International Journal of Research in Agricultural Sciences
Volume 6, Issue 5, ISSN (Online): 2348 – 3997

Growth Performance and Carcass Characteristics of Broiler Chicken Fed Diet Supplemented with Ginger (*Zingiber Officinale*), Garlic (*Allium Sativum*), Roselle (*Hibiscus Sabdariffa*) and their Combinations

Olayemi Christiana Olagoke, Akinyinka Olu Akinwumi* and Isiaka Adewale Emiola
Department of Animal Nutrition and Biotechnology, Ladoke Akintola University of Technology, Ogbomoso, Oyo State, Nigeria.
*Corresponding author email id: aoakinwumi @lautech.edu.ng

Date of publication (dd/mm/yyyy): 30/09/2019

***Abstract* – Effect of garlic, ginger, roselle and their combinations on the growth performance, nutrient digestibility and carcass characteristic of broiler chicken was investigated. A total of 210 1- day old Arbor Acre broiler chicks were randomly distributed into seven dietary treatments of three replicate each in a Completely Randomized Design. The diet consist basal diet (control, D1), control with 3% ginger (D2), 3% roselle (D3), 3% garlic (D4), 1.5% each of ginger + garlic (D5), ginger + roselle (D6) and 500IU vitamin E (D7). Data generated were subjected to One Way ANOVA using IBM SPSS version 21. The average daily gain, average daily feed intake and feed conversion ratio were not different (P>0.05) from the control, while nutrient digestibility were significant (P<0.05). Diet 4 had the highest (P<0.05) nutrient digestibility while D6 had the least. The result of the serum total protein indicated that values ranged from 2.67 to 4.17. High Density Lipoprotein value was highest (p<0.05) in D7 and closely followed by birds on D2, D4 and D6. The lowest blood cholesterol was recorded in D5 which was closely followed by D4 and D6. Carcass evaluation showed that birds fed ginger + garlic had better (p<0.05) live weight (1400g) and lowest (p<0.05) abdominal fat (0.69). The breast meat weight was highest (p<0.05) in D3. It was concluded that the natural antioxidants increased live weight, improved digestibility and reduced abdominal fat. Ginger + garlic, garlic and ginger + roselle reduced blood cholesterol while roselle, ginger-garlic and ginger-roselle supplementation improved serum total proteins of broiler chickens. Inclusion of natural antioxidant in the diets of broiler is hereby advocated.**

***Keywords* – Ginger, Garlic, Roselle, Serum, Carcass.**

I. INTRODUCTION

Description of Problem

Antioxidants are substances that when present in low concentration, significantly delay or prevent oxidation of that substance [1]. Antioxidants thereby protect susceptible substrate by removal of free radical initiators and propagators by transferring hydrogen atom to stabilize the free radicals in order to stop lipoperoxidative chain. Antioxidant phytochemicals such as vitamin C and E, phenolic compounds (flavonoids) vegetable pigments (antocyanins and carotenoids) as well as thiols (sulphur compounds) are able to slow down, stop or reverse oxidation of nucleic acids (DNA), proteins and lipids by scavenging oxidizing agents (ROS) [2]. In addition, these phytochemicals enhance the activities of the cellular antioxidant enzymes superoxide dismutase (SOD), catalase and glutathione peroxidase [3].

The uses of synthetic antioxidants have been discovered to reduce this kind of stress in poultry industry. Synthetic antioxidants such as Butylated Hydroxylanisole (BHA), Butylated Hydroxyltoluene (BHT), propyl gallate and alpha tocopheryl acetate, appears as foreign substance in the body which are also known to degrade

cells over time and cause adverse health effect like risk of cancer [4]. However, because of the restriction in the use of synthetic substances globally, the use of natural substances is now gaining ground. An effective natural antioxidant is needed to replace synthetic ones due to the problem of lipid oxidation which must not alters the quality of finished products and consumers' perception.

Natural Antioxidants

There are many identified natural antioxidant sources, among which are ginger (*Zingiber officinale*), garlic (*Allium sativum*) and roselle (*Hibiscus sabdarifa*). Garlic exerts modulatory effects on lipid metabolism in broiler [5]. Diets comprising garlic powder has ability to lower down serum and egg cholesterol level in hens [6]. When ginger is dried, shogaols is formed from dehydration reaction of gingerol [7]. The dehydration reaction makes ginger a naturally effective feed additive in poultry diets [8], thereby improving growth and enhance activities of antioxidants enzymes. The biological activities of ginger (*Zingiber officinale*) include anticancer, antioxidant, anti-inflammation and antimicrobial properties. Dried roselle calyces contain a high amount of ascorbic acid (260-280/100g). *Hibiscus sabdarifa* have a blood pressure-lowering effect [9]. Extract of *Hibiscus* may possess hypotriglyceridemic effect in Shika Brown laying hens which could cause increase in serum and egg yolk cholesterol [12].

