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## Research Article

# Haematological Profile and Serum Biochemistry of West African Dwarf Goats Fed Sun-dried Yellow Cashew Pulp Based Diets

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## Abstract

**Background and Objective:** The urgent need for alternative feeding stuffs which are not in competition with humans and animals are not scarce but readily available at low cost led to the study of the effect of sun-dried yellow variety of cashew (*Anacardium occidentale*) pulp meal on the haematology and serum of west African dwarf goats. **Materials and Methods:** Four diets containing 0 (control), 10, 20 and 30% sun-dried yellow cashew pulp (SYCP) coded as T<sub>1</sub>, T<sub>2</sub>, T<sub>3</sub> and T<sub>4</sub>, respectively, were compared. Twenty growing goats of about 6-7 months having an average initial weight of 6.42 kg were randomly assigned to the treatments; each treatment had five experimental units. The goats were fed and watered *ad libitum*. Completely randomized design was used in this experiment and data obtained were subjected to one-way Analysis of Variance (ANOVA) at 95% level of significance. Means that were significantly different were separated using least significant difference (LSD). At the end of the study, blood samples were collected from 3 replicates per treatment into EDTA bottles and EDTA-free bottles for haematological and serum biochemical analyses, respectively. **Results:** Results showed that the WBC was highly significantly affected ( $p < 0.01$ ) with goats fed T<sub>4</sub> (30% SYCP) recording the highest WBC while those fed T<sub>2</sub> (10% SYCP) recording the lowest WBC. White blood cell increased from T<sub>2</sub> to T<sub>4</sub> as the inclusion level of SYCP increased. The lymphocyte was significantly affected ( $p < 0.05$ ) by the levels of inclusion of cashew pulp meal with goats fed T<sub>2</sub> (10% SYCP) recording the highest lymphocyte while those fed T<sub>1</sub> (0% SYCP) recorded the lowest lymphocyte. All other haematological parameters were not significant ( $p > 0.05$ ). For results on serum biochemistry, total protein, urea and cholesterol were significantly affected ( $p < 0.05$ ) by the levels of sun-dried cashew pulp meal inclusion with goats on T<sub>4</sub> recording the highest values for total protein and cholesterol while those on T<sub>3</sub> recorded the lowest values for total protein and cholesterol. Goats on T<sub>3</sub> recorded the highest urea value while those on T<sub>4</sub> recorded the lowest value for urea. **Conclusion:** This study indicated that sun-dried cashew pulp can be fed to WAD goats up to 30% level of inclusion in diets without an adverse effect on the haematology and serum profile of the goats. This will also provide a cheaper source of feed and also help to reduce environmental pollution. The inclusion of sun-dried yellow cashew pulp in the diets of WAD goats to 30% level is strongly recommended.

**Key words:** Serum, haematology, yellow cashew pulp, goats

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**Competing Interest:** The authors have declared that no competing interest exists.

**Data Availability:** All relevant data are within the paper and its supporting information files.

## INTRODUCTION

Livestock farmers in developing countries are faced with various challenges that lead to considerable fall in the production of certain livestock species like goats, cattle, swine and poultry, which further leads to protein shortage. This is due to the high cost of production that originates from increase in prices of conventional feed ingredients and livestock species. There is therefore an urgent need for alternative locally available and cheap sources of feed ingredients particularly those that do not attract competition in consumption between humans and livestock or have no direct relevance in human food channel. Cashew apple pulp is an example of such feeding stuff that does not attract competition in consumption between humans and livestock.

In Nigeria, cashew grows successfully in virtually all agro-ecological zones including the semi-arid areas but with high concentration in the middle belt areas in small holder farms and plantations. Cashew production comes from over 20 States. These include: Anambra, Benue, Cross River, Edo, Enugu, Imo, Kebbi, Kogi, Kwara, Nassarawa, Ogun, Ondo, Osun, Oyo, Plateau and Sokoto among others<sup>1</sup>. The Cocoa Research Institute of Nigeria (CRIN), which has national mandate on cashew production estimates national production to be around 70,000 MT annually. It maintained a cashew observatory in Ochaja, Kogi state, where lots of cashew are harvested annually<sup>2</sup>.

