Available online@www.actasatech.com

acta SATECH 12 (1):1 – 13 (2020)

Journal of Life &Physical Sciences

Effect of ginger (*Zingiber officinale*) supplementation on performance, meat quality and blood profile of broiler chicken

***Olumide, M. D.; Oladejo. S.O; Ayo-Bello. T. A and Akinboye O.E.**

Department of Agriculture, School of Science and Industrial Technology, Babcock University, Ilishan Remo, Ogun State. Nigeria.

*Corresponding author: olumideM@babcock.edu.ng.

Abstract

The use of antibiotics as growth promoters in poultry and livestock production is facing serious disapproval as a result of resistance in bacteria and the residues in meat and other products. To overcome the poor performance and the increase susceptibility to diseases resulting from removal of antibiotics from bird's diets, attempts were made to find alternatives from medicinal plant, such as ginger ((*Zingiber officinale*) which is widely noted to contain some medicinal properties that could be useful in increasing poultry production.

A total of hundred and forty four day old Marshal Strains of broiler chicks were assigned to six dietary treatments with twenty-four birds with 3 replicates of 8 birds each in a Completely Randomized Design. The birds were fed in two phases (starter and finisher). The ginger powder was added to the diets at graded levels, basal diet (control)T1, basal diet + antibiotics) (T2), basal diet + 1.0% ginger(T3), basal diet +1.5% ginger(T4), basal diet + 2.0% ginger(T5), basal diet + 2.5% ginger(T6). The study lasted for a period of 7 weeks. Parameters evaluated are: performance, hematology, serum biochemistry and meat quality using standard methods, data were subjected to analysis of variance using statistical package of SAS and significant means were separated using Duncan multiple range test.

The results showed that weight gain of broilers fed diets supplemented with varying inclusion levels of ginger were significantly different ($P > 0.05$). The highest weight gain was obtained from birds in T3 (1776.40g) while the least value was obtained from T6 (1591.93g). Significant differences were also observed in the feed conversion ratio (FCR), highest value of (1.82) was obtained in T6 and lowest value of (1.62) in T3, highest feed intake was obtained in T1 (2934g) while the lowest value of (2813g) was obtained in T5. The blood profile of birds indicated no significant difference except for haemoglobin and eosinophil value which ranged between 2.50-6.00g/dl and 9.45-10.65 g/dl respectively. T6 had the highest cholesterol value of 118.49mg/dl and lowest value of 74.80mg/dl was obtained in T4. The lowest value of Alamine transamine was obtained from birds on T4 (1.12%) and while T6 had the highest value (6.17%). The drumstick freezing loss (DFL) and breast weight refrigerating loss(BWRL) were significantly different, (DFL) showed highest value of 6.80 at 1% supplementation and lowest value of 2.50 at 2.5% while the (BWRL) showed highest value of 4.86 at 1% and lowest value of 2.40% at 0% inclusion level.

Inclusion of ginger (*Zingiber officinale*) in the diets of broiler chicken had no detrimental effect on the performance characteristics of the birds but improved the average body weight, health status and meat quality.

Keywords: Broiler Chickens, *Zingiber officinale*, performance characteristics, supplementation, feed conversion ratio, meat quality.

Introduction

The use of antibiotics as growth promoters in poultry and livestock production is facing serious disapproval as a result of resistance in bacteria and the residues in meat and other products (Denli *et al.,* 2003). To overcome the poor performance and the increase susceptibility to diseases resulting from removal of antibiotics from bird's diets, attempts were made to find other alternatives (Zhang *et al.,* 2009). The use of growth promoters of natural origin such as garlic (*Allium sativum)*, clove (*Syzgium aromaticum*) and turmeric (*Curcuma longa*) became the focus of several studies in recent years. Spices are very common useful additives in broiler diets (Zhang *et al.,* 2009). Feed is a major component affecting net return from the poultry business, because 80% of the total expenditure is on feed purchase (Asghar *et al.,* 2000*;* Farooq *et al.,* 2001). To ensure more net return and to minimize high expenditure on feed which were the main challenges, many research strategies have been practiced such as introducing feed supplements and feed additives (Zhang *et al*., 2009 and Olumide *et al*., 2019).

Ginger (*Zingiber officinale*) is widely used in many countries as a food spice and as an herbal remedy (Chrubasik *et al,* 2005). Ginger is the rhizome of the plant *Zingiber officinale*, consumed as a delicacy, medicine, or spice. Preliminary research indicates that nine compounds found in ginger may bind to serotonin receptors which may influence gastrointestinal function (*Botsoglou et al.,* 2002). Ginger was found to possess antioxidants, anti-diabetic properties and immunity enhancers (Al-Amin *et al., 2006;* Zhang *et al., 2009*). The important compounds in Ginger (*Zingiber officinale*) are gingerol, gingerdiol and gingerdione which have the ability to stimulate digestive enzymes, affect the microbial activity and having antioxidative activity (Dieumou *et al.,* 2009). Ginger was observed to enhance the antimicrobial and antioxidants status of animals and improve their performance (Zhang *et al., 2009;* Khan *et al.,* 2012) and improve the quality of animal products (Saranya *et al.,* 2016). Ginger have been reported to possess useful pharmacological potent chemical substances for use in poultry (Akhtar *et al.,* 1984), this is due to its antioxidants, antibacterial, anti-inflammatory, antiseptic, anti-parasitic and immunomodulatory properties. Positive effect of ginger on blood circulation, gastric secretion, and enterokinesia were reported by Ali *et al*., (2008). In addition, ginger has been found to enhance digestive enzyme activities (Platel and Srinivasan, 1996, 2000). Antibiotics have been widely used to prevent infections and poultry diseases and also for the improvement of meat and egg production. Though, antibiotics are restricted due to drug resistance, drug residue in carcass and also alteration of natural gut micro flora (Botsoglou *et al.,* 2002). Ginger have been reported to retain useful pharmacological potent chemical substances for use in poultry (Akhtar *et al*., 1984), it is due to its antioxidants, antibacterial, anti-inflammatory, antiseptic, anti-parasitic properties

