

Changes in growth traits, semen, hematology, and serum biochemistry of rabbit-fed ginger in south-south Nigeria

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ABSTRACT

This study was carried out to assess the changes in semen, hematology, and serum biochemistry of rabbits fed ginger. A total of 36 week-old rabbits were used for this study. The rabbits were assigned randomly into 5 treatments of 0%, 10%, 20%, 30%, and 40% of ginger inclusion. The rabbits were kept in cages and fed *ad libitum*. Data on growth, semen, hematology, and serum biochemical parameters were collected and subjected to data analysis using Analysis of Variance on Statistical Package for Social Science (SPSS) version 16. Significant means were separated at $p < 0.05$. The results revealed significant differences in performance data except in initial body weight. The highest final body weight was observed in Treatment 2 (20g inclusion of ginger) (2665.00 ± 54.16 g). In addition, weight gain was highest also in Treatment 2 (885.00 ± 23.21 g). Treatment 2 also recorded the highest feed intake (3544.30 ± 28.13 g). The feed conversion ratio was least in Treatment 2 (4.00 ± 0.35) while the highest value was observed among the rabbits fed the control diet. There was no significant difference among the performance parameters across sex. Significant differences were identified in mean corpuscular volume (MCV) and mean corpuscular hemoglobin (MCH). In addition, significant differences were observed in ALP, glucose, urea, and creatinine. The result however revealed no significant difference in semen parameters across the treatment groups of buck rabbits. This study affirmed that ginger in rabbit nutrition positively influences body weight, biochemical and hematological parameters as well as semen characteristics.

Keywords: Rabbit, growth traits, hematology, serum biochemistry, ginger

INTRODUCTION

The world population has been predicted to reach 9.2 billion people by 2050 based on the rate of yearly changes in percentage population increase (UN, 2015). Many developing countries are facing a double burden of a growing population and malnutrition. However, by year the 2050, as assumed by FAO (2012), meat production would have increased from 200 million tons to 470 million tons. Rabbit remains one of the major underutilized economic livestock that could bridge the wide gap in dietary protein intake in Nigeria due to its

potential (Mailafia *et al.*, 2010). Some works have been done with the aim of improving rabbit breeds in Nigeria (Chineke *et al.*, 2003; Agaviezor and Ologbose 2020). Rabbits are herbivores and practice caecotrophy. They are prolific and fast-growing with short generation intervals and high genetic diversity. Rabbits are able to utilise forages and high-fibrous materials and can extract plant protein efficiently. Inefficient production systems, rabbits can turn 20 percent of the proteins they eat into edible meat (Raharjo, 2015).

Globally, there is a strong campaign encouraging livestock farmers to practice organic livestock production to prevent the negative effects of residues of antibiotics and hormones in animals used for disease treatment or growth enhancement. Different studies on the use of ginger (*Zingiber officinale*) as an antibiotic, growth enhancer, and semen booster have been carried out (Mohamed, 2019). This study, therefore, examined the changes in semen quality, hematological parameters, and serum of rabbit-fed diets with graded levels of ginger (*Zingiber officinale*). The outcome of this study constitutes a source of baseline data, for advising rabbit farmers as well as the public on the benefits of the inclusion of ginger (*Zingiber officinale*) in rabbit diets.

MATERIALS AND METHOD

The experiment was conducted at the Rabbitry unit of the University of Port Harcourt Research and Teaching Farm Choba campus, Port Harcourt, Rivers State, Nigeria. It is situated at latitude 4.8669° N and longitude 7.1252° E. The relative humidity is 71%. A total of 30 (thirty) rabbits, aged six (6) weeks old were used for the research. The rabbits were housed in wire cages measuring 2x2x2 by 2 feet (width, length, and height respectively) in an open facility that was demarcated into replicates. The bucks were assigned randomly into 5 treatments. Each treatment had 4 Does and 2 Bucks in a completely randomized design (CRD). Treatment groups were assigned to 0%, 10%, 20%, 30%, and 40% of ginger inclusion respectively. A scheduled daily routine of cleaning rabbits' cages and feeding were carried out. The rabbits were weighed weekly during the research period.

