

## Growth performance and haematological indices of mongrel rabbit bucks fed diets supplemented with Roselle (*Hibiscus sabdariffa*) calyx meal

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### Abstract

Many alternative feed resources have been identified and fed to rabbits without recourse to their physiological implications on the animals. Bioactive compounds present in Roselle and its content of vitamin C are believed to improve the performance of rabbits. To provide support to body defense mechanism, diets must contain sufficient amount of nutrients and antioxidants. The objective of this study was to evaluate the effects of dietary levels of Roselle calyx meal supplementation on growth performance and haematological indices of mongrel rabbit bucks. Twenty healthy mongrel rabbit bucks were purchased and used for this study. Four experimental diets were formulated to contain dietary levels of Roselle calyx meal at 0.00% (control), 2.00%, 4.00% and 6.00% and coded as T<sub>1</sub>, T<sub>2</sub>, T<sub>3</sub> and T<sub>4</sub> respectively. The four treatment groups were assigned to the four experimental diets in a completely randomized design. Each treatment was replicated three times with two rabbits per replicate. Each replicate received an assigned diet for eight weeks. The growth parameters evaluated were initial weight, final weight, total weight gain, daily weight gain, total feed intake, daily feed intake and feed conversion ratio. At the end of the experimental period, blood samples were collected from each replicate for haematological analysis. Haematological parameters determined in the course of the study include; packed cell volume (PCV), red blood cells (RBC), white blood cells (WBC), hemoglobin (HB), mean corpuscular hemoglobin (MCH), mean corpuscular haemoglobin concentration (MCHC), mean corpuscular volume (MCV), Neutrophils and lymphocytes. From the results, all the growth parameters evaluated except initial weight were significantly ( $p < 0.05$ ) influenced by Roselle calyx meal. Total weight gain was higher (231.33g) in T<sub>2</sub> (2.0% RCM) compared to other treatment groups. PCV (33.33%) and MCV (66.30fl) were higher in T<sub>4</sub> (6.0% RCM). T<sub>2</sub> (2.0% RCM) had higher WBC ( $5.80 \times 10^9/L$ ) while lower WBC was observed in T<sub>3</sub> (4.0% RCM). All the haematological indices evaluated varied ( $p < 0.01$ ) significantly among treatment groups. From the findings of this study, Roselle calyx meal supplementation at 2.0% in the diets of mongrel rabbit bucks is nontoxic, improves growth performance and ensures healthy status of mongrel rabbits.

**Keywords:** Mongrel rabbits, growth, Roselle, haematology

### Performance de la croissance et indices hématologiques de régimes alimentés de daim de lapins de Mongrel Supplément avec Roselle (*Hibiscus Sabdariffa*) Calyx Repas



### Résumé

De nombreuses ressources alimentaires alternatives ont été identifiées et nourries aux lapins sans recourir à leurs implications physiologiques sur les animaux. Des composés bioactifs présents dans Roselle et sa teneur en vitamine C sont censés améliorer la performance des lapins. Pour soutenir le mécanisme de défense corporelle, les régimes doivent contenir une quantité suffisante de nutriments et d'antioxydants. L'objectif de cette étude était d'évaluer les effets des niveaux alimentaires de la supplémentation de repas RoselleCalyx sur la