Muniz *et al.*<sup>3</sup> seeing the manner in which cashew apple pulp has been under utilized, suggested the development of a new product to minimize the pulp waste by fermenting the juice, yielding an alcoholic beverage such as wine. The pulp of cashew apple is very juicy, but the skin is fragile. When these fruits are dried, they turn brown due to effect of heat on them and these can be incorporated in feed to be fed to animals such as cattle and goats. It is rich in Vitamin C than oranges and contains high amount of mineral salts<sup>4</sup>. The cashew apple is very rich in vitamin C (262 Mg/100 ml of juice) and contains five times more vitamin C than orange.

Considering the very large quantity of cashew pulp produced during cashew season, sufficient cashew pulp can be gathered, processed, dried and stored to last throughout the dry season, thus overcoming the problem of seasonality in the production of cashew pulp. The availability of cashew at seasons when fresh succulent forage is in rare supply in Nigeria necessitates its exploration as feed for goats. Adequate utilization of cashew pulp by goats would not only increase feed resource base for goats but fill in gaps created by feed shortage in the dry season. Cashew pulp, when collected in large quantity and sun dried during its season could be stored and used as dry season feed for ruminants.

Inclusion of dried cashew apple waste in rabbit diet up 30% increased ( $p < 0.05$ ) the relative weights of kidney, liver and carcass cut parts<sup>5</sup>. The effects of sub-chronically administered extract on hepatocytes were minimal as the serum alkaline phosphatase, total bilirubin and total protein levels in treated animals were not significant ( $p < 0.05$ ).

Proteins also regulate and transport most of the constituent of plasma. The total protein level in the plasma is often used as an indication of health status of the patient<sup>6</sup>. Eggum<sup>7</sup> and Iyayi and Tewe<sup>8</sup> reported that serum urea and total protein contents depend on quality and quantity of protein supplied in the diet. Chronic diseases, such as liver and kidney disorders, cancer, parasitism and long term stress can be as a result of low total protein. Increased values may show chronic infections, dehydration or leucemia<sup>6</sup>. The total protein in animals is always a reflection of the dietary protein and the state of the animal. Serum creatinine indicates the extent of muscle wastage.

To solve this problem of feed inadequacy, one possible source of cheap feed material to be used is sun-dried yellow cashew pulp meal (SYCP), which is mostly left to constitute environmental pollution during its season.

## MATERIALS AND METHODS

**Blood sample collection and analysis:** At the end of the study, blood samples were collected (via the jugular vein of the goats) from 3 replicates per treatment for haematological and serum biochemical analysis. Blood samples for hematological parameters were emptied into blood sample bottles containing Ethylene diamine tetra-acetate or tetra acetic acid (EDTA), an anticoagulant to prevent blood clotting. However, blood samples for serum evaluation were collected in bottles without EDTA in order to allow blood clot, so as to harvest the serum separately. Blood indices measured were red blood cell (RBC), white blood cell (WBC), packed cell volume (PCV), haemoglobin (Hb), mean corpuscular haemoglobin concentration (MCHC), mean corpuscular haemoglobin (MCH), mean corpuscular volume (MCV), neutrophils, eosinophils, basophils, lymphocytes, monocytes, total protein, blood urea, cholesterol, albumin, creatinine, Aspartate aminotransferase (AST), Alanine Aminotransferase (ALT) and Alkaline Phosphatase (ALP).

Hemoglobin estimation (Hb, MCH, MCV, MCHC, WBC, PCV, RBC), lymphocyte, monocytes, neutrophils, eosinophils and basophils were determined according to the method described by Baker and Silverton<sup>9</sup> using Abacus Junior Haematology Analyzer 2.75 (Diatro Count 3 Haematology EC Diatron, MJ PCC, Hungary).

