Evaluation of the effects of feeding selected antioxidant plants supplements on the performance and carcass characteristics of broiler chickens

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Abstract

Consequent upon growing awareness of consumers about the use of antibiotics and other synthetic chemicals which may pose health risks in chicken production, it has become imperative for poultry producers to find natural and less hazardous substitutes to replace these chemicals. Therefore, this study was designed to investigate the influence of garlic (*Allium sativum*), ginger (*Zingiber officinale*) and roselle (*Hibiscus sabdarifa*) supplements at 1% inclusion level in broiler chicken diets on performance and carcass characteristics. A total of 150, one day old Arbor acres broiler chicks were obtained and used for the experiment. Five identical diets were formulated such that diet 1 (Negative control) had no antioxidant supplementation while diets 2, 3, 4, and 5 (positive control) were each supplemented with 1% of dried *Allium sativum* (AS), *Zingiber officinale* (ZO), *Hibiscus sabdarifa* (HS), and 200mg/kg vitamin E. The chicks were randomly divided into fifteen groups of ten birds each in a Completely Randomized Design. Each group was randomly assigned to one of the replicates of the dietary treatments, to have a total of 30 chicks per treatment. Average daily feed intake (ADFI), average daily weight gain (ADWG), and feed conversion ratio (FCR) were measured. Apparent nutrient retention, haematological parameters, blood cholesterol, and carcass characteristics were also determined. The ADWG and FCR were not significantly affected by the supplements. However, the birds fed AS supplemented diet had significantly ($p < 0.05$) higher feed intake, than those fed HS supplemented diet but similar to birds in the negative control. Dry matter retention was not significantly affected in any of the treatments. It was observed that birds fed the AS supplemented diet had significantly higher ($p < 0.05$) crude protein, crude fibre, and ether extract retention than all other treatments. Dressed weight was significantly ($p < 0.05$) higher (76.42%) in birds fed AS supplemented diets. In conclusion, the *Allium sativum*, *Zingiber officinale*, and *Hibiscus sabdarifa* supplements in the chicken diets did not adversely affect performance. However, it was noted that the *Allium sativum* supplemented diets elicited better performance in terms of nutrient retention and dressed weight of carcass.

Keywords: *Allium sativum*, *Zingiber officinale*, *Hibiscus sabdarifa*, apparent nutrient retention, blood cholesterol

Évaluation des effets de l'alimentation de certains suppléments de plantes antioxydantes sur les performances et les caractéristiques de la carcasse des poulets de chair

Résumé

Suite à la sensibilisation croissante des consommateurs à l'utilisation d'antibiotiques et d'autres produits chimiques synthétiques qui peuvent présenter des risques pour la santé dans la production de poulet, il est devenu impératif pour les producteurs de volaille de trouver des substituts naturels et moins dangereux pour remplacer ces produits chimiques. Par conséquent, cette étude a été conçue pour étudier l'influence des suppléments d'ail

