



Assessing the Hematology of Uda Rams Fed Graded Levels of Processed Cassava (*Manihot esculentus* L.) Peels

M. M. Mika'ilu¹, A. A. Kwaide², S. A. Maigandi¹, I. M. Ribah², K. M. Aljameel^{1*} and A. K. Muhammad¹

¹*Department of Animal Science, Usmanu Danfodiyo University, Sokoto, Nigeria.*

²*Department of Animal Science, Kebbi State University of Science and Technology Aliero, Kebbi State, Nigeria.*

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The experiment was carried out at Kebbi State University of Science and Technology, Aliero using thirty two (32) yearlings Uda Rams in two feeding trials ran concurrently. Sixteen (16) rams were used in each experiment with four treatments replicated four times in a completely randomized factorial design (2 × 4). The animal represents the replicates while the processing method (drying and ensiling) and the level of inclusion represents the treatments respectively. The level of inclusion are 0, 10, 20 and 30% dried cassava peels (DCP) and ensiled cassava peels (ECP) respectively. Data were collected in each trial on hematological characteristics. Data generated was subjected to analysis of variance and least significant difference (LSD) was used to separate the means. Hematological values of rams fed DCP were within the normal range while those fed ECP were below the normal range. The results shows significant difference (P<0.05) between dried and ensiled method of processing in terms of haemoglobin, MCH, WBC and MCV. Rams fed dried cassava peels had lower haemoglobin and PCV compared to normal range. It was concluded that there was no significant difference between rams fed dried cassava peels and those fed ensiled cassava peels at 30% level of inclusion.

*Corresponding author: Email: muhdkjameel@gmail.com;

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1. INTRODUCTION

1.1 Background of the Study

Small ruminants have the ability to utilize poor quality foodstuffs, such as grasses, legumes, forages, farm wastes and crop residues that are unsuitable for direct human consumption [1]. They are able to convert low quality feeds into food of high biological value for human beings. This is because they are adapted to utilize plant cell walls as major component of nourishment [2]. The semi-arid zone is the most important ecological region in the livestock industry of Nigeria (Malami *et al.*, 1998) and 70% of the small ruminants in the zone belong to the agro-pastoral system (FAO, 1991). Sheep husbandry have been developed in response to the climate and other environmental factors [3]. Kyiogwom *et al.* [4] reported that sheep rearing has been recognized as an integral part of the socio-cultural life of the people and hence production systems have remained largely traditional.

Ruminants, feed mainly on forages and crop residues and are affected by seasonality and experience seasonal weight fluctuation between the wet and dry periods of the year [5]. Seasonal availability of production inputs such as feed, water and quality pasture constitutes constraint to livestock production [6]. According to Adegbola [7], the scarcity of energy and protein feedstuffs during dry season is a major setback to ruminant livestock production in the tropics. During this period, the available forages are dry, protein content of which is very low and there is marked decrease in voluntary intake and digestibility by the animal [8-9]. Therefore, alternative sources of feed resources are being exploited.

The physiology of farm animals is affected by several factors, one of which is nutrition [10]. Nutritional status of an individual is dependent on dietary intake and effectiveness of metabolic processes. These can be determined by combinations of chemical, anthropometric, biochemical or dietary methods [11]. Feed is an important aspect of livestock production. The importance of feed supplementation in animal production has increased in the last few years [12]. Increase in meat production can be achieved through proper nutrition and inclusion of feed ingredients at normal or required levels

[13] Addass *et al.* [14] also posited that nutrition affects blood values of animals. Processing of feed could have effect on haematological parameters of farm animals (Aya *et al.*, 2013). Dietary content affect the blood profile of healthy animals as reported by Kortuglu *et al.* [15].

Cassava is among the feed resources exploited for its high fiber contents. Cassava has played a minor role as an ingredient in livestock feed in sub-Saharan Africa as cassava was often more expensive than imported maize [16]. The high cost of maize on the continent due to weather induced fluctuations, huge foreign debts and currency devaluation has forced a number of countries in Africa to search for alternatives to maize particularly for its livestock sub-sector [17]. The commonest parameter for measuring these implications is through the haematology of the animals [18]. Moreover, the comparison of blood profile with nutrient intake might indicate the need for adjustment of certain nutrients upward or downwards [19].