## Growth performance and haematological indices of mongrel rabbit bucks

performance de la croissance et les indices hématologiques de daim de lapin de Mongrel. Vingt daim de lapin de Mongrel en bonne santé ont été achetés et utilisés pour cette étude. Quatre régimes expérimentaux ont été formulés pour contenir des niveaux diététiques de farine de CalyxRoselle à 0,00% (contrôle), de 2,00%, 4,00% et 6,00% et codés comme T<sub>1</sub>, T<sub>2</sub>, T<sub>3</sub> et T<sub>4</sub> respectivement. Les quatre groupes de traitement ont été attribués aux quatre régimes expérimentaux dans une conception complètement randomisée. Chaque traitement a été reproduit trois fois avec deux lapins par réplication. Chaque réplique a reçu une alimentation assignée pendant huit semaines. Les paramètres de croissance évalués étaient un poids initial, un poids final, un gain de poids total, un gain de poids quotidien, une prise d'alimentation totale, un rapport de conversion quotidien d'alimentation et d'alimentation. À la fin de la période expérimentale, des échantillons de sang ont été collectés à partir de chaque réplication de l'analyse hématologique. Les paramètres hématologiques déterminés au cours de l'étude comprennent; volume de cellules emballé (VCE), globules rouges (GR), globules blancs (GB), hémoglobine (HB), hémoglobine corpusculaire moyenne (HCM), concentration moyenne de hésizoglobine corpusculaire (CMHC), volume corpusculaire moyen (VCM), neutrophiles et Les lymphocytes. Dont les résultats, tous les paramètres de croissance évalués à l'exception du poids initial ont été significativement ( $p < 0,05$ ) Influencés par RoselleCalyx Repas. Le gain de poids total était supérieur (231.33g) dans T<sub>2</sub> (2,0% de la MRC) par rapport à d'autres groupes de traitement. Le VCE (33,33%) et VCM (66.30FL) étaient plus élevés dans T<sub>4</sub> (MRC de 6,0%). T<sub>2</sub> (2,0% de la MRC) avait une GB plus élevée ( $5,80 \times 10^9 / L$ ) tandis que la GB inférieure a été observée dans T<sub>3</sub> (RCM de 4,0%). Tous les indices hématologiques évalués ont été significatifs de manière significative ( $p < 0,01$ ) parmi les groupes de traitement. Des conclusions de cette étude La supplémentation de repas de RoselleCalyx à 2,0% dans les régimes alimentaires de daim de lapin de Mongrel est non toxique, améliore la performance de la croissance et assure un statut sain des lapins de Mongrel.

**Mots-clés:** lapins de Mongrel, croissance, roselle, hématologie.

### Introduction

Rabbit production is a veritable way of alleviating animal protein deficiency in Nigeria (Ajala and Balogun, 2004). Lebas *et al.* (1997) earlier reported that rabbits can turn 20 percent of the proteins they eat into edible meat. Rabbits as reported by Flanders (2012) produce a nutritious white meat that is high in protein and low in fat and cholesterol than chicken, turkey, beef, or pork. Compared with the meat of other species, rabbit meat is richer in proteins and certain vitamins and minerals (Lebas *et al.*, 1997). Schiere (2004) reported that the rabbit meat is tasty, good quality and similar to chicken meat and added that there are few religious or other taboos on rabbit meat except in vegetarian cultures. Flanders (2012) reported that Rabbit meat can be

substituted for chicken in many recipes as it is a healthy alternative to more fatty meats. The rabbit's fast growth rate, high prolificacy, high genetic selection potential, high feed conversion efficiency and economic utilization of space (Hassan *et al.*, 2012) make them suitable for increased animal protein production. Taiwo *et al.* (2004) identified rabbit's high fecundity, low cost of investment, short generation interval, as well as ability to utilize diverse forages as advantages for increased production. Roselle is an important source of vitamins, minerals, and bioactive compounds, such as organic acids, phytosterols, and polyphenols, some of them with antioxidant properties (Buah, 2013). *Hibiscus sabdariffa* is rich in vitamin C, compared to other fruits (Al-Nasrawi,

2013). However, the calyces of Roselle was reported by Schippers (2000) to be the most exploited part of the plant and may be green, red or dark red. Amin *et al.* (2008) has also reported that the Calyces of Roselle contain nine times more vitamin C than citrus and considered a great source of natural antioxidants (Hertog *et al.*, 1993).

Haematological parameters are parameters that are related to the blood and blood forming organs (Bamishaiye *et al.*, 2009). Haematology results are valuable in diagnosing and monitoring diseases in livestock and humans (Merck Manual, 2012). The haematological picture gives an indication of the general health status of rabbits. The objective of this study is to evaluate the effect of Roselle calyx meal as a natural source of antioxidants on growth performance and haematological indices of mongrel rabbit bucks.

## **Materials and methods**

### ***Experimental site***

The study was carried out at the Rabbitry unit of Teaching and Research Farm of the Department of Animal Science, University of Uyo, Uyo, Akwa-Ibom State. Uyo is located at 5°2'N; 7°55'E with a mean annual temperature of between 26 °C and 28 °C while the mean annual rainfall ranges from 2000mm – 3000mm (Solomon and Udoh, 2017).