This is especially important in view of the commercial intensive system of production where birds are crowded and possibility of infection high, information about the effect of ginger (*Zingiber Officinale*) powder as natural feed additives on the performance, meat quality and blood profile of broiler chickens will be of advantage.

Materials and method

Experimental site: The experiment was conducted at the Teaching and Research Farm of Department of Agriculture and Industrial Technology, Babcock University, Ilishan-Remo, Ogun State. Ilishan-Remo is in the rain forest of South Western Nigeria with mean rainfall of 2400mm latitude of 6˚54'N from the equator and longitude 3˚42'E from the Greenwich Meridian and the mean annual temperature is about 27^0C.

Experimental material: Fresh ginger was purchased from Ilishan-Remo market, Ogun State, Nigeria. The ginger was cut into smaller pieces after washing under running tap to dislodge dirt and other extraneous materials, the pieces were thinly spread

under shade for air drying for a period of 14days, milled and stored at 4^0c for usage.

Proximate analysis: Samples of ginger meal were analysed for proximate composition and tannin content according to the methods of AOAC (1990).

Experimental diets: Six experimental diets were formulated with various inclusion levels of *Zingiber officinale* T1 basal diet (control) basal diet + no medication, T2 (0.0%) basal diet + (Tylosin), antibiotics ,T3 basal diet + (1.0%) ginger, (T4) basal diet + 1.5% ginger, (T5) basal diet + 2.0% ginger, (T6) basal diet + 2.5% ginger.

Experimental bird and management: A total of one hundred and Forty-four (144) day old broiler chicks were procured from a reputable hatchery On arrival, birds were randomly assigned to six treatments (T_1, T_2, T_3, T_4, T_5 and T_6) with three (3) replicates of 8 birds in a Completely Randomized Design (CRD). All the experimental birds were reared in well-ventilated moveable cages and kept under uniform management conditions. The formulated diets and water were supplied to the bird's *ad - libitum* throughout the study period. Each cage was 5×4 ft. in dimmesnsion for 24 birds. The cages were washed and disinfected using germicide as disinfectant and kept vacant for two weeks prior to the arrival of the chicks. The experimental birds were vaccinated but not medicated due to the nature of the experiment, except birds on treatment 2 that were treated medicated with Tylosin.

Data collection: All data collected on growth performance, meat quality and blood indices of broiler chicks.

Growth Performance

Feed Intake: Feed allotted to each replicate was determined daily by difference between the initial feed supplied and left over in the feeding trough.

Average feed intake/animal = Feed offered in (g) – feed left over (g)

Total number of birds in the group

Weight gain: Body weight gain of experimental birds was recorded on weekly basis by subtracting the values of initial body weight in grams from final body weight.

$$Weight\ Gain = Final\ Weight - Initial\ Weight.$$

$$Average\ weight\ gain/\ animal = \frac{Final\ weight\ gain\ (g) - initial\ weight\ gain(g)}{Total\ numbers\ of\ birds\ in\ the\ group}$$

Meat quality of broiler chickens

Meat quality of drumstick and breast part was determined for cooking loss, freezing loss, Water holding capacity and refrigerating.

Cooking loss %: This was determined as the difference between pre-cooked and post cooked weights and divided by pre-cooked weights of meat multiply by 100.

% cooking loss was determined according to the method of (Honikel 1998)

$$\%\ \text{cooking loss} = \frac{raw\ weight - cooked\ weight}{Raw\ weight} \times 100$$

Freezing loss %: was determined according to the method described by Fasae *et al*., (2010)

$$Freezing\ loss = \frac{Wo - Weof}{Wo} \times 100$$

Where, Wo is the initial sample weight, W*e* is the value at the end of freezing.

Water holding capacity: this was determined using li *et al., (*2012)

$$WHC = \frac{Sample\ weight - final\ weight\ x\ 100}{Initial\ weight}$$

Refrigerating loss %: This was determined according to the method described by (Honikel 1998)

$$\%\ \text{refrigerating loss} = \frac{(raw\ weight - after\ 24hours\ weight)}{raw\ weight} \times 100$$

Blood parameters

At the end of the 7weeks trial, blood samples were collected randomly from the jugular veins of two birds per replicate and a total of six birds per treatment into labeled sample bottles containing ethylenediamine tetracetic acid (EDTA) as the anticoagulant for the determination of haematological parameters. Packed cell volume (PCV) was determined by micro hematocrit methods. White blood cell (WBC) differentials e.g. eosinophils, basophils, lymphoctyes, monocytes, were determined using the improved neubeouer haemocytometer chamber while the differential leukocytes counts was determined according to the method of Schalm, (1975). Blood samples for serum biochemical indices were collected in another bottle without EDTA. Total

protein, Albumin, Glucose, Cholesterol, high density lipo- protein and low density lipo protein were determined, aspartate transaminase, alamine transaminase.

