Blood Count and Serum Biochemistry Profile in West African Dwarf Goats Fed Ensiled Mixtures of Cocoa Pod, Cassava Pulp and Acacia Leaf

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Research Article

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Abstract

This study investigated the effects of feeding ensiled graded combinations of cocoa pod, cassava pulp and Acacia leaf on haematological and serum biochemical of West African Dwarf goats. In the bid to control environmental pollution, the wastes of cocoa and cassava were applied as alternative feed ingredients for the goat in spite of its low nutrients' quality and digestibility. A total of Twenty-eight (28) WAD goats (bucks), aged 4 to 5 months with average body weight of 7.00 ± 0.2 kg was used in a completely randomized design for a 45 days study to evaluate the blood profiles of goats fed diet combinations (0:60:40) to (60:0:40). The results revealed significant differences in some of the blood parameters measured among the treatments. The red blood cell, packed cell volume and haemoglobin ranged from $4.90-7.87 \times 10^6/\text{ul}$, 19.25-26.83% and 7.33-11.15g/L respectively. The concentrations of mean corpuscular volume, mean corpuscular haemoglobin and mean corpuscular haemoglobin concentration varied significantly ($p < 0.05$), white blood cell ($5.57-9.75 \times 10^9/\text{L}$) were comparable and lymphocytes (%) ranged from 43.85-55.67. For serum biochemistry, values obtained for total protein and albumin with sodium followed the same trend while cholesterol, urea, creatinine and glucose followed the same trend. Alanine amino transferase, Aspartate aminotransferase and Alkaline phosphatase varied significantly ($p < 0.05$) among the treatment groups. Since the parameters measured were within the normal range for goats' blood profile, combinations of cocoa pod, cassava pulp with acacia leaves in the ratio of 0:60:40 to 20:40:40 as browse plants do not have any deleterious effect on the health of the animals.

Introduction

Presently, agricultural practices globally involved mixed farming which comprised of animal and crop production for proper utilization of resources and upgrade profitability (Yousuf *et al.*, 2013). One major factor which influenced livestock production system profitability is adequate feed utilization for productive and reproductive performance. Researchers has embarked on utilization of agro industrial by products and non-costly feeds with adequate nutritional composition due to high costs of concentrate diets. So, ruminants production survival especially in the tropics, diseases tolerant and feed conversion efficiency must be put into consideration (Oni *et al.*, 2010). Gebregiorgis *et al.* (2012) indicated that most farmers feed their animals with unbalanced nutrients intake which led to decrease feed intake, poor growth, reduced reproductive performance and milk production. Kim *et al.* (2012) reported that many of the agro industrial by products must be treated chemically, biologically and physically before using them as feeds. For example, cocoa pod was reported to contain 0.40% theobromine which can be eliminated or reduced during fermentation (Munier and Hartadi, 2012). Kenneth (2011) also reported that cassava products has helped in solving food challenges because it still gave high yield production where others food crops had failed. Samuel (2018) indicated that browse plants had been used as ruminants for many years especially during the dry seasons which means they are not affected by climatic changes. So, utilization of cassava pulp, cocoa pod and *Acacia* leaf could be good feed source for livestock in adverse environmental condition.

The effects of feed on blood profile of animals are very essential in determining the performance of such livestock not just on nutritional studies. It was reported that clinical examination is mandatory to diagnose any disease or infections and causal organisms so as to know the treatment applicable. So, blood profile verification is a mean of assessing the health status of the animals (Aderinboye *et al.*, 2009; Ojebiyi *et al.*, 2007). So, the means of getting safe and locally available feed ingredients to improve livestock reproduction especially goat production, prompted this study which aimed at determining the influence of cocoa pod based diets on the blood profile of West African Dwarf goats.

Materials And Methods

Experimental Site

The study was carried out at the Teaching and Research farm of the Department of Animal Science, Landmark University, Omu Aran, Kwara State, Nigeria. (Landmark university, 2011).

Experimental Animals and Design

Twenty-eight (28) West African dwarf goats (bucks), aged between 4 to 5 months with average body weight of 7.00 ± 0.2 kg was sourced from livestock market at Otun Ekiti. The animals were allotted to seven dietary treatments after 14 days of acclimatization in a completely randomized design with 4 animals per treatment under intensive system of management.

