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Performance, Hematology and Serum Biochemistry of West African Dwarf Goats Fed Ensiled Mixtures of Elephant Grass (*Pennisetum purpureum*) with Lima Bean, African Yam Bean and Pigeon Pea

Ajayi Festus Tope[1,*], Ogunleke Funmi[2], Adesina Adewumi[3] and Durotoye Emmanuel Sunday[1]

ABSTRACT

The performance, hematological and biochemical parameters of 16 West African dwarf goats fed ensiled elephant grass (*Pennisetum purpureum*) with pineapple pulp (Diet 1), pigeon pea plant (Diet 2), lima bean plant (Diet 3) and African yam bean plant (Diet 4) were investigated in a completely randomized design. Four goats were allotted to each diet in a 91-day feeding trial; each goat was fed at 5% of its body weight. The results showed that the crude protein, ether extract and ash contents of Diets 2–4 were similar ($P > 0.05$). The dry matter intake, crude protein intake and neutral detergent fiber intake of goats fed Diet 3 differed significantly ($P < 0.05$) from that of goats fed Diets 1, 2 and 4 which were 71.2, 28.8 and 52.7 g per kilogram $W^{0.75}$ per day (metabolic weight per day), respectively. The highest packed cell volume was observed in goats on Diet 2 (29.3%) and differed significantly ($P < 0.05$) from that of goats fed Diets 1, 3 and 4. Goats fed Diet 3 had the highest hemoglobin concentration, lymphocyte, monocytes and eosinophils. Goats fed Diet 4 had the highest total protein (70.2 $g.L^{-1}$) and cholesterol (42.0 $mmol.L^{-1}$).The highest urea nitrogen (3.8 $mmol.L^{-1}$), creatinine 97.0 $\mu mol.L^{-1}$), AST (51.9 $IU.L^{-1}$), ALT (6.7 $IU.L^{-1}$), glucose (3.1 $mmol.L^{-1}$) and lowest cholesterol (31.2 $mmol.L^{-}1$) were observed in goats fed with Diet 3. These results indicated that ensiling elephant grass with any of these legumes known to contain high concentrations of anti-nutrients was not detrimental to the health of the goats. Diet 3, comprising ensiled elephant grass with lima bean and pineapple pulp, produced the optimal growth rate and weight gain in the goats.

Keywords: biochemistry, goats, hematological parameters, silage

INTRODUCTION

One of the challenges facing ruminant livestock farmers in Nigeria is the poor nutrition levels in their animals during the dry season when there is a decline in the supply and quality of herbage for livestock. A main concern of animal scientists is feed production and utilization in the dry season to stem the cyclical pattern of weight gain and loss between seasons (Sowande *et al*.,

1 Institute of Agricultural Research and Training, Obafemi Awolowo University, P.M.B. 5029, Moor Plantation, Ibadan, Nigeria.

2 Federal College of Animal Health and Production Technology, Moor Plantation, Ibadan, Nigeria.

3 National Agricultural Extension Research and Liaison Service, Ahmadu Bello University, Moor Plantation, Ibadan, Nigeria.

* Corresponding author, e-mail: ajayiajay@yahoo.com

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2008). The use of herbaceous forage legumes in livestock production systems for ruminants in the tropics has increased as the legumes are rich in protein which is usually the most limiting nutrient in tropical animal diets (Ajayi and Babayemi, 2008). A practical way of addressing the problem of feeding ruminant livestock in the dry season is by using silage or hay. Silage is a sustainable means of supplementing poor quality feed for ruminants in the dry season. Ensiling is a general method for forage preservation and a form of treatment to occasionally salvage the impoverished pastures that have been degradated by livestock (Igbekoyi, 2008).The need to supplement herbaceous legumes in the diets of ruminants has been advocated (Ajayi *et al.,* 2009) as it will enhance the productivity of the animals. Annually, there is a large amount of biomass of legume foliage produced post harvest (Ajayi *et al.,* 2009).