Statistical analysis: All data collected on performance, meat quality and blood indices of experimental birds were subjected to analysis of variance using statistical package of SAS (1999), significant means were separated using Duncan multiple range test.

Table 1: Proximate composition ginger

Variables	Amount /100g)
Moisture Content	22.50
Dry Matter Content	77.50
Ash Content	1.31
Crude Fibre Content	1.04
Crude Protein Content	4.50
Nitrogen Free Extract	12.95
Percentage tannin	3.20

Table 2: Gross composition of broiler starter diets with graded levels of ginger inclusion

	TREATMENTS					
INGREDIENTS (%)	T1 0.0%	T 0.0%	T_3 1.0%	T_4 1.5%	T_5 2.0%	T_6 2.5%
Maize	60.00	60.00	60.00	60.00	60.00	60.00
Soybean Meal	30.00	30.00	30.00	30.00	30.00	30.00
Ginger	0.00	0.00	1.00	1.50	2.00	2.50
Wheat Offal	3.00	3.00	2.00	1.50	1.00	0.50
Fish Meal (72%)	2.45	2.45	2.45	2.45	2.45	2.45
Oyster shell	2.20	2.20	2.20	2.20	2.20	2.20
Bone Meal	1.30	1.30	1.30	1.30	1.30	1.30
Table Salt	0.25	0.25	0.25	0.25	0.25	0.25
Premix*	0.20	0.20	0.20	0.20	0.20	0.20
Lysine	0.30	0.30	0.30	0.30	0.30	0.30
Methionine	0.30	0.30	0.30	0.30	0.30	0.30
Total	100.00	100.00	100.00	100.00	100.00	100.00
Determined Analysis						
Crude Protein (%)	21.06	21.06	21.08	21.26	21.30	21.26
Ether Extract (%)	4.10	4.10	4..02	4.12	4.10	4.12
Crude fiber (%)	4.00	4.10	4.10	4.12	4.10	4.15
Metabolizable energy kcal/kg	2900.00	2900.15	2913.00	2918.00	2930.00	2925.00

*Premix per kg of diet vitamin A – 15,000,000IU, vitamin D3 – 3,000,000IU, vitamin E – 30,000IU, vitamin K 3,000mg, vitamin B2 – 6000mg, vitamin B – 5,000mg, vitamin B12- 10mg, Biotin 200mg,, Niacin – 40,000mg, Pantothenic acid 15,000mg, Folic acid – 2,000mg, Choline 300,000mg. Iron 60,000mg, manganese 80,000mg, copper 25,000mg, Zinc 80,000mg, Cobalt 150mg, Iodine 500mg, Selenium 310mg, Antioxidant 20,000mg.

Table 3: Gross composition of broiler finisher diets with graded levels of ginger inclusion

	TREATMENTS					
INGREDIENTS (%)	T_1 0.0%	T_2 0.0%	T_3 1.0%	T_4 1.5%	T_5 2.0%	T_6 2.5%
Maize	57.00	57.00	57.00	57.00	57.00	57.00
Soybean Meal	25.00	25.00	25.00	25.00	25.00	25.00
Ginger	0.00	0.00	1.00	1.50	2.00	2.50
Wheat Offal	10.20	10.20	9.20	8.70	8.20	7.70
Fish Meal	2.50	2.50	2.50	2.50	2.50	2.50
Oyster shell	2.00	2.00	2.00	2.00	2.00	2.00
Bone Meal	2.10	2.10	2.10	2.10	2.10	2.10
Table Salt	0.25	0.25	0.25	0.25	0.25	0.25
Premix*	0.55	0.55	0.55	0.55	0.55	0.55
Lysine	0.20	0.20	0.20	0.20	0.20	0.20
Methionine	0.20	0.20	0.20	0.20	0.20	0.20
Total	100.00	100.00	100.00	100.00	100.00	100.00
Determined Analysis						
Crude Protein (%)	19.58	19.58	19.60	19.58	19.84	19.58
Ether Extract (%)	3.86	3.80	3.90	3.85	3.94	3.86
Crude fiber (%)	4.32	4.30	4.35	4.35	4.44	4.50
Metabolizable energy	2812.90	2805.12	2852.00	2850.56	2820.30	2810.22

*Premix per kg of diet vitamin A – 15,000,000IU, vitamin D3 – 2,000,000IU, vitamin E – 20,000IU, vitamin K 3,000mg, vitamin B2 – 6000mg, vitamin B – 5,000mg, vitamin B12- 10mg, Biotin 200mg,, Niacin – 40,000mg, Pantothenic acid 10,000mg, Folic acid – 2,000mg, Choline 200,000mg. Iron 60,000mg, manganese 80,000mg, copper 25,000mg, Zinc 80,000mg, Cobalt 150mg, Iodine 500mg, Selenium 310mg, Antioxidant 20,000mg

Results and discussion

Performance characteristics of birds Fed graded Levels of ginger based diets:

Performance characteristics of broiler chickens fed diets containing graded levels of ginger are indicated in Table 4.