Table 1: Dietary Composition and Calculated Nutrients of combinations of cocoa pod, cassava pulp and *Acacia* leaf to WAD Goats (%)

Feedstuffs (%) Control**Control**

	T ₁	T ₂	T ₃	T ₄	T ₅	T ₆	T ₇
Cocoa pod	0.00	10.00	20.00	30.00	40.00	50.00	60.00
Cassava pulp	60.00	50.00	40.00	30.00	20.00	10.00	0.00
Acacia leaf	40.00	40.00	40.00	40.00	40.00	40.00	40.00
	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Chemical Composition of the experimental diets (% Dry matter)

Dry matter	65.08	60.43	73.19	79.07	71.00	82.58	60.23
Moisture	34.92	39.57	26.81	20.93	29.00	17.42	39.77
Content							
Crude Protein	12.51	11.23	11.91	13.17	12.07	12.05	13.20
Crude fibre	5.18	7.85	15.66	12.23	11.68	9.91	5.07
Ether Extract	18.10	13.31	18.53	23.12	17.61	24.58	16.30
Ash	2.46	2.75	6.14	8.77	5.78	8.50	3.44
Nitrogen free extract	39.31	36.49	35.05	36.72	35.90	39.55	35.39

EXPERIMENTAL PROCEDURE**Feeding Trials and Growth Performance Measurement**

They were kept in well ventilated pens (3m x 1.5m) as described by Olawoye (2017). All the goats were weighed and randomly allotted to different dietary groups (Table 1). They were dewormed by using anthelmintic (Super Ivermectin), according to the body weight and sprayed with acaricide (Parannex) against external parasites. The goats were fed with experimental diets, early in the morning (8:00am) and fresh drinkable water were supplied (*ad libitum*) during the experimental period. The feeding trial was carried out for 45 days in a complete randomized design (CRD) experiment.

DATA COLLECTION**HAEMATOLOGICAL DETERMINATION**

Blood samples (10ml) were collected from jugular vein of each of the 28 WAD goats into sampling bottles using disposable syringes and sterile needles (18-gauge inches) for haematology and serum biochemistry analysis. Prior to feeding in the morning, bleeding was done and the blood samples were placed in three vacutainers. One set of the blood samples (3ml) was collected into plastic tubes containing the anti-coagulant ethylene diamine tetra-acetic acid (EDTA) for the determination of haematological parameters as described by Al-Eissa and Alkahtani (2011). All samples were analysed for the haematology by the Mindray BC 3200 automated analyser. Parameters determined were red blood cells (RBC), white blood cells (WBC), lymphocytes, monocytes, neutrophils, eosinophil, haemoglobin (Hb), mean corpuscular volume (MCV), mean cell haemoglobin (MCH) and mean cell haemoglobin concentration (MCHC).

SERUM BIOCHEMISTRY DETERMINATIONS

The remaining blood samples (7ml) was drawn into anti-coagulant free plastic tubes (universal bottle) with lithium heparin allowed to coagulate at room temperature for biochemical analysis. The serum biochemistry determinations were done using commercial test kits, Quimica Clinica Aplicada (QCA) test kits, Randox test kits and UV spectrophotometer (Jenway Spectrophotometer 6305). The serum alanine aminotransferase (ALT) activity was determined by the Reitman-Frankel method (Reitman, 1954). The serum alkaline phosphatase (ALP) activity was determined by the phenolphthalein monophosphate method (Babson, 1966) while the serum total proteins was determined by the direct Biuret method (Tietz, 1995).

STATISTICAL ANALYSIS

The data obtained from the growth performance and analyses of the blood samples were subjected to standard methods of statistical analysis using windows-based SPSS (Version 20.0, 2014). The analysis of variance (ANOVA) test was used and Level of significance was set at $p < 0.05$.

Results

Erythrocyte's indices: The parameters studied were significantly different ($p < 0.05$) along the rows except MCV and MCH. White blood cell differential, lymphocytes, neutrophils, monocyte and eosinophils significantly fell within the normal range among all the groups. White blood cell differential count, lymphocyte, neutrophils, monocyte and eosinophils were not significantly ($p < 0.05$) different among the groups. Along the row, the concentrations of lymphocytes were significantly different but the concentration in the group of animals fed T1 (0% cocoa pod) was the highest, followed by T2 (10% cocoa pod) and T3 (20% cocoa pod).

