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Meat Quality of Noiler Chicken as Influenced by Dietary Natural Antioxidants Supplementations

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Some food spices and herbs with antioxidant properties have been identified as phyto-additives, of which roselle (*Hibiscus sabdariffa*), black pepper (*Piper nigrum L*), and green tea (*Camellia sinesis*) are important. This study aimed to assess the effect of natural antioxidants and its inclusion levels on performance and meat quality of Noiler chickens. A total of 270 one-day-old noiler chickens were distributed into nine groups, with 3 replicates of 10 birds per replicate. They were fed with basal diet (control 0 g/kg), basal diet + roselle, black pepper, green tea and combine (roselle + black pepper + green tea) at 0.5 g/kg and 1.0g /kg respectively. At the end of twelve (12) weeks, nine birds per treatments were sacrificed, scalded manually and dissected; blood samples were collected for heamatology and serum parameters. Data were also collected on carcass characteristics, primal cuts, internal organ, physical properties, lipid profile, lipid peroxidation and organoleptic properties. Data generated were subjected to Analysis of variance using the General Linear Model for factorial within a completely randomized design. The natural antioxidants significantly ($p<0.05$) influence the carcass characteristics, primal cut and internal organs of the birds. Birds fed green tea had significantly ($P<0.05$) low cooking loss when compared with treatment groups. There was no significance difference ($P>0.05$) in WBC, RBC, Hb and Haematocrit of the experimental birds. The serum parameters were also not significantly influenced ($P<0.05$). The CHO of the birds fed control, roselle and black pepper were significantly ($p<0.05$)

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higher compared to birds in other treatments. The birds fed diets with green tea and roselle had significantly (P<0.05) low HDL and birds fed black pepper had reduced level of LDL and MDA when compared to other treatments. Chicken meat from roselle and combine fed chickens has the most accepted flavour with inclusion level at 1.0g/kg compare to other dietary treatment. Meat from all the dietary treatment was generally accepted by the taste panellist. It therefore, means that natural antioxidants most importantly black pepper inclusion in noiler chicken's feed improved the carcass characteristics and had no deleterious effect and should be included in their feed at 1.0g/kg.

Keywords: Meat quality; performance; antioxidants; roselle; green tea; black pepper; noiler.

1. INTRODUCTION

The poultry industry in Nigeria has undergone a significant transformation since the early fifties, from a backyard, peasant and primitive household-oriented husbandry of in descript breeds of semi-wild chickens, to the cash-oriented, modern and large scale poultry which dot our country-side and urban centres today. This transformation and popularity of poultry birds in Nigeria is noteworthy and can be attributed to the numerous benefits associated with its production and other value chain [1]. Heise et al. [2] argue that poultry birds are good sources of protein either used as eggs or meat, the production is relatively cost effective, thus, making it possible for low income farmers to start up the business. More so, the return on investment is relatively high compared to other livestock production with high level of acceptability of the meat across diverse ethnic backgrounds and religious beliefs [1,3].

Poultry meat is very sensitive to oxidative deterioration because of its higher content of polyunsaturated fatty acids. To minimize oxidative deterioration, effective antioxidants are added to poultry diet. There is, therefore, a growing interest in the identification of natural antioxidants [4]. Interest in natural antioxidants in the poultry industry in recent years has been increasing. This fact is due to that synthetic antioxidants (butylated hydroxyanisole, butylated hydroxytoluene), despite the effectiveness of their use, can provoke the occurrence of various chronic diseases among both consumers, animals and birds, which significantly limits their use [5]. A good alternative to synthetic antioxidants are natural ones which are safer, cheaper, they are also able to prevent oxidative reactions in products during storage and do not cause metabolic diseases in animals and birds [6].