African yam beans (*Sphenostylis stenocarpa* Hochst ex A. Rich) Harms, lima beans (*Phaseolus lunatus*) and pigeon pea (*Cajanu cajan*) are underutilized grain legume plants which are widely known in most homesteads in central and west Africa. Although, referred to as minor grain legumes, they are indigenous and are usually cultivated in association with arable crops like yam and cassava (Adeparusi, 2001). Ajayi *et al.* (2009) reported the crude protein of the foliage types as: African yam bean (23.9%), lima bean (19.4%) and pigeon pea (20.2%) with secondary metabolites of 2.8–6.5 g per 100 grams tannin, 17.6–24.6 mg per gram phytate and 25.0–27.2 Tiu per milligram trypsin inhibitor. These legumes could be explored in the feeding of ruminants by ensiling with grass. The objective of this study was to determine the hematology, serum biochemistry and performance of goats fed silage made from elephant grass (*Pennisetum purpureum*) mixed with either pigeon pea, lima bean or African yam bean.

MATERIALS AND METHODS

Study location

The experiment was carried out in the sheep and goat section of the Institute of Agricultural Research and Training, Moor Plantation, Ibadan, Nigeria (latitude 7°15'–7°30'N and longitude 3°45'–4°0'E). The area has a tropical humid climate with a mean annual rainfall of 1,415 mm and an average daily temperature between 28 and 35 °C.

Silage preparation and ensiling procedures

The silo used for the experiment was lined with 20 mm thick nylon. Elephant grass was harvested at 6 wks regrowth from a paddock of the livestock farm. The grass was chopped into 5–7 cm-sized pieces and allowed to wilt; all the legumes were harvested 3 mth after planting and also chopped into about 7 cm-sized pieces and allowed to wilt. A mixture of grass and each of the legumes and pineapple pulp was packed into the silo in a ratio 60:30:10, respectively, while the control had grass and pineapple pulp at ratio of 90:10, respectively. Ensiling was done in layers. Each layer was compacted with a 20 kg load to remove air and ensure even compaction until the silo was filled. Fifty grams of sodium chloride salt was added to the material in layers in the silo as a sterilant. The nylon sheet was sealed and a heavy stone (about 20 kg) was placed on it. The silo was closed with the lid and a 20 kg load of metal placed on top until the expiration of fermentation (42 d).

Animal management and feeding trial

The procedures of animal experimentation used were in line with the guidelines of the University's Livestock Ethics Committee. The experimental house and individual pens for the goats were cleaned with disinfectant before being used by the goats. Individual pens were covered with wood shavings up to 5 cm depth. Sixteen West African Dwarf (WAD) breed of goat were

used, aged between 3 and 4 mth with an average live weight (± SD) of 6.54 ± 0.23 kg. They were purchased from villages about 45 km from the study area. Each goat was given prophylactic treatments on arrival at the farm; long acting antibiotics and levamisole were administered at a dose of 1 mL per 10 kg. Goats were also dipped in Diazintol at a dose of 2 mL to 6 L of water to protect against ectoparasites. The adaptation period lasted 14 d after which the goats were introduced to the silage diets. Goats were subjected to dietary treatments of elephant grass and silage mixtures as follows: Diet 1: *Pennisetum purpureum* + pineapple pulp; Diet 2: *Pennisetum purpureum* + *Cajanus cajan* + pineapple pulp; Diet 3: *Pennisetum purpureum* + *Phaseolus lunatus* + pineapple pulp; and Diet 4: *Pennisetum purpureum* + *Sphenostylis stenocarpa* + pineapple pulp.

There were four goats per diet treatment, with each goat serving as a replicate and being housed in a separate pen with access to feeding and water troughs. Goats were introduced to the diets in a completely randomized design at 5% of their body weight. Silage was offered at 0800 and 1600 h. Provision was made for a daily feed allowance of 10% above the previous week's consumption. Fresh water was made available on demand. The daily voluntary intake was calculated by subtracting feed remnants from the feed offered the previous day. The weight changes in goats were determined by weighing them every week before feeding in the morning.

Blood collection

At the end of feeding trial (91 d), two sets of blood samples were taken from each animal via a jugular vein puncture using a 10 mL 20 gauge syringe and 10 gauge needles. One set of the blood samples (5 mL) was collected into plastic tubes containing the anti-coagulant ethylene diaminetetraacetic acid (EDTA) for the determination of hematological parameters. The other set of blood samples (10 mL) was collected into anti-coagulant free plastic tubes, allowed to coagulate at room temperature and centrifuged for 5 min at 3000 rpm. The supernatant sera were then stored in a freezer for subsequent biochemical analysis.