The active substances in ginger are terpenoids, zingiberene and bisabolene and the aromatic gingerol. When ginger is dried, through dehydration reaction in the substance gingerol, shogaols is formed [11]. This dehydration reaction makes ginger a naturally effective feed additive in poultry diets [8], thereby improving growth and enhance activities of antioxidants enzymes. Dried roselle calyces contain a high amount of ascorbic acid 260-280/100g. Vitamin is an important element of antioxidants defense in stress conditions and it increased supplementation in combination with other antioxidants and when compared with its fresh form, contain 14mg ascorbic acid/100g [12, 13]. Dried roselle calyces contain the flavonoids, gosypetine and sabdaretine. Anthocyanin is a water soluble pigment responsible for orange colour of the calyces and their juices [14], which makes it a good colorant and a potential good source of antioxidants components. Whole garlic constitute primarily sulphur containing constituents viz: S-alk (en) yl-L-cystein sulfoxides, γ-glutamyl-S-alk (en) yl-L-cystein peptides and other odour free sulphur compounds [15]. When garlic is cut, crushed, chewed, dehydrated or further processed, alliinase, a vacuolar enzyme is released and quickly lyses the cytosolic (alliin) which are converted to hundreds of organo-sulphur compounds in a short period of time. Garlic contains antiplatelet activity in vitro, reduces serum cholesterol levels and arteriosclerosis severity [16].

Mixture of garlic and ginger improved egg weight with reduced cholesterol and triacylglycerol as well as better hen day production of laying hens; and also benefit growth, laying performance and lowered yolk lipid [17]. Ginger and garlic in broiler chicken diet resulted in an increase weight performance, boosted immunity and improved general wellbeing [18]. However, a report showed that single supplementation of garlic and ginger significantly improved body weight of birds as compared to control and their mixture [19].

Performance of broiler chicken and cellular activity depend on available nutrients in feed, its utilization and distribution of absorbed nutrients into the tissues and organs. It has been observed that blood components of animals can be used to diagnose diseases and dysfunctions as it affect physiological factors such as stress and pathological factors ([7, 20]. Therefore, this study was designed to investigate the effect of ginger, garlic, roselle and their combination on the growth performance, nutrient digestibility, blood profile and carcass characteristics

of broiler chickens.

II. Materials and Methods

Site of Experiment

This experiment was carried out at the Poultry Unit of the Teaching and Research Farm, Ladoke Akintola University of Technology, Ogbomoso, Nigeria.

Preparation of Test Ingredient

Ginger, garlic and roselle were procured from a local market within Ogbomoso metropolis. Fresh ginger rhizomes and garlic bulbs were purchased, peeled, sliced and sun dried for the period of one week. It was thereafter milled and stored in an airtight container. Roselle calyces were purchased dried and sun dried again, milled and kept in an airtight plastic container. Vitamin E was purchased from a reputable farm in Ibadan.

Experimental Diet

The experimental treatments consist of control (basal diet without antioxidant) as D1, while other diets were control supplemented with 3% ginger (D2), 3% roselle (D3), 3% garlic (D4), 1.5% each of ginger and garlic (D5), 1.5% ginger and roselle (D6) and 500IU vitamin E serving has the positive control. The diets were formulated to contain 23.64% Crude Protein and 2985.20Kcal/kg Metabolizable Energy at starter phase and 22.03% CP and 2961.60 Kcal/kg ME at finisher phase (Table 1).

Table 1. Diet Composition of Experimental Birds.

Ingredients	Starter phase	Finisher phase
Maize (%)	57.00	58.00
Soybean meal (%)	14.6	15.00
Groundnut cake (%)	19.00	14.00
Wheatbran (%)	4.00	8.15
Fishmeal (72%)	2.00	1.50
Bonemeal (%)	1.40	1.50
Limestone (%)	1.00	1.00
Salt (%)	0.20	0.20
Vitamin premix (%)	0.30	0.25
Methionine (%)	0.20	0.20
Lysine (%)	0.30	0.20
Total	100	100
Calculated analysis		
Crude protein (%)	23.64	22.03
Crude Fibre	3.40	3.54

Ingredients	Starter phase	Finisher phase
Metabolizableenergy (kcal/kg)	2985.20	2961.60
Phosphorus (%)	0.5	0.51
Calcium (%)	0.98	0.97
Lysine (%)	1.26	1.12
Methionine (%)	0.52	0.50

Vitamin premix (per kilogram of diet): vitamin A, 12,000 IU; vitamin D3, 2,000 IU; vitamin E, 50; IU; vitamin B1, 1 mg; vitamin B2, 3 mg; vitamin B6, 1 mg; vitamin B12, 10g; vitamin K, 2 mg; copper, 75 mg; nicotinic acid, 12 mg; pantothenic acid, 10 mg; iron, 200 mg; cobalt, 0.5 mg; manganese, 40mg; zinc, 90 mg, iodine, 1 mg; selenium, 0.2 mg; calcium, 31.25 g; salt, 25 g; sodium, 10 g.

Management of Birds

A total of 210 1-day old Arbor Acres broiler chicks were randomly divided into seven treatments of three replicates each in a Completely Randomized Design. Birds were given broiler starter diet for the first 3weeks while finisher diet was offered for the last 3 weeks. Feed and water were offered *ad libitum*. Daily routine management was followed birds were vaccinated and drugs were administered when necessary.