Significant variation ($P<0.05$) was observed on the final weight in all the treatments, values ranged from 1773.43 – 2017.20g with 1% and 1.5% inclusion level having the highest value and T5 having the lowest value of 1773.43g The result is not in accordance with the findings of Dieumou *et al*., (2009) who fed ginger essential oils to broilers and found that there were no significant differences ($P>0.05$), but agrees with the result of Herawati (2010) who reported that Hubbard strain broilers fed 2% supplemental red ginger in the diet had significantly higher final body weight than those on

the control diet. Average daily weight gain differs significantly ($p<0.05$) across the treatments with varying levels of inclusion of ginger with 1.5% having the highest value of 49.97 and 2.0% having the lowest value of 44.46. The result at 2% is similar to the finding of Herati and Marjuki (2011) who reported that, increasing ginger inclusion level in the ration up to 2% resulted in reduced total weight gain. This was contrary to the findings of Garcia *et al.* (2007); Ghazaiah *et al.* (2007) and Tollba *et al.* (2007) who observed no difference in bodyweight gain in broilers fed with ginger and pepper extract for a period of six weeks. The report of Onimisi *et al.* (2005) and Ademola *et al.* (2009) showed that ginger increased body weight when included up to 2% level in the diet. Similarly, Al-Homidan (2005) found increased in weight gain of broilers when fed 2% and 6% ginger. Onu (2010) reported that the use of 0.25% ginger in the ration of broilers resulted in improved body weight and feed conversion but no effect on feed intake.

No significant differences ($P>0.05$) were observed in the total feed and average daily feed intake of birds, an indication that incorporating ginger in broiler feed does not influence their feed intake but improved feed utilization up to 1.5% level of inclusion. These results are in agreement with those reported by Zomrawi *et al*., (2013) and Herawati (2006) who reported that, birds fed diet with 1.5-2.0% ginger consumed lesser quantity of feed compare to the control diet. Similar result was obtained by Herawati (2010) who reported that, broiler fed 2% dried supplementary red ginger meal had significantly lower feed intake than those fed on the control diet. Herati and Marjuki (2011) reported that ginger up to 2% in broiler diet showed lower feed intake compared to the control. This was contrary to the finding of Doley *et al*., (2009) who observed no difference in feed intake by broilers administered aqueous ginger extract for a period of six weeks.

The Feed Conversion Ratio (FCR) value obtained ranged from 1.62 –1.82 with 1.0% having the best feed conversion ratio compare to the control and other levels of inclusion. There was a significant ($P<0.05$) improvement in the feed conversion ratio for the birds fed diets supplemented with ginger. The better feed conversion ratio can be attributed to the anti-bacterial properties of the ginger powder which resulted in better absorption of the nutrients in the gut by improving healthy bacterial such as (lactobacillus) present in the gut of the animal thereby leading to better feed utilization and improved bird performance. These results were not in consonant with the finding of Herawati (2006); Tollba (2003); Herawati (2010); Moorthy et al., (2009) and Onimisi et al., (2005),who illustrated that birds fed with diets containing ginger up to 2% recorded better feed conversion ratio. The positive effect of ginger powder in broiler diets on the final body weight, body weight gain and feed conversion ratio can be explained by the fact that, ginger have medical and chemical properties that can enhance palatability the most noteworthy being gingerol and shagaol. It has antibacterial and anti-inflammatory actions (Zomrawi, 2012). Due to the active ingredients that are found in ginger, the formation of more stable intestinal flora and improved feed conversion efficiency in consequence of better digestion (Tekeli, 2007).

Treatment effect on mortality rate was not significant. All chicks used for the experiment were apparently healthy although birds fed diets containing ginger had no mortality all through the experimental period. This is an indication that ginger can improve the health status of the birds.

4: Performance Characteristics of Broiler Chickens Fed Ginger Supplemented Diet

	TREATMENT						
PARAMETERS	T1	T2	T3	T4	T5	T6	SEM
Initial weight (g)	266.80	255.43	240.80	247.33	247.17	253.43	6.12
Final weight (g)	1956.75^{ab}	1973.17^{b}	2017.20^{a}	2017.20^{a}	1873.43^{c}	1865.33^{c}	25.01
Total Weight gain (g)	1689.95^{ab}	1717.73^{b}	1776.40^{a}	1749.07^{a}	1626.26^{c}	1612.00^{c}	14.34
Average daily weight gain (g)	48.28^{b}	49.08^{a}	49.09^{a}	49.97^{a}	46.46^{c}	46.06^{c}	0.70
Total feed intake (g)	2934.00	2887.33	2874.33	2931.00	2813.00	2899.00	23.63
Avg. daily Intake(g)	83.83	82.49	82.12	83.74	80.37	82.83	0.68
Feed conversion ratio	1.74^{b}	1.68^{c}	1.62^{d}	1.67^{c}	1.80^{a}	1.82^{a}	0.02
Livability (%)	0.60^{a}	0.00^{b}	0.00^{b}	0.00^{b}	0.00^{b}	0.00^{b}	0.10

$^{a\,b\,c}$ Means on the same row with different superscripts are significantly different (P<0.05).
SEM: Standard Error of Means

Meat quality of broiler chickens fed ginger supplemented diet: Meat quality is a generic term used to describe properties and perceptions of meat. Quality is directly associated with usage and is a multifaceted concept (Webb *et al*., 2018). Physical quality of meat is important properties which strongly influence consumer's preference to the meat and these properties include pH, colour, flavor, juiciness, tenderness, water holding capacity, and cooking loss (Herawati and Marjuki, 2011). All these attributes are influenced by breed, sex, age, anatomical location, exercise, nutrition and internal variability (Siham *et al*., 2015).