Roselle (*Hibiscus sabdariffa*) is a leaf used to make a drink known as zobo, The seed is considered an excellent feed additive for chicken because of the presence of certain vitamins especially vitamin C which is known for its antioxidant property hence stimulating the immune system. Vitamin C is soluble in water and is naturally present in many fruits and vegetables. Most carotenoids are also found in fruits and vegetables [7] β-carotene, α-carotene, lycopene and lutein are the main carotenoids with antioxidant activity [8]. In addition to their antioxidant capacities, they have the possibility to be used as food colorants [9]. Green tea (*Camellia sinensis*) is one of the examples of antioxidants, due to its high content such as, flavanols, catechins, phenolic acids [10-12]. In addition, minor constituents such as caffeine, theobromine, theophylline, phenolic acids and gallic are also present. Biswas and Wakita [13], demonstrated that cholesterol and fat in liver and serum cholesterol were significantly reduced by feeding a green tea supplemented diet. It has also been shown that green tea has strong antioxidation properties [14]. Black pepper (*Piper nigrum* L.) is known as spices due to its pungent quality [15]. Black pepper is a flowering vine in the family Piperaceae, genus piper and species piper nigrum. Black pepper improves digestibility [16]. It was found to be rich in glutathione peroxidase and glucose-6-phosphate dehydrogenase and has been shown that piperine can dramatically increase absorption of selenium, vitamin B complex, beta carotene and curcumin as well as other nutrients [17]. Piperine enhances the thermogenesis of lipid and accelerates [18], energy metabolism in the body and also increases the serotonin and beta-endorphin production in the brain.

Noiler chicken is a dual purpose breed of chicken developed by Amo Farm Sieberer Hatchery Limited for small holders to address the challenges of food insecurity and financial dependency among rural populace, especially women who could be of help in adding to the household's income generation [19]. Noiler is

bred to survive on low quality feedstuffs to provide good quality meat and egg [20].

This study is therefore set to access and evaluate the effect of Roselle, Green tea and Black pepper and their combination as natural antioxidants on performance and meat quality of Noiler chickens.

2. MATERIALS AND METHODS

2.1 Experimental Site

The experiment was carried out at the Poultry unit of the Teaching and Research Farm, Ladoke Akintola University of Technology, Ogbomosho, Oyo – State, Nigeria.

2.2 Procurement of Test Ingredients

Dried Roselle (*Hibiscus sabdariffa*), Green tea (*Camellia sinensis*) and Black pepper (*Piper nigrum* L.) were purchased from a local market (Oja jagun) in Ogbomoso, Oyo state. They were grounded into powdered form and stored for usage.

2.3 Experimental Animal and Management

Two hundred and seventy (270) unsexed day-old noiler chicks was purchased from Amo farm Sieberer Hatchery Limited, Awe, Oyo state and used for the experiment. The birds were randomly allotted to nine (9) treatments of 3 replicates each in a Completely Randomized Design. On arrival, birds were fed diets and water mixed with vitamins and glucose to reduce transportation stress. The birds were subjected to normal brooding procedures routine medication and vaccination programs were strictly followed as required for the birds. The period of experiment lasted for twelve (12) weeks.

2.4 Experimental Diets

The test ingredient was included as additives at 0g, 0.5g and 1.0g respectively to the Basal diet (Chart 1). The treatments were captured as follow; Control (Basal diet + 0g antioxidants), Dried Roselle (Basal diet + 0.5g and 1.0g), Green tea (Basal diet + 0.5g and 1.0g), Black pepper (Basal diet + 0.5g and 1.0g) and the Combine i.e Dried roselle + Grean tea + Black pepper (Basal diet + 0.5g and 1.0g) to make a total of nine treatments.

2.5 Data Collection

Data were collected for the following parameters;

2.6 Carcass Characteristics

Nine birds per treatment with average weights were purposively selected, slaughtered, scalded manually and dissected [21,22]. The live, bled, defeathered, eviscerated and carcass 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.

2.7 Blood Profile

On the 84th 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. Haematological parameters were determined as described by Guyton and Hall (2006). Drops of whole blood were used to fill some heparinised microhematocrit capillary tubes to determine packed cell volume (PCV), and hemoglobin (Hb). Whole blood was also used to make three air dried blood smears. The smears were stained with Wright's stain and examined for red blood cell (RBC), white blood cell (WBC), differential WBCs (lymphocytes, heterophil, monocytes) and platelet estimate, while Mean corpuscular haemoglobin (MCH), Mean corpuscular haemoglobin concentration (MCHC) and Mean corpuscular volume (MCV) were calculated. Blood samples were also collected for biochemical analysis, centrifuged at 3000 rpm for ten minutes to isolate the serum. Total protein, albumin, globulin, creatinine, serum aspartate aminotransferase (AST), serum alanine aminotransferase (ALT) and blood urea nitrogen were determined by use of automated analysers as described by Meyer and Harvey (1998).

2.8 Meat Quality

Cooking loss: Meat portion of noiler chicken carcass were cut and cook in water bath for 20 minutes. The difference in weight before and after cooking was observed according to the procedure of King et al. [23].