Fresh rhizomes of ginger (*Zingiber officinale*) were sourced from Rumokoro market in Rivers State, Port Harcourt, Nigeria. The fresh ginger rhizomes were washed in water to remove dirt. They were chopped into smaller sizes using a kitchen knife and then sun-dried to reduce the moisture content. Thereafter, they were milled into fine particle sizes using a hammer mill. The ground samples were sieved through a 2.5 mm test sieve and then stored in an airtight container to avoid contamination by microbial activities. They were incorporated as additives to the formulated concentrates of 0, 10g, 20g, 30g, and

40g dietary levels for Control, T₁, T₂, T₃, and T₄, respectively (Table 1).

Live weights (kg) were measured weekly for buck and doe in each group using an Electronic weighing scale. The rabbits were fed *ad libitum*. Daily feed consumption was recorded and the feed leftover was weighed daily before supplying fresh feed to know the feed intake. Fresh clean water was also provided routinely throughout the experiment. Records of average daily feed intake and weekly body weight gain were taken. The daily feed intake was calculated by deducting feed leftovers from the total daily feed supplied. Also, the daily weight gain was calculated as the weekly weight gain divided by 7. The mortality rate was monitored and Feed Conversion Ratio (FCR) was calculated as the ratio of feed intake to body weight gain.

In the 8th week of the experiment, semen collection was done between 7.00 and 9.00 am in the morning to ensure optimum quality semen was obtained. This was achieved by using an artificial vagina which was placed in a beaker containing warm water at 40°C, to cause expansion of the glycerol within the lining and to provide the necessary pressure and temperature. The ejaculate obtained was evaluated for volume, pH, and colour. Microscopic examination was also carried out for motility, concentration, percentage of live spermatozoa, and morphological abnormalities. About 2 ml of blood sample was collected in the 8th week of the research into ethylenediamine tetraacetic acid (EDTA) impregnated sample bottles. Packed cell volume (PCV) was determined by the Microhematocrit method. Blood protein was determined by the Refractometer method, while complete RBC and WBC counts were carried out using Neubauer haematocytometer. The serum parameters were analysed for cholesterol, Albumin, globulin, Alanine transferase (ALT), aspartate aminotransferase (AST), triglyceride, high-density lipoprotein (HDL), and low-density lipoprotein (LDL).

Statistical analysis

The data obtained were subjected to statistical analysis of variance (ANOVA) using Statistical Package for Social Sciences (SPSS). Significant means were separated at $P < 0.05$.

Table 1: Composition of the experimental rabbit diets

Ingredients (%)	Control (0g)	T1(10g)	T2(20g)	T3(30g)	T4(40g)
Maize	44.59	44.59	44.59	44.59	44.59
Palm kernel cake	11.00	11.00	11.00	11.00	11.00
Soya bean meal	13.00	13.00	13.00	13.00	13.00
Ground nut cake	7.20	7.20	7.20	7.20	7.20
Wheat bran	15.00	15.00	15.00	15.00	15.00
Fish meal	3.50	3.50	3.50	3.50	3.50
Palm oil	2.30	2.30	2.30	2.30	2.30
Bone meal	2.70	2.70	2.70	2.70	2.70
Lysine	0.02	0.02	0.02	0.02	0.02
Methionine	0.04	0.04	0.04	0.04	0.04
Vitamin/mineral premix	0.25	0.25	0.25	0.25	0.25
Salt	0.40	0.40	0.40	0.40	0.40
Ginger (additive)(g)	0	10	20	30	40
Total	100	100	100	100	100
Nutritional constituents					
Metabolizable Energy (Kca/kg)	3020.75	2982.55	2942.80	2905.36	2870.40
Crude protein	17.25	17.25	17.25	17.25	17.25
Crude fiber	2.71	2.71	2.71	2.71	2.71
Ether extract	7.42	7.42	7.42	7.42	7.42
Ash	3.12	3.12	3.12	3.12	3.12
Calcium	1.26	1.26	1.26	1.26	1.26
Phosphorus	0.46	0.46	0.46	0.46	0.46
Lysine	1.05	1.05	1.05	1.05	1.05
Methionine	0.55	0.55	0.55	0.55	0.55