III. DATA COLLECTION

Growth Performance and Nutrient Digestibility

Birds assigned to different dietary treatments were allowed free access to feed and water. The initial body weight and final body weight were used to estimate body weight gain. Weekly feed consumption was also used to calculate feed intake and feed conversion ratio. At 42nd day, one bird per replicate were randomly taken and housed individually in a cage to determine the nutrient digestibility. The faecal samples were collected daily for three days. The feed and faeces were analyzed to determine the proximate composition (CP, CF, EE, Ash and NFE) according to [21].

Blood Profile Assessment

On the 42nd day of the study, birds were starved of feed for 12 hours while blood samples were randomly collected from three birds per treatment via the jugular vein into sterilized bottle. Blood samples for the determination of haematological indices were collected into vials containing Ethylene Diamine Tetraacetic Acid (EDTA) while vials without anticoagulant were used to collect blood for serum analysis. The blood samples were analyzed for total protein (TP) using Biuret method [22], albumin was determined by Bromocresol Green (BCG) method according to [23] while urea was determined according to the procedures of [24]. Blood cholesterol was analyzed enzymatically using commercially available reagent kit according to the manufacturer's guide. Cyanmethamoglobin method was used to determine haemoglobin concentration [25]. Red blood cell (RBC) and white blood cells (WBC) were determined using Wintrob micro haematocrit and haemocytometer consisting of a counting chamber and special cover slip. The mean corpuscular volume, (MCV), mean corpuscular haemoglobin (MCH), mean corpuscular haemoglobin concentration, high density lipoprotein cholesterol (HDL), low density lipoprotein cholesterol (LDL) and very low density lipoprotein cholesterol (VLDL) were determined.

Carcass Characteristics Determination

Three birds per treatment with average weights were purposively selected, slaughtered, scalded manually and dissected [26]. The live weights were recorded and the dressing % determined. Weights of the primal cuts (breast, thigh, and drumstick) and internal offal (liver, kidney, heart, lungs and abdominal fat) relative to body weight were also recorded.

Statistical Analysis

Data generated were subjected to One Way Analysis of Variance using IBM SPSS version 21 for Windows [27]. Means were separated with Duncan Multiple Range Test of the same statistical package. Significances were based on 95% confidence limits ($P < 0.05$).

IV. RESULTS

The growth performances and nutrient digestibility of broiler birds fed experimental diet are presented in Table 2. There were no significant differences ($P>0.05$) in the growth performance parameters examined while all the parameters for the nutrient digestibility were significantly ($P<0.05$) different. Diet 4 significantly ($P<0.05$) gave the highest values for all the nutrient digestibility parameters. Crude protein, CF and EE followed similar trend as the lowest ($P<0.05$) values were recorded in control (D1) except for EE that lowest ($P<0.05$) was found in D6. The values recorded for ash and NFE also followed similar trend with the least ($P<0.05$) values 10.99 and 8154 for D6 respectively.

Table 2. Growth Performance and Nutrient Digestibility of Broiler Chicken Fed Diet Supplemented with Different Antioxidants.

Parameters	Maize/soybean (no antioxidant)	Control+ Ginger	Control+ Roselle	Control+ Garlic	Control+ Ginger+ Garlic	Control+ Ginger+ Roselle	Control+ Vitamin E	SEM
ADG (g/bird)	30.17	28.78	29.76	30.30	29.31	29.16	30.18	0.32
ADFI (g/bird/day)	75.12	75.96	74.76	74.31	80.29	74.05	76.45	1.18
FCR	2.49	2.66	2.52	2.46	2.74	2.54	2.53	0.05
CP (%)	77.92^{f}	92.87^{bc}	91.62^{c}	96.02^{a}	88.31^{d}	85.63^{e}	94.33^{ab}	1.30
CF (%)	52.68^{f}	78.27^{b}	74.61^{c}	90.43^{a}	72.23^{d}	59.87^{e}	79.07^{b}	2.62
EE (%)	34.13^{d}	72.03^{ab}	59.31^{c}	72.88^{a}	32.92^{d}	22.31^{f}	71.00^{b}	4.49
Ash (%)	18.41^{e}	68.00^{b}	68.66^{b}	76.95^{a}	52.99^{c}	10.99^{f}	43.69^{d}	5.32
NFE (%)	89.64^{b}	89.09^{b}	88.19^{b}	97.57^{a}	85.25^{c}	81.54^{d}	84.04^{c}	1.09

^{abcdef} Means on the same row with different superscripts are significantly ($P<.0.05$) different. CP- Crude Protein, CF- Crude Fiber, EE- Ether Extract, NFE- Nitrogen Free Extract, ADG-average daily gain, ADFI-average daily feed intake, FCR-feed conversion ratio.