Serum total protein concentration was determined by Biuret colorimetric reaction. Total cholesterol was determined according to the method described by Friedewald *et al.*<sup>10</sup> serum albumin concentration was determined by bromocresol green colorimetric reaction, according to the method described by Doumas *et al.*<sup>11</sup> creatinine by methods described by Bartels *et al.*<sup>12</sup>.

**Experimental design and statistical analysis:** Completely randomized design was used. Data obtained were subjected to one way analysis of variance (ANOVA) and means that were significantly different were separated using least significant difference (LSD) both contained in SPSS for Window, version 16.

## RESULTS

**Effect of feeding sun-dried cashew pulp based diets on haematological profile of experimental goats:** The effect of feeding sun-dried cashew pulp based diet on haematological profile is presented in Table 1 and 2. White blood cell was highly significantly increased ( $p < 0.01$ ) as lymphocyte significantly decreased ( $p < 0.05$ ) by the levels of inclusion of SYCP. All the other haematological parameters were not significantly affected ( $p > 0.05$ ). Goats fed  $T_4$  (30% SYCP) recording the highest WBC while those fed  $T_2$  (10% SYCP) recording the lowest WBC. White blood cell increased from  $T_2$  to  $T_4$  as the inclusion level of SYCP increased. Also, goats fed  $T_2$  (10% SYCP) recording the highest lymphocyte while those fed  $T_1$  (0% SYCP) recorded the lowest lymphocyte.

**Effect of feeding sun-dried cashew pulp based diets on serum biochemistry of experimental goats:** The effect of feeding sun-dried cashew pulp based diets on serum

biochemistry of experimental goats is presented in Table 3. Total protein, urea and cholesterol were significantly affected ( $p < 0.05$ ) by the levels of sun-dried cashew pulp meal inclusion. All other serum biochemistry parameters were not significantly ( $p > 0.05$ ) influenced by the inclusion of sun-dried cashew pulp meal. Goats on  $T_4$  recording the highest values for total protein and cholesterol while those on  $T_3$  recorded the lowest values for total protein and cholesterol. Goats on  $T_3$  recorded the highest urea value while those on  $T_4$  recorded the lowest value for urea.

## DISCUSSION

Values of PCV in this study ranged from 37.67% ( $T_2$ )-41.20% ( $T_4$ ) and this were higher than 32% reported by Frandson and Elmer<sup>13</sup> as normal values for sheep and also higher than 20.75-31.00% reported by Oduguwa *et al.*<sup>14</sup>, who fed WAD goats varying levels of pineapple and cassava peel wastes basal diet. Unlike the PCV value in this study, that of Oduguwa *et al.*<sup>14</sup> earlier cited was significant ( $p < 0.05$ ). The slightly high PCV values for  $T_1$  and  $T_4$  indicates relative polycythemia (increase in Red blood cells). Higher PCV values suggested a minimum parasite challenge and better nutritional status. Haemoglobin range of 188.33 g L<sup>-1</sup> ( $T_3$ )-237.00 g L<sup>-1</sup> ( $T_4$ ) obtained in this study is higher than 80-120 g L<sup>-1</sup> reported by Blood *et al.*<sup>15</sup> as normal haemoglobin values for goats and also higher than 73.0-106 g L<sup>-1</sup> reported by Oduguwa *et al.*<sup>14</sup>. The values of Haemoglobin reported by were significant ( $p < 0.05$ )<sup>14</sup>. Observed values indicated that dietary treatment did not result in deficiency of minerals such as iron and magnesium for the synthesis of haemoglobin that would otherwise have comprised the capability of the red cell to transport oxygen. The range of  $4.68 \times 10^{12}/L$