### ***Experimental animals and management***

Twenty healthy mongrel rabbit bucks were purchased and used for this study. The rabbit bucks were allowed for two weeks of acclimatization period during which they were fed with commercial feed. Prior to the commencement of the experiment, the rabbits were treated against internal and external parasites by administering ivermectin injection at 0.1ml/rabbit subcutaneously and a broad-spectrum antibiotic (Oxytetracycline L.A) was given at 0.2 ml/rabbit using 2ml disposable syringe and needle. The rabbits were

managed intensively in a wired rabbit hutch. The experimental period was 56 days (8 weeks). The rabbits were weighed at the beginning of the experiment and subsequently on a weekly basis.

### ***Experimental diets***

Red Roselle calyx variety was purchased from Itam market in Uyo metropolis, dried, milled and used in this study as Roselle calyx meal (RCM). Four experimental diets were formulated to contain supplementary dietary levels of Roselle calyx meal at 0.00%, 2.00%, 4.00% and 6.00% and coded as T<sub>1</sub>, T<sub>2</sub>, T<sub>3</sub> and T<sub>4</sub> respectively. T<sub>1</sub> contained 0.00% of the test ingredients and hence served as the control diet. The diets were fortified with bone meal, vitamin premix and salt.

### ***Experimental design***

The four treatment groups were assigned to the four experimental diets in a completely randomized design (CRD). Each treatment was replicated three times with two rabbits per replicate each received an assigned diet for eight (8) weeks of the experiment.

### **Data collection**

#### ***Measurement of live weight changes***

Live weights (g) were measured for each buck in each group using a generic electronic compact scale (SF-400A) with a sensitivity of 1g weekly during the feeding period and changes in weights were recorded.

**Total weight gain:** this was calculated as the difference between the final and initial weights as follows:

Total weight gain (g) = final weight – Initial weight

**Daily weight gain:** Daily weight gain was obtained by dividing the total weight gain by 56 days as follows:

Daily weight gain (g) =  $\frac{\text{Total weight gain}}{56 \text{ days}}$

**Total feed intake:** Total feed intake was calculated by summing the total feed consumed by the animals for 56 days of the

## *Growth performance and haematological indices of mongrel rabbit bucks*

**Table 1: Composition of experimental diet**

Ingredients	Diets			
	T <sub>1</sub> (0.0% RCM)	T <sub>2</sub> (2.0% RCM)	T <sub>3</sub> (4.00% RCM)	T <sub>4</sub> (6.0% RCM)
Maize	38.20	38.20	38.20	38.20
RCM*	0.00	2.00	4.00	6.00
Soybean cake	31.80	31.80	31.80	31.80
Wheat Offal	26.00	26.00	26.00	26.00
Bone meal	3.00	3.00	3.00	3.00
Common salt	0.25	0.25	0.25	0.25
Vit-Premix	0.25	0.25	0.25	0.25
Lysine	0.25	0.25	0.25	0.25
Methionine	0.25	0.25	0.25	0.25
<b>TOTAL</b>	<b>100.00</b>	<b>100.00</b>	<b>100.00</b>	<b>100.00</b>
<b>Calculated composition</b>				
Metabolizable Energy (Kcal/Kg)	2751.70	2751.70	2751.70	2751.70
Crude Protein (%)	16.08	16.08	16.08	16.08
Crude fibre (%)	5.11	5.11	5.11	5.11
Ether Extract (%)	7.84	7.84	7.84	7.84

RCM – Roselle calyx meal, \* - supplement

experiment.

**Daily feed intake:** This was computed by dividing the total feed consumed by the bucks during the experiment by 56 days as follows:

$$\text{Daily feed intake (g)} = \frac{\text{Total Feed Intake}}{56 \text{ days}}$$

**Feed conversion ratio (FCR):** Feed conversion ratio was computed by dividing the total feed intake by total weight gain during the study as follows:

$$\text{Feed Conversion Ratio} = \frac{\text{Total feed intake}}{\text{Total weight gain}}$$

### ***Blood collection***

At the end of the eight weeks experiment, blood samples were collected from each replicate for haematological analysis. The blood samples were collected from a random buck in each replicate through the external ear vein using sterilized disposable syringe and needle between 7:00 and 8.00 am. 2mL blood samples were collected into labeled sterile universal bottles containing EthyleneDiamine-Tetra-Acetic acid (EDTA) as anticoagulant. Haematological parameters evaluated in the course of the study include; packed cell volume (PCV),

red blood cells (RBC), white blood cells (WBC), hemoglobin (HB), mean corpuscular hemoglobin (MCH), mean corpuscular hemoglobin concentration (MCHC), mean corpuscular volume (MCV), Neutrophils and lymphocytes. The blood samples were subjected to laboratory examinations using Auto Analyser – Sysmex kx-21n.