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(*Allium sativum*), de gingembre (*Zingiber officinale*) et de roselle (*Hibiscus sabdarifa*) à un niveau d'inclusion de 1% dans les régimes alimentaires pour poulets de chair sur les performances et les caractéristiques de la carcasse. Un total de 150 poussins de chair Arbor acres âgés d'un jour ont été obtenus et utilisés pour l'expérience. Cinq régimes identiques ont été formulés de telle sorte que le régime 1 (témoin négatif) n'avait pas de supplémentation en antioxydants tandis que les régimes 2, 3, 4 et 5 (témoin positif) étaient chacun supplémentés avec 1% d'*Allium sativum* (AS) séché, *Zingiber officinale* (ZO), *Hibiscus sabdarifa* (HS) et 200 mg/kg de vitamine E. Les poussins ont été répartis au hasard en quinze groupes de dix oiseaux chacun dans un plan complètement randomisé. Chaque groupe a été assigné au hasard à l'une des répétitions des traitements diététiques, pour avoir un total de 30 poussins par traitement. La prise alimentaire quotidienne moyenne (PAQM), le gain de poids quotidien moyen (GPQM) et le ratio de conversion alimentaire (RCA) ont été mesurés. La rétention apparente des nutriments, les paramètres hématologiques, le cholestérol sanguin et les caractéristiques de la carcasse ont également été déterminés. Le PAQM et le RCA n'ont pas été significativement affectés par les suppléments. Cependant, les oiseaux nourris avec un régime supplémenté en AS avaient une prise alimentaire significativement ($p < 0,05$) plus élevée que ceux nourris avec un régime supplémenté en HS mais similaire aux oiseaux du contrôle négatif. La rétention de matière sèche n'a été significativement affectée dans aucun des traitements. Il a été observé que les oiseaux nourris avec le régime supplémenté en AS avaient une rétention significativement plus élevée ($p < 0,05$) de protéines brutes, de fibres brutes et d'extraits éthers que tous les autres traitements. Le poids paré était significativement ($p < 0,05$) plus élevé (76,42 %) chez les oiseaux nourris avec des régimes supplémentés en AS. En conclusion, les suppléments d'*Allium sativum*, de *Zingiber officinale* et d'*Hibiscus sabdarifa* dans l'alimentation des poulets n'ont pas affecté négativement les performances. Cependant, il a été noté que les régimes alimentaires complétés par *Allium sativum* induisaient de meilleures performances en termes de rétention des nutriments et de poids habillé de la carcasse.

Mots clés : *Allium sativum*, *Zingiber officinale*, *Hibiscus sabdarifa*, rétention apparente de nutriments, cholestérol sanguin

Introduction

In recent times there has been a paradigm shift by poultry producers in pursuit of improving chicken health. In order to alleviate consumer fears as regards food quality along with reduction of dependence on synthetic medication, poultry producers in recent times intensified efforts in searching for natural feed supplements mainly herbs and spices, which have shown some promising results on broiler performance, carcass and quality parameters of meat (Aletor, 1986, Schleicher *et al.*, 1998, Onibi *et al.*, 2000, Gardzielewska *et al.*, 2003 and Lipinski *et al.*, 2019). A variety of herbs, including but not limited to *Aloe vera*, garlic (*Allium sativum*), ginger (*Zingiber officinale*), onions (*Allium cepa*), roselle (*Hibiscus*

sabdariffa), thyme (*Thymus vulgaris*) have been widely utilized by humans in the diet and for maintenance of good health because of their medicinal values (Freeman and Kodera, 1995). Garlic supplement in broiler chickens has been recognized for their strong stimulating effect on the immune system and its very rich aromatic oils enhance digestion in birds (Gardzielewska *et al.*, 2003). The main active ingredient in garlic is allicin which rapidly decomposes to several volatile organosulphur compounds with bioactivities (Chang and Cheong, 2008). Garlic is used as condiment, medicament, antioxidant, anticoagulant, hypolipidaemic, antihypertensive, anti-ageing, and heavy metal detoxifier (Agarwal, 1996 and Marilyn, 2001). Ginger contains phenolic compounds among other

substances. Phenolic compounds in ginger are made up of the shogaols and gingerols. Sesquiterpenes are the major active ingredients in ginger oils that include zingiberene and zingiberol. Ginger is used both as a spice and herb, it has been reported to have antioxidant, analgesic, sedative, antipyretic, hypocholesterolemic and antibacterial effects against both gram positive and gram negative bacteria. When fed as a dietary supplement to chickens, ginger increased digestion and also improved sensory properties of meat from chickens (Gardzielewska *et al.*, 2003). Roselle (*Hibiscus sabdariffa*) is widely grown in different parts of Nigeria. It has been reported to have a high content of ascorbic acid up to 28,000mg/kg (Akanya *et al.*, 1997) which makes it an excellent contender as a source of natural antioxidant in livestock feed and meat (Onibi and Osho, 2007). The objective of this study was to determine the effect of dietary supplementation with selected antioxidant plants (raw garlic, ginger and roselle) on the performance and carcass characteristics of broiler chickens.