Blood profile of broiler chickens fed natural antioxidants is as shown in Table 3. There were no significant ($P<0.05$) differences in the haematological indices among the treatment means except for the white blood cells; while all the parameters examined for serum were significantly ($P<0.05$) different. The white blood cells (WBC) of birds fed roselle (19.62) and vitamin E (19.46) were significantly ($P<0.05$) highest across the treatment groups. Birds fed diet supplemented with roselle had the highest ($P<0.05$) serum total protein. The albumin content showed statistical similarity ($P<0.05$) across the groups. Significantly reduced blood cholesterol levels were

observed in D5 (156.14) which compared with D4 (166.66) and D6 (174.56). The highest value (63.11) of HDL recorded in birds fed D7 compared with D2, D4 and D6. The lowest value of triglycerides was observed in D6 (43.71) which compared with D4 (48.54) and D1 (49.58).

Table 3. Blood Profile of Broiler Chicken Fed Diet Supplemented with Different Antioxidants.

Parameters	Maize/soybean (no antioxidant)	Control+ Ginger	Control+ Roselle	Control+ Garlic	Control+ Ginger+Garlic	Control+ Ginger+Roselle	Control+ Vitamin E	SEM
*PCV (%)	27.33	24.67	26.00	26.00	27.73	25.00	26.00	0.36
*Hb (g/dl)	8.73	7.97	8.70	9.07	8.90	8.50	8.90	0.14
*RBC (10^6ul)	2.80	2.24	2.80	3.27	2.65	2.85	2.85	0.14
*WBC (10^6ul)	16.73^{bc}	14.99^{c}	19.62^{a}	17.35^{b}	15.35^{bc}	16.27^{bc}	19.46^{a}	43.12
Platelet	245.93	159.30	303.83	337.33	247.67	194.77	324.93	228.93
*MCV (fl)	103.19	114.48	96.23	79.43	114.47	92.00	93.18	5.50
*MCH (pg)	32.32	37.11	32.27	27.70	37.10	31.82	32.15	1.63
*MCHC (%)	3.20	3.23	3.35	3.49	3.25	3.40	3.44	0.05
Total Protein (g/dl)	3.27^{bc}	2.67^{d}	4.17^{a}	3.91^{a}	2.92^{cd}	3.83^{a}	3.73^{ab}	0.87
Cholesterol(mg/dl)	214.91^{a}	207.03^{ab}	195.61^{abc}	166.66^{cd}	156.14^{d}	174.56^{bcd}	197.37^{abc}	4.78
Urea(mg/dl)	8.85^{a}	9.03^{a}	5.84^{b}	7.04^{ab}	6.68^{b}	9.02^{a}	6.51^{b}	0.28
Albumin(g/dl)	2.03^{ab}	1.78^{b}	2.04^{ab}	2.12^{a}	2.05^{ab}	1.88^{ab}	1.87^{ab}	0.36
Triglycerides(mg/dl)	49.58^{c}	53.13^{bc}	75.83^{a}	48.54^{c}	63.54^{b}	43.71^{c}	51.04^{bc}	1.90
*HDL(mg/dl)	48.53^{b}	59.29^{ab}	56.39^{ab}	57.38^{ab}	48.80^{b}	57.92^{ab}	63.11^{a}	1.36
*LDL(mg/dl)	47.26^{c}	48.33^{c}	71.35^{a}	54.89^{bc}	57.97^{b}	57.90^{b}	57.38^{b}	1.37
*VLDL	9.91^{c}	10.63^{bc}	15.17^{a}	9.71^{c}	12.71^{b}	8.75^{c}	10.21^{bc}	0.38

^{abcd} Means on the same row with different superscripts are significantly different (P<0.05) *HDL-High Density Lipoprotein, LDL-Low Density Lipoprotein, VLDL- Very Low Density Lipoprotein, PCV-Packed Cell Volume, Hb-Haemoglobin, RBC-Red Blood Cell, WBC-White Blood Cell, MCV-Mean Corpuscular Volume, MCH-Mean Corpuscular Heamoglobin, MCHC-Mean Corpuscular Haemoglobin Concentration.

The results of carcass characteristic, primal cuts and internal organs (Table 4) only showed significance in the live weight, breast weight, wings, gastro intestinal tract and abdominal fat. The results of the live weight showed that D5>D6>D2>D4>D7>D3>D1. Ginger (D2) and roselle (D3) diet alone significantly influenced (P<0.05) the breast cuts while the wing cut gave a superior (P<0.05) values at garlic diet (D4) alone.

Table 4. Carcass Characteristics, Primal Cuts and Organ Weights of Broiler Chicken Fed Natural Antioxidants.

Parameters	Maize/soybean (no antioxidant)	Control+ Ginger	Control+ Roselle	Control+ Garlic	Control+ Ginger+ Garlic	Control+ Ginger+ Roselle
Live weight(g)	1166.67^{b}	1325.00^{ab}	1250.00^{ab}	1316.67^{ab}	1400.00^{a}	1333.33^{ab}
Dressing%	63.27	64.14	63.60	62.65	61.76	58.34
Breast (%)	17.61^{ab}	18.19^{a}	19.41^{a}	17.84^{ab}	13.99^{b}	16.14^{ab}

Parameters	Maize/soybean (no antioxidant)	Control+ Ginger	Control+ Roselle	Control+ Garlic	Control+ Ginger+ Garlic	Control+ Ginger+ Roselle
Thigh (%)	10.26	9.72	11.01	10.61	10.74	11.60
Drumstick (%)	8.88	8.97	9.95	9.34	10.08	8.48
Wing (%)	8.99^{ab}	8.56^{ab}	8.52^{ab}	11.07^{a}	8.68^{ab}	7.83^{b}
Liver (%)	2.36	2.29	2.49	2.49	2.32	2.23
Kidney (%)	0.36	0.46	0.48	0.46	0.47	0.50
Heart (%)	0.41	0.42	0.50	0.48	0.41	0.48
Lungs (%)	0.52	0.54	0.51	0.47	0.48	0.51
Abdominalfat (%)	1.59^{a}	0.99^{bc}	1.20^{ab}	1.03^{bc}	0.69^{c}	0.82^{bc}

^{abc} Means on the same row with different superscript are significantly different ($P<0.05$).