### **Statistical analysis**

The experimental data were subjected to one-way analysis of variance (ANOVA) procedure in a completely randomized design, using IBM Statistical Package for Social Science (SPSS) version 21. Differences between treatment means were separated using Duncan multiple Range Test (Duncan, 1955).

### **Results**

#### ***Growth performance of mongrel rabbit bucks fed diets supplemented with Roselle calyx meal***

The result as seen in Table 2, revealed that all the growth parameters evaluated were statistically influenced ( $p < 0.05$ ) by Roselle calyx meal supplementation in bucks' diets

except initial weight. The initial weight did not vary ( $p>0.05$ ) though the highest numerical value (1521.50g) was observed in  $T_4$  (6.0% RCM) while  $T_1$  (0.0% RCM) and  $T_3$  (4.0% RCM) both had the least numerical values of 1489.69g and 1490.00g respectively.

There was significant difference ( $p<0.05$ ) in the final weight of the mongrel rabbits fed diets supplemented with Roselle calyx meal, the highest value (1730.83g) was

observed in treatment group 2 (2.0% RCM) followed closely by  $T_3$  (4.0% RCM) while treatment group 4 (6.0% RCM) had the lowest (1583.83g) value. The result revealed higher final weight with Roselle calyx meal supplementation in the bucks' diets except those in  $T_4$  (6.0% RCM).  $T_2$  (2.0% RCM) and  $T_3$  (4.0% RCM) recorded higher final weights with Roselle calyx meal supplementation when compared with the control and declined with increasing levels of Roselle calyx meal in the diets.

**Table 2: Growth performance of mongrel rabbit bucks fed diets supplemented with Roselle calyx meal**

Parameters	Treatments				SEM
	$T_1$ (0.0% RCM)	$T_2$ (2.0% RCM)	$T_3$ (4.0% RCM)	$T_4$ (6.0% RCM)	
Initial weight (g)	1489.67	1499.50	1490.00	1521.50	15.48
Final weight (g)	1686.5 <sup>b</sup>	1730.83 <sup>a</sup>	1699.67 <sup>ab</sup>	1583.83 <sup>c</sup>	34.94
Total weight gain (g)	196.83 <sup>b</sup>	231.33 <sup>a</sup>	209.67 <sup>ab</sup>	62.33 <sup>c</sup>	38.03
Daily weight gain (g)	3.51 <sup>a</sup>	4.13 <sup>a</sup>	3.74 <sup>a</sup>	1.11 <sup>b</sup>	0.68
Total feed intake (g)	3797.17 <sup>b</sup>	3792.83 <sup>b</sup>	3846.83 <sup>a</sup>	3767.33 <sup>b</sup>	27.71
Daily feed intake (g)	67.81 <sup>b</sup>	67.73 <sup>b</sup>	68.69 <sup>a</sup>	67.27 <sup>b</sup>	0.49
FCR	19.29 <sup>b</sup>	16.40 <sup>b</sup>	18.35 <sup>b</sup>	60.44 <sup>a</sup>	10.67

a b c – Means in the same row with different superscript are significantly different ( $P< 0.05$ ), RCM–Roselle Calyx meal, FCR feed conversion ratio

Rabbit bucks on the control treatment (0.00% RCM) and treatment group 3 (4.0% RCM) with similar initial weight recorded very close final weight values of 1686.50g and 1699.67g, respectively. Mean total weight gain values of mongrel rabbit bucks observed in this study were 196.83g, 231.33g, 209.67g and 62.33g for  $T_1$  (0.0% RCM),  $T_2$  (2.0% RCM),  $T_3$  (4.0% RCM) and  $T_4$  (6.0% RCM), respectively. Total weight gains of mongrel rabbit bucks on the different levels of Roselle calyx meal supplementation showed statistical variation ( $p<0.05$ ). However, bucks in  $T_2$  (2.0% RCM) recorded the highest (231.33g) total weight gain when compared to other treatment groups while  $T_4$  (6.0%) recorded the lowest weight gain. Daily weight gains of bucks in this study were statistically influenced ( $p<0.05$ ) by Roselle calyx meal supplementation among

