (Merck manual, 2010). Also the total protein values for T_1 – T_6 were below the 7.43 – 8.21 g/dL reported by Akingbade *et al.* (2015) for WAD goats fed concentrates varying in *Peuraria phaseoloides* leaf meal content. Nevertheless, T_5 and T_6 are similar to the 6.87 – 8.27 g/dL reported by Njidda *et al.* (2013) for Red Sokoto goats fed on natural grazing rangeland of Northern Nigeria. The higher absolute value observed in total protein for T_6 may be attributed to dehydration (Alex and Laverne, 1983) as the higher value cannot be justified by the crude protein intake.

Albumin was also similar among the treatments, suggesting no treatment effect on the albumin level of the animals. All the treatments except T_1 were within the 2.3 – 3.6 g/dL normal range for goats. The slightly lower (2.08 g/dL) value for T_1 may be due to liver disease, nephritic syndrome, protein losing enteropathy, malabsorbtion, malnutrition (Njidda *et al.,* 2013) but none of these could be substantiated in the current study. Although albumin level is an indicator of the protein status (Birt and Schuldt, 1982), the higher level of albumin observed in T_6 despite the poor growth performance of the goats in the group may be attributed to dehydration (Alex and Laverne, 1983) and not to the adequacy of the protein status, particularly from the point of view of the crude protein intake recorded in the treatment. The albumin range of 2.08 – 2.55 g/dL observed in this study is within the 1.28 – 2.65 g/dL reported by Odoemelam *et al.* (2014) for WAD bucks fed *Panicum maximum* supplemented with Bambara nut meal based concentrate diets and the 0.70 – 4.30 g/dL (2.5 ± 1.8 g/dL) reported by Tambuwal *et al.* (2002) for apparently healthy Red Sokoto goats. They were however lower than the 2.70 – 4.10 g/dL reported by Daramola *et al.* (2005) for WAD goats. The variation may be attributed to differences in diets (Etim *et al.,* 2014).

Globulin varied among the treatment with the highest value in T_6 and the lowest in T_1. T_6 is slightly above and T_1 slightly below the 2.7 – 4.4 g/dL normal range (Merck manual, 2010) for goats. The 2.08 – 4.78 g/dL is however lower than the 4.25 – 5.05 g/dL reported by Ngi (2012) for WAD goats fed composite graded levels of sweet orange peel meal. The variation confirms the findings that comparison of some blood parameters is less reliable across animal types or studies (Kohn *et al.*, 2005). The slight differences at the extreme values might not be of significance as range limits are not firm boundaries, being affected by variation in age, sex, breed or strain, sampling techniques and testing methodology (Etim *et al.,* 2014). Low level of globulin is reported to reduce the ability of animals to fight diseases (Robert *et al.,* 2003).

Glucose values were similar across the treatments and fall within the 48 -76mg/dL normal range reported by Merck manual (2010). The range of 55.95 – 60.90 mg/dL obtained in this study is comparable to the range of 63.00 – 63.74 mg/dL (1.66 ± 0.01 mmol/L) reported by Njidda *et al.* (2013) for Red Sokoto goats fed on natural grazing rangeland of Northern Nigeria but lower than the range of 67.32 - 114.80 mg/dL reported by Amuda (2013) for WAD sheep fed similar diets. The variation may be attributed to animal type (Kohn *et al.*, 2005) or testing methodology (Etim *et al.,* 2014).

Cholesterol values are generally higher than the range of 61.50 – 92.00 mg/dL reported by Ngi (2012) for WAD goats fed composite graded levels of sweet orange peel meal or the range of 62.12 -79.50 mg/dL reported by Amuda (2013) for WAD sheep fed similar diets. The observed values are however comparable to the range of 109.92 – 111.45 mg/dL (2.9 ± 0.02 mmol/L) reported by Njidda *et al.* (2013) for Red Sokoto goats fed on natural grazing rangeland in Northern Nigeria and fall within the 65 – 136 mg/dL normal range for goats (Merck manual, 2010). Although differences exist in the cholesterol values among the treatments, the fact that they are all within the normal range and well off from the extremes makes it improbable to suspect any coronary artery disease (Alex and Laverne, 1983). Creatinine was similar ($P > 0.05$) across the treatment groups with values within the normal range for goats. This may suggest that the treatments had no effect on the creatinine level.

Serum urea varied significantly among the treatments with values beyond the 13 – 26 mg/dL normal range in T_5 and T_6. High levels of serum urea had been attributed to excessive tissue protein catabolism consequent to poor feed protein composition (Oduye and Adadevoh, 1976; Elitok, 2012), although this might not be the case with T_5 which was supplemented with concentrate. The probable tissue protein catabolism suspected in T_6 may be

substantiated by the lowest nitrogen retention (Table 14) recorded in the treatment group. $T_1 – T_4$ are within the range of 10.0 – 26.15 mg/dL (4.7 ± 2.1 mmol/L) reported by Tambuwal *et al.* (2002) for healthy Red Sokoto goats and within the 13 -26 mg/dL normal range for goats (Merck manual, 2010).

The inverse relationship between serum total protein and serum urea noted by Daramola *et al.* (2005) is confirmed in this study between comparative treatment groups but not across the treatments in general. For instance, the relationship holds for T_2 and T_3 fed poultry litter ensiled green maize stover with or without concentrate supplement, respectively and between T_5 and T_6 fed poultry litter ensiled dry maize stover with or without concentrate supplement, respectively.

Aspartate aminotransferase (AST) and Alanine aminotransferase (ALT) are similar across the treatments and are within the 12.00 – 38.00 u/L and 15.00 – 52.00 u/L reported by Daramola *et al.* (2005) and Merck manual (2010), respectively for goats. This suggests that the treatments did not have detrimental effect on the enzymes and their functioning as to compromise the health of the goats. However T_6 had quite lower value of AST compared to the 12.00 – 38.00 u/L normal range for goats. Since elevated level of AST is the one attributable to myocardial infarction, hepatocellular disease, skeletal disorder, renal infarct and various haemolytic conditions (Alex and Laverne, 1983), none of which was observed in the current study, the low AST in T_6 may be attributed to chance effect. Alkaline phosphatase values are comparable to the 1.40 – 25.70 u/L reported as normal range for goats by Daramola *et al.* (2005)

5.0 CONCLUSION

It was concluded that maize stover ensiled with ground dried cassava peel or dried poultry can serve as dry season feed for goats if supplemented with concentrate without compromising the health of the goats.

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