Chemical analysis

Dried samples of feeds were milled using a 2 mm sieve in a Thomas hammer mill. (Cat. No. 3379-R30; Arthur Thomas Co.; Swedesboro, NJ, USA). Samples were analyzed for nitrogen by the micro-Kjeldahl method (AOAC, 1990). Dry matter content (DM), ether extraction and ash content were determined according to the Official Methods of Analysis (AOAC, 1990) while neutral detergent fiber (NDF), acid detergent fiber (ADF) and acid detergent lignin (ADL) were determined according to method of Van Soest *et al*. (1991).

Blood analysis

The hematological values of the blood samples were estimated for the packed cell volume (PCV) by the Jain (1993) method and the hemoglobin (Hb) concentration according to the method of Schalm *et al*. (1975). Red blood cell (RBC), total white blood cell count (WBC) and differential WBC counts were determined using the improved Neubauer hemocytometer counting chamber (BS748:1982; British Standard Institution; London, UK) after appropriate dilution. Mean corpuscular hemoglobin (MCH), mean corpuscular volume (MCV) and mean corpuscular hemoglobin concentration (MCHC) were calculated from RBC, Hb and PCV values, respectively, according to Dachie and Lewis (2001). Urea nitrogen and glucose were determined by an enzymatic colorimetric method (Helmut and Yvette, 1959) and the spectrophotometer was read at wavelengths of 550 nm and 600 nm, respectively. Creatinine was determined by the method of Bonsnes and Taussky (1945) while cholesterol was determined by the method of Allain *et al*. (1974). Serum total protein and albumin were determined by the method of Peters *et al*. (1984) and globulin according to

Coles (1986). The activity of the two enzymes, alanine aminotransferase (ALT) and aspartate aminotransferase (AST), was measured using the method of Reitman and Frankel (1957).

Statistical analysis

Data obtained were analyzed with the general linear model of SAS (1998) and the Duncan option of SAS (1998) and multiple range tests were used to detect significant differences among means at a level of 5%.

RESULTS AND DISCUSSION

The proximate composition of ensiled mixtures of elephant grass with lima bean, pigeon pea and African yam bean fed to West African Dwarf goats is presented in Table 1. Among the ensiled mixtures, crude protein (CP) ranged from 30.8% in Diet 2 to 31.5% in Diet 3. Ether extract was between 4.8% in Diet 2 and 6.1% in Diet 3. The lowest value of ether extract (EE) was obtained in Diet 2. However, Diet 4 was highest in NDF (40.2%) and in ADF (21.0%). The highest values of ADL (8.3%) and NFE (41.2%) were obtained for Diet 3 and these values differed significantly from the other diet treatments. The DM, CP, ash and EE values were higher than values reported elsewhere (Nkosi *et al*., 2010), probably due to combination of the legumes with grass. This corroborated the findings of Baraza *et al*., (2009) that different silage types resulted in different nutritional composition. The high NDF, ADF and ADL values obtained for elephant grass corresponded with reported values for guinea grass silage (Oduguwa *et al.,* 2007; Babayemi, 2009). The crude protein levels obtained for the mixtures of grass/legume silages and sole grass in this study were higher than 7.0 g per 100 grams recommended for small ruminants (NRC, 1981) and 10–12 g per 100 grams recommended by ARC (1980).

The performance of the goats fed ensiled mixtures of grain legume plants with elephant grass revealed significant differences among the treatments (Table 2). Goats fed Diet 3 had the highest DM intake (768 $g.d^{-1}$) whereas those fed Diet 1 had the least intake (579 $g.d^{-1}$). Goats fed silage did not differ significantly in DM and CP intake (gram per kilogram metabolic weight ($W^{0.75}$) per day) compared to goats on elephant grass silage. The dry matter and CP intakes for goats on Diet 3 were 71.2 and 28.8 g per kilogram $W^{0.75}$ per day, respectively, while the lowest values

Table 1 Chemical composition (g per 100 grams dry matter) of ensiled mixture of elephant grass and lima bean, pigeon pea and African yam bean plants.