Leukocyte's indices: The parameters studied were significantly different ($p<0.05$) along the rows except total white blood cell count (WBCs) which increased significantly ($p<0.05$) in group T7 ($9.750.64 \times 10^9/L$) than other groups. Packed Cell Volume concentrations were significantly different ($p<0.05$) among the treatment groups. The PCV is the measure of the ratio of the volume occupied by the Red Blood Cells to the volume of the whole body. It should be noted that those on combinations of 0% cocoa pod, 60% cassava pulp and 40% acacia leaf (T1) to combinations of 20% cocoa pod, 40% cassava pulp and 40% acacia leaf (T3) resulted in a significant ($p<0.05$) increased in PCV at the end of the study; suggesting that the combinations offered the animals a better plane of nutrition.

Table 2: Effect of ensiled combinations of cocoa pod and cassava pulp and acacia leaves on Haematological Parameters of West African Dwarf Goat

Parameters	Range	T1 (0/60/40)	T2 (10/50/40)	T3 (20/40/40)	T4 (30/30/40)	T5 (40/20/40)	T6 (50/10/40)	T7 (60/0/40)
PCV (%)	22-38	26.83 ^a ±1.44	23.40 ^{ab} ±1.55	22.27 ^{ab} ±1.84	21.53 ^b ±1.88	19.93 ^b 1.10	18.90 ^b 1.31	19.25 ^b 0.78
RBC ($10^6/UL$)	7-18	7.87 ^a 0.91	6.23 ^b 0.55	5.90 ^b ±0.46	5.57 ^a 0.55	5.30 ^b 0.76	5.13 ^b 0.86	4.90 ^b 0.57
WBC ($10^9/L$)	4-13	5.57 ^a 0.75	6.02 ^{ab} 0.73	6.90 ^{ab} 0.66	8.13 ^b 0.50	8.77 ^b 0.40	9.47 ^b 0.60	9.75 ^b 0.64
HB (g/dl)	7-15	7.33 ^a 0.74	8.87 ^b 0.75	9.53 ^c 0.85	9.70 ^c 0.70	10.37 ^d 0.51	11.40 ^e 0.92	11.15 ^e 0.78
MCHC (g/L)	30-36	33.47 ^a ±0.30	33.50 ^a 0.30	33.47 ^a 0.06	33.70 ^a ±0.10	33.93 ^a 0.23	34.27 ^a 0.57	34.15 ^a 0.35
MCH (pg)	5.2-8	11.70 ^a ±1.05	11.40 ^a ±0.10	10.97 ^b ±0.14	10.77 ^b ± 0.71	10.40 ^b ±0.46	10.13 ^c ±0.57	10.00 ^c ±0.71
MCV (fl)	16-25	33.13 ^a ±2.59	32.12 ^a ± 2.16	31.27 ^c ± 2.80	31.13 ^c ± 2.03	31.00 ^c ± 2.61	30.53 ^d ± 2.01	30.25 ^d ± 1.90
LYMPHOCYTE (%)	50-70	55.67 ^a ±2.65	55.50 ^a ± 3.08	55.03 ^a ±2.64	51.90 ^{ac} ± 2.55	46.47 ^{bc} ± 2.84	43.57 ^b ± 2.00	43.85 ^{bc} ± 1.63
MONOCYTE (%)	0-4	2.44± 1.62	3.17± 2.57	2.90± 2.25	3.23±0.40	2.17±1.26	2.37± 0.40	2.50± 1.13
NEUTROPHILS (%)	30-48	30.70 ^{ab} ±4.69	32.00 ^a ± 6.56	27.03 ^{ab} ± 2.75	24.83 ^{ab} ±1.04	24.27 ^{ab} ± 2.24	21.67 ^b ±1.27	21.65 ^{ab} ± 0.49
EOSINOPHIL (%)	1-8	3.20 ^a ± 0.53	3.13 ^a ±0.51	2.90 ^{ab} ±0.17	3.00 ^{ab} ± 0.00	2.30 ^{ab} ±0.36	2.17 ^b ± 0.20	2.30 ^{ab} ± 0.00

abcde = means within the same row with different superscripts are significantly ($P<0.05$) different.