Materials and methods

This study was conducted at the Department of Animal Science, University of Ibadan, Nigeria. Five identical diets (for starter and finisher phases) were formulated such that diet 1 (control) had no supplementation while diets 2, 3, 4, and 5 were each supplemented with 1% of dried *Allium sativum* (garlic), *Zingiber officinale* (ginger), *Hibiscus sabdariffa* (roselle), and 200mg/kg vitamin E, respectively. The experimental starter diets (Table 1) containing minimum of 2954.81Kcal/kg ME and the test ingredients were fed to the chicks for the first four weeks. The experimental finisher diets whose compositions are shown in Table 2 were fed to the birds for the last four weeks of the trial. A total of 150, one day old Arbor acres broiler chicks were obtained from a

commercial hatchery in Ibadan. The experimental chicks were randomly divided into fifteen groups of ten birds each in a completely randomized design. Each group was randomly assigned to one of the replicates of the dietary treatments, making a total of 30 chicks per treatment. The birds were supplied with feed and water *ad libitum* throughout the experimental period. Carcass analysis was determined at the end of the feeding trial. Three birds per treatment, one per replicate were randomly selected for this purpose and had their feed withdrawn overnight prior to slaughter. The selected birds were weighed and slaughtered, their carcass characteristics were subsequently determined. The body parts and organs were expressed relative to the liveweight of the birds. Proximate analysis for crude protein, ether extract, crude fibre, and ash was carried out according to the procedures described by AOAC (1995).

Statistical analysis

The data collected was subjected to statistical analysis using analysis of variance of SAS (1999) package.

Results and discussion

Performance

As shown in Table 3, neither the average daily weight gain or feed conversion ratio of the experimental birds were significantly affected by garlic, ginger, and roselle supplementation, compared to the control diet and the vitamin E supplemented positive control diets. This could probably be due to the fact that the supplements (garlic, ginger, and roselle) used in this study are all naturally sourced edible products and the level at which they were included in the diets were well tolerated by the birds. These observations were similar to the discoveries of Onibi *et al.* (2009) and Choi *et al.* (2010) that supplementation of broiler chicken diets with garlic and other natural products had no negative effect on their performance.

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Table 1: Composition of starter diets

Ingredients (%)	1 (Control)	2 (+1% AS)	3 (+1% ZO)	4 (+1% HS)	5 (+0.02% Vit. E)
Maize	56.90	56.49	56.49	56.49	56.88
SBM	14.60	14.60	14.60	14.60	14.60
GNC	19.00	18.50	18.50	18.50	19.00
Wheat Bran	4.00	4.00	4.00	4.00	4.00
Fishmeal (72%)	2.00	2.00	2.00	2.00	2.00
DCP	2.40	2.40	2.40	2.40	2.40
Salt (NaCl)	0.30	0.30	0.30	0.30	0.30
Vitamin-mineral. Premix	0.30	0.30	0.30	0.30	0.30
Methionine	0.20	0.20	0.20	0.20	0.20
Lysine	0.30	0.30	0.30	0.30	0.30
Garlic	-	1.00	-	-	-
Ginger	-	-	1.00	-	-
Roselle	-	-	-	1.00	-
Vit.E supplement	-	-	-	-	0.02
Total	100	100	100	100	100

**Calculated
Composition**

ME(kcal/kg)	2985.18	2954.81	2954.81	2954.81	2985.18
Crude protein (%)	22.50	22.14	22.14	22.14	22.50
Calorie: Protein	132.67	133.50	133.50	133.50	132.67
Lysine (%)	1.24	1.16	1.16	1.16	1.24
Methionine (%)	0.42	0.41	0.41	0.41	0.42
Crude fibre (%)	3.29	3.22	3.22	3.22	3.29
Calcium (%)	1.02	1.01	1.01	1.01	1.02
Phosphorus (%)	0.69	0.69	0.69	0.69	0.69

**Analysed
Composition (%)**

Dry matter	90.10	89.04	88.72	89.57	90.04
Crude Protein	22.56	22.18	22.21	22.10	22.57
Ash	6.13	5.97	6.46	7.01	6.11
Crude Fibre	7.04	6.83	7.14	6.92	7.05
Ether Extract	9.21	8.46	7.88	8.26	9.22
NFE	55.06	56.56	56.31	55.71	55.05