^a Contains in the following per kg: vitamin A: 2400000 IU, vitamin D: 1000000 IU, vitamin E: 16000 IU, vitamin K: 800 mg, vitamin B6: 1000 mg, vitamin B12: 6mg, niacin: 8000 mg, folic acid: 400 mg, pantothenic acid: 3000 mg, biotin: 40 mg, antioxidant: 3000 mg, cobalt: 80 mg, copper: 2000 mg, iodine: 400 mg, iron: 1200 mg, manganese: 1800 mg, selenium: 60 mg and zinc: 14000 mg.

T1 – Treatment 1, T2 – Treatment 2, T3 – Treatment 3, T4 – Treatment 4

RESULTS

The proximate compositions of ginger rhizome powder (dry matter basis) are presented in Table 2. Ginger rhizome powder had the following proximate compositions: Crude protein (7.43), Carbohydrate (28.18g/100g), Ash (3.00 g/100g), Moisture (15.40 g/100g), Fiber (43.64 g/100g), Mg/kg Ca⁺ (40.10 g/100g), Mg/kg P (72.7 g/100g), Energy value Kca/100g (163.59 g/100g) and Ether extract (2.35 g/100g).

Table 3 shows the influence of ginger on growth performance of rabbits. Significant difference ($p < 0.05$) was observed in all parameters considered except for initial weight. The highest final body weight was observed in Treatment 2 (2665.00±54.16g) while the least was observed in control. In addition, weight gain was highest

also in Treatment 2 (885.00±23.21g) while the least was also observed among the control.

Table 2: Proximate composition of ginger

Parameters	Concentration (g/100g)
Crude protein	7.43
Carbohydrate	28.18
Ash	3.00
Moisture	15.40
Crude fiber	43.64
Mg/kg Ca ⁺	40.10
Mg/kg P	72.7
Energy value Kca/100g	163.59
Ether extract	2.35

Treatment 2 recorded the highest feed intake (3544.30±28.13g) while the least was observed among rabbits fed Treatment 4. Feed conversion ratio was least in Treatment 2 (4.00±0.35) while

the highest value was observed among the rabbits fed the control diet.

Table 4 shows the effect of sex on performance of rabbits fed graded levels of ginger meal.

Result from the study revealed no significant ($P>0.05$) difference among the performance parameters across sex. However, higher values were observed among male rabbits than their female counterparts.

Table 3: Influence of ginger on growth performance of rabbit

Parameters (g)	Control (0g)	T1(10g)	T2(20g)	T3(30g)	T4(40g)
Initial body weight (g)	1600.00±31.18	1700.00±32.17	1780.00±43.15	1680.00±37.17	1600.00±23.18
Final body weight (g)	2180.00±21.17 ^c	2360.00±45.16 ^b	2665.00±54.16 ^a	2310.00±58.16 ^b	2280.00±33.45 ^c
Weight gain (g)	580.00±25.65 ^c	660.00±37.21 ^b	885.00±23.21 ^b	630.00±29.21 ^b	680.00±25.65 ^b
Feed intake (g)	2986.10±39.78 ^b	2904.75±36.59 ^b	3544.30±28.13 ^a	2790.40±30.59 ^c	2780.80±32.78 ^c
Feed Conversion Ratio	5.15±0.32 ^a	4.40±0.15 ^b	4.00±0.35 ^c	4.43±0.18 ^b	4.09±0.32 ^c

^{a, b} Means within row bearing distinct characters differ significantly ($P<0.05$).