2. MATERIALS AND METHODS

2.1 Experimental Site

The study was conducted at Kebbi State University of Science and Technology Aliero. It is located in the Sudano-Sahelian zone in extreme North-Western part of Nigeria. Aliero is located at the southeast of Kebbi State. It lies between longitude 4°2'N and latitudes 12°12'N and at altitude of 350m above sea level. The average temperature of 28.3°C (82.9° F), however the maximum daytime temperature are most of the year below 40°C (104.0°F), the dryness makes the heat bearable. The warmest months are February to April, where daytime temperature exceed 42°C (107.6°F). The rainy season is from late May to October; during which showers are a daily occurrence. Rainfall starts late and ends early with mean annual rainfall ranging between 550mm to 650mm. There are two major seasons in the State namely: wet and dry seasons. The dry season starts from October and last up to April, in some part and may extend to May or June in other part. The wet season on the other hand begins in most part of the state in May and last up to September or October [20]. The hammattan, a dry, cold and fairly dusty wind is experienced in the state between November and February. Heat is more severe in the state in

March and April. But the weather in the state is always cold in the mornings and hot in the afternoons except during the hammattan period.

2.2 Sources and Processing of Experimental Feeds

The ingredients used in the experiments include: cassava peels, whole cassava root and cassava leaves which were sourced from Kebbi State while the remaining feed materials including maize, rice offal, cowpea husk, cowpea haulms, cotton seed cake and salt were purchased from Sokoto Kara market. Maize, CSC and Cassava peels was crushed to reduce their particle size and they were mixed with cowpea husk, soy bean meal, rice milling waste, premix, bone meal and salt to formulate the ration.

2.3 Experimental Design and Diet Formulation

A completely randomized experimental design (CRD) in a factorial layout (2 by 4) was used in this experiment with two processing methods (Dried and Ensiled) and graded levels (0, 10, 20 and 30) of formulated feeds representing treatments combinations, while each animal serves as replication. Four animals were allocated to each treatment in which an animal serves as replicate. The animals were balanced for weight according to treatment. Each animal was housed in a pen measuring 2m × 1m, which was disinfected. Each group was assigned to one of the experimental diets and fed *ad libitum*

in the morning for 12 weeks. Water was offered *ad libitum* to the animals too.

2.4 Experimental Animals and Management

Thirty-two (32) Uda rams yearlings aged by dentition [21] were purchased from village market (Aliero), the animals were quarantine at the Livestock Teaching and Research farm at Kebbi State University of Science and Technology so as to be adapted to their new environment, the animals were dewormed using albendazole super 10% (5 mg of their body weight) and was given an antibiotic as prophylactic treatment. The feeding pens were cleaned and disinfected a week before the experiment commence. Feaces and urine were removed every day from the feeding pens to ensure adequate hygiene, minimal ammonia accumulation, feed and water troughs were also cleaned every morning before feeding.

2.5 Data Collection

2.5.1 Blood sample collection

Blood samples were collected from the animals in each groups after 12 weeks of experiment, the blood samples were collected from jugular vein using sterilized disposable 5ml syringe and 23 gauge needle. The samples from each replicate of the treatments were collected in tubes coated with ethylene diamine tetra acetic acid (EDTA). The blood samples in the EDTA bottles were analysed for haematological parameters.

Table 1. Gross composition of the experimental diets containing dried cassava peels

Ingredients	Control	Dried Cassava peels				Ensiled Cassava peels		
	T1	T2	T3	T4	T2	T3	T4	
Cassava peels	0	10	20	30	10	20	30	
Maize	10.00	3.00	0.00	0.00	3.00	0.00	0.00	
Cowpea husk	25.00	23.00	25.00	21.00	23.00	25.00	21.00	
Wheat offal	24.00	18.00	9.00	6.00	18.00	9.00	6.00	
Rice offal	14.00	15.50	14.50	11.50	15.50	14.50	11.50	
Soya bean meal	0.00	5.00	8.00	10.00	5.00	8.00	10.00	
Cotton seed cake	25.00	24.00	22.00	20.00	24.00	22.00	20.00	
Salt	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
Premix	0.50	0.50	0.50	0.50	0.50	0.50	0.50	
Total	100	100	100	100	100	100	100	
Calculated Chemical Analysis								
Energy (Kcal/Kg)	2261	2266	2300	2261	2266	2256	2300	
Crude Protein (%)	15.0	15.0	15.0	15.4	15.1	15.2	15.6	
Crude Fibre	20.8	22.5	24.0	23.3	22.5	23.5	24.0	

2.6 Analytical Techniques

2.6.1 Haematological indices determination

The haematological parameters measured include: packed cell volume (PCV), red blood cells (RBC) count, white blood cells (WBC) count, leucocytes differential count and haemoglobin concentration (Hb) in accordance with the methods outlined by Bush [22].