V. DISCUSSION

The results might indicate that all the dietary treatments were not detrimental to the growth performance of broiler chicken. This result agreed with other result that observed no significance differences in feed consumption and feed efficiency at increasing level of dietary dried garlic powder (2, 6 and 8%) [28]. However, this result was contrary to previous result that up to 3% garlic supplementation as compared to 5% improved feed consumption [29]. A substantial positive effect on broiler performance was observed when ginger and garlic combination were fed in powder form [30]. Contrary to the result of this study, improved body weight gain, feed consumption and conversion ratio in broilers fed roselle dietary supplementation was documented [31]. Better utilization of feed in broiler chicks given 4g of roselle calyx boiled in 1litre of water compared to control was also reported [32].

Better digestibility observed in garlic supplemented diet might be due to the active ingredients and phenolic compounds which are capable of reducing numbers of intestinal pathogen hence, minimizing nutrient loss and improving performance. This in turn results into protein deposition in the body tissues. Garlic was reported to be alternative growth promoters in poultry and its excellent effect on growth and digestibility was revealed [33]. A report showed that ginger rhizomes have higher antioxidative activity than α-tocopherol (vitamin E) [34]. It could be observed from this study that there were possible effect of antagonism between ginger and roselle in terms of nutrient digestibility. Antioxidant may become a prooxidant in the presence of certain other molecules or at high concentrations [35]. Our results suggested that farmers can employ single supplementation of garlic and ginger in the diet of broilers for better nutrient digestibility and performance.

The non-significance variations observed in values of PCV, Hb, RBC, MCV, MCH and MCHC might indicate that there were no cases of anaemia, there were adequate nutrient release for electropoiesis and oxygen carrying and releasing capacity of the blood was not adversely affected. This result was in consonance with a result where no significance ($P<0.05$) difference in the same parameters when ginger root powder were supplemented in the diet of broilers at 0.5%, 1% and 1.5% was recorded [36]. These results however, contradicted another result that significance difference in the values of Hb, PCV and RBC when turmeric and cayenne pepper were used as antioxidants [37].

An increase in WBC might indicate increased immunity in birds; a moderate level might indicate boosting of immunity [38] while a low level might be an indicator of no disease condition or low production from the bone m-arrow [39]. Single supplementation of bird's diet with roselle just like the synthetic antioxidant (vitamin E), better increased immunity of birds compared to other dietary groups. A boosted immunity observed when ginger and garlic were supplemented in broiler's diet [18] however, disagreed with our result.

It was also observed from this study that single supplementation of garlic and roselle and mixture of ginger and roselle supplementation in the diet of broiler improved protein metabolism. Serum protein has been observed to be responsible for replacement of tissue proteins, transportation of blood constituents like vitamins, iron, hormones and acts as buffer in acid-base balance [39]. Higher protein content in birds that received roselle supplemented diet could be attributed to the presence of protein in roselle whose red calyx has high protein [40]. A reduced value of total protein in ginger supplemented diet indicate adverse effect of ginger compounds like polyphenols that lowers protein digestion via inhibiting proteolytic enzymatic activity in ginger. In contrast, no effect of ginger at the rate of 5, 10 and 15g/kg on total protein was observed [41].

The lowest level of triglycerides in D6 and D4 might implies the synergistic effect of ginger-roselle mixture and that of garlic properties to lower triglyceride levels by its ability of anti-thrombotic, anti-platelet, anti-hypertensive and anti-lipidemia [42]. Bird on vitamin E dietary group had highest value of HDL which is statistically the same as birds on ginger, roselle and garlic single dietary groups. High density lipoprotein cholesterol helps in the reduction of serum cholesterol, ischemic heart disease, stroke and disease associated with artherosclerosis [43]. Highest triglycerides, cholesterol, LDL, and VLDL levels in birds fed roselle dietary treatment agreed with other result that *Hibiscus sabdarifa* increased serum cholesterol in laying hens [10]. On the other hand, garlic single supplementation and combination of ginger and garlic lowered blood cholesterol. This agreed with the result of other researchers [16, 17, 44]. However, values recorded for all the antioxidant sources were not more than the level (>240mg/dl) considered risky to human health [45]. Very low density lipoprotein cholesterol is the main carriers of triglyceride. It is also substrates to endothelial lipoprotein lipase, whereas through lipase hydrolysis triglycerides are transformed into LDL. This might be attributed to increased triglycerides, VLDL and LDL in birds fed roselle dietary treatments [5]. It thus, generally suggested to the farmers that supplementation of these natural antioxidants will not be detrimental but positively affect the blood chemistry of birds by preventing or delaying oxidative deterioration.