Silage mixture (Diet)	Dry matter	Crude protein	Ether extract	Ash	NDF	ADF	ADL	NFE
Elephant grass + Pineapple pulp	36.6^{b}	12.4^{b}	2.8^{b}	2.5^{b}	41.4^{a}	25.2^{a}	8.6^{a}	56.6^{a}
Pigeon pea + Elephant grass + Pineapple pulp	36.2^{b}	30.8^{a}	4.8^{ab}	6.5^{a}	39.4^{a}	20.2^{b}	7.7^{b}	36.5^{c}
Lima bean + Elephant grass + Pineapple pulp	38.4^{a}	31.5^{a}	6.1^{a}	6.4^{a}	37.8^{b}	17.4^{c}	8.3^{ab}	41.2^{b}
African yam bean + Elephant grass + Pineapple pulp	38.6^{a}	31.2^{a}	5.4^{a}	5.9^{a}	40.2^{a}	21.0^{b}	7.9^{b}	35.0^{c}
SEM	0.21	4.21	1.22	1.50	1.31	1.27	0.28	3.44

$^{a\,b\,c}$ = Means in the same column with the same superscript are not significantly different ($P > 0.05$). NDF = Neutral detergent fiber, ADF = Acid detergent fiber, ADL = Acid detergent lignin, NFE= Nitrogen free extract, SEM = Standard error of the mean.

of DM (57.8 g per kilogram $W^{0.75}$ per day) and CP (21.78 g per kilogram $W^{0.75}$ per day) were observed in goats on Diet 1. The dry matter intake of goats on Diets 2 to 4 were not significantly different. Similarly, the ADF intakes of goats on Diets 1 and 2, as well as for goats on Diets 3 and 4 were not significantly different. The observed variations in values of the ADL intake by the goats were also similar ($P > 0.05$) among the treatments. The weight gain by goats on Diet 3 was the highest (63.6 $g.d^{-1}$) and differed significantly among the treatments. This was followed by weight gain of goats on Diet 2 (36.4 $g.d^{-1}$) and goats on Diet 4 (30.9 $g.d^{-1}$). The least weight gain was observed in goats fed Diet 1. The DM intake (grams per day) for the goats was higher than the value obtained for sheep on silage made from potato hash with whey or sugarcane molasses (Nkosi *et al*., 2010). The high DM intake observed in the mixtures over the sole elephant grass silage in the current study was due to the high concentration of CP. This agreed with the findings of Umuna *et al*. (1995). The low intake of elephant grass silage by goats in the current study was also observed for sheep fed solely guinea grass silage (Babayemi, 2009).

It was clear that the DM intake reduced when ruminants were fed solely on grass silage. The differences in the DM intake were due to variations in the chemical composition of the different plants ensiled. The nutrient intake (g per kilogram $W^{0.75}$ per day) values of the goats on silage mixtures were better than those of goats on sole grass silage. The intakes of goats on Diet 3 showed the best performance with regard to nutrient intake and weight gain compared to the other mixtures ensiled. The high nutrient profile in the Diet 3 mixture increased the nutrient intake by the goats; this corroborated the findings of Kriszan and Randby (2007) that CP correlates positively with voluntary intake. The lowest weight gain was observed in goats on Diet 1 due to the low DM intake.

Table 2 Performance of West African Dwarf goats fed ensiled mixture of elephant grass and lima bean, pigeon pea and African yam bean plants.

Parameters	Elephant grass silage (Diet 1)	Elephant grass with pigeon pea silage (Diet 2)	Elephant grass with lima bean silage (Diet 3)	Elephant grass with African yam bean silage (Diet 4)	SEM
Dry matter intake ($g.d^{-1}$)	579^{c}	711^{b}	768^{a}	722^{b}	24.61
Nutrient intake in metabolic weight (g/kg W0.75/d)					
Dry matter	57.8^{b}	64.3^{a}	71.2^{a}	65.5^{a}	8.43
Crude protein	21.7^{b}	25.9^{a}	28.8^{a}	22.8^{ab}	3.07
NDF	48.9^{b}	48.3^{b}	52.7^{a}	47.4^{b}	1.10
ADF	32.3^{a}	32.7^{a}	30.4^{b}	30.7^{b}	0.88
ADL	10.1	8.3	8.0	8.5	1.24
Initial weight (kg)	7.4	7.5	7.4	7.3	0.11
Final weight (kg)	8.6^{b}	9.5^{b}	10.9^{a}	9.0^{b}	1.63
Weight gain ($g.d^{-1}$)	21.8^{c}	36.4^{b}	63.6^{a}	30.9^{bc}	5.48

$^{a\,b\,c}$= Means in the same row with the same superscript are not significantly ($P > 0.05$) different. NDF = Neutral detergent fiber, ADF = Acid detergent fiber, ADL = Acid detergent lignin, SEM = Standard error of the mean.

