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Effect of different feed types on haematological and serum biochemical parameters of male and female weaner rabbits

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***Target Audience:** Rabbit farmers, Animal Scientist and feed millers*

Abstract

Feed components affect blood constituents and less consideration is often given to health status of the animals used in feeding trials either with conventional or non-conventional feedstuffs; hence, blood analysis is usually carried out in order to assess the degree of well-being of such animal. A total of ninety (forty-five males and forty-five females) weaner rabbits with weight ranging from 790-830 grammes were used to investigate the effect of different feed types on haematological and serum biochemical parameters of weaner rabbits in first and second phase, respectively. The rabbits were allotted into 10 treatments after weight equalization on the basis of sex and different dietary groups (100% mash, 100% pellet, 50% mash + 50% Sunflower leaf, 50% pellet + 50% Sunflower leaf, and 100% Sunflower leaf) in a 2x5 factorial arrangement, with each treatment consisting of 9 rabbits; each treatment was further subdivided into 3 replicates and 3 rabbits per each replicate. The experiment lasted for 10 weeks. Data were collected on blood profile (haematology: packed cell volume – PCV, red blood cell counts – RBC, white blood cell counts – WBC, haemoglobin – Hb, lymphocytes, mean corpuscular and haemoglobin concentration – MCHC; serum biochemical indices: total serum protein, albumin, globulin, glucose, cholesterol, alkaline phosphate – ALP and aspartate transferase – AST) at the end of the 6^{th} and 10^{th} weeks of the experiment from one rabbit per replicate. All data generated were arranged in a 2 × 5 factorial layout and subjected to one-way analysis of variance in a completely randomized design. Results at 6^{th} week revealed both male and female rabbits fed combinations of concentrate and sunflower had the highest ($p<0.05$) red blood cell counts. Total protein and albumin were highest ($p<0.05$) in male rabbits than female rabbits. Serum indices of male rabbits fed 100% sunflower had the highest ($p<0.05$) values of total protein, albumin, urea, and creatinine. At the 10^{th} week, Packed cell volume and red blood cell were highest ($p<0.05$) in females fed 100% pellet. Red blood cells, neutrophils, urea, and creatinine were higher ($p<0.05$) in males than females. Females fed 100% pellet had the highest ($p<0.05$) values of urea, creatinine, and cholesterol. It was concluded that sex had no detrimental effect on haematological parameters and serum biochemical indices. However, feeding rabbits 100% forage reduced the ability of rabbits to fight infection resulting from reduced lymphocyte.

***Key words:** Feed forms, forage, rabbit, sex and haematology*

Description of Problem

The rising demand for animal protein has led to exploration of healthier meat options apart from cattle, sheep, and goats for the ever-increasing population. Rabbits are efficient feed converters, highly prolific and easy to manage with a short generation interval (1). Increase in meat production can be achieved through proper nutrition and inclusion of feed ingredients at required levels (2). In recent years, people involved in rabbit production are faced with high cost of feeding (3). The high cost of conventional feedstuffs is one of the major limiting factors to large scale commercial rabbit production in Nigeria (4). In corroboration, 5 also reported that

conventional feeding has been the most critical challenge of rabbit production, representing 70% of the overall production cost. This made rabbit rearing relatively expensive as there are no known customized commercial feeds for rabbits.

In an attempt to reduce feed cost in rabbit production, nutritional interventions such as feeding rabbits solely on some forage species have been successfully carried out (6 and 7). According to (3), forages could serve as a potential source of nutrients for animals, since rabbits can utilize fibrous materials for production of meat (8). Rabbits can also thrive on sunflowers because of their enlarged caecum, sunflower is cost-effective with high protein content of about 18% (8 and 9). Furthermore, nutrient uptake can be affected by the form of feed presentation; therefore, feed presentation such as mash, crumbs, and pellets are vital for effective utilization and a crucial meat yield factor (10). Pelleted feeding has been reported to reduce feed wastage, selective feeding, aids in the destruction of pathogenic organisms, and improves palatability (11). However, low weight gain was reported due to the presence of anti-nutritional factors in tropical forages which affect digestion and absorption of nutrients (12).

The combination of concentrate in different forms with forage is vital towards achieving optimum performance and profit maximization for the sustainability of rabbit production. However, many feed products are often fed to rabbits usually with the aim of improving performance with less recourse to the health and physiological status of the animals (13). Emphasis by animal nutritionist has always been on nutrient digestibility, utilization and performance of farm animals without given much consideration to the future health status of the animals. There are factors in the blood whose levels are usually determined in order to assess the degree of well-being of an animal as deviation in these factors is used to access nutritional stress or other factors that predispose animal to stress. The commonest parameter for measuring these implications is through the haematology of the animals (14). Haematological studies are important because the blood is the major transport system of the body, and an evaluation of the haematological profile usually furnishes vital information on the body's response to injury of all forms, including toxic injury (15, 16 and 17). Moreover, the comparison of blood profile with nutrient intake might indicate the need for adjustment of certain nutrients upward or downward for rabbits (18). Therefore, this experiment evaluated the effect of different feed types on the haematological and serum biochemical parameters of male and female weaner rabbits.

Materials and Methods

Experimental location

The experiment was carried out at the Rabbitry Unit of Teaching and Research Farms, Federal University of Agriculture, Abeokuta, while blood analyses were carried out at the College of Veterinary Medicine (COLVET) of the same institution. This area is situated in the rainforest vegetation zone of South-western Nigeria on Latitude 7° 13′ 49.46′′ N, Longitude 3° 26′ 11.98′′ E, and altitude of 98 m above sea level. The climate is humid with a mean annual rainfall of 1003 mm; temperature, 31.9 to 34.8 °C, and relative humidity between 79.7 to 90.1 % (19).

Sources of test ingredients

Wild sunflower (*Tithonia diversifolia*) leaves with succulent stems were harvested daily around the Teaching and Research farm of the Federal University of Agriculture Abeokuta, Ogun State.

Experimental rabbits' management

A total of ninety (forty-five males and forty-five females) weaner rabbits with weight ranging between 790-830 grammes were procured from a reputable farm in Abeokuta, Ogun state. Hutches and equipment were

thoroughly washed and disinfected before the commencement of the experiment, and the rabbits were acclimatized for two weeks. The dimensions of the hutches were as follows: length: 105cm, width: 85cm, and height: 60cm. They were placed inside a dwarf-walled stable with wire mesh at the upper part for adequate ventilation and covered with asbestos sheets as the roofing material. The hutches' bases were made of wire mesh for easy evacuation of faeces and urine. Afterwards, rabbits were randomly allotted into 10 treatments after weight equalization on the basis of sex (male and female) and different dietary groups (100% mash, 100% pellet, 50% mash + 50% Sunflower leaf, 50% pellet + 50% Sunflower leaf, and 100% Sunflower leaf) with each treatment consisting of 9 rabbits in a 2x5 factorial arrangement, with each treatment consisting of 9 rabbits; each treatment was further subdivided into 3 replicates and 3 rabbits per each replicate. Commercial concentrate (growers mash and pellet) diets as shown in Table 1 and water were provided *ad libitum* throughout the experiment that lasted for 10 weeks. The rabbits were raised under natural ambient temperature and light and daily routine management procedures were followed to ensure a good hygienic environment throughout the experiment with careful watchfulness.