The significant differences in the live weight of experimental birds indicate the potency of the natural antioxidants to improve live weight as compared with the control which gave the same result as synthetic. These results were not in consonance with the result that there were no differences in the live weight of broilers fed graded levels of ascorbic acid [46]. A number of literatures had observed that the dressing percentages were not affected by ginger and garlic [28, 47, 48]. The breast meat of broiler is one of the targets of consumers and meat processors, in this study sole supplementation of ginger and roselle increased relative breast meat weight of broiler chicken which contradicted other result [29].

The relative organ weights that were not significant in this study might imply that the antioxidants did not adversely affect the bird's organ as observed in another research [5]. The lowest abdominal fat pad (0.69) observed in birds fed combination of ginger and garlic indicates the potency of the test ingredient to synergistically reduce the abdominal fat of birds. Similar result was reported by other researchers [18, 46]. Our results then suggested

that as farmers are getting increased live weight of birds, the consumers are also benefitting from eating lean and functional and nutraceutical meats. Also, consumption of meat from these birds will improve consumers' health and wellness rather than increasing their health risk.

VI. CONCLUSION

Conclusively, single dietary treatment of garlic better improved nutrient digestibility, ginger and roselle singly increased immunity just like the synthetic counterpart while garlic, ginger + garlic and ginger + roselle improved protein metabolism. Furthermore, garlic, ginger + garlic and ginger + roselle reduced blood cholesterol, ginger, roselle, garlic and ginger + roselle improved good cholesterol while ginger alone lowered bad cholesterol. All of the natural antioxidants increase live weight more than the control group, ginger and roselle singly increased breast meat while ginger + garlic lowered abdominal fat more than other natural antioxidants. Generally, dietary supplementation of these natural antioxidants boosted endogenous antioxidants against oxidative stress and prevent lipid and protein oxidation. It enriched meat from the broiler chickens with health promoting bioactive compounds thereby preventing the tendency towards meat deterioration. Inclusion of all these natural antioxidants should therefore be advocated in their diets.

REFERENCES

[1] Halliwell B, and Gutteridge J.M.C. (1989). Free Radicals in Biology and Medicine. Academic Press: New York.
[2] Wilson, E.A. and Demming-Adams, B. (2007). Antioxidant, anti-inflamatory and antimicrobial properties of garlic and onions. Nutrition and Food Science; 37(3): 178-183.
[3] Awazu, S. and Horie, T. (1997). Antioxidant in garlic II. Protection of heart mitochondria by garlic extract and diallylpolysulfide from the doxorubicin-induced lipid peroxidation. In: Alejandra, C.C., Ana, C.S., Marta, C.M. and M. Villamiel (2010). A comprehensive survey of garlic functionality. Nova Science Publisher, Inc. ISBN 978-1-60741-642-5.
[4] Karen, P. (2007). Antioxidant Supplements. Retrieved from http://www.thetruthaboutvitamins.
[5] Jimoh A.A., Olorede, B.R., Bubakar, A.A., Fabiyi, J.P., Ibitoye, E.B., Suleman N.and Garba S. (2012). Lipid profile and haematological indices of broiler chickens fed garlic (*Allium sativum*) supplemented diets. *Journal of Veterinary Advances*, 2(10): 474-480.
[6] Mottaghitalab, M., and Taraz, Z. (2002). Effect of Garlic *(Allium sativum*) on egg yolk and blood serum cholesterol in Aryan bred laying hens. *British Poultry Science*, 43:42-43.
[7] Lin, H., Eddy, D. and Johan, B. (2006). Acute heat stress induces oxidative stress in broiler chickens. *Comp. Biochem. Physiol*., 144:11–17.
[8] Awadein, N.B., Abdel ghany, F., Hegazy, A. and Selim, N.A. (2012). Effect of Dried Ginger root (*Zingiberofficinale*) as Antibacterial on Productive, Reproductive and Physiological Performance of Laying hens. The 3rd Meditarranean Poultry Summit of WPSA (3rd MPS).
[9] Adegunloye, B. J., Omoniyi, J. O. and Owolabi, O.A. (1999). Mechanisms of the Blood Pressure Lowering Effect of the Calyx Extract of *Hibiscus sabdariffa* in Rats. *African. Journal of Medical Science*, 25: 235–238.
[10] Habibullah, S. A. Bilbis, L. S., Ladan, M. J., Ajagbonna, O. P. and Saidu, Y. (2010). Aqueous Extract of *Hibiscus sabdariffa* Calyces Reduces Serum in Laying Hens, Increases Serum and Egg Yolk Cholesterol of Shika Brown.
[11] Ling, H., Yang, H., Tan S-H, Chui, W-K and Chew, E-H (2010). 6-Shogaol, An active constituent of ginger, inhibits breast cancer cell invasion by reducing matrix metalloproteinase-9 expression via blockade of nuclear factor kB activation. *British Journal of Pharmacology*, 161:1763-1777.
[12] Duke J.A. (1983). *Hibiscus sabdariffa* L. Available online. http://www.hort.purdue.edu /newcropduke_enargy/ hibiscus_sabdariffa. html.
[13] Ismail, A., Ikram E. H. K. and Nazri H.S. M. (2008). Roselle (*Hibiscus sabdariffa L*) Seeds- Nutritional composition, protein quality and health benefits. *Food Global Science Books*, 2(1): 1-16.
[14] Tsai, P.J., and Olu A.S.M (1996). Colour degradation of dried roselle during storage. *Food Science* 23, 629-640.
[15] Lawson, L.D. (1993). Bioactive organosulphur compounds of garlic and garlic products: role in reducing blood lipids. In: Alejandra, C.C., Ana, C.S., Marta, C.M. and M. Villamiel (2010). A comprehensive survey of garlic functionality. Nova Science Publisher, Inc. ISBN 978-1-60741-642-5.
[16] Lawson, L.D., Sudhop, T. and von Bergmann, K. (1998). Effect of garlic on serum lipids. *Journal of the American Medical Association*: 280.1568.
[17] Ademola S.G., Lawal T.E., Egbewande O.O. and Farinu G.O. (2012). Influence of dietary mixtures of garlic and ginger on lipid composition in serum, yolk, performance of pullet growers and laying hens. *International Journal of Poultry Science*, 11(3): 196-201 ISSN1682-8356.
[18] Oleforuh-Okoleh, V.U., Chukwu, G.C. and Adeolu, A.I. (2014). Effect of ground ginger and garlic on the growth performance, carcass quality and economics of production of broiler chickens. *Global Journal of Bioscience and Biotechnology*, 3(3): 225-229.
[19] Karangiya V.K., Savsani, H.H., Patil, D.D., Garg, K.S., Murthy, N.K. Ribadiya and Vekariya S.J. (2016). Effect of dietary supplementation of garlic, ginger and their combination on feed intake, growth performance and economics in commercial broilers. *Veterinary World*, 9(3): 245-250.
[20] Szabo, A., Mezes, M., Horn, P., Suto, Z., Bazar, G. and Romvari, R. (2005). Developmental dynamic of some blood biochemical parameters in the growing turkey (*Melagris gallapavo*) Acta Veterinary Hungary, 53(4):397- 409.
[21] AOAC. Official Methods of Analysis (2000). 19th Edition AOAC International, Inc. Washington, DC.; 1219.
[22] Kohn, R.A. and M.S. Aleen (1995). Enrichment of proteolytic activity relative to nitrogen in preparations from the rumen for in-vitro studies. Animal Feed Science Technology; 52: 1-4.