Chart 1. Feed ingredients contained in the experimental basal diets

Ingredients	Starter (%) 0-4weeks	Finisher (%) 5-12 weeks
Maize	53	45
Soya bean meal	34	23
Wheat offal		3.5
Corn bran	05	11.02
Fish meal	2.5	2.5
Groundnut cake	02	05
Palm kernel cake		4.5
Limestone	1.0	1.5
Salt	0.25	0.25
Bone meal	1.5	3
Lysine	0.25	0.25
Methionine	0.25	0.18
Premix	0.25	0.25
Total	**100**	**100**
Calculated analysis		
Metabolizable energy (kcal/kg)	2987.32	2813.13
Crude fibre	4.00	4.85
Crude protein (%)	22.87	20.94
Crude fat (%)	3.68	3.72
Lysine (%)	1.48	1.15
Methionine (%)	0.60	0.50
Calcium (%)	1.04	1.66
Phosphorus (%)	0.61	0.83

Cold shortening: This was determined by measuring the length of the meat before chilling and then length of the meat after chilling [23]. The percentage change in length of meat is cold shortening.

Thermal loss: Meat portion of the noiler chicken was cut into length of 4cm each; the meat was subjected to cooking less than 80 degree Celsius temperature in a water bath for 15minutes. The change in length before and after cooking of the parts, was observed and recorded appropriately. According to the procedure of King et al. [23].

Drip loss: Meat portion of noiler chicken was cut and freeze for a period of 24 hours, the weight before and after was observed according to the procedure of King et al. [23].

Water holding capacity: Meat was cut from the breast of the noiler chicken, the meat was put in between two filter paper and was pressed with the use of table vice, will be put in the oven to dry for 10minutes. After which the area of water, area of meat and the weight of the dried meat was taken [22].

pH level: pH was observed using a pH meter, this was carried out by cutting meat sample and pound it in a mortal with 45ml of distil water added, after the pounding has achieve a homogenous state, then pH meter was used to take the pH of each samples. According to the procedure of A.O.A.C [24].

Chemical properties: Parameters that were taken on the chemical properties are Proximate composition (Moisture contents, Dry matter, Crude protein, Ash, Ether Extract), Lipid peroxidation, Lipid profile (total cholesterol, triglyceride, high density lipoprotein cholesterol (HDL), low density lipoprotein cholesterol (LDL)) and fatty acid profile. Samples of the experimental diets were analyzed for proximate composition by the methods of AOAC. [24].

Organoleptic properties: It was conducted using a 10 member trained panelists according to the procedures of AMSA (1995) and Akinwumi and Odunsi [22]. Meat preparation was done using a wet cooking method. The samples were wrapped in impervious polythene pouches which could not be destroyed by cooking process. In the process, the meat samples were cooked in boiling water for 20 minutes using water bath with no spices added to the meat. The meat was then served to 10 member taste panels drawn from students in the Faculty of Agricultural science, Ladoke Akintola University of

Technology, Ogbomoso. The trained panellists evaluated the samples for colour, flavour, juiciness, tenderness and general acceptability. The assessment was based on a 9 point hedonic scale. The score was arranged in a descending order, the maximum score 9 was given to extremely like condition while the lowest score 1 was for the poorest condition.

2.9 Statistical Analysis

Data generated were subjected to Analysis of variance using the General Linear Model for factorial (2*5 factorial arrangements) within a completely randomized design (SAS). Means were separated by Duncan's range option of the same statistical software.

3. RESULTS AND DISCUSSION

3.1 Results

Effect of natural antioxidants and inclusion levels on carcass characteristics of Noiler chickens: Effect of natural antioxidants and inclusion level on carcass characteristic of noiler chickens is presented in Table 1. The result revealed that there was significant difference (P<0.05) in carcass characteristics parameters except for the live weight. The result of the bled weight of chicken fed on black pepper was significantly (P<0.05) highest across the treatment groups. The bird fed on roselle and black pepper had highest (P<0.05) defeathered weight. The result of the eviscerated weight of the birds fed with roselle was also significantly highest (P<0.05) across the treatment groups. The natural antioxidants and its combination improved (P<0.05) the birds dressing weight except for green tea compare to the control.