Table 1: Gross composition of experimental diets fed to west African dwarf goats

Ingredients (%)	Experimental diets			
	$T_1$ (0%)	$T_2$ (10%)	$T_3$ (20%)	$T_4$ (30%)
Cashew pulp	0.00	10.00	20.00	30.00
Bambara nut waste	28.80	18.00	13.50	8.00
Maize offal	19.20	18.00	11.00	4.00
Rice offal	3.00	3.00	4.50	6.00
Burukutu waste	37.00	39.00	39.00	40.00
Oil palm sludge	6.00	6.00	6.00	6.00
Cassava peel	3.00	3.00	3.00	3.00
Bone meal	2.00	2.00	2.00	2.00
Salt	1.00	1.00	1.00	1.00
Total	100.00	100.00	100.00	100.00
<b>Calculated values</b>				
Crude protein (%)	17.26	17.17	17.10	17.10
Crude fibre (%)	16.76	16.11	16.06	16.05
ME (Kcal kg <sup>-1</sup> )	2513.91	2540.40	2575.49	2603.25

ME: Metabolisable energy

Table 2: Effect of feeding sun-dried cashew pulp based diets on haematological profile of experimental goats

Parameters	Experimental diets				SEM
	T <sub>1</sub> (0%)	T <sub>2</sub> (10%)	T <sub>3</sub> (20%)	T <sub>4</sub> (30%)	
PCV (%)	39.64	37.67	37.94	41.20	0.62 <sup>ns</sup>
Hb (g L <sup>-1</sup> )	206.67	190.67	188.33	237.00	8.23 <sup>ns</sup>
WBC (× 10 <sup>9</sup> /L)	6.57 <sup>bc</sup>	4.66 <sup>d</sup>	8.54 <sup>ab</sup>	10.69 <sup>a</sup>	0.79 <sup>**</sup>
RBC (× 10 <sup>12</sup> /L)	5.60	6.42	6.65	4.68	0.48 <sup>ns</sup>
MCV (fl)	83.67	81.67	92.67	89.67	3.80 <sup>ns</sup>
MCH (pg)	18.53	21.37	20.30	16.30	1.07 <sup>ns</sup>
MCHC (g L <sup>-1</sup> )	201.67	231.33	207.33	266.67	14.22 <sup>ns</sup>
Lymphocytes (%)	42.00 <sup>b</sup>	51.67 <sup>a</sup>	43.00 <sup>b</sup>	42.67 <sup>b</sup>	1.54 <sup>*</sup>
Neutrophils (%)	48.00	41.33	48.33	50.00	1.34 <sup>ns</sup>
Monocytes (%)	8.33	6.00	7.00	6.50	0.75 <sup>ns</sup>
Eosinophils (%)	1.33	0.67	1.00	1.00	0.25 <sup>ns</sup>
Basophiles (%)	0.33	0.33	0.67	0.00	0.14 <sup>ns</sup>

<sup>a-d</sup>Means with different superscripts on the same row are significantly different (p<0.01) or (p<0.05). SEM: Standard error of mean, ns: Not significant, \*\*Significant at p<0.01, \*Significant at p<0.05. PCV: Packed cell volume, Hb: Haemoglobin, WBC: White blood cell, RBC: Red blood cell, MCV: Mean corpuscular volume, MCH: Mean corpuscular haemoglobin and MCHC: Mean corpuscular haemoglobin concentration

Table 3: Effect of feeding sun-dried cashew pulp based diets on serum biochemistry of experimental goats