Table 1: Nutrient Composition of the Commercial Growers mash and pellet as declared by the manufacturer

Ingredients	Composition
Crude protein (%)	16.00
Fat/Oil (%)	5.00
Crude fibre (%)	7.00
Calcium (%)	1.60
Available phosphorus (%)	0.45
Lysine (%)	0.75
Methionine (%)	0.36
Salt (min) (%)	0.30
Energy (Kcal/Kg)	2450

Data collection

Blood collection and Analysis

At the end of the 6^{th} and 10^{th} weeks of the experiment, blood samples were collected from one rabbit per replicate for determination of hematological and biochemical components as described by (20). 2.5ml of blood was collected by puncturing the jugular vein and allowing free flow of blood into labeled sterile universal bottle containing 1.0mg/ml ethyl diamine tetracetic acid (EDTA) as anticoagulant to determine the haematological component according to the methods described by (21) and (22). Another 2.5ml was also collected into a labeled sterile sample bottles without anticoagulant to determine the biochemical components (20 and 21). All blood samples were collected in the morning before feeding (between 7.00 am to 9.00 am) and transported immediately to the laboratory for analysis. Haematological parameters analyzed were packed cell volume (PCV), haemoglobin concentration (Hb), white blood cell counts (WBC), red blood cell counts (RBC), neutrophil, lymphocytes, basophils, eosinophils, monocytes, mean corpuscular volume (MCV), mean corpuscular haemoglobin (MCH) and mean corpuscular haemoglobin concentration (MCHC). Packed cell volume (PCV) was determined with Wintrobe's microhaematocrit method while red blood cell (RBC) and white blood cell (WBC) were determined with an improved Neubauer haemocytometer. Haemoglobin

concentration (Hb) was determined using cyano-methaemoglobin method. The erythrocytic indices, mean cell volume (MCV), mean cell haemoglobin (MCH) and mean cell haemoglobin concentration (MCHC) were calculated (22). For serum biochemical analyses, blood samples collected into plain tubes without anticoagulant were centrifuged (Rotofix 32®-Hettich) at 3000 rpm for 10 min, the serum was collected and kept at 20°C until analysis. Total serum protein was determined using the Biuret method as described by (23). Albumin was determined using Bromocresol Green (BCG) method while globulin was estimated by subtracting albumin values from total protein. Serum cholesterol was determined spectrophotometrically using commercial Bio-La-Tests, and serum glucose was estimated using a commercial glucose colorimetric assay kit.

Table 2: Main effects of sex and feed types on haematological parameters of weaner rabbits at 6th week of the experiment

	Sex		Feed types				
Parameters	**Male**	**Female**	**100% Mash**	**100% Pellet**	**50%Mash+ 50%sunflower**	**50%Pellet +50%sunflower**	**100% sunflower**
Packed Cell Volume (%)	—	35.47±1.42	32.83±2.57	35.17±2.33	38.50±1.77	35.83±1.67	36.00±0.68
Haemoglobin conc. (g/dl)	12.11±0.35	12.00±0.45	11.17±0.84	11.93±0.74	12.95±0.57	12.10±0.56	12.13±0.19
Red blood cell (×10⁶/µl)	9.92±0.36	8.87±0.94	4.88±1.06[b]	5.31±0.41[ab]	5.98±0.26[a]	5.39±0.28[ab]	5.42±0.12[ab]
White blood cell (×10³/µl)	5.41±0.17	5.38±0.23	8.00±1.06	9.63±1.84	10.77±0.99	8.90±0.82	9.68±0.58
Neutrophil (%)	40.20±5.51	39.13±5.65	42.33±8.78[ab]	31.67±4.83[b]	23.00±4.64[b]	42.33±9.84[ab]	59.00±8.47[a]
Lymphocytes (%)	58.60±5.22	59.00±5.70	60.67±7.02[a]	66.17±15.50[a]	54.50±9.77[ab]	75.17±4.21[a]	37.50±8.11[b]
Basophil (%)	0.10±0.07	0.07±0.10	0.00±0.00	0.00±0.00	0.00±0.00	0.17±0.17	0.25±0.18
Eosinophil (%)	1.03±0.28	0.73±0.25	0.67±0.33[ab]	0.33±0.33[b]	0.83±0.48[ab]	1.83±0.40[a]	0.75±0.36[ab]
Monocytes (%)	1.80±0.44	1.67±0.35	1.33±0.71	2.67±0.76	1.00±0.63	1.17±0.40	2.50±0.22
MCV (fL)	66.28±0.53	66.25±0.68	67.22±1.03[a]	66.73±1.38[ab]	64.27±0.57[b]	66.63±0.79[ab]	66.48±0.47[ab]
MCH (pg)	22.40±0.21	22.44±0.28	22.90±0.34[a]	22.70±0.60[ab]	21.62±6.22[b]	22.50±0.30[ab]	22.38±0.21[ab]
MCHC (%)	33.76±0.07	33.91±0.15	34.07±0.32	34.00±0.29	33.68±0.15	33.77±0.11	33.68±0.12

[ab]Means on the same row having different superscripts are significantly ($p<0.05$) different
MCV: Mean Corpuscular Volume
MCH: Mean Corpuscular Haemoglobin
MCHC: Mean Corpuscular Haemoglobin Concentration

Statistical Analysis

Data collected at 6th and 10th week were arranged in a 2 × 5 and 2 × 4 factorial layout and subjected to one way analysis of variance as described by (24). The factors were sex (male and female) and 5 different feed types (100% mash, 100% pellet, 50% mash + 50% Sunflower leaf, 50% pellet + 50% Sunflower leaf, and 100% Sunflower leaf)) and (sex (male and female) and 4 different feed types (100% mash, 100% pellet, 50% mash + 50% Sunflower leaf and 50% pellet + 50% Sunflower leaf)) for the6th and 10th week, respectively. Significant differences across means were separated using Duncan's Multiple Range Test of the same software.