There were no significant differences (P>0.05) from the freezing loss among the broiler breast, water holding capacity for the breast and drumstick meat samples. While the drumstick freezing loss of the meat sample of broilers fed ginger had significant difference (P>0.05) where T3 was observed to be the highest with (6.80). There was significant differences (P>0.05) in the refrigerated loss of the breast meat, were T3 had the highest this was in line with the work of (Alcicek *et al*., (2004), while, for the drumstick it was not significant (P>0.05).

The percentage breast cooking loss had a significant differences (P>0.05) with T6 been the highest, while percentage drumstick cooking loss had significant differences (P>0.05) in the parameter with T2 having the highest this was not in line with the work of Chioma *et al*., (2017).

On water absorption power, there were no differences (P>0.05) in both breast and drumstick meat samples from experimental diet.

Table 5: Hematological Parameters of broilers chickens fed ginger supplemented diet

Parameters	T_1 (0.0%)	T_2 (0.0%)	T_3 (1.0%)	T_4 (1.50%)	T_5 (2.0%)	T_6 (2.5%)	SEM	STD
PCV (%)	29.00	32.50	34.00	30.50	30.00	30.00	0.96	22-35
RBC(mm^3x10^6)	3.35	3.37	3.40	3.40	3.30	3.31	0.02	2-4.0
WBC(mm^3 $x10^3$)	12.55	14.83	14.70	14.25	16.60	15.27	0.02	9.2-31
Lymphocyte (%)	69.00	74.50	73.50	71.50	72.00	76.00	0.99	47-81
Monocytes (%)	3.50	3.00	2.50	2.50	2.00	2.50	0.22	3.3-9
Eosinophil's (%)	2.50^b	2.50^b	4.50^{ab}	5.50^{ab}	6.00^a	4.00^{ab}	0.50	2.2-6
Basophils (%)	0.00	0.00	0.50	0.50	0.00	0.50	0.03	0.5-1
Hemoglobin (g/dl)	9.45^b	10.65^{ab}	16.05^a	9.90^b	9.65b	9.70^b	0.86	7-13

a,b,c: Means along the same row having any identical superscript are not significant (p>0.05) SEM =standard error of mean.

Serum biochemistry of birds fed ginger supplemented diet: The values obtained for total protein, albumin, high density lipoprotein, low density lipo-protein, glucose and aspartate transaminase were not significantly (p>0.05) different among treatments, while those of cholesterol and alani transaminase were significantly different among treatments.

Table 6: Serum biochemistry of broilers chicken fed ginger supplemented diets.

Parameters	T_1 (0.0%)	T_2 (0.0%)	T_3 (1.0%)	T_4 (1.5%)	T_5 (2.0%)	T_6 (2.5%)	SEM
Total protein(g/dl)	4.19	4.03	3.28	3.90	3.69	4.10	0.12
Albumin (g/dl)	1.79	1.58	1.36	1.55	1.56	1.70	0.05
Cholesterol (mg/dl)	112.61^{ab}	100.00^{bc}	78.99^{bc}	74.80^c	115.97^a	118.49^a	5.10
High-density lipoprotein	112.25	97.10	81.95	63.90	61.60	104.36	9.92
Low-density lipoprotein	13.93	21.56	31.81	12.58	43.65	23.57	4.62
Glucose(mg/dl)	176.46	194.19	150.44	154.58	152.29	158.96	15.23
Aspartate Transaminase (%)	10.78	8.76	11.73	11.13	10.42	14.45	0.72
Alamine Transaminase (%)	2.56^{ab}	4.48^{ab}	6.40^{ab}	2.92^{ab}	1.12^b	8.17^a	0.63

a, b, c: Means along the same row having any identical superscript are not significant (p>0.05) SEM =standard error of mean.

Table 7: Meat Quality of Broiler Chicken Fed Ginger Supplemented Diet

Parameters	TREATMENTS						
	T1 (0.0%)	T2 (0.0%)	T3 (1.0%)	T4 (1.5%)	T5 (2.0%)	T6 (2.5%)	SEM
% Breast freezing loss	4.00	3.93	3.43	4.43	4.76	2.80	0.41
% Drumstick freezing loss	2.80^{b}	4.60^{ab}	6.80^{a}	2.83^{b}	3.53^{b}	2.50^{b}	0.50
% Breast refrigerating loss	2.40^{b}	3.33^{ab}	4.86^{a}	2.50^{b}	2.90^{ab}	3.67^{ab}	0.31
%Drumstick refrigerating loss	2.87	2.63	3.10	3.83	3.43	2.73	0.36
% Breast cooking loss	2.80	2.85	8.78	2.85	2.80	2,80	0.32
% Drumstick cooking loss	3.10	4.93	3.93	3.13	2.73	3.83	0.30
% Breast water holding capacity	13.03	14.70	15.00	16.83	13.60	13.33	0.60
% Drumstick water holding capacity	14.26	16.20	15.63	15.26	15.73	16.20	0.53