The natural antioxidants at 1.0g/kg of inclusion level greatly influenced (P<0.05) the carcass characteristic above the control. The chicken fed with roselle, black pepper and green tea at 1.0g/kg inclusion level improved (P< 0.05) the carcass characteristics better than their inclusion at 0.5g/kg and the control. Significant (P<0.05) differences was however noted in all the carcass characteristics parameters due to the interaction of natural antioxidants and inclusion levels.

Effect of natural antioxidants and inclusion levels on primal cut of Noiler chickens: Effect of natural antioxidants and inclusion level on primal cut of noiler chickens is as presented in Table 2. The result showed significance (P<0.05) differences in all the primal cuts except the shank. The breast of the birds fed on roselle (16.71%) was significantly highest with the lowest in the combine (14.89%). The thigh has a highest significant (P<0.05) weight in the birds fed black pepper (11.66%) with the lowest in the control (10.26%). The result also shows that black pepper fed birds shows the highest (P<0.05) significant effect on the drumstick, back, wing, head and neck. The inclusion of natural antioxidants at 1.0g/kg significantly (P<0.05) improved the primal cut above 0.5g/kg, except for the drum stick, back and head. Interaction due to natural antioxidants and inclusion levels showed significant (P<0.05) differences in all the primal cut parameters examined.

Effect of natural antioxidants and inclusion levels on internal organ of Noiler chickens: Table 3 shows the effect of natural antioxidant and inclusion levels internal organ of noiler chickens. The result shows that the natural antioxidant significantly (P<0.05) influenced the internal organ parameters except the lungs and pancreas. The whole gizzard and empty gizzard of the birds fed on green tea shows the highest (P<0.05) significant difference in the entire dietary treatment group. The liver of the birds fed with black pepper and it combination with the other two antioxidants has the highest (P<0.05) value. The kidney weight shows statistical similarity (P>0.05) across the treatment group except green tea. The combined antioxidants have the highest significant (P<0.05) effect on the spleen and abdominal fat and also the birds feed with black pepper has the highest (P<0.05) effect on the heart. The natural antioxidants have no significant (P>0.05) effect at the two (0.5g/kg and 1.0g/kg) inclusion levels. The interactions due to natural antioxidants and inclusion levels were found significant (P<0.05) for all the internal organs parameters examined.

Table 1. Effect of natural antioxidants and inclusion levels on carcass characteristics of Noiler chickens

Parameters	Live Weight (kg)	Bled Weight (%)	Defeathered Weight (%)	Eviscerated Weight (%)	%Dressing Weight
Control	2.18	92.87^{bc}	86.73^{b}	70.49^{d}	63.11^{a}
Roselle	2.15	91.65^{c}	86.01^{c}	74.23^{a}	65.85^{a}
Black Pepper	2.10	96.68^{a}	91.84^{a}	73.53^{b}	67.34^{a}
Green Tea	2.13	93.07^{bc}	87.58^{b}	71.73^{cd}	53.06^{b}
Combine	2.13	94.14^{b}	88.47^{b}	72.34^{bc}	63.18^{a}
SEM	55.03	0.61	0.80	0.49	2.01
P-value	NS	*	*	*	*
Inclusion level					
0.5g/kg of feed	2.05^{b}	92.57^{b}	86.77^{b}	71.39^{b}	58.99^{b}
1.0g/kg of feed	2.24^{a}	95.27^{a}	92.67^{a}	74.30^{a}	66.75^{a}
SEM	38.91	0.43	0.57	0.35	1.42
P-value	*	*	*	*	*
Interaction					
Natural antioxidant vs Inclusion level					
P-value	*	*	*	*	*

^{abc} *– Means along the same column with different superscripts differs according to the level of significance within each main effect (P<0.05). SEM - Standard Error of Mean, NS: Non Significant; *P<0.05*

Table 2. Effect of natural antioxidants and inclusion levels on primal cut of noiler chickens