T1 – Treatment 1, T2 – Treatment 2, T3 – Treatment 3, T4 – Treatment 4

Table 4: Influence of sex on growth performance of rabbit

Parameters (g)	Female	Male
Initial body weight	1644±0.09	1782±0.12
Final body weight	2219±0.09	2641±0.12
Weight gain	648.33±65.53	860.00±87.06
Feed intake	2819.71±1.97	3193.53±2.62
Feed Conversion Ratio	4.18±1.73	4.80±2.30

The result of hematological parameters of rabbits fed graded levels of ginger is shown in Table 5. Significant differences were identified in mean corpuscular volume (MCV) and mean corpuscular hemoglobin (MCH), while no significant difference was observed in packed cell volume (PCV), red blood cells (RBC), white blood cells (WBC), platelet neutrophil, lymphocytes, eosinophil, monocytes, and mean corpuscular hemoglobin concentration (MCHC). The average value for mean corpuscular volume (MCV) had a statistical mean average difference of 11% between Treatment 2 (highest) and Treatment 5 (lowest).

Furthermore, corpuscular hemoglobin had mean values at 20g, significantly ($P<0.05$) lower than 0g but thus higher when compared to 10g, 30g and 40g inclusion levels of ginger.

Table 6 shows the effect of ginger on the serum biochemistry of rabbits fed ginger. Significant differences ($p<0.05$) were observed in ALP, Glucose, Urea, and Creatinine while others were not significantly ($p<0.05$) affected. The highest ALP of 43.50±2.51 was observed in Treatment 3 and the lowest value was observed in Treatment 1 (29.75±2.51). Furthermore, the highest glucose concentration was observed in Treatment 2 (6.68±0.42) and the lowest in control (3.83±0.42). The highest concentration of urea was observed in Treatment 1 (9.05±0.34) and the highest concentration of creatinine was also in Treatment 1 (181.00±6.74). Table 7 shows the effect of a ginger meal on the semen quality of male rabbits. The result from the study highlighted a non-significant difference ($p<0.05$) in semen parameters across the treatment groups of buck rabbits.

Table 5: Effect of ginger on blood profile of rabbit

Parameters	Control (0g)	T1(10g)	T2(20g)	T3(30g)	T4(40g)	Reference Range
Packed Cell Volume (%)	27.25±2.23	30.00±2.23	25.50±2.23	28.75±2.23	28.25±2.23	30-50
Hemoglobin (g/dl)	9.08±0.75	10.00±0.75	8.50±0.75	9.58±0.75	9.43±0.75	8.2 – 17.1
Red Blood Cells (10 ⁶ /μl)	3.73±0.32	4.33±0.32	3.58±0.32	4.13±0.32	4.18±0.32	3.87 – 6.46
White Blood Cells (10 ³ /μl)	5.33±0.44	5.90±0.44	5.95±0.44	4.80±0.44	5.85±0.44	3.64 – 13.9
Platelet (10 ⁹)	254.75±15.87	289.25±15.87	325.50±15.87	300.75±15.87	310.75±15.87	103.17 – 409.33
Neutrophil (%)	27.75±2.98	37.00±2.98	35.00±2.98	30.00±2.98	32.25±2.98	17.7 – 89.3
Lymphocyte (%)	61.25±2.78	52.50±2.78	52.50±2.78	59.25±2.78	58.00±2.78	15.41 – 64.37
Eosinophil (%)	3.50±0.50	2.50±0.50	4.00±0.50	2.50±0.50	3.50±0.50	0 -7.65
Monocyte (%)	7.50±0.79	8.00±0.79	8.50±0.79	8.25±0.79	6.25±0.79	0.82 – 12.29
Mean Corpuscular Volume (fl)	73.08±0.70 ^a	69.39±0.70 ^{ab}	71.37±0.70 ^{ab}	69.90±0.70 ^{ab}	67.67±0.70 ^c	93.32 – 118.28
Mean Corpuscular Hemoglobin Concentration (g/dl)	33.30±0.05	33.33±0.05	33.33±0.05	33.30±0.05	33.35±0.05	28.23 – 36.71
Mean Corpuscular Hemoglobin (pg)	24.34±0.23 ^a	23.13±0.23 ^{bc}	23.79±0.23 ^{ab}	23.28±0.23 ^{bc}	22.57±0.23 ^c	30-79 – 39.18

