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Effect of graded levels of ginger rhizome (*Zingiber officinale*) meal on haematology of pubertal New Zealand white rabbits

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ABSTRACT: Forty-eight sexually matured (7 to 8 months old) healthy New Zealand White rabbits consisting of male and female of equal sexes were used to determine the effect of graded levels of ginger rhizome meal on haematological parameters. The rabbits were divided into 4 treatment groups, identified as T_1, T_2, T_3 and T_4 and randomly assigned to four treatment diets in a randomized complete block design (RCBD). Each of the treatment groups consisted of 12 rabbits (6 does and 6 bucks) replicated 3 times with 4 rabbits per replicate. The levels of inclusion of the ginger rhizome meal were 0.00, 5.00, 10.00 and 15.00% identified as T_1, T_2, T_3 and T_4 respectively. Treatment one (T_1) which contained no ginger rhizome meal served as the control. The rabbits were fed twice daily, in the morning and evening. Water was given *ad libitum* to the rabbits. After 30 days of the feeding trail, blood samples were randomly collected from 12 rabbits (6 does and 6 bucks) in each treatment group for hematological evaluation. The results showed that there were significant differences ($P<0.05$) among the treatment groups in haematological parameters: haemoglobin (HB), packed cell volume (PCV), mean corpuscular volume (MCV) , white blood cells (WBC), neutrophil, lymphocyte and monocyte values. There were no significant differences ($P>0.05$) among the treatment groups in red blood cells (RBC), mean corpuscular haemoglobin (MCH) and mean corpuscular haemoglobin concentration (MCHC), basophils and monocyte values. The results further showed that the HB, PCV, RBC, WBC, neutrophil and lymphocyte values of the rabbits were significantly ($P<0.05$) influenced by sexes. Haemoglobin (12.72g/dl) PCV 37.87% RBC 5.54 ($x10^{12}$/L) and lymphocytes (47.67%) of the male rabbits (bucks) were significantly ($P<0.05$) higher than their female (doe) counterparts 11.97 g/dl, 34.60%, 4.98 ($x10^{12}$/L) and 39.00% respectively. Mean corpuscular volume (70.43 fl), WBC ($9.07x10^9$/L) and neutrophils (60.00%) of the female rabbits differed significantly ($P<0.05$) from their male counterparts 67.65 fl, $6.40x10^9$/l and 51.33% respectively. The results of this study indicate that inclusion of ginger rhizome meal in the diets of the pubertal rabbits up to 5% improved the haematological indices of these rabbits.

Key words: Blood, feed, trial, evaluation, gender, rabbits.

INTRODUCTION

The rapid increase in the world population in general and in the Nigeria population in particular has aggravated the animal protein deficiency. Food and Agricultural Organization (2006) estimated the average animal protein consumption in Nigeria to be 7.4 g per capita/day as compared to 38 g per capita/day of animal protein consumed in South Africa. The increasing demand for animal protein indicates the need to intensify livestock production. Poultry production which was the quickest way to bridge this animal protein deficiency gap was observed to be characterized by high cost of production due to high cost of feeds which accounts for more than 70 to 80% of the total production costs (Akinmutimi, 2001; Ojebiyi et al., 2006). As a result of this high cost of production in the poultry sector, most of the livestock producers are shifting to other farm animals where the

cost of production is low. The rabbit was identified to possess the potential of becoming an important source of animal protein with its ability to utilize forage and cheap feedstuff efficiently.

Rabbits are highly prolific animals with short generation interval, short gestation period and a good ability to convert a wide range of feedstuffs to edible meat (Aduku and Olukosi 1990; Olupona and Balogun, 2004; Akinmutimi and Anakebe 2008). There is therefore, the need to develop cheaper alternative sources of animal protein for rabbit to bridge the wide gap that exist between animal protein supply and intake. In addition, the FAO recipe to fight hunger has rabbit as its key component (Prathap and Ponnusaing, 2007).

Ginger is underground rhizome of plant *Zingiber officinale* belonging to the family *Zingiberaceae* and it is a common constituent of diet worldwide (Bartley and Jacobs, 2000; Zhang et al., 2009). Medicinal herbs such as garlic (*Allium sativum*) and ginger (*Zingiber officinale*) were reported to possess antibacterial, antiseptic, anti-inflammatory, anti-parasitic and immunomodulatory properties (Muhammad et al., 2009 and Zhao et al., 2011). Moreover, ginger is well known all over the world especially for its use in disorders of the gastrointestinal tract such as constipation, dyspepsia, nausea and vomiting (Afzal et al., 2001; Zhang et al., 2009; Ogbuewu et al., 2014). They reported that ginger has medicinal properties against digestive disorders, rheumatism and diabetes.