[23] Peters, T., G.T. Biamonte and B.T. Doumas, (1982). Protein (total protein) in serum. In: Selected methods of clinical chemistry. G.W.R. Faulknr and S. Mcites (Eds.) American Association of Clinical Chemistry.
[24] Olorede, B.R., Onifade, A.A., Okpara, A.O., and Babatunde, G.M. (1996). Growth, nutrient retention, haematoology and serum chemistry of broiler chickens fed she a butter cake or palm kernel cake in the Humid Tropics. *Journal of Applied Animal Research*, 10: 173-180.
[25] Jain, N.C., (1986). Scanning electron micrography of blood cells. In: Schlam's Veterinary Haematology 1992. Reproductive toxicity of theobromine Volume 4, 4th Edn. Philadelphia: 63-70.
[26] Abdullah, A.Y., Al-beitawi, N. A., Rjoup, M.M. S., Qudsieh, R.I. and Ishmais, M. A. A. (2010). Growth performance, carcass and meat quality characteristics of different commercial crosses of broiler strains of chicken. *Japan Poultry Science*, 47:13-21
[27] Statistical Package for Social Sciences, (2012). IBM Corporation Released 2012. IBM SPSS, Statistics for Windows, Version 21.0. Armonk, New York: IBM, Corporation SPSS
[28] Sohail H. K., Rozina S. and Mohammed A.A. (2007). Effects of dietary garlic on performance and serum and egg yolk cholesterol concentration in laying hens. *Asian Journal of Poultry Science*, 1(1): 22-27.
[29] Elagib H., El-Amin, A.A., Elamin W. I.A. and Malik H.E.E. (2013). Effect of dietary garlic (*Allium sativum*) supplementation as feed additives on broiler performance and blood profile. *Journal of Animal Science Advance*, 3(2); 58-64.
[30] Belal, S.A., Uddin, M.N., Hassan, M.K., Islam, M.S. and M.A. Islam (2018). Effect of ginger (*ZIngiber officinale*) and garlic (*Allium sativum*) on productive performance and haematological parameters of broilers. *EPH- International Journal of Agriculture and Environmental Research*,4(1):1-12. ISSN: 2208-2158.
[31] Mamdooh, A.M.A. (2013). Evaluation of roselle *Hibiscus sabdariffa* flower as a nutritive additive on the productive performance of broiler. *The Iraqi Journal of Veterinary Medicine*, 37(1): 69-74.
[32] Awodola, P.O., Ajiboye, A.A and Longe, O.G. (2015). Effect of graded levels of roselle (*Hibiscus sabdariffa* LINN.) calyx extract on performance and carcass characteristics of broiler chickens. *International Journal of Poultry Science*, 14(6): 343-347
[33] Bampidis V.A., Christodoulou, V., Christaki, E., Florou-Paneri P., Spais, A. B. (2005). Effect of dietary garlic bulb and garlic husk supplementation on performance and carcass characteristics of growing lambs. *Animal Feed Science Technology*: 121: 273- 283.
[34] Kikuzaki, H. and Nakatani N. (2006). Antioxidant effects of some ginger constituents. *Journal of Food Science,* 58(6): 1407–1410
[35] James, E.H., (2003). Natural antioxidant review. Proceedings of the 56th American Meat Science Association Reciprocal Meat Conference; 95-98.
[36] Zomrawi, W.B., Abdel Atti Kh.A., Dousa, B.M and A.G. Mahala (2012). The effect of ginger root powder (*Zingiber officinale*) supplementation on broiler chicks performance, blood and serum constituents. *Online Journal of Animal and Feed Research*, 1(6): 457-460.