Erythrocyte indices which include the mean corpuscular volume (MCV), mean concentration of haemoglobin (MCH) and mean corpuscular haemoglobin concentration (MCHC) were computed in accordance with the standard formulae of [23-24] as shown below:

$$MCV = \frac{PCV}{RBC \text{ Count In } 10^6/Mm^3} \times \frac{10}{1}$$

$$MCH = \frac{Hb (G/Dl)}{RBC (In 10^6/Mm^3)} \times \frac{10}{1}$$

$$MCHC = \frac{Hb (G/Dl)}{PCV (\%)} \times \frac{100}{1}$$

2.7 Statistical Analysis

Data collected were subjected to analysis of variance using SPSS version 22. Least Significant Difference (LSD) was used to express the difference between treatment means. The level of significance was set at $P < 0.05$.

3. RESULTS

3.1 Blood Haematological Characteristics of Uda rams fed graded levels of dried and ensiled cassava peels

Haematological result of rams fed graded levels of dried cassava peels is presented in Table 2. The result shows significant variation ($P < 0.05$) in PCV, MCV, MCHC, WBC, monocytes and neutrophil. Rams fed T2 had higher PCV compared to rams fed T1. There is no difference between T1, T3 and T4 in terms of PCV. Values obtained for PCV is within the normal reference range. MCV and WBC are higher for rams in T2 compared to those in T4. Neutrophils are higher in T3 and T4 compared to T2. Lower than normal range of RBC is observed in rams fed T1 and T3. While slightly higher values of MCHC is obtained for rams in T1 compared to normal range.

The haematological result of rams fed ensiled cassava peels (Table 3) shows significant variation ($P < 0.05$) in haemoglobin, MCH, MCV, MCHC, WBC and lymphocytes. RBC and MCV values are lower than normal range for all the treatments. While T3 and T4 had lower haemoglobin than normal reference range. Haemoglobin concentration is significantly higher ($P < 0.05$) in T1 and T2 compared to T3 and T4. MCH values are significantly ($P < 0.05$) higher for rams in T3 and T4 compared to those in T1 and T2. Lower MCV is recorded in T3 and T4 compared to T1 ($P < 0.05$). The only difference observed in terms of WBC is between T3 and T1. T2 had higher lymphocytes compared to T1, T3 and T4.

3.2 Main and Interactive Effect of Level of Inclusion and Processing Methods on Haematology of Rams Fed Graded Levels of Processed Cassava Peels

The main effect of level of inclusion level on blood haematology of Uda rams is presented in Table 4. The results shows significant difference ($P < 0.05$) in haemoglobin, RBC, PCV, MCH and Lymphocytes. Values obtained for RBC is lower than normal range for all the treatments. T3 and T4 had lower haemoglobin, while T1, T3 and T4 had lower PCV compared to normal reference range. T1 had higher MCHC while T4 had lower MCHC compared to normal range (Table 2). Rams fed T2 had higher ($P < 0.05$) values of haemoglobin, RBC, PCV and lymphocytes compared to T4. Higher MCH is recorded in T4 compared to T2. T1 record higher MCV and MCHC compared to T4. The results shows significant difference ($P < 0.05$) between dried and ensiled method of processing in terms of haemoglobin, MCH, WBC and MCV. Rams fed dried cassava peels had lower haemoglobin and PCV compared to normal range. RBC and MCV are also lower than normal reference range for rams fed ensiled cassava peels. Rams fed ensiled cassava peel gave significantly ($P < 0.05$) higher haemoglobin and MCV than those fed dried, while the reverse is the case in terms of MCH and WBC (Table 4).

4. DISCUSSION

4.1 Haematology of Uda Rams Fed Graded Levels of Processed Cassava Peels

The haematological characteristics of rams fed graded levels and forms of cassava peels as

shown in Tables 2-4 reveals the PCV values obtained were lower than the finding of Egbe-Nwiyi *et al.* [26] who reported value of 43.8-60% and 38-45% respectively, and within the range reported by Jain [24]. It further showed that in all the treatments, animals did not suffer from anaemia or dehydration. This confirms the report of Elmhust *et al.* [25] that a low PCV value was an indication of anaemia while sharp increase in PCV is most often caused by dehydration.