Ginger extract possesses anti-oxidative characteristics, since it can scavenge superoxide anion and hydroxyl radicals (Muhammad et al., 2009). Arshad et al. (2014) reported that numerous active ingredients are present in ginger including terpenes and oleoresin which are called ginger oil. Ginger also constitutes volatile oils approximately 1 to 3% and non-volatile pungent components oleoresin (Zick et al., 2008). The major identified components from terpene are sesquiterpene hydrocarbons and phenolic compounds which are gingerol and shogaol (Hazan et al., 2012) and lipophilic rhizome extracts yielded potentially active gingerols which can be converted to shogaols and paradol (Arshad et al ., 2014). The extracts of ginger have multiple pharmacological effects. Guyer (2003) outlined to include inhibition of prostaglandin, thromboxane and leukotrienes synthesis. Ginger extract are important in the inhibition of catarrh and platelet aggregation. They are also important for their cardiotonic effects and gastro-intestinal actions. Ginger extracts have thermogenic and antibiotic activities and are important as digestive stimulants (Guyer, 2003).

Studies have shown that ginger can be used as a natural growth promoter as it enhanced immune function and favoured meat quality in animals (Okoye et al., 2006). Again, understanding the haematological constituents of rabbits fed diets supplemented with ginger rhizome meal is important, since such data indirectly reflect in the physiological responsiveness of the animals (Esonu et al., 2001). Therefore, this study was carried out to determine the effect of graded levels of ginger rhizome meal on haematological parameters of pubertal New Zealand White rabbits.

MATERIALS AND METHODS

Processing of ginger rhizome meal

Fresh rhizomes of ginger (*Zingiber officinale*) were sourced from Ogbete market in Enugu, Enugu State, Nigeria. The fresh ginger rhizomes were washed in water to remove dirt. They were chopped into smaller sizes using kitchen knife. They were sun-dried to reduce the moisture content. Thereafter, they were milled into fine particle sizes using hammer mill. The ground samples were sieved through 2.5 mm test sieve and thereafter used to formulate the experimental diets.

Experimental animals, management and diets

Forty - eight sexually matured male and female rabbits of New Zealand white breed of equal sexes aged 7 to 8 months were used for this experiment. The rabbit bucks had an average weight of 1200.00 g whereas the rabbit does had an average weight of 1250.00 g. Each animal was housed in a single hutch of 50 x 50 cm^2 with wire mesh floor and wooden frames. Each hutch was tagged for easy identification of the rabbits used for the experiment. The house was naturally ventilated and the rabbits were reared in a clean environment. The animals were dewormed before the commencement of the experimental. The experimental period lasted for 30 days. The animals were fed commercial concentrate diet only for 2 weeks of acclimatization.

Four experimental diets were formulated using NRC (1994) to meet the nutrient requirement of the rabbits. The diets were represented as T_1, T2, T_3 and T_4. Treatment one (T_1) which had no ginger rhizome meal served as the control (0%) while T_2, T_3 and T_4 contained 5, 10 and 15% ginger rhizome respectively. Freshly cut forage consisting of *Panicum maximum, Pennisetum purpureum* and *Centrosema pubescens* was fed as basal diet. The animals were fed two times daily using 1 kg of the experimental diets and 700 g of forage. Water was provided *ad libitum* and multivitamin drugs were given to them through drinking water to boost their immunity against infections. A randomized complete block design was used to assign the animals to the experimental diets such that there were 12 rabbits (6 bucks and 6 does) on each diet. The nutrient composition of the experimental diet is shown in Table 1. The rabbits were fed the test diets for 30 days after which blood collection and evaluation were carried out.

Table 1. Chemical Composition of the Forages (%).

Parameters	CP	PM	PP
Dry matter	73.38	85.30	73.69
Crude protein	25.20	9.79	7.87
Ether extract	3.34	1.20	2.59
Crude fibre	7.89	8.10	8.51
Ash	8.10	8.70	8.50
Nitrogen free extract	33.53	41.60	42.40
ME (MJ/Kg DM)	0.93	1.46	1.20

PM, *Panicum maximum,* PP, *Pennisetum purpereum,* CP, *Centrosema pubescens.* ME, metabolizable energy, (MJ/Kg DM) = mega joule/kilogram dry matter.

Experimental design

Forty-eight sexually matured (7 to 8 months) healthy New Zealand white rabbits of equal sexes were used for this study. They were divided into four treatment groups represented as T_1, T_2, T_3 and T_4. Each treatment group consisted of 12 rabbits (6 bucks and 6 does) replicated three times with 4 rabbits per replicate in a completely randomized block design (CRBD) and completely randomized design (CRD) with four levels of ginger meal supplemented diets as treatments. The levels of ginger rhizome meal inclusion are 0.00 (T_1), 5.00 (T_2), 10.00 (T_3) and 15.00% (T_4). Treatment one (T_1) which contained no ginger rhizome meal served as the control.