[37] Adegoke, A.V., Abimbola, M.A., Sanwo, K.A., Egbeyale, L.T., Abiona, J.A., Oso, A.O and Iposu, S.O. (2018). Performance and blood chemistry profile of broiler chicks fed dietary turmeric (*Curcuma longa*) powder and cayenne pepper (*Capsicum frutescens*) powder as antioxidants. *Veterinary and Animal Science*, 6:95-102.
[38] Clement, I. M., Ibrahim, D. K., Joseph, I., & Iro, N. (2010). Carcass and blood components of broiler chickens fed sorghum or millet as replacement for maize in the semiarid zone of Nigeria. *Agriculture and Biology Journal of North America*, 1(3), 326–329.
[39] Adedeji, A. O. (1992). Rapid interpretation of routine clinical laboratory tests (1st ed.). Samaru, Zaria, Nigeria: S. Asekome, and Co10–16
[40] Ajala, L.O., Oyeleke, G.O. and Olangunjo, E.O. (2013). Nutritional assessment of juice extract from *Hibiscus sabdariffa*. *International Journal of Biology, Pharmacy and Allied Sciences*, 2(1): 10- 19.
[41] Farinu, G.O., Ademola, S.G. Ajayi, A.O., Obe and Babatunde G.M. (2004). Growth, haematological and biochemical studies on garlic and ginger-fed broiler Chickens. *Moor Journal of Agricultural Resources*, 5:122–128.
[42] Amagase, H. (2006). Clarifying the real bioactive constituents of garlic. *The Journal of Nutrition,* 136, 716-725.
[43] Vinay, K.S. and Dimesh, K.S. (2008). Pharmacological effects of garlic (*Allium sativum L.*). *Annual Review of Biomedical Sciences*, 10:6-26.
[44] El-katcha, M.I., Soltan, M.A., Sharaf, M.M. and Hasan A. (2016). Growth performance, immune response, blood serum parameters, nutrient digestibility and carcass traits of broiler chicken as affected by dietary supplementation of garlic extract (Allicin). *Alexzandria Journal of Veterinary Science*, 49(2):50-64.
[45] Helen AG (1989). Introductory Nutrition. Times mirror, Mosby College publishing Co.
[46] Ogunwole, O.A., Oso, Y.A., Omotoso, R.R., Majekodunmi, B.C., Ayinde, B.O. and Oikeh, I. (2013). Performance and carcass characteristics and meat physicochemical properties of broiler chickens fed graded levels of supplemental ascorbic acid. *Agriculture and Biology Journal of North America*; 4(4): 485-495. Doi:10.5251/abjna.2013.4.4.485.495.
[47] Dieumou F E, Teguia A, Kuiate J. R, Tamokou J. D, Fonge N. B and Dongmo M. C (2009). Effects of ginger (*Zingiber officinale*) and garlic (*Allium sativum*) essential oils on growth performance and gut microbial population of broiler chickens. *Livestock Research for Rural Development; 21,* , http://www.lrrd.org/lrrd21/8/dieu21131.htm
[48] Samanthi K.A.M., Nayananjalie, W.A.D. Adikari, A.M.J.R and Liyanage R. (2014). Dietary garlic (*Allium sativum L.*) supplementation on performance, meat quality and lipid profile in broilers. *Annual Symposium*. 6.

AUTHOR'S PROFILE

Olayemi Christiana Olagoke
PhD Student, Meat Scientist, Animal Products and Processing Technology Unit, Department of Animal Nutrition and Biotechnology, Ladoke Akintola University of Technology, Ogbomoso, Oyo State, Nigeria.

Akinyinka Olu Akinwumi
Meat Scientist, Animal Products and Processing Technology Unit, Department of Animal Nutrition and Biotechnology Ladoke Akintola University of Technology, Ogbomoso, Oyo State, Nigeria.

Isiaka Adewale Emiola
Professor of Animal Nutritional Toxicology, Department of Animal Nutrition and Biotechnology Ladoke Akintola University of Technology, Ogbomoso, Oyo State, Nigeria.