treatment groups. Higher values were however observed with Roselle calyx supplementation in comparison with the control group (0.0% RCM) that had daily weight gain of 3.51g. Daily weight gain was highest (4.13g) in  $T_2$  (2.0% RCM) and lowest in  $T_4$  (6.0% RCM). Bucks fed  $T_3$  (4.0% RCM) recorded daily weight value of 3.74g similar to those of  $T_2$  (2.0% RCM). There was significant improvement ( $p<0.05$ ) in total feed intake of bucks with Roselle calyx supplementation. Total feed intake recorded in this study were 3797.17g, 3792.83g, 3846.83g and 3767.33g for  $T_1$ ,  $T_2$ ,  $T_3$  and  $T_4$  respectively. The result shows that bucks fed diets supplemented with Roselle calyx meal recorded higher total feed intake compared to bucks fed the control diet without Roselle calyx meal. The highest total feed intake was observed in  $T_3$  (4.0% RCM) while the

### *Growth performance and haematological indices of mongrel rabbit bucks*

least value is seen in T<sub>1</sub> (0.0% RCM). Daily feed intake of bucks in this study also show statistical difference ( $p < 0.05$ ) with Roselle calyx meal supplementation in bucks' diets though the highest (68.69g) daily feed intake was observed in T<sub>3</sub> (4.0% RCM) while the lowest (67.27g) value was observed in T<sub>4</sub> (6.0% RCM) group. T<sub>2</sub> (2.0% RCM) and T<sub>1</sub> (0.0% RCM) recorded values of 67.73g and 67.81g respectively. The feed conversion ratio (FCR) of mongrel rabbit bucks observed in this study were significantly influenced ( $p < 0.05$ ) by Roselle calyx meal supplementation. The result also revealed that FCR increased with increased levels of Roselle calyx meal in bucks' diets. FCR was lowest (16.40) in T<sub>2</sub> (2.0% RCM) and highest in T<sub>4</sub> (6.0% RCM).

#### ***Haematological indices of mongrel rabbit bucks fed diets supplemented with Roselle calyx meal***

The result of haematological indices of mongrel rabbit bucks fed diets supplemented with Roselle calyx meal is presented in Table 3. The findings of this study revealed that Roselle calyx meal supplementation significantly ( $p < 0.01$ ) influenced the packed cell volume (PCV) of rabbit bucks. PCV was seen to be highest (33.33%) in T<sub>4</sub> (6.0% RCM) and lowest in T<sub>3</sub> (4.0% RCM). T<sub>1</sub> (0.0% RCM) and T<sub>2</sub> (2.0% RCM) recorded PCV values of 30.27% and

31.50 % respectively. Red blood cells (RBC) of rabbit bucks fed supplementary levels of Roselle calyx meal varied ( $p < 0.01$ ) significantly among treatment groups. The RBC obtained in this study were  $4.74 \times 10^{12}/L$ ,  $4.89 \times 10^{12}/L$ ,  $2.17 \times 10^{12}/L$  and  $5.02 \times 10^{12}/L$  for T<sub>1</sub> (0.0% RCM), T<sub>2</sub> (2.0% RCM), T<sub>3</sub> (4.0% RCM) and T<sub>4</sub> (6.0% RCM) respectively. T<sub>4</sub> (6.0% RCM) recorded the higher RBC value ( $5.02 \times 10^{12}/L$ ) while T<sub>3</sub> (4.0% RCM) again recorded the lower value.

Roselle calyx meal supplementation in bucks' diets greatly influenced ( $p < 0.01$ ) white blood cells of mongrel rabbit bucks in this study. The higher WBC value ( $5.80 \times 10^9/L$ ) was observed in T<sub>2</sub> (2.0% RCM) while rabbit bucks in T<sub>3</sub> (4.0% RCM) had the least WBC value followed by animals on the control diet (0.0% RCM). T<sub>4</sub> (6.0% RCM) however recorded WBC value of  $5.00 \times 10^9/L$  while T<sub>1</sub> (0.0% RCM) recorded  $2.93 \times 10^9/L$ . Haemoglobin of bucks fed diets containing Roselle calyx meal as supplement showed significant ( $p < 0.01$ ) variation among treatment groups. The values obtained in this study were 11.30 g/100mL, 11.40 g/100mL, 5.30 g/100ml and 11.00 g/100mL for T<sub>1</sub> (0.0% RCM), T<sub>2</sub> (2.0% RCM), T<sub>3</sub> (4.0% RCM) and T<sub>4</sub> (6.0% RCM), respectively. The hemoglobin was highest in T<sub>2</sub> (2.0% RCM) and lowest in T<sub>3</sub> (4.0% RCM).