Blood collection and haematological evaluation

After 30 days of feeding trial, four animals from each replicate making a total of 12 rabbits (6 does and 6 bucks) per treatment were randomly selected for bleeding. 3 ml of blood was aspirated from the marginal ear vein of each rabbit using needle and syringe for haematological evaluation. They were transferred into Bijou bottles containing ethylene diamine tetra-acetic acid (EDTA). The blood samples were analyzed within 2 hours of their collection for packed cell volume (PCV) and haemoglobin (HB). Erythrocyte or red blood cells (RBC) and leucocyte count were determined as described by Jain (1986). Erythrocyte count was done in a haemocytometer chamber placed under a light microscope. Packed cell volume was determined by the microhaematocrit method (Jain, 1986) with 75 x 16 mm capillary tubes filled with blood and centrifuged at 3000 rpm for 5 minutes. Haemoglobin concentration was also determined by the cyanmethemyoglobin method (Jain, 1986). The various red cell indices like mean corpuscular haemoglobin (MCH), mean corpuscular haemoglobin concentration (MCHC) and mean corpuscular volume (MCV) were calculated from RBC, HB and PCV (Lazzaro, 2003). Total leucocyte count was carried out using a Neubaer haemocytometre placed under a light microscope under x10 magnification, after using Natt and Henricks dilution to obtain a 1:200 blood dilution. Differential leucocyte count was achieved using blood smears stained with Wright's dye and each type of cell (neutrophil, lymphocyte, eosinophil, monocyte and basophil) was determined with a counter.

The experiment was performed in accordance with the ethical guidelines and regulations of the Abia State University, Uturu, Abia State, Nigeria and in accordance with the internationally accepted principles for laboratory animal care and use.

Data analysis

Data obtained on haematological indices of the male and female rabbits were subjected to analysis of variance (ANOVA) with Dunnett's control test using the SPSS (1996) package. Significant treatment means were separated using Duncan's New Multiple Range Test as described by Obi (2002). Statistical differences between sexes were determined by students's t-test. The analysis is considered significant at $P<0.05$.

RESULTS AND DISCUSSION

The results of haematological parameters of New Zealand white rabbits fed graded levels of ginger rhizome meal are shown in Table 3. There were significant differences ($P<0.05$) among the treatment groups in HB, PCV, MCV, WBC, neutrophils, lymphocytes and monocytes values. Conversely, there were no significant differences ($P>0.05$) among the treatment groups in RBC, MCH, MCHC, basophils and eosinophil values.

The haemoglobin values obtained in this study ranged from 11.51 to 13.65 g/dl. Rabbits in T_1 had the highest haemoglobin value of 13.65 g/dl and this differed significantly ($P<0.05$) from rabbits on T_3 and T_4 which were similar ($P>0.05$) to each other in HB vales. There

Table 2. Composition of experimental diets**.**

Ingredients	T_1	T_2	T_3	T_4
	0%	**5%**	**10%**	**15%**
Maize	40	40	40	40
Ginger meal	-	5	10	15
Wheat offal	15	10	5	-
P.K.C	14	14	14	14
S.B.M	22	22	22	22
Fish meal	2	2	2	2
Oyster shell	2.5	2.5	2.5	2.5
Bone meal	3.0	3.0	3.0	3.0
Methionine	0.25	0.25	0.25	0.25
Lysine	0.25	0.25	0.25	0.25
Vitamin / Premix	0.25	0.25	0.25	0.25
Salt	0.5	0.5	0.5	0.5
Mycofix	0.25	0.25	0.25	0.25
Total	100	100	100	100
Calculated analysis				
Crude protein %	20.01	19.79	19.57	19.36
ME (Kcal / kg)	2,747.62	2,771.67	2,808.84	2,846.01

ME; metabolizable energy, Kcal/kg,; kilo Cal/kilogram,; PKC, palm kernel cake,; SBM, soya bean meal.

Table 3. Hematology Parameters of New Zealand white rabbits fed graded levels of ginger rhizome meal.