Table 3: Interaction Effect of sex and feed types on haematological parameters of weaner rabbits at 6th week of the experiment

Sex	Male					Female				
Feed type	100%Mash	100%Pellet	50%mash+ 50%Sunflower	50%pellet+ 50%Sunflower	100% Sunflower	100% Mash	100% pellet	50% Mash+ 50%Sunflower	50%pellet+ 50%Sunflower	100% Sunflower
Parameters										
Packed Cell Volume (%)	35.0±2.52	37.7±0.88	38.7±3.84	33.0±2.82	35.0±1.15	30.7±4.70	32.7±4.48	38.3±0.88	38.7±1.20	37.0±0.00
Haemoglobin (g/dl)	11.8±0.90	12.7±0.29	13.0±1.23	11.2±0.77	11.9±0.32	10.5±1.50	11.1±1.40	12.9±0.33	13.0±0.39	12.4±0.00
Red blood cell(×10^3/µl)	5.3±0.28^{ab}	5.7±0.14^{ab}	6.1±0.57^{a}	4.8±0.28^{ab}	5.2±0.14^{ab}	4.5±0.62^{b}	4.9±0.83^{ab}	6.0±0.73^{a}	5.9±0.11^{a}	5.7±0.00^{ab}
White blood cell (×10^3/µl)	9.7±0.81	9.4±0.99	10.4±0.74	10.1±0.67	10.1±1.24	6.3±1.49	9.9±3.99	11.1±2.06	7.7±1.23	9.3±0.00
Neutrophil (%)	55.0±14.53^{ab}	29.3±10.08^{b}	22.0±9.02^{b}	50.7±11.85^{ab}	44.0±11.55^{ab}	29.7±3.84^{b}	34.0±3.05^{b}	24.0±5.03^{b}	34.0±16.56^{b}	74.0±0.00^{a}
Lymphocytes (%)	53.0±13.20^{ab}	65.7±10.65^{a}	76.7±8.35^{a}	46.7±12.02^{ab}	51.0±12.12^{ab}	68.3±3.67^{a}	66.7±6.12^{a}	73.7±4.09^{a}	62.3±16.48^{a}	24.0±0.00^{b}
Basophil (%)	0.0±0.33^{c}	0.0±0.67^{c}	0.0±1.00^{c}	0.0±1.67^{c}	0.5±1.50^{a}	0.0±0.00^{c}	0.0±0.00^{c}	0.0±0.00^{c}	0.3±0.33^{ab}	0.3±0.00^{b}
Eosinophil (%)	0.3±0.33^{ab}	0.7±0.67^{ab}	1.0±1.00^{ab}	1.7±0.67^{ab}	1.5±0.29^{ab}	1.0±0.58^{ab}	0.0±0.00^{b}	0.7±0.33^{ab}	2.0±0.51^{a}	0.0±0.00^{b}
Monocytes (%)	1.7±1.20	3.0±1.53	0.3±0.33	1.0±0.00	3.0±0.00	1.0±1.00	2.3±0.67	1.7±1.20	1.3±0.88	2.0±0.00
MCV (fL)	66.4±1.49^{ab}	66.2±0.33^{ab}	63.3±0.39^{b}	68.1±0.55^{a}	67.5±0.38^{ab}	68.1±1.53^{a}	67.2±3.04^{ab}	65.3±0.71^{ab}	65.2±0.81^{ab}	65.5±0.00^{ab}
MCH (pg)	22.5±0.62^{ab}	22.4±0.06^{ab}	21.2±0.03^{b}	23.0±0.34^{a}	22.9±0.03^{ab}	23.3±0.13^{a}	23.0±1.31^{a}	22.0±0.32^{ab}	22.0±0.23^{ab}	21.9±0.00^{ab}
MCHC (%)	33.8±0.19	33.8±0.06	33.6±0.17	33.8±0.23	33.9±0.20	34.4±0.62	34.2±0.42	33.8±0.33	33.7±0.33	33.5±0.00

$^{a\ b}$Means on the same row having different superscripts a re significantly ($p<0.05$) different

MCV: Mean Corpuscular Volume

MCH: Mean Corpuscular Haemoglobin

MCHC: Mean Corpuscular Haemoglobin Concentration

Table 4 : Main effects of sex and feed types on haematological parameters of weaner rabbits at 10th week of the experiment

	Sex		Feed types			
Parameters	Male	Female	100% Mash	100% Pellet	50% Mash+ 50% sunflower	50% Pellet+ 50% sunflower
Packed Cell Volume (%)	50.75±0.97	48.33±1.08	48.08±0.45^{ab}	52.25±1.17^{a}	47.67±2.04^{b}	50.17±1.42^{ab}
Haemoglobin conc. (g/dl)	16.98±0 .32	16.20±0.38	16.13±0.17^{ab}	17.53±0.36^{a}	15.95±0.69^{b}	16.75±0.49^{ab}
Red blood cell (×10 ^{3}/µl)	10.56±0.18^{a}	10.01±0.19^{b}	10.00±0.15^{b}	10.81±0.26^{a}	9.91±0.33^{b}	10.43±0.25^{ab}
White blood cell(×10 ^{3}/µl)	10.76±0.94	12.34±1.03	12.73±1.77	12.05±1.61	11.25±1.07	10.17±1.24
Neutrophil (%)	30.98±1.56^{a}	17.92±1.41^{b}	20.33±3.40^{b}	25.42±4.63^{ab}	24.00±2.80^{ab}	28.00±2.27^{a}
Lymphocytes (%)	65.25±1.54^{b}	78.17±1.46^{a}	75.75±3.51^{a}	70.58±4.53^{ab}	72.50±2.84^{ab}	68.00±2.44^{b}
Basophil (%)	0.00±0.00	0.17±0.11	0.00±0.00	0.17±0.17	0.17±0.17	0.00±0.00
Eosinophil (%)	1.00±0.24	1.42±0.39	1.00±0.52	1.00±0.45	1.50±0.62	1.33±0.333
Monocytes (%)	2.96±0.34	2.33±0.49	2.92±0.49	2.83±0.70	1.83±0.60	3.00±0.63
MCV (fL)	48.09±0.36	48.24±0.39	48.10±0.32	48.40±0.70	48.05±0.74	48.03±0.31
MCH (pg)	15.86±0.15	16.16±0.14	15.88±0.22	16.22±0.25	16.07±0.24	15.87±0.15
MCHC (%)	33.45±0.05	33.52±0.07	33.53±0.06	35.54±0.10	33.52±0.11	33.40±0.05

^{ab}Means on the same row having different superscripts are significantly ($p<0.05$) different

MCV: Mean Corpuscular Volume

MCH: Mean Corpuscular Haemoglobin

MCHC: Mean Corpuscular Haemoglobin Concentration

Results and discussion

The main effects of sex and feed types on haematological parameters of rabbits at 6th week of experiment are depicted in Table 2. There were no significant ($p>0.05$) differences in all haematological parameters measured as influenced by sex. This result corroborated the report of (25) and (26), that no differences among the sexes for most haematological parameters. However, red blood cell count