T1: 0% cocoa pod, 60% cassava pulp and 40% acacia leaf; T2: 10% cocoa pod, 50% cassava pulp and 40% acacia leaf; T3: 20% cocoa pod, 40% cassava pulp and 40% acacia leaf; T4: 30% cocoa pod, 30% cassava pulp and 40% acacia leaf; T5: 40% cocoa pod, 20% cassava pulp and 40% acacia leaf; T6: 50% cocoa pod, 10% cassava pulp and 40% acacia leaf; T7: 60% cocoa pod, 0% cassava pulp and 40% acacia leaf

RBC= Red Blood Cells; WBC= White Blood Cells; PCV=packed cell volume and Hb=haemoglobin; MCH= Mean Corpuscular Haemoglobin; MCV= Mean Corpuscular Volume; MCHC= Mean Corpuscular Haemoglobin Concentration

*Reference ranges by Daramola *et al.* (2005); **Blood, *et al.* (2007).

The results from **Table 3** below showed serum biochemical parameters of West African Dwarf goats fed ensiled combinations of cocoa pod and cassava pulp and *Acacia Senegalia brevispica* leaves. Treatment has significant ($p<0.05$) effect on Total protein, Sodium, Glucose, AST, ALT, ALP, and inorganic phosphorus while Albumin, Total Cholesterol, Potassium, Urea and Creatinine were not affected by treatment ($p>0.05$). The Total protein decreased with increasing addition of cocoa pod and the differences in the values were significant ($p<0.05$) at widely varied ratios of mixture of the feed inputs. The glucose (mg/dl) determined in this study increased significantly in group on combinations of 0% cocoa pod, 60% cassava pulp and 40% acacia leaf (T1) (35.60 mg/dl), on combinations of 10% cocoa pod, 50% cassava pulp and 40% acacia leaf (T2) (41.60 mg/dl) when compared with groups on combinations of 50% cocoa pod, 10% cassava pulp and 40% acacia leaf (T6) (60.50mg/dl) and on combinations of 0% cocoa pod, 60% cassava pulp and 40% acacia leaf (T7) (61.30mg/dl), respectively. Glucose and ALT, increased with decreasing cassava pulp and differences in the values were significant at widely varied ratios of the feed inputs. Comparatively cocoa pod seemed to supply high sodium and the addition of cassava pulp exerted marked reduction ($p<0.05$) in sodium along the row. Cocoa pod supplied inorganic phosphorus in significant ($p<0.05$) amount as the ratio of the mixture of the feed inputs became wider.

Table 3. Serum Biochemical Parameters of West African Dwarf Goats fed combinations of cocoa pod and cassava pulp and *Acacia Senegalia brevispica* leaves