Vitamin Premix supplies the following per Kg of diet: Vit . A 7812.50IU, Vit .D3 1562.50IU, Vit K 1.25mg, Vit E 25mg, Vit . B1 1.88mg, Vit B2 3.44mg, Niacin 34.38mg, Calcium pantothenate 7.19mg, Vit B6 3.13mg, Vit B12 0.016mg, Choline chloride 312.50mg, Folic acid 0.62mg, Biotin 0.05mg, Mn 75mg, Fe 62.5mg, Zn 50mg, Cu 5.31mg, Iodine 0.94mg, Cobalt 0.19mg, Se 0.075mg DCP=Dicalcium Phosphate, SBM=sSoybean Meal, GNC=Groundnut Cake

Table 2: Composition of finisher diets

Ingredients (%)	1 (Control)	2 (+1% AS)	3 (+1% ZO)	4 (+1% HS)	5 (+0.02% Vit. E)
Maize	58.00	58.00	58.00	58.00	58.00
GNC	13.50	13.50	13.50	13.50	13.50
Wheat Bran	7.15	6.15	6.15	6.15	7.13
SBM	15.00	15.00	15.00	15.00	15.00
Fishmeal (72%)	1.50	1.50	1.50	1.50	1.50
DCP	3.00	3.00	3.00	3.00	3.00
Oyster shell	1.00	1.00	1.00	1.00	1.00
Vit. Premix	0.25	0.25	0.25	0.25	0.25
Methionine	0.20	0.20	0.20	0.20	0.20
Lysine	0.20	0.20	0.20	0.20	0.20
Salt (NaCl)	0.20	0.20	0.20	0.20	0.20
Garlic	-	1.00	-	-	-
Ginger	-	-	1.00	-	-
Roselle	-	-	-	1.00	-
Vit.E supplement	-	-	-	-	0.02
Total	100	100	100	100	100
Calculated					
Composition					
ME(kcal/kg)	2929.73	2910.63	2910.63	2910.63	2929.73
Crude protein(%)	20.50	20.30	20.30	20.30	20.50
Calorie: Protein	142.87	143.38	143.38	143.38	142.87
Lysine (%)	1.02	1.01	1.01	1.01	1.02
Methionine (%)	0.40	0.40	0.40	0.40	0.40
Crude Fibre (%)	3.09	3.02	3.02	3.02	3.09
Calcium (%)	1.53	1.51	1.51	1.51	1.53
Phosphorus (%)	0.84	0.82	0.82	0.82	0.82
Analysed					
Composition (%)					
Dry matter	89.38	90.01	91.52	91.07	90.83
Crude Protein	21.03	21.05	22.05	21.80	21.24
Ash	6.02	4.01	6.88	5.10	6.02
Crude Fibre	5.87	7.13	6.04	5.26	5.88
Ether Extract	8.00	7.21	9.11	8.04	8.00
NFE	59.08	60.6	55.92	59.80	58.86

Vitamin Premix supplies the following per Kg of diet: Vit . A 7812.50IU, Vit .D3 1562.50IU, Vit K 1.25mg, Vit E 25mg, Vit . B1 1.88mg, Vit B2 3.44mg, Niacin 34.38mg, Calcium pantothenate 7.19mg, Vit B6 3.13mg, Vit B12 0.016mg, Choline chloride 312.50mg, Folic acid 0.62mg, Biotin 0.05mg, Mn 75mg, Fe 62.5mg, Zn 50mg, Cu 5.31mg Iodine 0.94mg, Cobalt 0.19mg, Se 0.075mg, DCP=Dicalcium Phosphate. SBM=sSoybean Meal, GNC=Groundnut Cake

Table 3: Performance characteristics of broilers fed diets supplemented with some selected antioxidant rich plants

Parameters	1 (Control)	2 (+1% AS)	3 (+1% ZO)	4 (+1% HS)	5 (+0.02%Vit. E)	SEM
Average Daily Feed Intake (g)	166.24 ^a	165.56 ^a	152.26 ^b	154.88 ^b	158.59 ^b	1.98
Average daily Weight Gain (g)	55.23	57.01	53.90	55.07	52.62	0.76
FCR	3.01	2.91	2.84	2.81	2.86	0.04