^{a, ab, bc, b, c} Means within row bearing distinct characters differ significantly ($P<0.05$)

T1 – Treatment 1, T2 – Treatment 2, T3 – Treatment 3, T4 – Treatment 4

DISCUSSION

The proximate composition from the current study showed that crude protein is closer to the 12.6% reported by Bhat *et al.* (2010), which corroborates the diet as a good source of protein. However, the quantity of carbohydrates contained in the diet was lower than that reported by Oforma *et al.* (2019) who in their work reported that ginger can provide accessible fuel for physical performance and regulate nerve tissues, but cannot be considered a major carbohydrate source when compared to tubers and cereals (Ameh *et al.*, 2016). The ash content of the sample was 3.00%, lower than the 4.07% reported by Latona *et al.* (2012). The low value of ash content in this study indicated the level of essential or non-essential mineral elements in the sample. The moisture content of the sample was 15.40% which shows that ashing ginger could be less time-consuming (Latona *et al.*, 2012). Thus, the fiber content was lower than $76.4 \pm 1.30\%$ confirmed by (Sasidharan *et al.*, 2012). This low fiber is desirable since it helps to reduce serum cholesterol levels. Ether extract content from the sample was also lower than 4.07% reported by Latona *et al.* (2012). This indicates that ether extract contained fewer amounts of biologically active ingredients but not enough for to be called an oil plant (Ajagun *et al.* 2017). According to Latona *et al.* (2012) the presence of essential minerals like calcium, magnesium, and phosphorus is important in extra-cellular and intra-cellular body functions. The results of this study further confirm the potency of ginger root as a potential functional food for livestock animals as well as humans. The results revealed a direct relationship between feed intake and levels of ginger. This result is also supported by Ozkan *et al.* (2012). The reason for this could be attributed to the fact that ginger tends to enhance palatability and stimulate appetite (Momoh *et al.*, 2015). This result is also in consonance with those reported by Peiretti *et al.* (2011), and Habibi *et al.* (2014). However, the variation in weight gain recorded in the study could be attributed to the ability of the ginger diet to stimulate the activities of digestive enzymes and thus, limit the growth and colonization of numerous pathogenic and non-pathogenic species as confirmed by

Mohamed (2019). Thus, the variation in feed intake and feed conversion ratio with regards to the control group may be linked to the aromatic nature of ginger, which serves a critical role in improving feed consumption.

The higher values of performance parameters in buck rabbits were in harmony with those reported by Ilo and Egu, (2018), Ozkan *et al.* (2012); Iyeghe-Erakpotobor (2012), and Merck (2012). This may be attributed to the sex hormone of the buck (androgens anabolic effect), the age of animals as agreed by Saad (2017). The results of the effect of ginger on hematological parameters are similar to those reported by other authors. Etim *et al.* (2014) reported that blood is a vital nutritional, physiological, and pathological parameter in an organism. The mean corpuscular volume (MCV) values obtained in the study were higher than the normal range of 58 to 67 reported for rabbits (Merck, 2010). This is in harmony with Okosun *et al.* (2018) that affirmed the highest MCV in control as compared to treatment groups of weaners rabbits fed Parboiled Pun dried False Yam Meal. The mean corpuscular hemoglobin (MCH) values obtained in this study were higher than the range of 19.88 to 21.93pg reported by Ogbuewu *et al.* (2013). The reasons could be due to differences in sex and nutritional status of the rabbits to withstand adverse weather conditions (Isaac *et al.*, 2013). The non-significant ($P>0.05$) difference observed in the current study is in harmony with the findings of (Agina *et al.*, 2017) which stipulated no significant ($P>0.05$) difference in both sexes of the quails. However, the slight increase in the blood component of the buck more than the doe is in tandem with the report of (Uchendu *et al.*, 2010 and Agina *et al.*, 2017). This disparity may be due to differences in gender, nutrition, and age of animals, as these factors have been reported to be responsible for variations in the hematological values of rabbits (Etim *et al.*, 2014).