(RBC) was significantly ($p<0.05$) highest (5.98 $\times 10^3/\mu l$) in rabbits fed 50% mash+50% sunflower and lowest (4.88 $\times 10^3/\mu l$) in rabbits fed 100% mash. RBC counts according to (27) are influenced among other factors by nutrition, physical activities and volume and its reduction indicates anaemia. In this study, there was no clinical state of anaemic condition. This result is an indication that the feed types had no negative effect on the RBC but instead has the ability to improve it. Rabbits fed 100% sunflower had significantly ($p<0.05$) highest (59.00%) neutrophil count and lowest (31.67 and 23.00%) were observed in rabbits fed 100% pellet and 50% mash+50 sunflower, respectively. The neutrophil values gotten in this study remained within the reference range indicating that the feed types did not compromise the welfare of the rabbits. Lymphocyte count was significantly ($p<0.05$) highest in rabbits fed 100% mash (60.67%), 100% pellet (66.17%), 50% pellet+50% sunflower (75.17%), and lowest in rabbit fed 100% sunflower (37.50%). This may imply that feeding rabbits 100% sunflower may decline the ability of rabbits to fight infection. According to (27), significantly lower lymphocyte count is an indication of a reduction in the ability of the experimental rabbits to produce and release antibodies when infections occur. Rabbits offered 50% pellet+50% sunflower had the highest ($p<0.05$) eosinophil (1.83%) while the lowest value (0.33%) was obtained in rabbits offered 100% pellet with values falling within the range earlier established by (28) for rabbits. Significantly ($p<0.05$) highest (67.22 and 22.90 fL) mean corpuscular volume (MCV) and mean corpuscular haemoglobin (MCH), respectively were recorded in rabbits fed 100% mash while lowest values (64.27 and 21.62 fL) were obtained in rabbits fed 50% mash+50% sunflower. Similarly, (29) posited that MCV, MCH and MCHC are used in diagnosing anaemic conditions. However, values recorded for MCV and MCH were slightly higher than the normal range of 60.15 – 60.18 and 19.85 – 20.06, respectively reported by (27) for rabbits. The interaction between sex and feed types on haematological parameters at 6th week of the experiment shown in Table 3 also revealed significant differences ($p<0.05$) across treatments for parameters such as red blood cell counts, neutrophils, lymphocytes, eosinophil, basophils, MCV and MCH.

In Table 4, the main effects of sex and feed types on haematological parameters measured in the 10th week of the experiment revealed sex significantly influenced ($p<0.05$) red blood cell counts, neutrophils, and lymphocytes. Red blood cells and neutrophils were higher ($p<0.05$) in male rabbits while lymphocytes were ($P<0.05$) higher in females. This is in accordance with reports by (30) who listed sex as one of the several factors that can affect haematological parameters of rabbits. Higher red blood cell count and neutrophils in males may be due to androgens' effect, which stimulates erythropoiesis (31). However, all values obtained for the haematological parameters are within the range of values for healthy rabbits (32). Previous studies by (30) and (33) stated sex as one of many significant factors influencing red cell blood count in rabbits. Similarly, results by (34) discovered that sexual dimorphism favoured haematological parameters measured in males than females. The higher lymphocyte count in female rabbits at 10th week of this study does not comply with the findings of (34) who observed higher values for lymphocytes in males. However, in experiments conducted by (35) and (36), no significant differences in lymphocytes were obtained between male and female animals.

Table 5: Interaction Effect of sex and feedtypes on haematological parameters of weaner rabbits at 10th week of the experiment

Parameters	Male				Female			
	100% Mash	100% Pellet	50% Mash: 50% sunflower	50% Pellet: 50% sunflower	100% Mash	100% Pellet	50% Mash: 50% sunflower	50% Pellet: 50% sunflower
Packed Cell Volume (%)	47.7±0.33 b	50.0±1.00 ab	47.0±4.04 b	48.7±2.40 ab	48.5±0.87 ab	54.5±0.87 a	48.3±2.03 ab	51.7±1.45 ab
Haemoglobin conc. (g/dl)	16.0±0.15 ab	16.9±0.34 ab	15.7±1.42 b	16.2±0.84 ab	16.3±0.32 ab	18.2±0.29 a	16.2±0.61 ab	17.3±0.52 ab
Red blood cell (×10 3/µl)	9.9±0.20 b	10.3±0.11 b	9.7±0.64 b	10.2±0.45 b	10.1±0.22 b	11.3±0.17 a	10.1±0.33 b	10.7±0.21 ab
White blood cell (×10 3/µl)	13.5±2.55	13.2±2.66	12.5±1.57	10.2±2.06	12.0±2.94	11.0±2.17	10.0±1.29	10.0±1.86
Neutrophil (%)	12.7±2.40 d	16.3±0.88 cd	19.3±1.86 cd	23.3±1.76 bc	28.0±0.00 ab	34.5±4.91 a	28.7±3.76 ab	32.7±0.88 a
Lymphocytes (%)	83.0±3.00 a	79.7±1.20 ab	77.3±0.67 ab	72.7±2.73 bc	68.5±0.29 dc	61.5±4.33 d	67.7±4.06 d	63.3±0.67 d
Basophil (%)	0.0±0.00	0.3±0.33	0.3±0.33	0.0±0.00	0.0±0.00	0.0±0.00	0.0±0.00	0.0±0.00
Eosinophil (%)	2.0±0.58	1.0±1.00	1.7±1.20	1.0±0.58	0.0±0.00	1.0±0.00	1.3±0.67	1.7±0.33
Monocytes (%)	2.3±0.88	3.5±0.29	2.7±1.45	3.0±0.58	1.3±0.88	2.3±0.88	3.0±1.00	3.0±1.00
MCV(fL)	48.3±0.66	47.9±0.17	48.7±0.50	48.2±1.47	48.3±1.54	47.8±0.54	47.7±0.32	48.4±0.50
MCH (pg)	16.2±0.20	15.6±0.32	16.4±0.21	16.1±0.49	16.1±0.52	16.0±0.12	15.9±0.15	15.8±0.29
MCHC (%)	33.6±0.12 ab	33.5±0.06 ab	33.7±0.12 a	33.4±0.03 b	33.4±0.15 ab	33.6±0.17 ab	33.4±0.09 ab	33.4±0.07 ab

abcdMeans on the same row having different superscripts are significantly ($p<0.05$) different

MCV: Mean Corpuscular Volume

MCH: Mean Corpuscular Haemoglobin

MCHC: Mean Corpuscular Haemoglob in Concentration

Table 6 : Main effects of sex and types on serum biochemical parameters of weaner rabbits at 6th week of the experiment