	Breast (%)	Thigh (%)	Drumstick (%)	Back (%)	Wing (%)	Head (%)	Neck (%)	Shank (%)
Control	15.18^{bc}	10.26^{c}	10.58^{a}	15.67^{a}	8.37^{c}	3.50^{a}	5.61^{b}	4.26
Roselle	16.71^{a}	11.09^{b}	10.35^{ab}	12.08^{b}	8.66^{b}	3.28^{ab}	5.20^{c}	4.15
Black Pepper	15.91^{ab}	11.66^{a}	10.55^{a}	14.27^{a}	9.60^{a}	3.45^{a}	6.30^{a}	4.15
Green Tea	15.21^{bc}	10.61^{bc}	9.35^{c}	14.28^{a}	8.60^{bc}	3.05^{b}	5.81^{b}	4.43
Combine	14.89^{c}	10.82^{ab}	9.95^{b}	14.42^{a}	8.41^{bc}	3.60^{a}	5.85^{b}	4.35
SEM	0.27	0.14	0.17	0.44	0.89	0.09	0.13	0.15
P-value	*	*	*	*	*	*	*	NS
Inclusion level								
0.5g/kg of feed	15.07^{b}	10.49^{b}	10.25^{a}	14.15^{a}	8.57^{b}	3.41^{a}	5.76^{b}	4.16^{b}
1.0g/kg of feed	16.31^{a}	11.54^{a}	9.93^{b}	13.76^{b}	9.01^{a}	3.30^{b}	5.78^{a}	4.40^{a}
SEM	0.19	0.10	0.12	0.31	0.06	0.07	0.09	0.11
P-value	*	*	*	*	*	*	*	*
Interaction								
Natural antioxidant vs inclusion level								
P-value	*	*	*	*	*	*	*	*

^{abc} *– Means along the same column with different superscripts differs according to the level of significance within each main effect (P<0.05). SEM - Standard Error of Mean, NS: Non Significant; *P<0.05*

Table 3. Effect of natural antioxidants and inclusion levels on internal organ of Noiler chicken

	W.G(%)	E.G (%)	Liver (%)	Kidney (%)	Lung (%)	Spleen (%)	Pancreas (%)	Heart (%)	Abdominal fat (%)
Control	3.96^{b}	2.17^{c}	1.62^{bc}	0.48^{a}	0.49	0.15^{ab}	0.23	0.51^{b}	0.45^{b}
Roselle	3.95^{b}	2.62^{b}	1.57^{c}	0.48^{a}	0.57	0.15^{ab}	0.23	0.45^{c}	0.45^{b}
Black Pepper	3.78^{b}	2.53^{b}	1.84	0.47^{a}	0.54	0.14^{b}	0.24	0.56	0.31^{b}
Green Tea	4.46^{a}	2.86^{a}	1.70^{ab}	0.38^{b}	0.55	0.14^{b}	0.23	0.50^{b}	0.98^{a}
Combine	3.91^{b}	2.50^{b}	1.76^{a}	0.43^{a}	0.54	0.16^{a}	0.24	0.48^{b}	1.23^{a}
SEM	0.10	0.07	0.03	0.02	0.02	0.00	0.01	0.01	0.11
P-value	*	*	*	*	NS	*	NS	*	*
Inclusion level									
0.5g/kg of feed	4.19	2.64	1.66	0.43	0.51	0.15	0.23	0.49	0.59
1.0g/kg of feed	3.80	2.49	1.76	0.46	0.56	0.15	0.23	0.50	0.86
SEM	0.07	0.05	0.02	0.01	0.02	0.00	0.01	0.01	0.08
P-value	NS	NS	NS	NS	NS	NS	NS	NS	NS
Interaction									
Natural antioxidant vs inclusion level									
P-value	*	*	*	*	*	*	*	*	*

^{abc} *– Means along the same column with different superscripts differs according to the level of significance within each main effect (P<0.05). WG- Whole Gizzard; EG- Empty Gizzard; SEM - Standard Error of Mean, NS: Non Significant; *P<0.05*

Table 4. Effect of natural antioxidants and inclusion levels on heamatology of Noiler chickens

	WBC (*10^3/uL^{-1})	RBC (*10^6/uL^{-1})	HGB (g/dL^{-1})	HCT (%)	MCV (fL)	MCH (pg)	MCHC (g/dL^{-1})
Control	212.61	1.95	9.00	25.50	131.74^{c}	46.20^{c}	35.30^{b}
Roselle	214.40	1.58	9.30	28.30	134.70^{c}	62.80^{a}	45.70^{a}
Black Pepper	216.55	1.85	9.30	28.40	154.50^{a}	50.45^{b}	32.70^{b}
Green Tea	209.50	1.89	9.45	28.25	148.85^{b}	50.65^{b}	34.30^{b}
Combine	211.60	1.89	9.20	28.60	148.25^{b}	27.60^{d}	32.15^{b}
SEM	0.20	0.11	0.40	0.15	0.23	0.31	0.18
P-value	NS	NS	NS	NS	*	*	*
Inclusion level							
0.5g/kg of feed	212.38	2.00	9.40	28.22^{a}	139.62^{b}	46.62^{b}	33.68^{b}
1.0g/kg of feed	214.12	1.59	9.13	14.89^{b}	151.31^{a}	59.03^{a}	39.15^{a}
SEM	0.31	0.38	0.17	0.21	0.42	0.14	0.23
P-value	NS	NS	NS	*	*	*	*
Interaction							
Natural antioxidant vs inclusion level							
P-value	NS	NS	NS	*	*	*	*