Parameters	Dietary Levels (%)				SEM
	T_1	T_2	T_3	T_4	
	0.0	**5.0**	**10.0**	**15.0**	
Haemoglobin (g/dl)	13.65^{a}	12.45^{b}	11.51^{b}	11.78^{b}	0.31
PCV (%)	39.67^{a}	38.14^{a}	33.69^{b}	33.62^{b}	0.63
RBC ($x10^{9}$/l)	6.09	5.18	4.59	5.18	0.17
MCH (pg)	23.19	24.35	24.66	23.78	0.57
MCHC (%)	34.16	34.96	35.25	33.63	0.69
MCV (fl)	64.97^{c}	70.55^{ab}	71.95^{a}	68.69^{b}	0.72
WBC ($x10^{3}$µ/l)	6.57^{c}	8.57^{b}	10.17^{a}	4.90^{d}	0.15
Neutrophils (%)	57.33^{d}	63.67^{b}	58.67^{c}	70.00^{a}	0.17
Basophils (%)	0.00	0.00	0.00	0.00	0.00
Eosinophil (%)	0.01	0.00	0.33	0.67	0.06
Lymphocytes (%)	42.33^{a}	34.67^{c}	40.67^{b}	28.33^{d}	0.21
Monocytes (%)	0.33^{b}	1.66^{a}	0.33^{b}	1.00^{ab}	0.17

^{a,ab,b,c,d}:Means within the same row with different superscripts differ significantly (P<0.05); SEM = Standard Error of means; PCV = packed cell volume; RBC = red blood cell; WBC = white blood cell; MCH = mean corpuscular haemoglobin; MCHC = mean corpuscular haemoglobin concentration; MCV = mean corpuscular volume.

was no significant difference (P>0.05) between rabbits on T1 and T2 in HB values. Rabbits on T_3 had the least value of 11.51 g/dl in HB. The haemoglobin values obtained in this study were within the range of 9.80 to 15.80 g/dl reported earlier (Research Animal Resources (RAR), 2009; Merck, 2010) for rabbits. Since haemoglobin is responsible for cellular respiration which is important in metabolic reactions, a decrease in haemoglobin is an important determinant of anaemia which may lead to reduction in the oxygen carrying capacity of blood, that is to say there was no anaemia reported in this study

The PCV values ranged from 33.62 to 39.67%. Rabbits on T_1 recorded the highest value of 39.67% and this

differed significantly (P<0.05) from rabbits on T_3 (33.69%) and T_4 (33.62%) which were similar (P>0.05) to each other in PCV values. Rabbits on T_2 (38.14%) had the lowest value in PCV. The result followed a downward trend from T_1 to T_4. The values obtained in T_1 and T_2 were higher than the range of 35.98 to 36.83% reported by Ogbuewu et al. (2013) who fed pubertal rabbits with ginger rhizome powder supplemented diets. While the values obtained in T_3 and T_4 were lower than this range. The disparity in the result may be connected to the differences in sex, age, physiological and nutritional status of the rabbits (Chineke et al., 2006: Isaac et al., 2013: Esonu et al., 2001).

The RBC values ranged from 4.59 to 6.09 ($x10^{12}$/l). The highest numerical value of 6.09 ($x10^{12}$/l) was recorded in T_1, followed by T_2 and T_4 which had the same value 5.18 ($x10^{12}$/l). Rabbits on T_3 had the lowest value of 4.59 ($x10^{12}$/l). The RBC values obtained in this study were lower than the range of 5.79 to 6.49 ($x10^{12}$/l) reported by Ogbuewu et al. (2013) in rabbits, except rabbits on T_1 whose RBC value was within the range. However, the RBC values obtained in this study agreed with the values reported by Ayalew (2001) and Mohammed et al. (2010) for rabbits.

The MCH values ranged from 23.19 to 24.66 pg. Rabbits on T_3 recorded the highest numerical value of 24.66 pg; followed by T_2 24.35 pg, then T_4 and T_1 which had the lowest value of 23.19 pg. Mean corpuscular haemoglobin values obtained in this study fall within the normal range of 19.20 to 29.50 pg reported by (Merck, 2010). However, the MCH values obtained in this study were higher than the range of 19.88 to 21.93 pg reported by Ogbuewu et al. (2013) in rabbits. The reasons could be due to differences in age, sex, breed and nutritional status of the rabbits (Isaac et al., 2013).

Mean corpuscular haemoglobin concentration values ranged from 33.63 to 35.25 g/dl. Rabbits on T_3 had the highest numerical value of 35.25 g/dl followed by T_2 (34.96 g/dl), T_1 (34.16 g/dl) and T_4 (33.63 g/dl). The values obtained agreed with the normal range of a healthy rabbit 31.10 to 37.00 g/dl as reported by (Merck, 2012). More so, it agreed with the range of 32.09 to 33.78 g/dl as reported by Odetola et al. (2010) and Mohammed et al. (2010) and the range of 34.40 to 34.90 g/100ml reported by Ogbuewu et al. (2013) in rabbits.