Parameters	T1 (0/60/40)	T2 (10/50/40)	T3 (20/40/40)	T4 (30/30/40)	T5 (40/20/40)	T6 (50/10/40)	T7 (60/0/40)	P-value
Total Protein (g/dl)	7.23 ^a ±0.06	6.67 ^{ab} ±0.40	6.50 ^{abc} ±0.20	5.90 ^{abcd} ±0.56	5.60 ^{bcd} ±0.44	5.20 ^{cd} ±0.51	5.00 ^d ±0.99	0.001
Albumin (g/dl)	3.70±0.36	2.97±0.83	2.77±0.70	2.67±0.67	2.40±0.79	2.17± 0.81	2.10± 0.71	0.206
Total Cholesterol (mg/dl)	82.60±3.99	97.77±3.72	108.27±5.32	123.00± 6.84	123.07±6.25	126.70± 6.23	118.55±5.35	0.460
Sodium (mmol/L)	136.13 ^a ±0.61	121.17 ^b ±9.38	114.60 ^{bc} ±3.77	110.43 ^{cd} ±1.17	106.03 ^{cd} ±2.30	100.40 ^d ± 3.55	99.70 ^d ± 1.98	0.000
Potassium (mmol/L)	4.97±0.25	5.33±0 .65	5.50±0.80	5.63± 1.01	5.83±0.90	6.00±0.85	5.50± 0.71	0.753
Urea (mg/dl)	26.90±2.00	34.43±2.11	38.93±2.71	40.43± 3.44	43.47± 3.45	45.60± 3.56	40.85±3.69	0.883
Glucose (mg/dl)	35.60 ^a ±3.15	41.60 ^{ab} ±4.89	48.47 ^{ab} ±4.82	50.77 ^{ab} ±5.34	55.53 ^{ab} ±5.37	60.50 ^b ± 6.76	61.30 ^{ab} ±6.47	0.035
Creatinine (mg/dl)	0.90±0.17	1.47±0.49	1.73±0 .67	1.77±0.71	2.10±0.72	2.20±0 .70	2.30±0.71	0.189
AST (IU/L)	91.57 ^a ±6.12	104.67 ^{ab} ±7.85	111.73 ^b ±7.14	130.80 ^c ±7.31	136.10 ^c ± 7.52	141.37 ^c ±8.30	143.20 ^c ±8.78	0.000
ALT (IU/L)	45.23 ^a ±3.16	64.93 ^{ab} ±4.39	73.96 ^{ab} ± 4.42	86.70 ^{ab} ±5.91	94.77 ^{ab} ± 6.92	106.03 ^b ±6.44	104.60 ^{ab} ±6.46	0.024
ALP (U/L)	60.90 ^a ±3.63	79.63 ^{ab} ± 4.41	93.77 ^{abc} ±5.82	99.73 ^{abc} ±6.63	111.53 ^{bc} ±6.79	130.07 ^c ± 6.30	131.10 ^c ±6.23	0.001
Inorganic Phosphorus (mg/dl)	5.73 ^a ±0.21	6.63 ^{ab} ± 0.59	6.83 ^{abc} ±0.65	8.47 ^{bc} ±0.87	8.77 ^{bc} ±0.95	9.37 ^{bc} ± 1.50	9.45 ^d ±0.91	0.001

^{abcd} = means within the same row with different superscripts are significantly (P<0.05) different.

T1: 0% cocoa pod, 60% cassava pulp and 40% acacia leaf; T2: 10% cocoa pod, 50% cassava pulp and 40% acacia leaf

T3: 20% cocoa pod, 40% cassava pulp and 40% acacia leaf; T4: 30% cocoa pod, 30% cassava pulp and 40% acacia leaf

T5: 40% cocoa pod, 20% cassava pulp and 40% acacia leaf; T6: 50% cocoa pod, 10% cassava pulp and 40% acacia leaf

T7: 60% cocoa pod, 0% cassava pulp and 40% acacia leaf

AST = Aspartate aminotransferase; ALP = Alkaline phosphatase; ALT = Alanine aminotransferase.

Discussion

HAEMATOLOGY

The diets in this study imposed significant differences (p<0.05) on the blood profile of the animals. Most of the Erythrocyte Indices still fell within the normal range reported for blood functions by Daramola *et al.* (2005); Blood *et al.* (2007) and Arash (2018). It had been reported that haematological indices revealed the physiological state and health status of the animals to their environments which helped in diagnosing the suspected toxicant in feed given (Isikwenu *et al.*, 2012). The results of the analysis showed that Packed Cell Volume values corroborated the reports of Swati and Varsha (2014). Such high PCV values had been regarded as signs of healthy state and high productive and resourceful animals according to Addass *et al.* (2010). It was observed that feeding West African Dwarf goats with 0-20% cocoa pod supplementation could probably have a high tendency for a

return of PCV to normal level as the goat is the only animal with PCV value higher than 22% documented by Veterinary manual for goats to be normal for circulatory system in goats (Susan, 2015). Ikhimioya and Imasuen (2007) also indicated that only goats on those combinations could probably have a high tendency for a return of PCV to normal level following an infection through compensatory accelerated production; as they were the only animals with PCV value above minimum levels 22% documented by Daramola and Adeloye (2005) to be adequate for circulatory system in goats. The low PCV values which were reported in the combinations of (30:30:40) to combinations of (60:0:40) in the study could be a result of hepatic toxicity consequent on high intake of cocoa pod according to Adeyina (2008). The increase in final PCV values (26.83%) for the goats on combinations of (0:60:40); combinations of (10:50:40) (23.40%) and combinations of (20:40:40) (22.27%) might be due to increased dietary nutrients indicative of compensatory accelerated production of PCV. The PCV values observed in this study were comparable with the range of values (22-30%) earlier reported for WAD goats by Daramola and Adeloye (2005).