**Table 3: Haematological indices of mongrel rabbits buck fed diets supplemented with Roselle calyx meal**

Parameters	Treatments				SEM
	T <sub>1</sub> (0.0% RCM)	T <sub>2</sub> (2.0% RCM)	T <sub>3</sub> (4.0% RCM)	T <sub>4</sub> (6.0% RCM)	
PCV (%)	30.27 <sup>a</sup>	31.50 <sup>a</sup>	14.40 <sup>b</sup>	33.33 <sup>a</sup>	2.33
RBC ( $\times 10^{12}/L$ )	4.74 <sup>a</sup>	4.89 <sup>a</sup>	2.17 <sup>b</sup>	5.02 <sup>a</sup>	0.57
WBC ( $\times 10^9/L$ )	2.93 <sup>c</sup>	5.80 <sup>a</sup>	0.89 <sup>d</sup>	5.00 <sup>b</sup>	0.68
Hb (g/100ml)	11.30 <sup>a</sup>	11.40 <sup>a</sup>	5.30 <sup>b</sup>	11.00 <sup>a</sup>	0.92
MCV (fl)	64.10 <sup>b</sup>	64.40 <sup>b</sup>	66.10 <sup>a</sup>	66.30 <sup>a</sup>	0.56
MCH (pg/cell)	23.47 <sup>b</sup>	23.30 <sup>b</sup>	24.30 <sup>a</sup>	21.90 <sup>b</sup>	0.56
MCHC (%)	37.17 <sup>a</sup>	36.20 <sup>a</sup>	36.80 <sup>a</sup>	29.67 <sup>b</sup>	1.05
Lymphocytes(%)	59.60 <sup>b</sup>	26.20 <sup>d</sup>	78.10 <sup>a</sup>	45.60 <sup>c</sup>	5.75
Neutrophils (%)	38.50 <sup>c</sup>	73.40 <sup>a</sup>	16.13 <sup>d</sup>	53.40 <sup>b</sup>	6.36

a b c d – Means in the same row with different superscript are significantly different ( $P < 0.01$ ); RCM – Roselle calyx meal; PCV – packed cell volume; RBC – Red blood Cells; WBC – white blood Cells; Hb – Haemoglobin; MCV – mean cell volume; MCH – mean cell haemoglobin; MCHC – mean cell haemoglobin concentration.

Mean cell volume (MCV) of rabbit bucks fed diets containing supplementary dietary levels of Roselle calyx meal differed ( $p < 0.01$ ) significantly among treatment groups.  $T_4$  (6.0% RCM) recorded the highest value (66.30fl) followed closely by  $T_3$  (4.0% RCM) with MCV value of 66.10fl while rabbit bucks in the control group (0.0% RCM) and  $T_2$  (2.0% RCM) recorded similar values of 64.10fl and 66.40fl respectively for MCV. Mean Cell hemoglobin (MCH) of bucks was significantly influenced ( $p < 0.01$ ) by Roselle calyx meal supplementation in this study. MCH was at its' peak (24.30 pg/cell) in treatment group 3 (4.0% RCM) and lowest (21.90 pg/cell) in rabbit bucks on treatment group 4 (6.0% RCM).  $T_1$  (0.0% RCM) and  $T_2$  (2.0% RCM) recorded MCH values of 23.47 pg/cell and 23.30 pg/cell respectively. Roselle calyx meal supplementation in bucks' diets significantly ( $p < 0.01$ ) affected the mean cell hemoglobin concentration (MCHC) of mongrel rabbit bucks in this study. The values obtained were 37.17%, 36.20%, 36.80% and 29.67% for  $T_1$  (0.0% RCM),  $T_2$  (2.0% RCM),  $T_3$  (4.0% RCM) and  $T_4$  (6.0% RCM) respectively. The higher value (37.17%) of MCHC was observed in rabbit bucks fed  $T_1$  (0.0% RCM) diet while the lower (29.67%) value of MCHC was observed in rabbit bucks fed  $T_4$  (6.0% RCM) diet. The result also showed that lymphocytes values of rabbit bucks was statistically influenced ( $p < 0.01$ ) by Roselle calyx meal supplementation with higher (78.10%) and lower (26.20%) values been observed in  $T_3$  (4.0% RCM) and  $T_2$  (2.0% RCM) respectively. The lymphocytes values observed in this study were 59.60%, 26.20%, 78.10% and 45.60% for  $T_1$  (0.0% RCM),  $T_2$  (2.0% RCM),  $T_3$  (4.0% RCM) and  $T_4$  (6.0% RCM) respectively. Neutrophils of rabbit bucks fed dietary levels of Roselle calyx