$^{a\,b\,c}$ Means on the same row with different superscripts are significantly different ($P<0.05$).
SEM: Standard Error of Mean

Haematological parameters of broilers chicken fed ginger supplemented diets:

Haematological parameters generally provide information on inflammation, necrosis, and various infections on organ (NseAbasi *et al*., 2014) The values of packed cell volume, red blood cell and white blood cell obtained in this study were not significantly ($p>0.05$) different. Chickens supplemented with different levels of ginger powder were slightly higher than the control group this might be attributed to immunomodulation characteristics of ginger.

The haematological values obtained indicated that all the parameters were within the normal range as reported by Oyawoye (2004).which elucidate that bone marrow of the birds were functioning normally with the absence of macrocytic and hypochromic anemia. Eosinophil and haemoglobin were significantly ($p<0.05$) value ranged from 2.50-6.00% and 9.45-16.05g/dl respectively. Haemoglobin has the physiological function of transporting oxygen to tissues of the animal for oxidation of ingested food so as to release energy for the other body functions as well as transport carbon dioxide out of the body of animals (Omiyale, Yisa, & Ali-Dunkrah, 2012; Ugwuene, 2011).

Eosinophils is one the major components of white blood cell. The major functions of the white blood cell and its differentials are to fight infections, defend the body by phagocytosis against invasion by foreign organisms and to produce, transport and distribute antibodies in immune response. Thus, animals with low white blood cells are exposed to high risk of disease infection, while those with high counts are capable of generating antibodies in the process of phagocytosis and have high degree of resistance to diseases (Soetan *et al*., 2013) and enhance adaptability to local environmental and disease prevalent conditions (Iwuji, *et al* 2012; Kabir, *et al*, 2011; Okunlola, *et al.*, (2012).

It can also be deduced from this findings that there was appropriate release of energy and transportation of carbon dioxide in the body of the animal thereby causing nutrient metabolism and food efficiency in the body of the animal

Serum activities of ALT and AST are the most commonly used biochemical markers of liver injuries. Increased serum levels of AST and ALT have been attributed to the structural damage of the liver as a result of their cytoplasmic location which is released into circulation after cellular damage (Huang *et al* 2017). Total protein showed no significance different ($p>0.05$) with 2% inclusion level having the highest value this indicate that there was efficient utilization of protein in the blood this result agrees with (Ozkan., 2012) who assess the effect of moringa oleifera leaf extract on blood parameters of albino rat. Cholesterol reduced drastically at 1.5% inclusion level this may be attributed to bioactive component in the plant which acts by inhibiting the absorption of cholesterol hence reducing serum cholesterol and its deposition in the muscle (Aderemi, 2004).

Conclusion and recommendation

In this study it was observed that ginger (*Zingiber Officinale*) can be used in the diets of broilers without any medication to improve their health and give better feed conversion at 1.0% inclusion level of ginger. Futhermore inclusion of *Zingiber Officinale* in broiler diet has significant advantages ($P<0.05$) on the average body weight and feed intake of broiler chickens. Inclusion of *Zingiber Officinale* in broiler diet reduces the rate of mortality in the experimental birds; helps in optimum growth, meat quality, *Zingiber Officinale* also improve overall health of broiler chickens.

In conclusion the inclusion of ginger at 1% improve blood indices, growth performance and overall quality of meat this implies that their use can be recommended to farmers in the place of antibiotics.

References

Ademola, S.G.; Farinu, G. and Babatunde, G.M. (2009): Serum lipid, growth and hematological parameters of broilers fed garlic, ginger and their mixtures. World J. Agric. Sci., 5: 99-104.

Aderemi, F. A. (2004). Effects of replacement of wheat bran with cassava root sieviate supplemented or unsupplemented with enzyme on the haematology and serum biochemistry of pullet chicks. Tropical Journal of Animal Science, 7, 147-153.

Asghar, A., M. Farooq, M.N. Mian and A. Khurshid, 2000. Economics of broiler production in Mardan division. J. Rural Dev. Admin., 32: 56-64.

Association of Analytical Chemists (1990). Official method of Analysis. 15th Edition, Washington, DC., USA.

Akhtar, M.S.; Afzal, H. and Chaudry, F. (1984): Preliminary in vitro antibacterial screening of Bakain, and Zarisk against salmonella Medicos, 9: 6-7.

Alcicek, A.; Bozkurt, M. and Cabuk, M. (2004): The effect of mixture of herbal essential oils, an organic acid or a probiotic on broiler performance. South Afr. J. Anim. Sci., 34(4): 217-222.

Al-Homidan, A.A. (2005): Efficiency of using different sources and levels of Allium cepa, Allium sativum and Zingiber officinale on broiler chick's performance. Saudi Journal of Biological Science, 12 (2): 96-102.