Parameters	Sex		Feed types				
	Male	Female	100% Mash	100% Pellet	50% Mash+ 50% Sunflower	50% Pellet+ 50% Sunflower	100% Sunflower
Glucose(mg/dl)	85.47±4.16	90.31±3.79	98.38±7.55 a	89.82±7.24 ab	77.20±4.36 b	88.25±6.96 ab	85.80±1.99 ab
Total protein(g/dl)	70.90±0.82 a	68.96±0.95 b	67.57±1.41 b	68.08±1.15 b	71.77±1.39 a	69.87±1.57 ab	72.38±0.85 a
Albumin(g/dl)	40.80±0.52 a	38.93±0.93 b	38.25±1.09 b	38.35±0.83 b	41.95±1.48 a	39.25±1.29 ab	41.53±0.76 a
Globulin(g/dl)	30.10±0.48	30.03±0.36	29.32±0.53	29.73±1.24	29.82±0.14	30.62±0.54	30.85±0.12
Urea(mmol/l)	15.17±1.87	15.48±2.39	12.20±1.34	13.50±2.12	18.32±5.83	13.52±0.85	20.60±3.61
Creatinine(mg//dl)	0.83±0.07	0.80±0.04	0.75±0.04 b	0.77±0.08 b	0.68±0.07 b	0.72±0.05 b	1.15±0.07 a
Cholesterol(mg/dl)	84.89±4.19	83.82±4.30	84.47±9.43	87.97±9.22	78.68±4.54	86.47±4.72	84.20±5.09
AST (U/L)	78.28±3.29	88.39±5.38	87.33±6.64	71.62±5.09	91.57±10.23	76.15±6.83	90.03±4.44
ALT (U/L)	39.90±2.55	44.67±3.07	47.20±2.95 a	33.35±2.64 b	43.70±4.19 ab	43.27±6.06 ab	43.93±5.02 ab
ALP (U/L)	48.69±4.12	42.18±3.23	35.98±2.41 b	36.80±4.27 b	44.52±8.21 ab	59.33±5.34 a	50.55±2.32 ab

abMeans on the same row having different supe rscripts are significantly ($p<0.05$) different

AST= Aspartate transaminase , ALT= Alanine transaminase , ALP= Alkaline Phosphate

Feed type significantly affected parameters like packed cell volume (PCV), haemoglobin concentration (Hb), red blood cells (RBC), neutrophil, and lymphocytes. The values obtained for PCV, Hb, and RBC were significantly ($P<0.05$) highest in rabbits fed 100% pellet (52.25%, 17.53 g/dl, 10.81×10^3/µl) and the lowest value (47.67%, 15.95 g/dl and

$9.91\times10^3/\mu l$) was recorded in rabbits fed 50% mash+50% sunflower. These values indicated the diets had no adverse effect on the rabbits. (37) reported that the normal ranges of value for rabbits are as follows: PCV: 30 – 35%, Hb: 9.3 – 19.3g/dl and RBC: 4.00 – 8.60(x106/mm3). According to (27), when the haematological values fall within the normal range reported for rabbits by (37), it is an indication that the diets did not show any adverse effects on haematological parameters during the experimental period, but when the values fall below the normal range, it is an indication of anaemia (37, 38 and 39). Rabbits fed 50% pellet+50% sunflower had the highest ($p<0.05$) value (28.00%) for neutrophils, while rabbits fed 100% mash had the lowest value (20.33%). Comparative values were recorded for those on 100% pellet and 50% mash+50% sunflower. However, rabbits on a 100% mash diet had the highest value (75.75%) of lymphocytes, while rabbits fed 50% pellet+50% sunflower recorded the lowest value (68.00%). These values were within the normal range presented by (27) for rabbits. Furthermore, PCV, Hb, RBC, neutrophils, lymphocytes, and MCHC differed significantly across treatments as influenced by the interaction between sex and feed types (Table 5). Results further confirmed earlier reports by (31) that the haematological parameters of rabbits can be affected by several factors, especially by stress, age, sex, and season, the nutritional and hormonal status.

Main effects of sex and feed types on serum biochemical parameters of weaner rabbits at 6^{th} week of the experiment is shown in Table 6. Total protein and albumin were higher ($p<0.05$) in male rabbits than female rabbits. This is in agreement with (40) who ascribed significantly higher total protein and serum albumin levels among males to the androgens anabolic effect. On the other hand, serum glucose was significantly ($p<0.05$) highest (98.38mg/dl) in rabbits fed 100% mash and lowest (77.20mg/dl) in rabbits on 50% mash+50% sunflower. Similar values were obtained in rabbits on other feed types. The glucose level observed in rabbits fed different feed types indicated that rabbits had the right metabolic energy balance corroborating earlier reports by (41); elevated glucose levels in rabbits are generally due to various stress factors. The highest value for total protein and albumin were recorded in rabbits served 50% mash+50% sunflower and 100% sunflower while the lowest value was recorded in rabbits fed 100% mash and 100% pellet respectively. Serum protein and albumin synthesis are related to the amount of available protein (42). The significant increase observed in total protein and albumin in rabbits fed feed types containing sunflower forage might be that the rabbits were able to utilize the available protein in their feed better. Creatinine was significantly highest ($p<0.05$) in rabbits fed 100% sunflower when compared with similar values obtained in rabbits fed other feed types. This might be due to the presence of some bioactive compounds which have been reported to block the energy metabolic pathway in animals, thus making it difficult for the animals to meet their energy requirement. ALT value (47.20U/L) recorded in rabbits fed 100% mash is higher ($p<0.05$) while rabbits fed 100% pellet had the lowest value (33.35U/L) compared to those fed other feed types. Rabbits fed 50% pellet+50% sunflower had the highest ALP value (59.33U/L), those fed 100% mash (35.98U/L) and 100% pellet (36.80U/L) had the least values respectively. The values were comparable with the normal reference ranges for healthy rabbits reported by (32). Furthermore, interaction between sex and feed types depicted on Table 7 revealed all serum biochemical parameters at 6^{th} week of experiment differed significantly ($p<0.05$) except serum cholesterol.

Table 7 : Interaction Effect of sex and feed types on serum biochemical parameters of weaner rabbits at 6th of the experiment