Recently, the researches indicated that cocoa pod that can be developed and processed into high valuable feedstuffs (Wulandari *et al.*, 2014). The major limitation of cocoa pod in this respect is the alkaloid and theobromine that may have cumulative effect in livestock production system. Red Blood Cells (RBCs) counts ($4.90-7.87 \times 10^6/\mu\text{l}$) was within the normal range of $7-18 \times 10^6/\mu\text{l}$ (Blood *et al.*, 2007; Daramola *et al.*, 2005). Since it is the red blood cells (RBCs) that carried the respiratory pigments (Hb), reduction in the amount of red blood cell means reduction in the amount of haemoglobin which resulted in oxygen accessed by the animals. The Hb values (7.33-11.15g/dl) among the treatment groups fell within the normal range (7.00 to 15.00g dL⁻¹) as reported by Tambuwal *et al.* (2002) for WAD goats and Sudanese goats (Babeker and Elmansoury, 2013). The decrease in Haemoglobin (Hb) content on combinations of 0% cocoa pod, 60% cassava pulp and 40% acacia leaf and combinations of (20:40:40) in this study would have translated to an advantage in favour of the animals on decrease in cocoa pod content which resulted in low theobromine concentrations. Such an observation was regarded by Opara *et al.* (2010) as an advantage in terms of the blood's oxygen-carrying capacity.

The mean corpuscular haemoglobin (MCH) and mean corpuscular volume (MCV) were not significantly ($p>0.05$) different on combinations of (0:60:40) to combinations of (10:50:40). The values ranged between 30.25 and 33.13fl and 10.00–11.70pg respectively. The mean corpuscular volume (MCV) and the higher MCH values recorded in the present study compared well with the values reported elsewhere by Anya (2018) who described MCV as indications of regenerative anaemia emanating from high destruction which led to erythropoiesis in the tissues. The mean corpuscular haemoglobin concentration (MCHC) was not significantly different ($p>0.05$) among the groups. The concentrations obtained across the treatments for MCHC in this study (33.47- 34.27g/dl) were within 30.00-36.00g/dl reported by (Daramola and Adeloye, 2005) for clinically healthy animal. Increase in MCHC on combinations of (50:10:40) and combinations of (60:0:40) implied that the animals were suffering from anaemia.

In general, the differences in all the parameters measured in all groups could be a result of varied concentrations of the ingredients. The total white blood cells (TWBC) fell within values earlier reported for WAD goats (Daramola *et al.*, 2005) and Sudanese goats (Babeker and Elmansoury, 2013). West African Dwarf goats seemed to possess protective system, providing a quick defence against any infection and this is probably the physiological basis for the adaptation of this species to this ecological zone which is characterized by high occurrences of diseases (Opara *et al.*, 2010). The White Blood Cells played a prominent role in disease resistance especially with respect to the generation of antibodies. In 0-20% inclusion of cocoa pod, WBC counts ($5.57 \times 10^9/\text{L}$ to $6.90 \times 10^9/\text{L}$) were lower than the value ($5 \times 10^6/\text{dl}$ to $11 \times 10^6/\text{dl}$) reported by Scott *et al.* (2006) for sheep but within the level reported for WAD goats (Daramola *et al.*, 2005). This implied that goats on diets of (0:60:40) to (20:40:40) remained clinically healthy as indicated by researchers (Konlan *et al.*, 2012). and that the animals had good immune defence system against any foreign body in the circulatory system. The white blood cell (WBC) played a prominent role in disease resistance especially with respect to the generation of antibodies.