meal as supplement also varied ( $p < 0.01$ ) significantly among the different treatment groups in this study. Neutrophils of the rabbit bucks was highest (73.40%) in  $T_2$  (2.0% RCM) and lower (16.13%) in treatment group 3 (4.0% RCM). Rabbit bucks fed the control diet and those fed  $T_4$  (6.0%) recorded neutrophil values of 38.50 and 53.40% respectively.

## **Discussion**

### ***Growth performance of mongrel rabbits buck fed diets supplemented with Roselle calyx meal***

The results obtained in this study for growth performance of mongrel rabbit bucks fed diets supplemented with Roselle calyx meal showed statistical significance except the initial weight and daily feed intake of bucks which did not show significant difference. This result agrees with the findings of Al-Nasrawi (2013) who reported improved body weight, Body weight gain, feed consumption and conversion ratio when feeding Roselle. This improvement according to Hamodi and AL-Khalain (2001) could be due to the active compounds that are present in Roselle (anthocyanin and protocatechuic acid) and its content of vitamin C, which had a positive effect on all cell activity and increase oxygen ( $O_2$ ) consumption and as a result stimulate thyroid gland which play a major role in metabolism. The feed intake observed in this study could be attributed to the fact that Roselle calyx has lots of vitamins (Amin *et al.*, 2008), protein and minerals as reported by Mahadevan *et al.* (2009) which aided increased feed consumption. The feed intake in this study disagrees with the result of Unigwe (2011) who reported increase in average daily feed intake on chicken with increased levels of Roselle calyx. The reduction in weight gain with increased levels of Roselle calyx meal agrees with the findings of Iyare and Iyare (2008) and could be due to increased levels

### *Growth performance and haematological indices of mongrel rabbit bucks*

of compounds present in the Roselle calyx that may have negative impact on weight gain. The increase in feed conversion ratio (FCR) and improved weight gain could be due to increased feed digestibility (Brown, 1995) making more nutrient available to the rabbit bucks. El Mesallamy (2016) also reported higher growth performance and feed utilization at 1% Roselle calyx inclusion in Nile tilapias' diet.

***Haematological indices of mongrel rabbits buck fed diets supplemented with Roselle calyx meal*** Haematological indices is an index and a reflection of the status of the blood available for an animal to meet its physiological, biochemical and metabolic necessities (Ewuola *et al.*, 2004). The mean PCV of rabbit bucks supplemented with Roselle calyx meal in this study indicates that there was no loss of RBC. The mean values of PCV were close to the value range (33.0 - 50.0%) reported by Mitruka and Rawnsley (1977) and within the range of 27-57% reported by Bennette and Hawkey (1988). The PCV values implies that the rabbits had good health status throughout the study period, thus supporting the finding of Aster (2004) who reported that low PCV values implies anaemic condition while high PCV values suggest dehydration. Rastogi (2009) also supported this by stating that low PCV indicates such conditions as anaemia or overhydration while high vales denote such conditions as polycythemia or dehydration.