Mean corpuscular volume (MCV) values ranged from 64.97 to 71.95 fl. T_3 had the highest value of 71.95 fl and this differed significantly (P<0.05) from rabbits on T_1 and T_4 which were also significantly different (P<0.05) from each other in MCV values. There was no significant difference (P>0.05) between rabbits onT_3 and T_2 in MCV values. Rabbits on T_1 had the lowest value of 64.97 fl in MCV. The result did not follow a definite pattern. The MCV values obtained in the study were higher than the normal range of 58 to 67 fl reported for rabbits (Merck, 2010), except rabbits on T_1 whose MCV value was within the normal range. Also, the MCV values obtained in this study were higher than the range of 57.01 to 63.55 fl reported by Ogbuewu et al. (2013) in rabbits. Mean corpuscular volume (MCV) of blood is an indication of the average volume of blood cells (Lazzaro, 2003; Etim et al., 2014).

The white blood cell WBC values ranged from 4.90 to 10.17 ($x10^9$/l). The highest value of 10.17 ($x10^9$/l) in WBC was obtained from rabbits on T_3 and this differed significantly (P<0.05) from rabbits on T_2 ($8.57x10^9$/l), T_1 ($6.57x10^9$/l) and T_4 (4.90 $x10^9$/l) which were also significantly different (P<0.05) from each other in WBC values. The lowest value in WBC was obtained from rabbits on T_4. The values of WBC obtained in this study were lower than the range of 9.15 to 11.50 (x109/l reported by Ogbuewue et al. (2013) who fed prepubertal rabbits with ginger rhizome powder supplemented diets, except rabbits on T_3 whose WBC value was within the range. The lower limit of the results of Odetola et al. (2010) was higher than that obtained in this study. The differences observed could be due to age and sex of rabbits as reported by Isaac et al. 2013 and Etim et al. 2014). White blood count generally varies due to various stress factors and blood collection methods (Silva et al. 2005; Melillo, 2007). Abnormal production of white blood cell in the blood of animals is usually associated with immune response by animals due to the presence of an antigen (foreign body) in the body. The values of white blood cells obtained in this study also depicts absence of infections since elevation of white blood cells suggests infection by microorganisms especially bacteria (Aka et al., 2008; Sowande et al., 2008).

Neutrophil values ranged from 57.33 to 70.00%. The highest value of 70.00% was observed in rabbits on T_4 and this differed significantly (P<0.05) from rabbits on T_1 (57.33 %), T_2 (63.67%) and T_3 (58.67%) which were also significantly different (P<0.05) from each other in neutrophil values. The lowest value in neutrophil was observed in rabbits on T_1. The values of neutrophil obtained in this study disagreed with the ranges of 19.25 to 30.75(%), 33.33 to 38.67(%) and 39.00 to 46.58% reported by Mohammed et al. (2009), Odetola et al. (2010), Ogbuewu et al. (2013) respectively. The high neutrophil values (neutrophilia) obtained in this study is an indication of possible infection or tissue damage (Cheesbrough, 2000; Aka et al., 2008). Neutrophils are very important for defense whenever acute infection is present (Banerjee, 2007).

For basophil, the values obtained in the study for all the treatment was 0.00%. The basophil values obtained in this study differed from the values 1.00 to1.50% reported by Mohammed et al. (2014). The differences observed could be due to age and treatment as they fed growing rabbits using rumen content mixtures.

Eosinophil values ranged from 0.00 to 0.67%. Highest numerical value of 0.67% was observed in T_4, followed by 0.33% in T_3, while T_1 and T_2 values were 0.01and 0.00% respectively. Value obtained from the study disagrees

Table 4. Effect of sex on haematological parameters of New Zealand white rabbits fed graded levels of ginger rhizome meal.

Parameters	Male	Female	SEM
Haemoglobin (g/dl)	12.72[a]	11.97[b]	0.22
PCV (%)	37.87[a]	34.60[b]	0.44
RBC (x10^{12}/L)	5.54[a]	4.98[b]	0.12
MCV (fl)	67.65[b]	70.43[a]	0.51
MCH (pg)	23.91	24.12	0.41[ns]
MCHC (g/dl)	34.78	34.22	0.40[ns]
WBC (x10^{9}/l)	6.40[b]	9.07[a]	0.15
Neutrophils (%)	51.33[b]	60.00[a]	0.27
Lymphocytes (%)	47.67[a]	39.00[b]	0.21
Monocytes (%)	0.67	0.67	0.08[ns]
Basophils (%)	0.00	0.00	0.00
Eosinophils (%)	0.33	0.33	0.13[ns]

[a,b]:Means within the same row with different superscripts differ significantly (P<0.05). SEM, Standard Error of means, PCV, packed cell volume, RBC, red blood cell, MCV, mean corpuscular volume, MCH, mean corpuscular volume, MCHC, mean corpuscular haemoglobin concentration.

with the higher values 3.00 to 6.50% and 1.67 to 2.67% reported by Odetola et al. (2010) and Mohammed et al. (2014) respectively. They fed mature rabbits using chaya plant and whole kenaf seed meal. The disparity in the results may not be unconnected to nutrition (Chineke et al., 2006).