^{abcd} *Means along the same column with different superscripts differs according to the level of significance within each main effect (P<0.05). WBC – white blood cells, HGB – haemoglobin, RBC – red blood cells, HCT – haematocrit or packed cell volume (PCV), MCV – mean corpuscular volume, MCH – mean corpuscular haemoglobin, MCHC – mean corpuscular haemoglobin concentration. SEM - Standard Error of Mean, NS: Non Significant; *P<0.05*

Table 5. Effect of natural antioxidants and inclusion levels on serum of Noiler chickens

	TP (g/dL)	ALB (g/dL)	GLO (g/dL)	ALP (U/L)	ALT (U/L)	AST (U/L)	CR (mg/dL)	UREA (mg/dL)
Control	3.30	1.75	1.56	16.28	20.83	102.34	0.91	3.72
Roselle	3.36	1.78	1.59	16.57	20.83	100.79	1.00	4.44
Black Pepper	3.36	1.78	1.59	16.57	17.15	96.84	1.00	4.16
Green Tea	3.58	1.89	1.69	17.65	18.57	98.03	1.00	3.15
Combine	3.67	1.94	1.73	17.65	18.38	103.55	1.18	3.82
SEM	0.43	0.27	0.21	0.11	0.31	0.22	0.15	0.19
P-value	NS	NS	NS	NS	NS	NS	NS	NS
Inclusion level								
0.5g/kg of feed	3.16	1.97	1.75	18.34	20.00	101.32	1.02	3.88
1.0g/kg of feed	3.72	1.67	1.49	15.57	17.67	98.42	1.05	4.27
SEM	0.21	0.34	0.45	0.16	0.25	0.12	0.33	0.18
P-value	NS	NS	NS	NS	NS	NS	NS	NS
Interaction								
Natural antioxidant * inclusion level								
P-value	NS	NS	NS	NS	NS	NS	NS	NS

SEM - Standard Error of Mean, AST – Aspartate aminotransferase, ALT - Alanine aminotransferase CR-Creatine, ALP-Alkaline phosphate, TP-total protein, GLO- Globulin. NS: Non Significant

Effect of natural antioxidants and inclusion levels on heamatology of Noiler chickens: Table 4 shows the effect of natural antioxidants and inclusion levels on the heamatology of noiler chickens. The result shows that the natural antioxidants have no significant (P> 0.05) effect on the heamatology parameters except on the MCV, MCH, MCHC. The MCV of birds fed on black pepper (154.50fL) has the highest significance (P<0.05) effect with the least value in control (131.20fL) and roselle (134.70fL). The birds fed on roselle also have the highest significance (P<0.05) effect on MCH (62.80pg) and MCHC (45.70g/dL) better than other dietary treatment groups. The result also shows that the natural antioxidant at the two inclusion levels influenced (P<0.05) HCT, MCV, MCH and MCHC. Interaction due to natural antioxidants and inclusion levels showed significant (P<0.05) differences in all the heamatology parameters examined except RBC, WBC, and HGB.

Effect of natural antioxidants and inclusion levels on serum of Noiler chickens: Table 5 shows the effect of natural antioxidants and inclusion levels on serum of noiler chickens. The result shows that the natural antioxidants have no significance (P> 0.05) effect on the serum parameters examined. The natural antioxidants at the two inclusion levels do not have significant (P>0.05) effect on the serum parameters. Interaction due to natural antioxidants and inclusion levels showed no significant (P>0.05) differences in all the serum parameters examined.