The haemoglobin (Hb) values obtained in the present study is decreasing with increasing levels of ensiled cassava peels supplementation while it is not significant with regards to dried cassava peels. The haemoglobin values were lower (both for those fed dried and ensiled) the normal range (8 – 16g/dl) of haemoglobin for healthy sheep [27] this may indicate lower oxygen circulation which in turn may leads to anaemia. Normally, increase in the Hb

concentration is connected with better ability to combat disease and infection. Low level is an indication of vulnerability of disease and poor nutrition [28]. The RBC values in this trial (both dried, ensiled and overall) were within the values obtained by Njidda *et al.*, [29] for values (6.49–9.25 g/dl) adult Uda breed of sheep. The values of RBC in this finding were similar to the reports of Frandson (1981); Aljameel *et al.*, [27] in sheep. The main function of the RBC is to carry oxygen from lung to the body tissue and transfer carbon dioxide from tissue to the lungs. The high RBC values may be related with conditions that cause the body to build too numerous red blood cells or impaired pulmonary function, while low RBC counts may be associated with iron deficiency, internal bleeding, some types of anemia or some vitamin deficiency [29]. Thus feeding graded levels and forms of cassava peels did not indicate mal-or-under nutrition of the animals.

Table 2. Haematological Parameters of Uda Rams Fed dried cassava peels

Parameter	Treatment				SEM	Reference values*
	T1	T2	T3	T4		
Haemoglobin (g/dL)	9.58	11.0	9.15	9.08	0.59	9-15
RBC (x10 ⁶ /ul)	7.63	9.00	8.13	7.65	0.46	9-15
PCV (%)	25.75 ^b	32.00 ^a	27.00 ^{ab}	27.00 ^{ab}	0.99	27-45
MCH (pg)	23.05	18.5	21.63	27.22	5.80	8-12
MCV (fl)	22.23 ^{ab}	30.00 ^a	21.71 ^{ab}	14.78 ^b	3.98	28-40
MCHC (g/dL)	35.37 ^a	31.75 ^b	32.20 ^{ab}	31.10 ^b	0.92	31-34
WBC (x 10 ⁹ /L)	4.00 ^{ab}	4.63 ^a	3.55 ^b	3.95 ^b	0.21	4-12
Monocyte (x10 ⁹ /L)	0.70 ^{ab}	0.63 ^b	0.70 ^{ab}	1.00 ^a	0.09	0-0.8
Lymphocyte (x10 ⁹ /L)	1.50	3.25	3.00	2.00	0.69	2-9
Neutrophil (x10 ⁹ /L)	2.00 ^{ab}	1.00 ^b	2.13 ^a	2.38 ^a	0.34	-

a,b,c means in the same row with different superscripts are significant ($P<0.05$) different. PCV- Packed cell volume, RBC- Red blood cells, MCV- Mean corpuscular volume, MCH- mean corpuscular haemoglobin, MCHC- mean corpuscular haemoglobin concentration, WBC-white blood cells. *source =[25]

Table 3. Haematological parameters of Uda Rams Fed Ensiled Cassava Peels

Parameter	Treatment				SEM	Reference values*
	T1	T2	T3	T4		
Haemoglobin (g/dL)	9.58 ^a	9.38 ^a	7.93 ^b	7.60 ^b	0.27	9-15
RBC (x10 ⁶ /ul)	7.63	8.15	7.53	7.23	0.42	9-15
PCV (%)	25.75	28.25	25.50	25.50	0.99	27-45
MCH (pg)	25.05 ^b	27.46 ^b	34.22 ^a	35.35 ^a	2.01	8-12
MCV (fl)	22.23 ^a	15.93 ^{ab}	10.58 ^b	10.55 ^b	2.57	28-40
MCHC (g/dL)	35.37 ^a	32.84 ^{ab}	31.13 ^b	29.85 ^b	1.06	31-35
WBC (x 10 ⁹ /L)	4.00 ^b	5.35 ^{ab}	5.75 ^a	4.95 ^{ab}	0.49	4-12
Monocyte (x10 ⁹ /L)	0.70	0.68	0.85	0.70	0.09	0-0.8
Lymphocyte (x10 ⁹ /L)	1.50 ^b	4.25 ^a	2.00 ^b	1.75 ^b	0.48	2-9
Neutrophil (x10 ⁹ /L)	2.00	2.25	1.75	1.74	0.65	-

a,b,c means in the same row with different superscripts are significant ($P<0.05$) different. PCV- Packed cell volume, RBC- Red blood cells, MCV- Mean corpuscular volume, MCH- mean corpuscular haemoglobin, MCHC- mean corpuscular haemoglobin concentration, WBC-white blood cells. *source =[25]

Table 4. Haematological parameters of Uda Rams fed Dried and ensiled cassava Peels