The hematology of the goats fed ensiled elephant grass with legume plants differed significantly among the treatments (Table 3). The packed cell volume (PCV) of goats on Diet 2 was significantly the highest (29.3%) whereas the values for goats on Diets 1, 3 and 4 were not significantly different. The PCV values were within those cited by Daramola *et al*. (2005) and Ikhimioya and Imasuen (2007). The hemoglobin content of goats on Diet 3 was the highest (91.0 $g.L^{-1}$) and was followed by value for goats on Diet 2 (90.8 $g.L^{-1}$) while the least value of hemoglobin was observed in goats on Diet 1.The hemoglobin concentrations were within the range 80–140 $g.L^{-1}$ reported for goats (Sirois, 1995). The highest red blood cell count was in goats on Diet 4 and was not significantly different from that of goats on Diet 3; however, the least RBC was observed in goats fed Diet 1 (9.9×10^{12} L^{-1}). The highest values of MCV and MCH were found in goats fed Diets 1 and 2. The MCHC of goats fed Diet 2 was the lowest in the treatments. The MCV, MCH and MCHC values in this study were within the normal ranges for clinically healthy goats (Sirois, 1995) which are 16-25 fL, 5-8 fmol and 28-34%, respectively. The white blood cell count was highest in goats fed Diet 3 (4.67×10^9 L^{-1}), followed by that of goats fed Diet 2 (4.58×10^9 L^{-1}). Although, the WBC values obtained for the goats were low, values for goats on Diets 1–3 were within the $4–13 \times 10^9$ L^{-1} for clinically healthy goats (Sirois, 1995). The lymphocyte concentration was high in goats on Diet 3 (69.0%) while the lowest lymphocyte concentration was observed in goats fed Diet 4 (48.5%). The lymphocytes values observed in the goats were higher than the 27.0–30.3% reported by Belewu and Ogunsola (2010). Lymphocytes are responsible for humoral and cell-mediated immunity responses (Mahgoub *et al*., 2008). Goats on Diet 4 had the highest neutrophil concentration, while the least concentration of neutrophils (28.5%) was observed in goats on Diet 2. The monocytes and eosinophils of the goats differed significantly. The highest values of monocytes (3.8%) and eosinophils (3.73%) were found in goats fed Diet 3. Monocytes are

Table 3 Hematological values of West African Dwarf goats fed ensiled elephant grass with legume plants.

Parameters	Elephant grass silage (Diet 1)	Elephant grass with pigeon pea silage (Diet 2)	Elephant grass with lima bean silage (Diet 3)	Elephant grass with African yam bean silage (Diet 4)	SEM
PCV (%)	25.5^{b}	29.3^{a}	26.8^{b}	25.8^{b}	1.11
Hb ($g.L^{-1}$)	80.6^{c}	90.8^{b}	91.0^{a}	90.6^{b}	0.74
RBC ($\times 10^{12}$ L^{-1})	9.9^{c}	10.8^{b}	14.3^{a}	14.8^{a}	1.62
MCV (FL)	25.76^{a}	27.13^{a}	18.74^{b}	17.43^{b}	1.55
MCH (fmol)	8.14^{a}	8.41^{a}	6.36^{b}	6.12^{b}	0.81
MCHC (%)	31.60^{c}	31.0^{c}	33.94^{b}	35.11^{a}	1.12
WBC ($\times 10^{9}$ L^{-1})	4.45^{c}	4.58^{b}	4.67^{a}	3.81^{d}	0.96
Lymphocytes (%)	53.3^{c}	67.0^{b}	69.0^{a}	48.5^{d}	1.81
Neutrophils (%)	31.3^{c}	28.5^{d}	37.3^{b}	40.3^{a}	1.43
Monocytes (%)	3.53^{a}	2.97^{c}	3.80^{a}	2.92^{c}	0.22
Basophils (%)	0.80	0.78	0.80	0.82	0.03
Eosinophils (%)	2.30^{d}	3.11^{c}	3.73^{a}	3.46^{b}	0.25