The WBC counts in this study ($8.46-12.75 \times 10^9/\text{L}$) was lower than the ($23.40 \times 10^9/\text{L}$) value obtained by Anya (2018) but fell within the level ($4-13 \times 10^3/\text{UL}$) reported for WAD goats (Daramola *et al.*, 2005). This confirmed that goats on the diets on combinations of (0:60:40) to (20:40:40) still remained clinically healthy as indicated by researchers (Tweyongyere and Katongole, 2002; Konlan, 2012). High value of WBC has been associated with toxicity of diets or poor detoxification process as the WBC is responsible for fighting foreign substances in the body (Nwakolor, 2001; Alexander *et al.*, 2008). The condition is elicited in this study at dietary levels of (30:30:40) to combinations of (60:0:40). Lymphocytes used the blood to travel round the body but can wander freely in other types of tissues using the lymphatic channels. The lymphocytes are also known to play key roles in the immune defence system as a function of the immune status. High lymphocytes in animal blood showed ability to resist viral, parasitic and bacterial infection. In summary, the values reported on combinations of (0:60:40) to (20:40:40) fell within the values (50–70%) reported by Daramola *et al.* (2009) for normal blood profile of WAD goats, however, with increasing cocoa pod, the decline in the blood lymphocytes may be traced to the increasing theobromine in the diets upon which compromise the animal dies.

SERUM BIOCHEMISTRY

Biochemical indices contributed to the knowledge of metabolic profiles in feedlots performance of West African Dwarf goats and their possible disorders according to Oloche (2015). Serum parameters have been reported to be important in the proper maintenance of the osmotic pressure between the circulating fluid and tissue space so that the exchange of materials between the blood and cell could be facilitated (Isidahomen, Njidda and Olatunji, 2012). The Total proteins in the diet combinations of (0:60:40) to (20:40:40) (6.50-7.23g/dl) were comparable to the normal range of goats (6.4-7.5g/dl) reported by Dhanotiya (2004). The results in this study were lower than 9.8 g/dl reported by Ibrahim *et al.* (2005) and 7.48 g/dl reported by Zubcic (2001), and the difference is suggestive of the influence of feeds on the goats according to Anya (2018). The albumin in this study (2.10-3.70g/dl) compares well with 2.7-3.9g/dl reported by Dhanotiya (2004) and 3.30g/dl reported by Ibrahim *et al.* (2005). The Total Protein and Albumin obtained for the diet on combinations of (0:60:40) (7.23g/dl and 3.70g/dl) respectively to (20:40:40) (6.50g/dl and 2.77g/dl) showed that the

high levels of total protein and albumin were safe and beneficial, and according to Soliva *et al.* (2005) impact some qualities of rumen undegradable protein, to improve the protein availability and utilization. Albumin which is also very good indicator of health was observed to be normal in this present study.

There comparable values of the cholesterol suggested that the meat from the experimental animals was safe for consumption according to Igwebuike *et al.* (2008) who reported that cholesterol in the serum is associated with the quantity and quality of protein supplied in the diet. It can therefore be concluded that the protein in the combinations of (0:60:40) to (20:40:40) are of good quality to meet the nutritional needs of the animals. The results on glucose agreed with the normal 50-75mg/dl for goats reported by Dhanotiya (2004), it thus appears plausible to infer that the observed depressed serum glucose in diet combinations of (30:30:40) (50.77 mg/dl) to (60:0:40) were due to cocoa pod intoxication according to Anya (2018). The measurement of the AST (Aspartate aminotransferase) and ALP (alkaline phosphatase) level ALP also assessed cardiac, hepatic and muscle function (Susan, 2015). Perhaps, this implied that goats fed diets on combinations of (40:20:40); (50:10:40) and (60:0:40) had severe liver injury and this could be responsible for the nervous disorder and infections. The response in terms of haematological indices and serum biochemistry profiles by dwarf goats indicated that cocoa pod and cassava pulp with acacia leaves up to a ratio of 20:40:40 can serve as a sustainable feedstuff for dwarf goats most especially during the dry-season without adverse effects. Thus, the formulated diets were rich in nutrients, highly digestible, and could meet the nutrient requirements for growth and maintenance by ruminant animals

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Declarations

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Conflict of interest- None

Ethics approval - Approval was obtained from the ethics committee of University of Ilorin, Kwara State, Nigeria.

Consent to participate- Informed consent was obtained from all individual participants included in the study.

Consent for publication- The participant has consented to the submission of the case report to the journal.

Availability of Data and material- All data generated or analysed during this study are included in this published article [and its supplementary information files].

Code Availability-Not applicable

Authors contributions- Fully contributed

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