Means along the same row with the same superscripts are not significantly different (P<0.05)

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Average daily feed intake was significantly higher for both birds on control diet and garlic supplemented diet which resulted in marginally higher weight gain by birds compared to other treatments; this suggested that the strong odour of garlic did not negatively influence the feed intake of the experimental birds. This observation is also in agreement with the observation of Onibi *et al.* (2009) that supplementation of broiler chicken diets with dried garlic did not negatively affect feed intake due to its salutary effect on the digestive processes in the gut.

Apparent nutrient retention

As shown in Table 4, the supplementation of broiler diets with garlic, ginger, and roselle did not have any significant effect

on the dry matter retention. However, birds on garlic supplemented diet had significantly higher crude protein, crude fibre, and ether extract retention when compared to the other diets. This observation is in agreement with earlier reports by Demir *et al.* (2003) and Lewis *et al.* (2003) that supplementation of broiler diets with low concentration of garlic products led to better digestion and performance by broilers. This effect could also be attributable to the medicinal nature of garlic as it has been shown that garlic constituents, mainly allicin interact with the gut endocrine system, and are able to stimulate selective population of intestinal cells and cause enlargement of intestinal villi, with a resulting increase of the absorptive capacity (Esmail, 2012).

Table 4: Apparent nutrient retention of broilers fed diets supplemented with some selected antioxidant rich plants

Parameter (%)	1 (Control)	2 (+1% AS)	3 (+1% ZO)	4 (+1% HS)	5 (+0.02% Vit. E)	SEM
Dry Matter	75.31	77.15	76.02	74.53	77.02	1.37
Crude protein	73.99 ^b	78.10 ^a	75.80 ^b	71.04 ^c	76.65 ^b	3.11
Crude fibre	51.52 ^c	58.58 ^a	50.51 ^c	54.34 ^b	57.32 ^a	2.12
Ether Extract	70.39 ^c	76.60 ^a	70.15 ^c	72.35 ^b	78.44 ^a	3.36
Ash	58.57 ^b	55.36 ^c	57.34 ^b	60.27 ^a	59.47 ^a	1.69
NFE	73.28 ^c	75.41 ^b	76.18 ^b	80.95 ^a	79.68 ^a	2.51

^{a,b} Means on the same row with similar superscripts are not significantly different (P<0.05)

Overall, birds on diets supplemented with garlic, ginger and roselle generally had better rates of nutrient retention when compared to birds fed the control diet and this in agreement with observation made by Gadzielewska *et al.* (2003) that supplementation of broiler chicken diets with natural products like herbs improved the performance of birds.

Haematology and blood cholesterol

The haematological parameters and blood cholesterol of the experimental birds are shown in Table 5. The purpose of investigating blood composition in experimental animals is to have a way of distinguishing normal states from a state of

stress in animals, such stress factors can be inadequate nutrition, poor management, environmental and or physical stress (Adeyemo and Longe, 2007). The supplementation of diets with garlic, ginger and roselle did not have any significant influence on the white blood cells, monocytes, lymphocytes and eosinophils. Significant differences with similar trends were observed for the packed cell volume and haemoglobin values, than birds on negative control, with the garlic supplemented diets having the highest values. All the values recorded however are within the normal ranges reported by Mitruka and Rawnsley (1977). Generally,

the results indicate good health status of the birds; this suggests that garlic, ginger, and roselle supplementation of broiler diets at

levels used in this study are not detrimental to the normal haematological status of broiler chickens.