Parameter	Level of inclusion				SEM	Reference values*
	T1	T2	T3	T4		
Haemoglobin (g/dL)	9.75 ^{ab}	10.19 ^a	8.54 ^{bc}	8.34 ^c	0.40	9-15
RBC (x10 ⁶ /ul)	7.63 ^{ab}	8.58 ^a	7.83 ^{ab}	7.44 ^b	0.31	9-15
PCV (%)	25.75 ^b	30.13 ^a	26.25 ^b	26.25 ^b	0.98	27-45
MCH (pg)	23.05 ^{bc}	17.98 ^c	27.92 ^{ab}	31.29 ^a	1.98	8-12
MCV (fl)	22.23 ^a	22.96 ^a	16.15 ^b	12.67 ^b	1.83	28-40
MCHC (g/dL)	35.37 ^a	32.30 ^b	31.66 ^b	30.46 ^b	0.70	31-34
WBC (x 10 ⁹ /L)	4.00	4.99	4.65	4.45	0.33	4-12
Monocyte (x10 ⁹ /L)	0.70	0.65	0.78	0.85	0.07	0-0.8
Lymphocyte (x10 ⁹ /L)	1.5 ^b	3.75 ^a	2.5 ^{ab}	1.85 ^b	0.43	2-9
Neutrophil (x10 ⁹ /L)	2.00	1.65	1.43	2.06	0.67	-
Forms						
	Dried	Ensiled		SEM	Interaction	
Haemoglobin (g/dL)	8.62 ^b	9.70 ^a		0.30	NS	
RBC (x10 ⁶ /ul)	7.63	8.10		0.24	NS	
PCV (%)	26.25	27.94		0.81	NS	
MCH (pg)	30.03 ^a	20.10 ^b		3.16	NS	
MCV (fl)	14.84 ^b	22.18 ^a		2.21	NS	
MCHC (g/dL)	32.30	32.60		0.71	*	
WBC (x 10 ⁹ /L)	5.01 ^a	4.03 ^b		0.21	NS	
Monocyte (x10 ⁹ /L)	0.73	0.76		0.05	*	
Lymphocyte (x10 ⁹ /L)	2.38	2.44		0.38	*	
Neutrophil (x10 ⁹ /L)	1.67	1.87		0.47	*	

a,b,c means in the same row with different superscripts are significant ($P < 0.05$) different. PCV- Packed cell volume, RBC- Red blood cells, MCV- Mean corpuscular volume, MCH- mean corpuscular haemoglobin, MCHC- mean corpuscular haemoglobin concentration, WBC-white blood cells. *source = [25]

The white blood cells (WBC) were within the normal range values of sheep 4 to 12 x 10⁹/L Njidda *et al.*, [29] respectively. This trial showed that the animals fed both dried and ensiled cassava peels were healthy because decrease in number of WBC below the normal range is an indication of allergic conditions, while elevated values (leucocytosis) indicate the existence of a recent infection, usually with bacteria [30].

The neutrophils, lymphocytes and monocyte recorded in the study are comparably similar with the normal range observed by Elmhurst *et al.*, [25]. The non-significant variations in the WBC differentials values recorded in this study could be compared with the report of Bush [22]. Therefore, the differential count values obtained showed that the animals were in good health. This MCHC values reported in this indicates that the forms of cassava peels used were not toxic to the animals. The MCV, MCH and study were slightly lower than the normal reference range with the report of Elmhurst *et al.*, [25] respectively. These parameters were used to measure the size and hemoglobin content of erythrocytes and the values are useful in diagnosing various forms of anemia. The higher

MCH and MCV values may be due to age [26] The values of MCV and MCH are very important in the diagnosis of anemia and also serve a useful index of the capacity of the bone marrow to produce red blood cells [27]

Mean corpuscular Volume (MCV) values obtained for sheep were slightly lower than 35.3 – 43.7fl reported by Elmhurst *et al.*, [25,31]. These parameters were used to measure the size and hemoglobin content of erythrocytes and the values are useful in diagnosing various forms of anaemia.

5. CONCLUSIONS

Based on the findings of the study, Rams fed dried cassava peels have higher WBC, MCH and sodium while those fed ensiled cassava peels have higher haemoglobin, MCV and Albumin. All the remaining haematology and serum biochemistry parameters remains statistically similar ($P > 0.05$) between those fed dried and ensiled cassava peels.

The study recommend feeding cassava peels in dried form as the process of ensiling take time and additional cost.

DISCLAIMER

The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

ETHICAL APPROVAL

As per international standard or university standard written ethical approval has been collected and preserved by the authors.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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