Parameters	Experimental diets				SEM
	T <sub>1</sub> (0%)	T <sub>2</sub> (10%)	T <sub>3</sub> (20%)	T <sub>4</sub> (30%)	
Total protein (g L <sup>-1</sup> )	15.79 <sup>ab</sup>	7.73 <sup>c</sup>	6.91 <sup>c</sup>	26.71 <sup>a</sup>	2.91 <sup>*</sup>
Albumin (g dL <sup>-1</sup> )	3.00	2.43	3.31	3.03	0.14 <sup>ns</sup>
Urea (mg L <sup>-1</sup> )	10.85 <sup>c</sup>	31.08 <sup>ab</sup>	39.65 <sup>a</sup>	9.29 <sup>c</sup>	5.00 <sup>*</sup>
Cholesterol (mg dL <sup>-1</sup> )	107.94 <sup>c</sup>	134.97 <sup>ab</sup>	69.72 <sup>c</sup>	200.08 <sup>a</sup>	16.90 <sup>*</sup>
Creatinine (mg dL <sup>-1</sup> )	0.79	0.23	0.40	0.42	0.12 <sup>ns</sup>
ALT (U L <sup>-1</sup> )	7.57	8.96	3.79	5.76	1.71 <sup>ns</sup>
AST (U L <sup>-1</sup> )	33.60	49.70	63.58	49.18	5.70 <sup>ns</sup>
ALP (U L <sup>-1</sup> )	113.77	116.95	110.23	89.15	5.85 <sup>ns</sup>

<sup>a-c</sup>Means with different superscripts on the same row are significantly different (p<0.05), SEM: Standard error of mean, ns: Not significant, \*Significant at p<0.05, ALT: Alanine aminotransferase or glutamic pyruvic transaminase (SGPT), AST: Aspartate aminotransferase or glutamic oxaloacetic transaminase (SGOT) and ALP: Alkaline phosphatase

(T<sub>4</sub>)-6.65 × 10<sup>12</sup>/L (T<sub>3</sub>) obtained in this study for RBC are lower than 8 × 10<sup>12</sup>/L-18 × 10<sup>12</sup>/L reported by Blood *et al.*<sup>15</sup> as normal RBC values for goats. Low RBC values obtained in this study might have suggested that the experimental goats were susceptible to anaemia related disease conditions. White blood cell values (4.66 × 10<sup>9</sup>/L (T<sub>2</sub>)-10.69 × 10<sup>9</sup>/L (T<sub>4</sub>)) obtained in this study is within the normal range (4.0 × 10<sup>9</sup>/L-13.0 × 10<sup>9</sup>/L) for goats reported by Blood *et al.*<sup>15</sup>. The value for WBC in T<sub>4</sub> was significantly higher (p<0.01) than for other treatments. Values of lymphocytes in this study was significant (p<0.05) and ranged from 42.00% (T<sub>1</sub>)-51.67% (T<sub>2</sub>). The value for lymphocytes in T<sub>2</sub> was significantly higher (p<0.05) than for other treatments. All the authors cited fed different feeds to WAD goats. The variations in haematological parameters may be due to the difference in feed, methods of collection and handling of blood samples, as well as the environment, etc.

Total protein, urea and cholesterol were affected by the levels of sun-dried cashew pulp meal inclusion. All other serum biochemistry parameters were not affected. Total

protein was significantly (p<0.05) different among the treatments, with T<sub>4</sub> being significantly higher than for other treatments. This showed that there were differences in the immunity levels of the experimental goats. Values for total protein in this study (6.91 g L<sup>-1</sup> (T<sub>3</sub>)-26.71 g L<sup>-1</sup> (T<sub>4</sub>)) is lower than 59-74 g L<sup>-1</sup> reported by Blood *et al.*<sup>15</sup> as normal range of total protein for goats and also lower than 57.50-66.30 and 52.28-73.97 g L<sup>-1</sup> reported by Oduguwa *et al.*<sup>14</sup> and Olukomaiya *et al.*<sup>16</sup>. Low total serum protein could mean poor quality protein utilization Tambuwal *et al.*<sup>17</sup>. Olukomaiya *et al.*<sup>16</sup> studied the mineral composition of pastures and mineral status of west African Dwarf does manage under the traditional farming system during the wet season. Values for albumin in this study (2.43 g dL<sup>-1</sup> (T<sub>2</sub>)-3.31 g dL<sup>-1</sup> (T<sub>3</sub>)) are closely related to 2.7-3.9 g dL<sup>-1</sup> reported by Blood *et al.*<sup>15</sup> as normal range of albumin for goats, but lower than 3.35-3.76 g dL<sup>-1</sup>, reported by Oduguwa *et al.*<sup>14</sup>. This could mean that the goats were not prone to haemorrhage. The value for urea in T<sub>3</sub> was higher than for other treatments. The value for cholesterol in T<sub>4</sub>