Parameters	Female					Male				
	100%Mash	100%Pellet	50%Mash+ 50%Sunflower	50%Pellet+ 50%Sunflower	100% Sunflower	100%Mash	100%Pellet	50%Mash+ 50%Sunflower	50%Pellet+ 50%Sunflower	100% Sunflower
Glucose(mg/dl)	103.9±8.33^{a}	97.7±13.68^{ab}	84.1±5.40^{ab}	99.8±3.92^{ab}	86.1±0.00^{ab}	92.9±13.62^{ab}	82.0±3.64^{ab}	96.7±12.49^{a}	70.3±4.28^{b}	85.5±4.45$^{a b}$
Total protein(g/dl)	64.7±0.63^{d}	68.7±0.26^{bcd}	73.4±2.21^{ab}	67.4±2.27^{cd}	70.6±0.00$^{ab c}$	70.5±1.06$^{a bc}$	67.5±2.48^{cd}	72.3±1.17$^{a bc}$	70.1±1.42$^{ab c}$	74.2±0.66^{a}
Albumin(g/dl)	36.2±0.56^{c}	37.2±1.04^{bc}	43.7±2.39^{a}	37.5±2.20^{bc}	40.0±0.00$^{ab c}$	40.3±1.22$^{a bc}$	39.5±0.99$^{ab c}$	41.0±0.69$^{a b}$	40.2±1.44$^{ab c}$	43.1±0.78^{a}
Globulin(g/dl)	28.5±0.24^{bc}	31.5±1.09^{a}	29.7±0.23$^{ab c}$	29.9±0.79^{abc}	30.6±0.00^{ab}	30.2±0.79$^{a bc}$	27.9±1.82^{c}	31.3±0.55^{a}	30.0±0.17$^{ab c}$	31.1±0.12$^{a b}$
Urea(mmol/l)	14.1±1.97^{b}	15.1±3.75^{ab}	21.7±12.39^{ab}	13.8±1.67^{b}	12.7±0.00^{b}	10.3±1.22^{b}	11.9±2.40^{b}	13.3±0.89^{b}	14.9±2.15^{ab}	28.5±1.62^{a}
Creatinine(mg//dl)	0.8±0.03$^{b c}$	0.7±0.15^{c}	0.8±0.10^{bc}	0.7±0.88^{bc}	1.0±0.00^{b}	0.7±0.88^{bc}	0.8±0.88^{bc}	0.7±0.06^{c}	0.6±0.03^{c}	1.3±0.06^{a}
Cholesterol(mg/dl)	86.7±13.79	94.1±12.85	74.6±5.60	90.9±8.66	72.8±0.00	82.2±15.79	81.9±14.92	82.0±4.06	82.8±7.41	95.6±0.00
AST (U/L)	89.8±7.55$^{ab c}$	76.1±7.88$^{ab c}$	106.0±16.69^{a}	70.5±12.87$^{b c}$	99.5±0.00^{ab}	84.8±12.54$^{ab c}$	67.1±6.88^{c}	81.8±6.03$^{a bc}$	77.1±6.06$^{ab c}$	80.6±2.97$^{a bc}$
ALT (U/L)	48.3±4.86$^{ab c}$	32.1±2.12^{c}	50.3±6.04^{ab}	37.6±9.34^{abc}	54.6±0.00^{a}	45.6±4.16$^{a bc}$	34.6±5.37^{bc}	48.9±8.03$^{a bc}$	37.1±2.84$^{ab c}$	33.3±3.49$^{b c}$
ALP (U/L)	34.6±3.41^{b}	30.0±5.57^{c}	44.9±10.03^{ab}	51.9±6.41^{ab}	49.5±0.00^{ab}	37.4±3.92^{b}	43.6±3.78^{ab}	66.8±6.82^{a}	44.1±15.38^{ab}	51.6±5.08$^{a b}$

^{abc} on the same row having different superscripts are significantly ($p<0.05$) different
AST=Aspartate transaminase, ALT=Alanine transaminase, ALP= Alkaline Phosphate

Table 8: Main effects of sex and feed types on serum biochemical parameters of weaner rabbits at 10th of the experiment

	Sex		Feed types			
Parameters	**Male**	**Female**	**100% Mash**	**100% Pellet**	**50% Mash+ 50% Sunflower**	**50% Pellet+ 50% Sunflower**
Glucose (mg/dl)	79.07±4.76	83.03±3.88	76.91±4.90	81.86±5.46	76.35±5.39	89.07±8.08
Total protein (g/dl)	68.59±0.92	68.63±0.81	69.28±1.19	68.13±1.04	70.05±1.08	66.98±1.37
Albumin (g/dl)	39.46±0.83	39.40±0.64	39.50±1.15	39.78±0.75	40.20±0.94	38.20±1.28
Globulin (g/dl)	29.13±0.24	29.22±0.29	29.72±0.17^{a}	28.35±0.33^{b}	29.85±0.27^{a}	28.78±0.34^{ab}
Urea (mmol/l)	16.13±1.30^{a}	12.04±0.36^{b}	12.79±0.64	15.33±1.59	14.75±2.45	13.48±1.25
Creatinine (mg//dl)	0.83±0.06^{a}	0.67±0.02^{b}	0.76±0.04	0.84±0.13	0.70±0.04	0.67±0.42
Cholesterol (mg/dl)	76.79±6.26	59.17±6.36	64.79±3.85	78.33±11.93	52.22±5.27	76.58±11.83
AST (U/L)	131.97±5.99	135.57±10.26	145.36±15.08^{ab}	151.57±9.25^{a}	125.32±10.65^{ab}	112.83±2.33^{b}
ALT (U/L)	75.15±4.90	85.93±6.14	86.96±12.63	81.04±5.44	79.23±6.65	74.92±6.84
ALP (U/L)	39.25±1.98^{b}	47.95±4.01^{a}	41.34±1.55	47.72±7.23	41.05±3.32	44.30±5.62

^{ab} on the same row having different superscripts are significantly ($p<0.05$) different
AST= Aspartate transaminase , ALT= Alanine transaminase , ALP= Alkaline Phosphate

Table 9: Effect of sex and feed types interaction on serum biochemical parameters of growing rabbits at 10th week of the experiment

	Male				Female			
Parameters	**100% Mash**	**100% Pellet**	**50% Mash+ 50% Sunflower**	**50% Pellet+ 50% Sunflower**	**100% Mash**	**100% Pellet**	**50% Mash+ 50% Sunflower**	**50% Pellet+ 50% Sunflower**
Glucose (mg/dl)	84.9±7.37	78.9±7.59	78.8±7.34	89.6±11.17	69.0±1.65	84.9±9.09	73.9±9.23	88.5±14.21
Total protein (g/dl)	69.2±0.75	66.6±1.73	70.4±1.07	68.3±2.42	69.4±2.57	69.7±0.20	69.7±2.13	65.7±1.37
Albumin (g/dl)	39.7±0.79	38.5±1.10	40.3±0.71	39.2±2.39	39.5±2.45	41.1±0.02	40.1±1.97	37.2±1.22
Globulin (g/dl)	29.5±0.32^{abc}	28.1±0.67^{d}	30.1±0.43^{a}	29.1±0.17^{abcd}	29.9±0.11^{ab}	28.6±0.17^{bcd}	29.6±0.34^{abc}	28.5±0.63^{cd}
Urea (mmol/l)	12.0±0.89^{ab}	12.6±1.06^{ab}	11.2±0.48^{b}	12.4±0.29^{ab}	13.6±0.84^{ab}	18.1±2.05^{a}	18.3±4.13^{a}	14.6±2.55^{ab}
Creatinine (mg//dl)	0.7±0.00^{b}	0.6±0.03^{b}	0.7±0.03^{b}	0.7±0.09^{b}	0.9±0.03^{ab}	1.1±0.20^{a}	0.7±0.08^{b}	0.7±0.03^{b}
Cholesterol (mg/dl)	60.8±7.17^{ab}	59.2±14.89^{ab}	43.6±7.02^{b}	73.1±18.69^{ab}	68.8±2.62^{ab}	97.5±11.09^{a}	60.8±3.93^{ab}	80.1±8.38^{ab}
AST (IU/L)	160.1±29.69	151.8±20.49	121.5±11.26	108.9±1.21	130.7±6.21	151.3±2.71	129.2±20.62	116.8±3.19
ALT (IU/L)	103.2±22.47	90.9±1.85	78.0±4.45	71.6±2.63	70.8±5.46	71.2±6.84	80.4±14.14	78.3±14.69
ALP (IU/L)	40.4±3.21	60.9±8.77	38.9±6.11	51.6±8.39	42.3±0.95	34.5±3.41	43.2±3.63	37.0±5.89