Biochemical components are sensitive to elements of toxicity and also can be used to monitor the protein quality of feeds. It also signifies the proper functioning of some internal organs (Ilo and Egu, 2018). The values of ALP

obtained in this study agreed with the range of 17.00-192.00 (iu/l) reported by (Merck, 2010), but was contrary to the range of 5.92 to 8.38 iu/l reported by Ewuola and Egbunike (2010), who fed weaner rabbits with prebiotics and probiotics. The disparity may not be unconnected with the differences in physiological factors of these rabbits (Ilo and Egu, 2018). The glucose values obtained in this study did not agree with the findings of Ewuola *et al.* (2012) who reported a higher glucose range of 114.00 to 142.00 mmol/l when fed rabbits with graded levels of *Moringa oleifera* leaf meal. The result was slightly below the range of 80 to 150 mmol/l reported by Mufwa *et al.* (2011). Glucose is one of the metabolites measured as an indicator of the energy status of animals (Ilo and Egu, 2018). The study affirmed that there was no wasting or catabolism of muscle tissue and that rabbits were not surviving at the expense of body reserve as corroborated by Ilo and Egu (2018).

Furthermore, values for urea in this study were close to the normal reference range of 10.00 to 33.00 mmol/l reported by Merck (2012). The normal blood urea values obtained in this trial were indications that the amino acid of the test diets was balanced as affirmed by ILO and Egu, (2018). However, the creatinine values from this study were within the normal range postulated by Ozkan *et al.* (2012). This affirmed that the dietary treatments did not impose renal

dysfunction in the rabbits as corroborated by Isidahomen *et al.* (2011). The absence of significant difference with respect to sex and treatment interaction was in agreement with the postulations of (Agina *et al.*, 2017) that affirmed similar results in quail birds. The higher values of serum reported in buck rabbits were in harmony with those reported by Ilo and Egu, (2018). This may be attributed to the sex hormone of the buck (androgens anabolic effect), nutrition, and age of animals as agreed by Saad (2017).

The report of non-significant ($p>0.05$) difference observed in semen changes across the dietary treatments was in consonance with the findings of Shetaewi *et al.* (2017). However, variations in the values across the parameters were observed. This variation may be attributed to the bioactive constituents of ginger to increase the activities of testicular antioxidant enzymes to scavenge free radicals, superoxide dismutase, glutathione, and catalase and reduced level of malondialdehyde, thereby leading to an increase in the spermatogenesis number and seminiferous tubules volume by preventing apoptosis in the spermatogenesis process as reported by Shetaewi *et al.* (2017). This shows that ginger has the tendency to improve semen characteristics without any detrimental effect on the health of the buck (Shetaewi *et al.* 2017).