was higher than for other treatments. Values of cholesterol 69.72-200.08 mg dL<sup>-1</sup> in this study is higher than 41.00-62.80 mg dL<sup>-1</sup> reported by Oduguwa *et al.*<sup>14</sup>. Creatinine values of 0.23 mg dL<sup>-1</sup> (T<sub>2</sub>)-0.79 mg dL<sup>-1</sup> (T<sub>1</sub>) obtained in this study is lower than 0.70-1.50 mg dL<sup>-1</sup> reported by Fraser<sup>18</sup> as normal values for goats. Lower values of creatinine do not suggest muscular wastage as higher values than normal does. Values for AST (33.60 U L<sup>-1</sup> (T<sub>1</sub>)-63.58 U L<sup>-1</sup> (T<sub>3</sub>)) obtained in this study are lower than 67-17 U L<sup>-1</sup> reported by Blood *et al.*<sup>15</sup> as normal values for goats. This indicated there was no damage to heart muscle, liver, muscle cells and to liver functions. The values of ALP (89.15 U L<sup>-1</sup> (T<sub>4</sub>)-116.95 U L<sup>-1</sup> (T<sub>2</sub>)) obtained in this study are within the normal range of 42-775 U L<sup>-1</sup> for goats reported by Blood *et al.*<sup>15</sup>. This could have indicated that inclusion of sun-dried cashew pulp meal in the diets of WAD goats up to 30% had no adverse effect on bone formation of the experimental goats. Abnormally high serum levels of ALP indicate bone disease, liver disease or bile obstruction. The variations in serum biochemistry parameters may also be due to the difference in feed, methods of collection and handling of blood samples, genetic composition of the animal and difference in environment, sex and age.

### CONCLUSION AND FUTURE RECOMMENDATION

Goats fed T<sub>4</sub> (30% SYCP) recorded the highest WBC while those fed T<sub>2</sub> (10% SYCP) recorded the lowest WBC which was significant. White blood cell increased from T<sub>2</sub> to T<sub>4</sub> as the inclusion level of SYCP increased. Those fed T<sub>2</sub> (10% SYCP) recorded the highest lymphocyte which was significant while those fed T<sub>1</sub> (0% SYCP) recorded the lowest lymphocyte. Goats on T<sub>4</sub> recorded the highest values for total protein and cholesterol which were significant while those on T<sub>3</sub> recorded the lowest values for total protein and cholesterol. Goats on T<sub>3</sub> recorded the highest urea value which was also significant while those on T<sub>4</sub> recorded the lowest value for urea. This study indicated that sun-dried cashew pulp can be fed to WAD goats up to 30% level of inclusion in diets without an adverse effect on the haematology and serum profile of the goats. This will also provide a cheaper source of feed and also help to reduce environmental pollution. The inclusion of sun-dried yellow cashew pulp in the diets of WAD goats to 30% level is strongly recommended. Further research involving the feeding of the red variety of cashew pulp to West African dwarf goats is also recommended.

### SIGNIFICANCE STATEMENT

This study discovered that yellow cashew pulp, when collected and sun-dried can be beneficial for the feeding of ruminants (especially west African dwarf goats used in this research) without any adverse effect. This study will help the researchers to uncover the critical areas of availability, non-harmfulness, resourcefulness (as a non-conventional feeding stuff) of sun-dried yellow cashew pulp and the uniqueness of the yellow variety (since most of the literature just studied cashew without being varietal specific) that many researchers were not able to explore. Thus a new theory on the utilization of yellow cashew pulp when sun-dried may be arrived at. Utilization of this material as feeding stuff is more beneficial, rather than been left to cause environmental pollution.

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