Lymphocyte values ranged from 28.33 to 42.33%. The highest value of 42.33% was recorded by rabbits on T_1 and this differed significantly (P<0.05) from rabbits on T_2 (34.67%), T_3 (40.67%) and T_4 (28.33%) which were also significantly different (P<0.05) from each other in lymphocyte values. The lowest value was observed in T_4. The lymphocyte values were however within the normal range of 31.50 to 52.10% reported by Merck (2012). Mohammed et al. (2014) reported a higher range of 56.33 to 63.00%. Differences observed could be due to treatment as they fed rabbits with rumen content mixtures. The non-elevated values obtained suggest that the animals were clinically healthy.

The monocyte values ranged from 0.33 to 1.66 (%). The highest monocyte value of 1.66% was recorded in T_2 and this differed significantly (P<0.05) from rabbits on T_1 and T_3 which were similar (P>0.05) to each other and similar (P>0.05) to rabbits on T_4 which had 1.00%. There was no significant difference (P>0.05) between rabbits on T_2 and T_4 in monocyte values. The lowest values of 0.33% were recorded in T_3 and T_1. The monocyte values obtained in this study were slightly lower than the ranges of 2.00 to 2.75% and 1.00 to 2.33% reported by Odetola et al. (2010) and Mohammed et al. (2014) respectively, and lower than the normal range of 6.60 to 13.4% reported by Merck (2010). The low leucocyte counts observed in this study may be due to differences in physiological status of the animals as was reported by Chineke et al. (2006).

The results of haematological parameters of male and female New Zealand White rabbits fed graded levels of ginger rhizome meal are shown in Table 4. There were significant differences (P<0.05) among the treatment groups in haemoglobin, PCV, RBC, MCV, white blood cell, neutrophils and lymphocytes. Conversely, there were no significant differences (P>0.05) among the treatment groups in MCH and MCH, basophils, monocytes and eosinophils.

The RBC, PCV and HB ranges were 4.98 to 5.54 (x10^{12}/l), 11.97 to 12.72 (%) and 34.60 to 37.87 (g/dl) respectively. The results obtained showed that male rabbits had higher PCV and haemoglobin values than the females. The result obtained agreed with the findings of Addass et al (2012) that cocks had higher values of PCV, RBC than hen. The values fall within the normal range for rabbits, 8.0 to 12.00% and 33.0 to 50.0 g/l for PCV and HB respectively (University of Pennsylvania School of Veterinary Medicine 2002; Merck, 2012).

The MCV, MCH and MCHC values ranged from 67.65 to 70.43 fl, 23.9 to 24.12 pg and 34.22 to 34.78 g/dl respectively. The results revealed that female rabbits had higher MCV and MCH values than the males, while the males had higher MCHC values than the females. The results of this study agreed with the range reported by University of Pennsylvania School of Veterinary Medicine (2002) and Merck (2012). The result of MCH agreed with the report of Isaac et al. (2013) that female rabbits had higher MCH value than male rabbits.

Generally a significant sex effect was reported by Addass et al. (2012) and Etim et al. (2014) that the majority of haematological parameters for indigenous chicken increase with advancing age; males generally had higher values than females. The results of the study revealed that white blood cell, neutrophils and monocytes

of male rabbits were higher than those of the female rabbits. It agreed with the report of Onu and Aja (2011) and Isaac et al. (2013). They studied the haematological properties of different sexes of rabbits. Sex significantly influenced the total WBC and monocyte counts of animals (Addass et al., 2012; Etim et al., 2014).

Conclusion

The results of this study showed that ginger rhizome meal improved haematological indices of pubertal male and female rabbits at inclusion level of 5%.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

REFERENCES

Addass, P. A., David, D. L., Edward, A., Zira, K. E., & Midau, A. (2012). Effect of Age, Sex and Management System on Some Haematological Parameters of Intensively and Semi-Intensively Kept Chicken in Mubi, Adamawa State, Nigerian. *Iranian Journal of Applied Animal Science,* 2(3), 277-282.

Aduku, A. O., & Olukosi, J. O. (1990). Rabbit management in the tropics; production, processing, utilization, marketing, economics. Practical training research and future prospects. G. U. Publications, Abuja, Nigeria.

Afzal, M., Al-Hadili, D., Menon, M., Pesek, L., & Dhami, M. S. C. (2001). Ginger: an ethnomedicinal, Chemical and pharmacological review. Drug Metab. *Drug Interact*., 18, 159-190.