The decrease in the level of RBC in this study contradicts the findings of Ashafa *et al.* (2011) who indicated that Roselle calyx extract has beneficial properties that result in increased red blood cell count, implying that there was increase in the rate of production of RBCs within the study period. Other authors (Kuriyan *et al.*, 2010; Mungole and Chaturvedi, 2011) have also attributed the elevation in RBC to the stimulation of the bone marrow and lymphoid organs by compounds such as

alkaloids, flavonoids, polyphenolics, ascorbic acid and other vitamins which may have been negatively affected in this study. Roselle calyx extract according to Polenakovic and Sikole (1996) and Sanchez-Elsner *et al.* (2004), may also stimulate erythropoietin release in the kidney, which is the humoral regulator of RBC production. Roselle calyx meal also influenced the white blood cells (WBC) of rabbit bucks in this study. The high levels of WBC in rabbit bucks administered Roselle calyx meal as supplement in their diets indicates that the animal's ability to combat infection or illness was not negatively affected since WBC is known to be among body defense mechanisms that fight against non-self or pathogenic organisms except for T<sub>3</sub> (4.0% RCM) which though did not show physical sign of disease condition, had the lowest WBC level compared with control and other treatments. The WBC play prominent role in disease resistance especially with respect to the production of antibodies and the process of phagocytosis (Soetan *et al.*, 2013). The mean WBC values of rabbits were within the range of 4.50 - 11.00 X 10<sup>3</sup>/uL for normal rabbits (RAR, 2009) except T<sub>3</sub>(4.0% RCM). Haemoglobin (Hb) of the rabbit bucks in this study were significantly influenced with Roselle calyx meal supplementation and disagrees with the report of Ali *et al.* (2016) who attributed the increment in Hb in female rabbits to the presence of compounds found in the herb, which may stimulate the hemopoietic tissue. Ali *et al.* (2005) in their study attributed the significant elevation in the levels of hemoglobin to the treatment with *H. Sabdariffa* calyces extract which contain a high percentage of protein in its composition. Haemoglobin is responsible for the red colour of the blood and helps transport oxygen and carbon dioxide (Flanders, 2012; Akers and Denbow, 2013; Moyes and Schulte, 2014; Reece *et al.*,



2015). High values of haemoglobin depends on the number of RBCs and amount of Hb in each molecule (Rastogi, 2009) while a low level of Hb indicates anaemia, a reduction in the concentration of functional RBCs in the blood (Frandsen *et al.*, 2009). This implies that the bucks in this study suffered anaemia in the course of the study as they were below the range of  $5.0 - 8.0 \times 10^{12}/L$  documented by Merck Manual (2012) except  $T_4$  (6.0% RCM) that recorded  $5.02 \times 10^{12}/L$  for RBC. The MCV, MCH and MCHC of bucks varied significantly in the study. These parameters are used to diagnose the type of anemic conditions in animals. MCV increased with corresponding increase in levels of Roselle calyx meal while MCH and MCHC decreased with increasing levels of Roselle calyx meal except  $T_3$  (4.0% RCM). Ali *et al.* (2016) concluded that *Hibiscus sabdariffa* extract may increase Hb and RBC thus may be useful in treating anaemia and also has the potential to increase blood volume, enhance immunity by increasing granulocyte count. The study recorded significant influence of Roselle calyx meal on the neutrophil counts of mongrel rabbit bucks except  $T_3$  (4.0% RCM) that became very low (16.13%) corresponding to the lowest WBC recorded in the treatment group. Moyes and Schulte (2014) identified neutrophils as the most common leukocyte in vertebrates' blood. As immune cells, they engulf damaged cells, microorganisms, and other foreign pathogens by phagocytosis. Neutrophils function primarily as phagocytes and are important in infectious conditions and in inflammation (Harcourt – Brown, 2002). An increase in the number of circulating neutrophils causes a rise in total white blood cell count. Lymphocytes count of the bucks differed significantly with Roselle calyx supplementation in bucks' diet. Akers and Denbow (2013) noted that

lymphocytes accounting for 25% of the WBCs, make antibodies and is involved in recruiting macrophages and neutrophils to the site of infection, releasing cytotoxic agents to kill foreign or dying cells, and helping B-cells to produce antibodies. They have also been said to be involved in immunological responses (Harcourt – Brown, 2002) and are distributed throughout the body in various tissues including blood, bone marrow, lymph nodes, spleen and gut-associated lymphoid tissue.

### **Conclusion**

The study indicated that Roselle calyx meal at 2.0% enhanced growth performance and haematological indices in mongrel rabbit bucks thus improved production and health of mongrel rabbits.

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*Growth performance and haematological indices of mongrel rabbit bucks*

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*Growth performance and haematological indices of mongrel rabbit bucks*

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