$^{a\,b\,c}$ = Means in the same row with the same superscript are not significantly different ($P > 0.05$). PCV = Packed cell volume, Hb = Hemoglobin, RBC = Red blood cell, WBC = White blood cell, MCV = Mean corpuscular volume, MCH = Mean corpuscular hemoglobin, MCHC = Mean corpuscular hemoglobin concentration, SEM = Standard error of the mean.

essential for the immune system because they are the precursors of macrophages; values obtained in this study were within 1-4% as reported (Sirois, 1995) for clinically healthy goats. The basophil values of the goats were similar ($P > 0.05$) in all the treatments.

The observed variations in the values of the serum biochemistry of the goats fed ensiled elephant grass with legume plants differed significantly except in the glucose concentration (Table 4). Goats fed Diet 4 had the highest total protein (70.2 $g.L^{-1}$), followed by goats on Diet 3 (62.0 $g.L^{-1}$). With the exception of the goats on Diet 1, the values obtained were within those reported elsewhere (Žubčič, 2001) for clinically healthy goats. Similarly, albumin was highest in goats fed Diet 2 (29.3 $g.L^{-1}$) and was least (24.0 $g.L^{-1}$) in goats fed with Diet 1. The values obtained were within the range 18.9–44.5 $g.L^{-1}$ for healthy goats (Žubčič, 2001). The highest globulin value was in goats fed Diet 4 (33.6 $g.L^{-1}$) followed by that of goats fed Diet 3 (26.0 $g.L^{-1}$) while the least value was in goats fed with Diet 1. The creatinine value in goats fed with Diets 2 and 3 did not differ significantly and the least value of 82.0 $\mu mol.L^{-1}$ was observed in goats fed with Diet 1. The urea nitrogen values of goats fed with Diet 2 was the highest (4.2 $mmol.L^{-1}$) and differed significantly among the goats fed mixtures of silage; goats fed with Diet 4 had the least urea nitrogen (3.5 $mmol.L^{-1}$). The urea nitrogen values obtained were within the normal range (3.5–10.7 $mmol.L^{-1}$) for healthy goats (Sirois, 1995). The highest values of ALT and AST were observed in goats fed with Diet 3. The least values recorded were in goats fed with Diet 1. AST and cholesterol are among the blood indices used for diagnosing hepatic damage; ALT is a liver-specific hepatocellular enzyme used to assess liver damage (Mahgoub *et al.*, 2008). The values of AST and ALT obtained fell within the normal ranges of 43–132 $IU.L^{-1}$ and 7–24 $IU.L^{-1}$, respectively (Sirois, 1995). The glucose concentrations of the goats were not significantly different. Goats fed Diet 3 had the lowest cholesterol content.

CONCLUSION

Goats fed silage made from elephant grass (*Pennisetum purpureum*) and lima bean (Diet 3) had the highest nutrient intake per metabolic weight which culminated in the optimal

Table 4 Serum biochemistry of West African Dwarf goats fed ensiled elephant grass with legume plants.

Parameter	Elephant grass silage (Diet 1)	Elephant grass with pigeon pea silage (Diet 2)	Elephant grass with lima bean silage (Diet 3)	Elephant grass with African yam bean silage (Diet 4)	SEM
Total protein ($g.L^{-1}$)	47.3^{d}	55.0^{c}	62.0^{b}	70.2^{a}	0.53
Albumin ($g.L^{-1}$)	24.0^{d}	29.3^{b}	26.2^{c}	28.4^{a}	0.46
Globulin ($g.L^{-1}$)	20.8^{c}	24.8^{b}	26.0^{b}	33.6^{a}	1.28
Creatinine ($\mu mol.L^{-1}$)	82.0^{c}	96.2^{a}	97.0^{a}	84.5^{b}	1.12
Urea ($mmol.L^{-1}$)	3.3	4.2	3.8	3.5	0.34
ALT ($IU.L^{-1}$)	5.7^{b}	6.6^{a}	6.7^{a}	6.3^{a}	0.81
AST ($IU.L^{-1}$)	49.5^{c}	50.0^{b}	51.9^{a}	51.6^{a}	0.33
Glucose ($mmol.L^{-1}$)	2.7	2.7	3.1	2.9	0.43
Cholesterol ($mmol.L^{-1}$)	37.2^{b}	34.0^{c}	31.2^{d}	42.0^{a}	1.56