Aka, L. O., Eze, L., Ofor, G. C., & Igbokwe, C. O. (2008). Time dependent postpartum haematological, biochemical and rectal temperature changes in West African Dwarf ewes. *Nigerian Society of for Animal Production. Proceeding of 23rd Annual Conference*, Pp. 111-115.

Akinmutimi, A. H., & Anakebe, O. C. (2008).Performance of Weaner Rabbits Fed Graded Levels of Yam and Sweet Potato Peel Meal in Place of Maize-Based Diet. *Pakistan Journal of Nutrition,* 7(5), 700-704.

Akinmutimi, A. H. (2001). The Effect of Potash-Cooked lima bean (*Phaseoluslunatus*) on Broiler Starter Diets. *Nigeria Agricultural Journal,* 32, 109-118.

Arshad, H. R., Fahad, M. A., & Salah, M. A. (2014). Active ingredients of ginger as potential candidates in the prevention and treatment of diseases via modulation of biological activities. *Int. J. Physiol. Pathophysiol. Pharmacol*., 6(2),125-136.

Ayalew, T. (2001), Primary Hematology. Totowa, NJ: Humana Press. Research Animal Resource (RAR). (2009). *Reference values for laboratory animals: Normal haematological values*. RAR Websites, RAR, University of Minnesota. Retrieved from http://www.ahc.umn.edu/rar/refvalues.html.

Banerjee, G. C. (2007). A Textbook of Animal Husbandry (8th edition) Oxford and IBH Publishing co PVT Ltd New Delhi India.

Bartley, J., & Jacobs, A. (2000). Effects of drying on flavor compounds in Australian grown ginger (*Zingiberofficinale*). *J. Sci. Food and Agric*., 80, 209-215.

Cheesbrough, M. (2000).District Laboratory Practice in Tropical Countries. Part 2.

Chineke, C. A., Ologun, A. G., & Ikeobi, C. O. N. (2006). Haematological parameters in rabbit breeds and crosses in humid tropics.*Pakistan Journal of Biological Sciences, 9*(11), 2102-2106.

Esonu, B. O., Emenalom, O. O., Udedibie, A. B. I., Herbert, U., Ekpor, C., & Iheukwuemere, F. C. (2001). Performance and Blood Chemistry of Weaner Pigs Fed Raw *Mucuna* Bean Velvet Bean Meal. *Trop. Anim. Prod. Invest.,* 4, 49-54.

Etim, N. N., Williams, M. E., Akpabio, U., & Offiong, E. A. (2014). Haematological Parameters and Factors Affecting Their Values. *Agricultural Science*, 2(1), 37-47.

FAO (2006). Food and Agricultural Organization Statistical Data Base. Rome, Italy. Pp. 234-236.

Guyer, D. (2003). Advanced Medical Centre. Zionsville, Indian, Indianapolis, U. S. A.

Hazan, H. A., Rasheed Raauf, A. M., Abd Razik, B. M., & Rassool Hassan, B. A. (2012). Pharmaceut Chemical Composition and Antimicrobial Activity of the Crude Extracts Isolated from Zingiber Officinale by Different Solvents. *Pharmaceute Anat. Acta*., 3, 184.

Isaac, L. J., Abah, G., Akpan, B., & Ekaette, I. U. (2013). Haematological properties of different breeds and sexes of rabbits. *Proceedings of the 18th Annual Conference of Animal Science Association of Nigeria*, 24-27

Jain, N. C. (1986). Veterinary Haematology.4th edition. Baillere, Tindall. p. 297.

Lazzaro, J. (2003). Normal Blood Chemistry for Goats, Sannendoah Dairy Goats.

Melillo, A. (2007). *Rabbit Clinical Pathology. J. Exot.* Pet. Med., 16: 135-145.

Merck N. J. (2010). The Merck Veterinary Manual. *10th Edition Merck and Co., Inc. White House Station N. J*., USA., Pp. 1470-1492.

Merck N. J. (2012). The Merck Veterinary Manual.*12th Edition Merck and Co*. *Inc. White House Station N.J., U S A*.,Pp. 1470-1492.

Mohammed, G., Igwebuike, J. U., Adamu, S. B., Alade N. K., & Asheikh, L. G. (2014). Effect of Feeding Different Blood-Rumen Content Mixtures on Blood Parameters and Carcass Measurements of Growing Rabbits. *International Journal of Science and Nature,* 5(1), 61-66.

Mohammed, G., Igwebuike, J. U., & Alade, N. K. (2010). Performance of growing rabbits fed graded levels of bovine blood-rumen content mixture. *Agric. Biol. JN Am.,* 5(1), 61-66.