Effect of natural antioxidants and inclusion levels on physical properties of Noiler chickens: Table 6 shows the effect of natural antioxidants and inclusion levels on physical properties of noiler chickens. The result reveals that the physical properties were significantly (P<0.05) influenced by the natural antioxidants except the pH values. Green tea greatly improved (P<0.05) the chicken cooking loss compare to other treatment groups. The least (P<0.05) values were reported in chicken of birds fed blackpepper (32.06%) for thermal shortening, roselle (14.42%) for cold shortening, and control (1.59%), roselle (1.98%), and combine (1.88%) for drip loss. The natural antioxidants fed at the two inclusion levels strongly influenced the chicken physical properties except drip loss and pH. The natural antioxidants fed at 1.0g/kg inclusion level improved (P< 0.05) the cooking loss, thermal shortening and cold shortening better than 0.5g/kg. Significant (P<0.05) differences were noted in all the chicken physical properties parameters examined due to the interaction of natural antioxidants and inclusion levels.

Effect of natural antioxidants and inclusion levels on lipid profile and lipid peroxidation of Noiler chickens: The effect of natural antioxidants and inclusion levels on lipid profile of noiler chickens is shown in Table 7. The result shows that the natural antioxidants have significant (P<0.05) effect on the lipid profile. The fed birds with green have the highest CHO (94.41mg/dL) compare to other dietary treatment group. The TAG of the birds fed on roselle, green tea and the combine (roselle + green tea + black pepper) has the highest significant (P< 0.05) effect across the treatment group. Birds fed with blackpepper (48.62mg/dL) has the highest (P<0.05) value of HDL, with the least value in roselle (22.89mg/dL) and green tea (22.46mg/dL). Birds fed green tea (58.86mg/dL) has the highest (P<0.05) value of LDL, with the least in black pepper (10.51mg/dL). MDA of the chicken at control has the highest significant (P<0.05) effect compare to the dietary treatment group. The inclusion of the natural antioxidants at the two inclusion levels do not have significant (P>0.05) effect on the lipid profile except CHO and LDL. The birds fed natural antioxidants at the inclusion level of 0.5g/kg has a higher CHO (79.40mg/dL) and LDL (34.84mg/dL) value than the one at inclusion level of 1.0g/kg. The interactions due to natural antioxidants and inclusion levels were reported significant (P<0.05) for all the lipid profile parameters examined.

Effect of natural antioxidants and inclusion levels on organoleptic properties of Noiler chickens: The effect of natural antioxidants and inclusion levels on organoleptic properties of noiler chickens is shown in Table 8. All the parameters examined were influenced (P<0.05) by the dietary treatments except in flavour, ease of fragmentation and acceptability. The colour of noiler meat from birds fed with roselle (7.44) and black pepper (7.56) were moderately light (P<0.05) compare to those fed with combine (7.17), green tea (6.94), and control (6.78). The mean value of juiciness and residue after eating were highest (P<0.05) for meat of noiler chicken fed with roselle and black pepper. The mean values of apparent adhesion were highest (P<0.05) for meat of noiler chicken fed with black pepper (5.72), while the least value was obtained in meat from birds fed with green tea and control.

The result also reveal that the natural at the two inclusion level do not have significant (P>0.05) effect on all the organoleptics properties parameters. The interactions due to natural antioxidants and inclusion levels were reported significant (P<0.05) for all the organoleptic properties parameters examined.

Table 6. Effect of natural antioxidants and inclusion levels on physical properties of Noiler chickens

	Cooking Loss (g)	Thermal shortening (cm)	Cold shortening (cm)	Drip Loss (g)	pH
Control	49.25^{a}	45.97^{a}	39.91^{a}	1.59^{c}	6.75
Roselle	41.68^{b}	42.46^{b}	14.42^{c}	1.98^{c}	6.48
Black Pepper	39.01^{bc}	32.06^{c}	25.82^{b}	3.96^{b}	6.78
Green Tea	35.17^{c}	47.59^{a}	31.89^{a}	6.65^{a}	6.78
Combine	42.09^{b}	50.64^{a}	12.64^{c}	1.88^{c}	6.83
SEM	1.38	1.11	1.51	0.36	0.02
P-value	*	*	*	*	NS
Inclusion level					
0.5g/kg of feed	43.95^{a}	44.23^{a}	26.35^{a}	3.07	6.70
1.0g/kg of feed	36.35^{b}	42.58^{b}	19.42^{b}	3.79	6.74
SEM	0.98	0.78	1.07	0.25	0.02
P-value	*	*	*	NS	NS
Interaction					
Natural antioxidant vs Inclusion level					
P-value	*	*	*	*	*