$^{a\,b\,c}$ = Means in the same row with the same superscript are not significantly different ($P > 0.05$). ALT = Alanine aminotransferase, AST = Aspartate aminotransferase, SEM = Standard error of the mean.

weight gain per day observed. The results of the hematology and serum biochemistry of the goats fed this silage mixture revealed that it is safe and not detrimental to the health of the goats. The low cholesterol level observed indicates that it is suitable for human consumption.

LITERATURE CITED

Adeparusi, E.O. 2001. Effect of processing on some minerals, anti-nutrient and nutritional composition of African yam bean. **J. Sust. Agric. and Environ.** 3(1): 101–108.

Ajayi, F.T., S.R. Akande, A.A. Adegbite and B. Idowu. 2009. Assessment of seven under-utilized gain legume foliage as feed resources for ruminants. **Liv. Res. for Rural Dev.** 21(9). [Available from: www.lrrd.org/lrrd21/9/ajay21149.htm]. [Sourced: 6 June 2011].

Ajayi, F.T. and O.J. Babayemi. 2008. Comparative *in vitro* evaluation of mixtures of *Panicum maximum* cv Ntchisi with stylo (Stylosanthes guianensis), Lablab (*Lablab purpureus*), Centro (*Centrosema pubescens*) and Histrix (*Aeschynomene histrix*). **Liv. Res. for Rural Dev.** 20(6). [Available from: www.lrrd.org/lrrd20/6/ajay20083.htm]. [Sourced: 4 October 2011].

AOAC. 1990. **Official Methods of Analysis,** 15th ed. Association of Official Analytical Chemists. Washington, DC, USA.

Allain, C.C., L.S. Poon, W.R. Chan and P.C. Fu. 1974. Enzymatic determination of total serum cholesterol. **Clin. Chem.** 20: 470–475.

ARC. 1980. **The Nutrient Requirements Of Ruminant Livestock.** Commonwealth Agricultural Bureaux. Farnham Royal, Slough, UK 351 pp.

Bonsnes, R.W. and H.H.J. Taussky. 1945. Determination of creatinine in plasma and urine. **J. Biochem.** 58: 581–589.

Babayemi, O.J. 2009. Silage quality, dry matter intake and disputability by West African dwarf sheep of Guinea grass (*Panicum maximum* cv Ntchisi) harvested at 4 and 12 week regrowths. **Afri J. of Biotech.** 8 (16): 3983–3988.

Baraza, E., S. Angeles, A. Garcia and A.Valiente -Banuet. 2009. Adoption of silage as a Methodology to improve domestic goat productivity for marginal farmers of the Tehuacan valley in Mexico. **Liv. Res. for Rural Dev.** 21(9). [Available from: www.lrrd.org/lrrd21/12/bara 21215.htm]. [Sourced: 6 June 2011].

Belewu, M.A. and F.O. Ogunsola. 2010. Haematological and serum indices of goat fed fungi treated *Jatropha curca*s kernel cake in a mixed ration. **J. Agric. Biotech and Sust. Dev.** 2(3): 35–38.

Coles, E.H. 1986. **Veterinary Clinical Pathology of Domestic Animals.** 4th ed. W.B. Sanders Company, Philadelphia, PA, USA. 338 pp.

Dacie, J.V. and S.M. Lewis. 2001. **Practical Haematology.** 9th ed. Churchill Livingstone. London. 663 pp.

Daramola, J.O., A.A. Adeloye, T.A. Fatoba and A.O. Soladoye. 2005. Haematological and biochemical parameters of West African Dwarf goats. **Liv. Res. for Rural Dev.** 17 (8). [Available from: http://www.cipav.org.co/lrrd/lrrd17/8/dara17095.htm]. [Sourced: 4 June 2011].

Helmut, J.R. and S.L. Yvette. 1959. A simple method for the determination of blood Urea Nitrogen, with special automatic colorimeter analysis. **Clin. Chem.** 5: 617–620.