Muhammad, J., Durrani, F., Hafeez, A., Khan, R. U., & Ahmad, I. (2009). Effect of aqueous extract of plant mixture on carcass quality of broiler chicks. *Journal of Agriculture and Biological* Science, 9, 56-59.

NRC (1994). National Research Council Nutrient Requirement for Rabbits 9th edition.

Obi, I. U. (2002). Statistical Methods of Detecting Differences between treatment means, 16th edition, Snapp Press, Enugu, Nigeria.

Odetola, O. M., Ewuola, E. O., Raji, A. M., Adejimi, O. O., & Olumide, M. D. (2010). Serum biochemistry and organ histopathology of rabbits fed graded levels of whole kenaf seed meal. In: Proc of 15th Conf. ASAN 13th -15th September, University of Uyo.

Ogbuewu, I. P., Kadurumba, O. E., Okoli, I. C., & Iloeje, M. U. (2013).Effec of ginger rhizome powder supplements and sex on haematological indices of prepubertal rabbits. *Journal of Agricultural Tecnology,* 9(1), 11-19.

Ogbuewu, I. P., Jiwuba, P. D., Ezeokeke, C. T., Uchegbu, M. C., Okoli, I. C., & Iloeje, M. U. (2014). Evaluation of phytochemical and nutritional composition of ginger rhizome powder. *Int'l Journal of Agric and Rural Rural Dev*., 17(1), 1663-1670.

Ojebiyi, O. O., Farinu,G. O. Togun, V. A. Akinlade, J. A. Aderininola, O. A., & Rafiu, T. A. (2006). Effect of quantitative concentrate reduction on the growth of weaned rabbits. Proc. of the 11th Annual Conf. of Animal Science Association of Nigeria. Pp. 121-125.

Okoye, F. C., Ugwueme, M. C., & Mbarab, J. U. (2006). Effect of local species on the utilization of cassava peel meal based diets by weaner rabbits. *Parkistan Journal of Nutrition,* 5(3), 202-205.

Olupona, J. A., & Balogun, O. A. (2004). Nutrient utilization by rabbits fed brewers 'dried grains from different portions of barley, maize and sorghum. *Nig. J. Anim. Prod.*, 31, 89-193.

Onu, P. N., & Aja, P. M. (2011). Growth Performance and Haematological Indices of Weaned Rabbits Fed Garlic (*allium sativum*) and Ginger (*zingiber officinale*) Supplemented Diets. *International Journal of Food, Agriculture and Veterinary Sciences,* 1(1), 51-59.

Prathap, D. P., & Ponnusamy, K. A. (2007).Factors influencing the attitude of farmers of Jamill Nada, India towards farming. *Livestock Reseach for Rural Development* 19(6), 51-54.

RAR (2009). Research Animal Resources.

Silva, T. D. O., Kreutz, L. C., Barcellos, L. J. G., Borella, J., Soso, A. B., & Souza, C. (2005). Reference values for Chinchilla (*Chinchilla laniger*) blood cells and serum biochemical parameters. *Cienc. Rural,* 35, 602-606.

Sowande, O. S., Aina, A. B. J., Oguntona, E. B., Fanimo, A. O., Unaka, V. U., Itassan, T. A., & Oseni, M. O. (2008). Performance, blood biochemical constituents and mineral balance of West African Dwarf Sheep fed preserved Elephant grass, Layer's droppings and cassava peel diet during dry season. *Nig. J. Anim. Prod*. 35(1), 90-102.

SPSS (1996). Statistical package for social Sciences. SPSS/STAT version 7.5 for windows.

University of Pennsylvania School of Veterinary Medicine (2002). Rabbit reference range.

Zhang, G. F., Yang, Z. B., Wang, Y., Yang, W. R., Jiang, S. Z., & Gai, G. S. (2009). Effect of ginger root (*Zingiber officinale*) processed to different particle sizes on growth performance, antioxidant status, and serum metabolites of broiler chickens. *Poultry Science*, 88, 2159–2166

Zhao, X., Yang, Z. B., Yang, W. R., Wang, Y., Jiang, S. Z., & Zhang, G. G. (2011). Effects of ginger root on laying performance and antioxidant status of laying hens and on dietary oxidation stability. *Poult. Sci.,* 90, 1720-1727.

Zick, S. M., Djuric, Z., Ruffin, M. T., Litzinger, A. J., Normolle, D. P., Alrawi, S., Feng, M. R., & Brenner, D. E. (2008). Pharmacokinetics of 6-gingerol, 8-gngerol, 10-gingerol, and 6-shogaol and conjugate metabolites in healthy human subjects. *Cancer Epidemiol. Biomarkers prev*., 17, 1930-1936.