^{abcd} on the same row having different superscripts are significantly ($p<0.05$) different
AST= Aspartate transaminase , ALT= Alanine transaminase , ALP= Alkaline Phosphate

Serum biochemical parameters provide essential information about visceral organ damage, particularly for the liver and the kidneys (42, 30 and 33). On the 10th week of the experiment, serum biochemical parameters presented in Table 8 revealed that sex significantly ($P<0.05$) influenced urea, creatinine, and ALP with male rabbits recording significantly ($P<0.05$) higher urea and creatinine while ALP was significantly higher ($P<0.05$) in females. Serum ALP activity originates from both liver and bone and varies by age, and in young individuals' serum ALP levels are higher because of rapid bone growth; hence, serum ALP activity in this study might be due to the differences in age and growth period of the animals. These results contradicted earlier reports by (26) that no statistically significant difference existed between sexes for any serum biochemical parameters of New Zealand white rabbits. Globulin was significantly ($P<0.05$) highest (29.72g/dl) in rabbits fed 100% mash and 50% mash+50% sunflower (29.85g/dl) and lowest (28.35g/dl) in rabbits fed 100% pellet. Significantly ($P<0.05$) highest (151.57U/L) AST was recorded in rabbits fed 100% pellet while the lowest value (112.83U/L) was observed in rabbits fed 50% pellet+50% sunflower. Aminotransferases are normally intracellular enzymes, with low levels found in the plasma representing the release of cellular contents during normal cell turnover. The serum ALT and AST levels are elevated in nearly all liver diseases and are particularly high in conditions that cause extensive cell

necrosis, including severe viral hepatitis or toxic liver injury (42). AST occurs in a wide variety of tissues, but with high concentrations in muscular tissues and liver; hence, the decrease in AST activity in rabbits fed 50% pellet+50% sunflower could be a reflection of the absence of degenerative changes in their muscles and livers. Similarly, globulin, urea, creatinine and cholesterol differed significantly across treatments by the interaction between sex and feed type (Table 9). Values recorded were within the range of reference values reported for rabbits in previous studies (43, 44 and 30). Increase in urea in the blood of an animal is an indication of an increase in muscles metabolic activities anaerobically resulting to formation of ketones. Similarly, in the evaluation of the effect of chemicals in the kidney, an increase in serum urea implies an increase in rate of deamination in the liver (45).

Conclusion and Applications

1. Sex had no detrimental effect on haematological parameters and serum biochemical indices as most of the values obtained in this study fall within the normal literature values for rabbits..
2. Feeding rabbits 100% sunflower reduced the ability of rabbits to fight infection and also cause difficulty for the animals to meet their energy requirement as indicated by the reduced lymphocyte and increased creatinine respectively.

References

1. Egbo, M.L., Doma, U.D. and Lackaks, A.B. (2001). Characteristics of small rabbit production and management in Bauchi metropolis, *Proceedings of the26th Annual Conference of Nigerian Society for Animal Production (NSAP),* 18th – 21st March
2. Etim, N. N. and Oguike, M. A. (2010). Egg production of the domestic fowl (Gallus gallus): Implications for food security. *Proceeding of the 35th Annual Conference of the Nigeria Society for Animal Production (NSAP),* 660.
3. Wafar, R.J., Tarimbuka, L.I., Sini, T and Adi, Z.A (2019). Evaluation of fermented sorrel (Hibiscus sabdariffa l.) seed meal on growth performance and carcass characteristics of weaner rabbits. *FUDMA Journal of Agriculture and Agricultural Technology*, 5(1): 9-17
4. Bawa, G.S., Ajide, S.O., Adeyinka, I.A. and Ajala, M.K. (2008). Effect of varying levels of groundnut haulms and cowpea shells on the performance of weaner rabbits. *Asian Journal of Animal and Veterinary Advances*. 3(2):54–61.
5. Oliveira, A.F.G., Scapinello, C., Maria, B.G, Jobim, C.C., Monteiro, A.C., Furuta, L. and Ferreira, W.M. (2008). Use to simplify diet with cassava by products for rabbits. *Proceedings 9th World Rabbit Congress, 10-13 June 2008, Verona, Italy, 775-779.*
6. Phimmasan, H., Kongvongxay, S., Chhayty, P. and Preston, T.R. (2004). Water Spinach (*Ipomea aquatica*) and stylo 184 (*Stylosanthes guianesis* CIAT 184) as basal diet for growing rabbits. *Livestock Research for Rural Development.* 16:46-59.
7. Hue, K.T. and Preston, T.R. (2006). Effect of different sources of supplementary fibre on growth of rabbits fed a basal diet of fresh water spinach (*Ipomea aquatica*). *Livestock Research and Rural development*. Vol: 18
8. Aduku, A.O. and Olukosi, J.O. (1990). Rabbit Management in the Tropics: Production, Processing, Utilization, Marketing, Economics, Practical training, Research and Future Prospects, Living Book Services, G.U. Publications, Abuja.
9. Olayeni, T.B., Farinu, G.O., Togun, V.A., Adedeji O.S. and Aderiola, O.A. (2006). Performance and haematological characteristics of weaner pigs fed wild sun flower (*Tithonia diersifolia* Hemsl. A. Gray) leaf meal, *Journal of Animal and Veterinary Advances* Vol. 5, pp. 499-502.
10. Sogunle, O.M., Olatunbosun, O.O., Adeyemi, A.O., Oso, O.A., Ekunseitan, D.A. and Bello, K.O. (2014). Feed forms of different particle sizes: growth response,

carcass yield, and intestinal villus morphology of growing rabbits. *Bulletin of University of Agricultural Sciences and Veterinary Medicine cluj-Napoca Veterinary Medicine*. 71(1): 84-90