Table 5: Haematological parameters and blood cholesterol of broiler chickens fed diets supplemented with some selected antioxidant rich plants

Parameters	1 (Control)	2 AS)	(+1% 3 ZO)	(+1% 4 HS)	(+1% 5 (+0.02% Vit. E)	Reference values *	SEM
PCV (%)	39.83 ^a	41.83 ^a	31.50 ^b	31.00 ^b	30.17 ^b	24.9-40.7	1.25
Haemoglobin (%)	13.52 ^a	13.08 ^a	10.47 ^b	10.30 ^b	10.27 ^b	7.40-12.2	0.11
MCV(fl)	123.31 ^a	118.16 ^a	94.88 ^b	122.04 ^a	102.62 ^b	102-129	1.14
MCH(pg)	41.86 ^a	36.95 ^a	31.53 ^b	40.55 ^a	34.93 ^b	25.9-33.9	2.03
MCHC (%)	33.94	31.27	33.24	33.23	34.04	31.9-40.7	1.93
WBC (10 ³ /mm ³)	20.92	23.94	22.81	21.90	21.63	9.2-28.6	0.05
RBC (x10 ⁶ /mm ³)	3.23 ^{ab}	3.54 ^a	3.32 ^a	2.54 ^b	2.94 ^{ab}	1.58-3.82	0.03
Lymphocytes (%)	74.33	69.83	62.33	74.17	61.50	47.2-81.2	2.57
Monocytes (%)	2.00	1.83	1.67	2.00	2.50	0.06-0.78	0.48
Eosinophils (%)	5.33	7.67	6.83	4.50	7.67	6.25-8.25	0.31
Cholesterol (mg/dl)	163.60 ^a	98.22 ^c	110.94 ^b	128.75 ^b	136.26 ^b	52.0-148.0	5.36

*Mitruka and Rawnsley (1977)

^{a b} Means on the same row with similar superscripts are not significantly different (P<0.05)

PCV- Packed Cell Volume

MCHC=Mean corpuscular haemoglobin concentration

WBC- White Blood Cells

MCV=Mean corpuscular volume

RBC- Red Blood Cells

MCH=Mean Corpuscular haemoglobin

SEM-Standard Error of the Mean

Blood cholesterol was significantly different among the various treatments, and birds on garlic supplemented diet had the significantly lowest cholesterol value followed by birds on the ginger, roselle supplemented diets and the positive control. This observation is in agreement with reports of several earlier studies by Agarwal, (1996); Marilyn, (2001) and Gadzielewska *et al.* (2003); that reported the cholesterol lowering effect of garlic when fed as dietary supplement to domestic chickens. Though the mechanism through which garlic leads to cholesterol reduction is yet to be fully understood. Yeh (2005) deduced that s-allyl-cysteine, s-ethyl-cysteine and s-propyl-cysteine are the predominant active ingredients that inhibit the synthesis of cholesterol in the liver by depressing the activity of the enzyme HMG-CoA reductase which is crucial to

cholesterol synthesis. Ahmed and Sharma (1997) posit that some degree of cholesterol lowering effect elicited by ginger may be due to enhanced bile secretion while Chang and Cheong (2008) believe that the key active ingredient, allicin rapidly decomposes to several volatile organosulphur compounds with bioactivities.

Carcass characteristics

The carcass characteristics of the experimental birds fed selected natural antioxidant sources are presented in Table 5. Liveweight ranged from 2.96Kg for birds in Treatment 1 to 2.55Kg for birds in treatment 4. The liveweight of birds in treatment 1 showed no significant difference from the liveweight of birds in treatment 3, while liveweight values for birds on treatments 2, 4, and 5 were not

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significantly different from one another. The bled weight, plucked weight and eviscerated weight of the birds on treatments 1 to 5 did not significantly differ from one another and this suggests that

garlic, ginger, and roselle supplementation in broiler diets elicited similar weight patterns as the control diet and can be successfully blended with broiler diets at the levels tested in this experiment.