Ali, B.H.; Blunden, G.; Tanira, M.O. and Nemmar, A. (2008): Some phytochemical, pharmacological and toxicological properties of ginger (Zingiber officinale Roscoe): A review of recent research. Feed Chem. Toxico., 46: 409-420

Al-Amin, Z. M., Thomson, M., Al-Qattan, K. K. PeltonenShalaby, R., & Ali, M. (2006) Anti-diabetic and hypolipideamic properties of ginger (Zingiber officinale) in streptozotocin-induced diabetic rats. Br. Journ. Nutr. 96: 660-666.

Botsoglou, N.A., Florou-Paneri, E., Christaki, E., Fletouris, D. J. and Spais B.A. (2002) Effect of dietary oregano essential oil on performance of chickens and on iron-

induced lipid oxidation of breast, thigh and abdominal fat tissues. *Brit. Poultry Sci*. 43(2), 223-230

Chrubasik, S.M.H.; Pittler and Roufogalis, B.D. (2005): Zingiberis rhizome: A comprehensive review on the ginger effect and efficacy profiles. Phytomedicine, 12: 684-701.

Chioma, G.O, Akinsoyinu. O.A., Olumide. M.D., Ajayi.O.A. Ndubuisi-Ogbona. L.C., Akinboye. O.E., Adeyeye.J.A. Ayo-Bello. T., and Afodu. O. j. (2017).Carcass and performance characteristics of broiler chickens fed with *Cymbopogon citratus* leaf meal as alternative to Mycotoxin binder. *International Journal of Agricultural Science Research* Vol.6 (4), pp.018-023.

Denli, M., Okan, F. and Celik, F (2003). Effect of dietary probiotic, organic acids and antibiotic supplementation to diets on Broiler performance and carcass yield. Parkistan journal of nutrition 2(2):89-91

Dieumou, F.E.; Teguia, A.; Kuiate, J.R.; Tamokou, J.D.; Fonge, N.B. and Donogmo, M.C. (2009): Effect of ginger (Zingiber officinale) and garlic (Allium sativum) essential oils on growth performance and gut microbial population of broiler chicks. Livestock Research for Rural Development, 21 (8): 21-33.

Doley, S.; Cupta, J.J. and Reddy, P.B. (2009): Effect of supplementation of ginger, garlic and turmeric in broiler chicken. Indian Vet. J., 86(6): 644-645.

Farooq, M., M.A. Mian and A. Asghar (2001). Factors affecting cost of production and net profit per broiler in the subtropics. Livestock Res. Rural Dev. Vol 4(2): 23-28

Fasae A, Adu IF, Aina ABJ, and Dipeolu (2010). Growth performance carcass characteristics and meat sensory evaluation of West African dwarf sheep fed varying levels of maize and cassava hay tropical animal health and production 43(2): 11-16.

Garcia, V.P.; Catala-gregori, P.; Hernandez, F.; Megias, M.D. and Marid, J. (2007). Effect of formic acid and plant extracts on growth, nutrient digestibility, intestinal mucosa morphol ogy and meat yield of broilers. J. Appl. Poult. Res., 16: 555-562.

Ghazaiah, A.A.; El-Hakim, A.S. and Refaie, A.M. (2007). Response of broiler chicks to some dietary growth promoters throughout different growth periods. Egypt. Poult. Sci., J. 27: 53-57

Gardzielewska, J., Pudyszak, K, Majewska, T., Jakubowska, M. and Promianowski, J. (2003) Effect of plant-supplemented feeding on fresh and frozen storage quality of broiler chicken meat. Animal husbandry series of electronic. Journal of Polish Agric-Univ. 6 (2), 3l1- 376

Honikel, K.O (1998). Reference method for the assessment of physical characteristics of meat. Meat science 49 (47: 447-457

Herati and Marjuki (2011). Effect of feeding red ginger as phytobiotic on broiler slaughter weight and meat quality. Int. J. Poultry Sci., 10: 12- 983-986.

Herawati, (2006): Effect of red ginger (Zingiber officinale Rosc) phytobiotic addition to the broiler performance and blood profile. Pengaruh Penambahan Fitobiotik Jahe Merah, 14: 142-173.

Herawati, (2010): The effect of feeding red ginger as photobiotic on body weight gain, feed conversion and internal organs condition to broiler. Int. J. Poult. Sci., 9: 963-967.

Huang. K. H, Ravindran. V, Li. X, Ravindran. G, Bryden. W. L (2017). Apparent ileal digestibility of amino acids in feed ingredients determined with broilers and layers. J. Sci. Food Agric., 87 (1):47-53. https://doi.org/10.1002/jsfa.2667

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

Iwuji, T. C., and Herbert, U. (2012). Haematological and serum biochemical characteristics of rabbit bucks fed diets containing garcimiola kola seed meal. Proceedings of 37th Annual Conference of Nigerian Society for Animal Production, pp.87-89

Kabir, M., Akpa, G. N., Nwagu, B. I., Adeyinka, I. A., & Bello, U. I. (2011).Sexual dimorphism, breed and age characteristics of rabbits in Zaria, Nigeria). Proceedings of the 16th Annual Conference of Animal Science Association of Nigeria. 133-137

Khan, S. H., Sardar, R. & Anjum, M. A. (2007) Effects of dietary garlic on performance and serum and egg yolk cholesterol concentration in laying hens. Asian-Australian Journal of Animal Sciences 21: 22-27.