Igbekoyi, A.J. 2008. **Intake Growth and Digestibility of Ensiled *Albizia saman* Pods with Guinea Grass (*Panicum maximum* cv Ntchisi) by West African Dwarf Rams.** MSc. Thesis, University of Ibadan, Nigeria.

Ikhimioya, I. and J.A. Imasuen. 2007. Blood profile of West African Dwarf Goats fed *Panicum maximum* supplemented with *Afzelia Africana* and *Newbouldia laevis* **Pakistan J. of Nutr.** 6: 79–84.

Jain, N.C. 1993. **Essential of Veterinary Haematology. Comparative Haematology of Common Dometic Animals.** Lea and Febiger. Philadephia, PA, USA. 417 pp.

Krizsan, S.J. and A.T. Randby. 2007. The effect of fermentation on the voluntary intake of grass silage by growing cattle fed silage as a sale feed. **J. of Animal Sci.** 85: 984–996.

Mahgoub, O., I.T. Kadim, M.H. Tageldin, W.S. Al-marzooql, S.Q. Khalaf and A.A. Ali. 2008. Clinical profile of sheep fed non-conventional feeds containing phenols and condensed tannins. **Small Rum. Res.** 78: 115–122.

NRC. 1981. Nutrient Requirement of Goats: **Angora, Dairy and Meat Goats in Temperate and Tropical Countries.** National Academy of Sciences, No 15. Washington DC, USA. 93 pp.

Nkosi, B.D., R. Meeske and I.B. Groenewald. 2010. Effects of ensiling potato hash with either whey or sugarcane molasses on silage quality and nutrient digestibility in sheep. **Liv. Res. for Rural Dev.** 22(1). [Available from: www.lrrd.org/lrrd22/1/nkos22001.htm]. [Sourced: 6 June 2011].

Oduguwa, B.O., A.O. Jolaosho and M.T. Ayankoso. 2007. Effects of ensiling on the physical properties, chemical composition and mineral contents of guinea grass and cassava top silage. **Nig. J. of Animal Prod.** 34: 100–106.

Peters, T., E.T. Biamonte and B.T. Doumas. 1984. Protein (Total protein) in serum, urine and cerebrospinal fluid; albumin in serum. *In* W.R. Faulkner and S. Meites, (ed.). **Selected Methods in Clinical Chemistry, Vol. 9.** American Association of Clinical Chemistry. Washington, DC, USA. 682 pp.

Reitman, S. and S. Frankel. 1957. A calorimetric method for determination of serum glutamic oxalo-acetics transaminase, serum glutamic pyruvic transaminase. **Am. J. Clin. Path.** 28: 56–63.

SAS. 1998. **Statistical Analytical Systems.** SAS/STAT User's Guide Statistical Analysis Institute Inc. Version 6, 3rd ed. Cary, North Carolina, USA. 943 pp.

Schalm, O.W., N.C. Jain and E.J. Carroll. 1975. **Veterinary Haematology.** 3rd ed. Lea and Febiger. Philadelphia, PA, USA. 807 pp.

Sirois, M. 1995. **Veterinary Clinical Laboratory Procedure.** Mosby Year Book Inc. St Louis, MO, USA. 160 pp.

Sowande, O.S., A.B.J. Aina, E.B. Oguntona, A.O. Fanimo, V.U. Unaka, T.A. Hassan and M.O. Oseni. 2008. Performance, blood constituents and mineral balance of West African dwarf Sheep fed preserved elephant grass, layers droppings and cassava peel diets during dry season. **Nig. J. of Animal Prod.** 35: 90–102.

Umuna, N.N., P.O. Osuji, I.V. Nsahlai, H. Khalili and M.A. Mohammed -Salem. 1995. Effect of supplementing oat hay in lablab, sesbania, tagasaste and wheat middling on voluntary intake, N utilization and wheat gain of Ethiopia Menz Sheep. **Small Rum. Res.** 18: 113–120.

Van Soest, P.J., J.B. Robertson and B.A. Lewis. 1991. Methods for dietary fiber, neutral detergent fiber, and nonstarch polysaccharides in relation to animal Nutrition. **J. Dairy Sci.** 74: 3583–3597.

Žubčič, D. 2001. Some biochemical parameters in the blood of grazing German improved fawn goats from Istria, Croatia. **Vet. Archiv.** 71: 237–244.