Table 6 : Carcass characteristics and primal cuts of broilers fed diets supplemented with some selected antioxidant rich plants (as percentage of live weight)

Body Parts/Organs	1 (Control)	2 (+1% AS)	3 (+1% ZO)	4 (+1% HS)	5 (+0.02% Vit. E)	SEM
Liveweight (kg)	2.96 ^a	2.65 ^b	2.77 ^{ab}	2.55 ^b	2.69 ^b	0.02
Bled weight (%)	97.40	97.36	95.81	96.85	95.90	1.58
Plucked weight (%)	92.22	91.96	91.84	92.81	92.07	0.94
Eviscerated weight (%)	81.45	78.88	80.30	82.20	80.80	2.15
Dressed weight (%)	76.10 ^a	76.42 ^a	68.20 ^b	72.46 ^{ab}	69.76 ^b	4.69
Primal Cuts						
Thighs (%)	10.66	9.91	10.36	10.95	10.47	0.87
Drumsticks (%)	10.42	9.81	11.18	11.15	10.77	0.52
Breast (%)	21.46 ^{ab}	22.05 ^{ab}	20.68 ^b	22.95 ^{ab}	23.73 ^a	0.83
Back (%)	16.00	17.38	16.60	15.14	14.99	0.78
Neck (%)	5.10	4.98	5.03	5.20	4.98	0.02
Abdominal fat (%)	1.68 ^c	2.57 ^{ab}	1.94 ^{abc}	2.68 ^a	1.79 ^{bc}	0.01
Wings (%)	7.68 ^{bc}	7.59 ^c	8.15 ^{ab}	8.33 ^a	8.37 ^a	0.42
Legs (%)	4.02	3.65	4.46	3.55	3.54	0.03
Head (%)	2.63	2.12	2.29	2.19	2.26	0.01
Organ Weights						
GIT (%)	4.77 ^{ab}	5.78 ^a	5.24 ^{ab}	4.72 ^{ab}	4.68 ^b	0.02
Liver (%)	1.64	1.68	2.00	1.93	1.61	0.02
Heart (%)	0.39	0.35	0.40	0.35	0.37	0.01
Gizzard (%)	2.32 ^{ab}	2.24 ^{ab}	2.71 ^a	2.20 ^{ab}	1.96 ^b	0.04

Means along the same row with the same superscripts are not significantly different ($P < 0.05$)

Thighs, drumsticks, back, neck, legs and head did not show any significant difference across the various treatments. However, %breast muscle values ranged from 23.73% in treatments 5 to 20.68% in treatment 3, though there were no significant differences in breast values among the treatments this implies that ginger supplementation slightly depresses density of broiler breast muscle. This finding is at variance with the observations of Gardzilewska *et al.* (2003) who reported no significant difference in breast muscle weight between broilers fed ginger supplements and other plant- based supplements. Mazur-Kusnerek *et al.* (2019) observed improved breast muscle weights in broilers fed diets with plant-polyphenol supplemented diets. The differences in findings could be due to climate,

types/cultivars or parts of plant used, and levels at which they were used in the different studies or the breed of chickens used for the individual studies. Significant differences were observed for abdominal fat with birds on treatment 1 having significantly lower abdominal fat. This differs from observations by Lydia (2001) and Onibi *et al.* (2009) where birds fed garlic supplemented diets (5,000mg/Kg) recorded lower abdominal fat weights. This observation may be due to processing methods, cultivar and other test ingredients used in this study. Liver and heart weights did not show any significant difference among the five treatments and this implies that the garlic, ginger, and roselle supplements did not have any toxic effects on these vital organs and their development.

Only the birds in Treatment 5 had significantly lower GIT and gizzard weights, this shows that the garlic, ginger, and roselle supplements did not negatively impinge on the GIT and gizzard development of the birds fed with them especially considering the fact that the fibre levels of the concerned diets are within or did not deviate much from the recommended 5% of diet (NRC,1994), these results are also in agreement with observations by Svihus *et al.* (2004) and Ademola *et al.* (2004) who fed broiler chickens on garlic and ginger supplemented diets.

Conclusion

The study showed that supplementation of broiler chicken diets with garlic, ginger, roselle at 1% inclusion rate for their medicinal and anti-oxidative properties; resulted in similar feed intake, weight gain and haematological indices as the control diets with marginally improved effects on the carcass characteristics. While the garlic supplemented diet elicited significantly lower blood cholesterol than other treatments However, the magnitude of the deposition of the active compounds in garlic, ginger and roselle in meat are suggested for examination in future studies.

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Received: 11th September, 2021

Accepted: 10th December, 2021