Li C.B, Liu D, Zhou G.X, Xu X.L, Qi, J et al (2012) Meat quality and cooking attributes of thawed pork with different low field NMRT21 meat science 92:79-83

NRC, National Research Council (1994): Nutrient requirements of poultry (9th Rev. ed) National Academy Press, Washington, D.C., USA.

NseAbasi N. Etim, Mary E. Williams, Uduak Akpabio, and Edem E. A. Offiong (2014) Haematological Parameters and Factors Affecting Their Values. Agricultural Science. Volume 2(1): 37-47 DOI: 10.12735/as.v2i1p37

Onimisi, P.A.; Dafwang, I.I. and Omage, J.J. (2005): Growth performance and water consumption pattern of broiler chicks fed graded levels of ginger waste meal. J. Agric., Forestry and Social Sci., 3: 113-119.

Olumide, M. D. and Odunowo, O. O (2019). Blood profile of broiler chickens fed supplemented garlic-based diets. Nig. J. Anim. Prod. 2019, 46(3) pp 253-262.

Okunlola, D. O., Olorunisomo, A. O., Aderinola, A. O., Agboola, A. S., and Omole, O. G. (2012).Haematology and serum quality of red Sokoto goats fed Baobab (*Adansonia digitata*) fruit meal as supplement to guinea grass. Proceedings of the 17th Annual Conference of Animal Science Association of Nigeria p.427-433.

Omiyale, C.A., Yisa,, A.G., and Ali-Dunkrah, L. A. (2012). Haematological characteristics of Yankasa sheep fed fonio (Digitaria iburua) straw based diets. Proceedings of 37th Annual Conference of Nigerian Society for Animal Production .p_p 87-89)

Onu, P. N. & Aja, P. M. (2011) Growth performance and haematological indices of weaned rabbits fed garlic (Allium sativum) & ginger (Zingiber officinale) supplemented diets. Inter. J. of Food, Agric. and Vet. Sci. Vol. (1)) Oct. – Dec. 51-59

Özkan, C., Kaya, A., & Akgül, Y. (2012). Normal values of haematological and some biochemical parameters in serum and urine of New Zealand White rabbits. World Rabbit Science, 20(4), 253-259.

Oyawoye, B. M., & Ogunkunle, H. N (2004). Biochemical and haematological reference values in normal experimental animals (p. 212-218). New York

Mitruka, B. M., and Rawnsley, H. M. (1977). Clinical biochemical and hematological reference values in normal experimental animals (p.134-135). USA: Masson Publishing Inc.

Platel, K. and Srinivasan, K. (1996). Influence of dietary spices or their active principles on digestive enzymes of small intestinal mucosa in rat. Int. J. Food Sci. Nutr., 47: 55-59.

Platel, K. and Srinivasan, K. (2000). Influence of dietary spices and their active principles on pancreatic digestive enzymes in Albino rats. Nahrung, 44(1): 42-46.

SAS. (2002). User's Guide Statistics version, 10th edition, SAS statistical package Inc., Cary,

North Carolina, U.S.A.

Schalm, O. W., Jain, N. C., & Carroll, E. J. (1975). Veterinary haematology (3rd ed., p.15-218). USA: Lea & Fabiger, Philadelphia.

Siham AA, Elshafia SA, Huda MZA (2015). Study in mineral composition of camel meat and beef. Pyrex J. Agric. Res. 1(3):014-019

Soetan, K. O., Akinrinde, A.S., & Ajibade, T.O. (2013). Preliminary studies on the haematological parameters of cockerels fed raw and processed guinea corn (Sorghum bicolor) . Proceedings of 38th Annual Conference of Nigerian Society for Animal Production. 49-52

Tollba, A.A.; Azouz, H.M.M. and Abd-Samad, M.H. (2007): Antioxidants supplementation to diet of Egyptian chicken under different environmental conditions. 2. The growth during cold winter stress. Egyptian Poultry Science J., 27: 727-748

Tekeli, A. (2007): Potential use of plant extracts and propolis to be natural growth promoter in broiler chicks diets Ph.D. Thesis, University of Cukurova Institute of Natural and Applied, Department of Animal Science, Adana.

Ugwuene, M. C. (2011). Effect of Dietary Palm Kernel Meal for Maize on the Haematological and Serum Chemistry of Broiler Turkey. *Nigerian Journal of Animal Science*, 13, 93- 103.

WebMD (2018). Ginger. Retrieved from https://www.webmd.com/vitamins/ai/ingredientmono-961/ginger

Zhang, G.F., Yang, Z.B., Wang, Y., Yang, W.R., Jiang, S.Z. And Gai, G.S. (2009) Effects of gingerroot (Zingiber officinale) processed to different particle sizes on growth performance, antioxidant status, and serum metabolites of broiler chickens. *Poultry Science* 88(15), 2159-2166.

Zomrawi, W.B.; Abdel Atti, K.A.A.; Dousa, B.M. and Mahala, A.G. (2012): The effect of ginger root powder (Zinger officinale) supplementation on broiler chick's performance, blood and serum constituents. Online Journal of animal and Feed Research, 6: 457-460.