11. Mirgheleni, S. A. and Golian, A. (2009). Effects of feed form on development of digestive tract, performance and carcass traits of broiler chickens. *Journal of Animal and Veterinary Advances*, 8(10): 1911-1915.
12. Safwat, M. A., Sarmiento-Franco, L. and Santos-Ricalde, R. H. (2014). Rabbit production using local resources as feedstuffs in the tropics. *Tropical and Subtropical Agroecosystems*, 17 (2): 161-171
13. Etim N.N., Williams, M.E., Akpabio, U., and Offion E.E.A. (2014). Haematological Parameters and Factors Affecting their Values; *Agricultural Science*, 2 (1): 37 - 47
14. Aro, S. O., Ogunwale, F. F. and Falade, O. A. (2013). Blood viscosity of finisher cockerel fed dietary inclusions of fermented cassava tuber wastes. *Proceeding of the 18th Annual Conference of Animal Science Association ofNigeria*, 74-77.
15. Schalm, O. W., Jain, N. C. and Caroll, E. J. 1975. Veterinary haemtology. 3rd edition Lea and Fabiger, Philadelphia
16. Coles, E.H. (1986) Veterinary Clinical Pathology. 4th Edition W.B. Saunders Company, Philadelphia, 17-19.
17. Ihedioha, J. T., Okafor, C. and Ihedioha, T. E. (2004). The haematological profile of the Sprague Dawley out bred albino rat in Nsukka. *Animal Research International*, 1:125-132
18. Rafiu, T. A., Aderinola, O. A., Akinwumi, A. O., Alabi, T. A. and Shittu, M. D. (2013). Performance and blood chemistry of broiler chickens fed Moringa oleifera leaf meal. *Proceeding of the 18th Annual Conference of Animal Science Association of Nigeria*, 294.
19. Google Earth. 2019. http:// www.google earth.com
20. Uko, O. J., Usman, A. and Ataja A. M. (2021). Some biological activities of Garcinia kola in growing rats. *Veterinary arhives* 71, 287-297
21. Ajagbonna, O.P., Onifade K.I. and Suleiman U. (1999). Hematological and Biochemical changes in rats given extract of Calotropis procera. *Sokoto Journal of Veterinary Sciences*. 1:36-42
22. Jain, N.S. (1986). Scanning electron micrograph of blood cell in: Schalms Veterinary Haematology (4th edition). Lea and Febiger. Philadephia. USA.
23. Kohn R.A.and Allen M.S. 1995. Enrichment of proteolysis activity relative to nitrogen in preparations from the rumen for in vitro studies. *Animal Feed Science Technology*, 52: 1-4
24. S.A.S. (2008): Statistical Analysis Systems Institute. User's Guide release 9.0. S.A.S. Institute Incorporated, Cary, NC, USA
25. Chineke, C.A., Ologun, A.G. and Ikeobi, C.O.N. (2006). Haematological parameters in rabbit's breeds and crosses in humid tropics. *Pakistan Journal Biological Science* 9 (11): 2102–2106
26. Özkan, C., Kaya, A., and Akgül, Y. (2012). Normal values of haematological and some biochemical parameters in serum and urine of New Zealand White rabbits. *World Rabbit Science*, 20, 253–259.
27. Togun, V. A., Oseni, B. S. A., Ogundipe, J. A., Arewa, T. R., Hammed, A. A., Ajonijebu, D. C., Oyeniran, A., Nwosisi, I. and Mustapha, F. (2007). Effects of chronic lead administration on the haematological parameters of rabbit – a preliminary study. *Proceeding of the 41st Conference of the Agricultural Society of Nigeria, 341*.
28. Olabanji, R. O., Farinu, G. O., Akinlade, J. A. and Ojebiyi, O. O. (2007). Growth performance and haematological characteristics of weaner rabbits fed different levels of wild sunflower (Tithonia diversifolia Hems L A. Gray) leaf blood meal mixture. *Proceeding of 32nd Animal Conference of Nigeria Society for Animal Production, 207-209*
29. Njidda, A. A., Igwebuike, J. U. and

Isidahomen, C. E. (2006). Haematological parameters and carcass characteristics of weaning rabbits fed grade levels of molasses. *Global Journal of Agricultural Science*, 5(7):167-172.
30. Melillo, A. (2007). Rabbit clinical pathology. Journal of Exotic Pet Medicine, 16, 135–145
31. Kelani, O.L. and Durotoye, L.A. (2002). Haematological responses of the African giant rat (Cricetomys gambianus) to castration and androgen replacement. *Veterinarski Arhiv* 72:39–49
32. Medirabbit, 2011. Complete blood count and biochemical reference values in rabbits. Retrieved from www.medirabbit.com, 22nd July, 2016, 12:30 pm.
33. Jenkins J.R. (2008). Rabbit diagnostic testing. Journal of Exotic Pet Medicine, 17: 4-15.
34. Anlade, Y. D. R., Muftau, M. A., Peni, J. I., Ribah, M. I., Bello, S. and Musa, A. A. (2015). Effects of sex and age on haematological parameters of rabbits in sub-humid savannah of Nigeria. *Equity Journal of Science and Technology*, 3(1)
35. Lacerda, L., Campos, R., Sperb, M., Scares, E., Barbosa, P., Godinho, E., Ferreira, R., Santos V. and Gonzalez F. (2006). Haematological and biochemical parameters in three high performance horse breeds from Southern Brazil. *Archives of Veterinary Science* 11:40–43
36. Tomenenendalova, J., Vodicka, R., Uhrikova I. and Doubek J (2014). Determination of haematological and biochemical parameters of Przewalski horses (*Equus Przewalskii*) kept by the Prague zoo. *Veterinarni Medicina-Czech* 59:11–21
37. Mitruka, B. M. and Rawnsley, H. M. (1977). Clinical, biochemical and haematological reference values in normal and experimental animals. Masson Publishing, USA, Inc., 83:134-135.
38. Radostits, O. M., Gays, C. C. and Blood, D. C. (1994). Veterinary medicine: A textbook of disease of cattle, sheep, goats, pigs and horses. W. B. Saunders (eds.) 304
39. Ameen, S.A., Adedeji, O.S., Akingbade, A.A., Olayeni, T.B., Oyedapo, L.O. and Aderinola, A. (2007). The effect of different feeding regimes on haematological parameters and immune status of commercial broilers in derived savannah zone of Nigeria. *Proceeding of Annual Conference Nigeria Society for Animal Production* 32:146-148.
40. Saad, M. S., Mohamed A. M. and Khalid, H. (2017). Some Haemato-Biochemical Values in White New Zealand Rabbits. *Journal of Agriculture and Veterinary Science (IOSR-JAVS).* Volume 10, Issue 7, PP 40-44
41. Ologhobo, A. D., Apata, D. F., Oyejide, A., and Akinpelu, R. O. (1992). Toxicity of raw lima beans (Phaseolus lunatus) and lima bean fractions for growing chicks. *British Poultry Science*, 34, 505–522.
42. Jurcik, R., Suvegova, K., Hanusova, E., Massanyi, P., Ryban, L., Chrenek, P. (2007). Evaluation of haematological, biochemical and histopathological parameters of transgenic rabbits. *Journal of Veterinary Medicine A*, 54: 527-531.
43. Yazar, E., Çöl. R., Konyalıoğlu, S., Birdane Y.O., Elmas M. and Baş A.L. (2004). Effects of vitamin E and prednisolone on biochemical and haematological parameters in endotoxaemic New Zealand White Rabbits. *Bulletin-Veterinary Institute in Pulawy*, 48: 105-108
44. Elmas M., Yazar E., Uney K. and Karabacak A. (2006). Pharmacokinetics of flunixin after intravenous administration in healthy and endotoxaemic rabbits. *Veterinary Resources Community*30: 73-81
45. Davis, M.E. and Berndt, W. D. (1994). Renal Methods for toxicology, In: Hayes, A.W. (Eds); Principles and methods of toxicology, 3rd Ed. New York Raven. 871-89.