Table 6: Effect of ginger on serum biochemistry of rabbits

Parameters	Control (0g)	T1(10g)	T2(20g)	T3(30g)	T4(40g)	Reference Range
Albumin (g/l)	41.75±1.93	42.00±1.93	43.00±1.93	43.50±1.93	41.75±1.93	35 – 50
Globulin (g/l)	34.50±3.81	31.75±3.81	36.25±3.81	43.50±3.81	35.50±3.81	16 – 42
AST (u/l)	40.00±4.81	31.50±4.81	34.00±4.81	46.25±4.81	41.25±4.81	0 – 55
ALT(u/l)	12.00±1.46	12.50±1.46	12.25±1.46	16.00±1.46	14.25±1.46	15 – 63
ALP (u/l)	38.50±2.51 ^{ab}	29.75±2.51 ^c	31.00±2.51 ^{bc}	43.50±2.51 ^a	17.25±2.51 ^d	3.00 – 72.00
Total cholesterol(mm/l)	3.03±0.43	2.75±0.43	3.00±0.43	2.88±0.43	2.43±0.43	0.00 – 9.86
Glucose(mm/l)	3.83±0.42 ^c	4.98±0.42 ^b	6.68±0.42 ^a	5.20±0.42 ^b	4.98±0.42 ^b	3.31 -6.1
Urea (mm/l)	8.30±0.34 ^a	9.05±0.34 ^a	7.10±0.34 ^b	8.50±0.34 ^a	8.05±0.34 ^{ab}	0.00 – 9.86
Creatinine (mm/l)	166.00±6.74 ^a	181.00±6.74 ^a	142.00±6.74 ^b	170.00±6.74 ^a	161.00±6.74 ^{ab}	34 – 166
Total protein (g/l)	76.00±5.33	73.75±5.33	79.25±5.33	87.00±5.33	77.25±5.33	64 - 83

^{a, b, c, d} Means within row bearing distinct characters differ significantly ($P<0.05$)

AST- Aspartate aminotransferase, ALT-Alanine aminotransferase, ALP- Alkaline phosphatase, UR- Urea, TP- Total protein, ALB-Albumin, TC- Total cholesterol, CR-Creatinine, GLO-globulin, and GLU-glucose

T1 – Treatment 1, T2 – Treatment 2, T3 – Treatment 3, T4 – Treatment 4

Table 7: Effect of ginger on semen characteristics of male rabbits

Parameters	Control (0g)	T1(10g)	T2(20g)	T3(30g)	T4(40g)
Volume (ml)	2.25±0.54	1.50±0.54	2.25±0.54	2.25±0.54	2.00±0.54
pH (ml)	8.00±0.00	8.00±0.00	8.00±0.00	8.00±0.00	8.00±0.00
Viability (%)	75.00±4.18	87.50±4.18	87.50±4.18	80.00±4.18	75.00±4.18
Normal (%)	75.00±4.84	85.00±4.84	85.00±4.84	81.50±4.84	75.00±4.84
Abnormal (%)	25.00±4.47	15.00±4.47	15.00±4.47	20.00±4.47	25.00±4.47
Actively (%)	75.00±4.03	85.00±4.03	85.00±4.03	75.00±4.03	72.50±4.03
Slug (%)	5.50±21.27	5.00±21.27	7.50±21.27	10.00±21.27	10.00±21.27
Decy (%)	15.00±3.54	10.00±3.54	7.50±3.54	15.00±3.54	17.50±3.54
Sperm concentration (%)	450.00±145.34	775.00±145.34	800.00±145.34	600.00±145.34	500.00±145.34

T1 – Treatment 1, T2 – Treatment 2, T3 – Treatment 3, T4 – Treatment 4

CONCLUSIONS

Rabbits fed Treatment 2 (20g of ginger) performed better than others. The diet did not have any negative influences on the growth performance of the rabbits. Ginger supplementation in rabbit nutrition significantly influences hematological parameters like platelets, means corpuscular hemoglobin, and means corpuscular volume. Sex had no influence on the hematological and biochemical serum of the rabbits. Ginger diet had a significant influence in ($P<0.05$) in ALP (Alkaline phosphatase,), GLU (glucose), urea, and creatinine but did not impose any adverse effect on the body metabolism of the rabbits. Supplementation of ginger diet in the buck nutrition had no detrimental effect on semen characteristics. From the study above, it can be affirmed that ginger in rabbit nutrition positively influences body weight, biochemical and hematological parameters as well as semen characteristics.

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