^{abc} *means along the same row with different superscripts are significantly different (P <0.05), SEM - Standard Error of Mean*

Table 7. Main effect of natural antioxidants and inclusion levels on lipid profile of Noiler chickens

	CHO (mg/dL)	TAG (mg/dL)	HDL (mg/dL)	LDL (mg/dL)	MDA (U/L)
Control	70.97^{b}	53.86^{b}	32.27^{b}	27.93^{b}	21.54^{a}
Roselle	67.10^{b}	65.45^{a}	22.89^{c}	31.11^{b}	7.94^{c}
Black Pepper	69.68^{b}	52.74^{b}	48.62^{a}	10.51^{d}	7.54^{c}
Green Tea	94.41^{a}	65.45^{a}	22.46^{c}	58.86^{a}	16.83^{ab}
Combine	69.03^{b}	65.08^{a}	32.20^{b}	23.82^{c}	14.81^{b}
SEM	0.00	0.00	0.00	0.00	0.00
P-value	*	*	*	*	*
Inclusion level					
0.5	79.40^{a}	60.60	32.44	34.84^{a}	12.22
1.0	68.60^{b}	62.09	30.60	25.59^{b}	13.66
SEM	0.00	0.00	0.00	0.00	0.00
P-value	*	NS	NS	*	NS
Interaction					
Natural antioxidants*Inclusion level					
P-value	*	*	*	*	*

^{abc} *means along the same row with different superscripts are significantly different (P <0.05), SEM - Standard Error of Mean, TAG- Tri-acetyl-glyceride, CHO-Cholesterol, MDA- Malondialdehyde, HDL- High density lipoprotein, LDL- Low density lipoprotein. SEM - Standard Error of Mean, NS: Non Significant; *P<0.05*

Table 8. Main effect of natural antioxidants and inclusion levels on organoleptic properties of Noiler chickens

	Colour	Flavour	Juiciness	Ease of Fragmentation	Apparent Adhesion	Residue after chewing	Acceptability
Control	6.78[b]	6.11	5.44[b]	5.67	5.22[ab]	4.56[b]	6.22
Roselle	7.44[a]	6.56	6.28[b]	6.28	5.06[ab]	5.72[a]	6.22
Black Pepper	7.56[a]	6.06	6.33[a]	6.39	5.72[a]	5.94[a]	6.78
Green Tea	6.94[b]	6.50	6.22[ab]	5.61	4.89[b]	4.56[b]	6.61
Combine	7.17[ab]	6.56	5.72[ab]	6.17	5.17[ab]	5.39[ab]	6.11
SEM	0.14	0.27	0.25	0.24	0.24	0.29	0.27
P-value	*	NS	*	NS	*	*	NS
Inclusion level							
0.5g/kg of feed	7.18	6.38	6.24	6.16	5.16	5.09	6.58
1.0g/kg of feed	7.28	6.39	5.83	5.94	5.28	5.58	6.19
SEM	0.09	0.17	0.16	0.15	0.15	0.18	0.17
P-value	NS	NS	NS	NS	NS	NS	NS
Interaction Natural antioxidant vs inclusion level							
P-value	NS	NS	NS	NS	NS	NS	NS

*[ab] means along the same row with different superscripts are significantly different (P <0.05). SEM - Standard Error of Mean, NS: Non Significant; *P<0.05*

3.2 Discussion

The result of this experiment indicates that all the dietary treatments have variance effect on the carcass characteristics, primal cut and internal organ of noiler chicken. This result agrees with Olagoke et al. [25] that observed significance differences in the carcass characteristics, primal cut and internal organ of broiler fed on ginger, garlic, roselle and their combination. Black pepper and Roselle was found to be the best medicinal plant to improve productive performance as it increased the dressing percentage. The observed differences in the live weight of experimental birds indicate the potency of the natural antioxidants at 1.0g/kg of feed and combine at 0.5g/kg to improve live weight as compared with the control. The breast meat of poultry birds is one of the targets of consumers and meat processors, in this study sole addition of roselle increased relative breast meat weight of noiler which contradicted the result of Elagib et al. [26] and Awodola et al. [27].

The result of internal organ weights in this study is consistent with the finding of Jimoh et al. [28]. This might implies that the natural antioxidants did not adversely affect the bird's organ. The lowest abdominal fat pad (0.31) observed in the birds fed on black pepper indicates the potency of the test ingredient to synergistically reduce the abdominal fat in noiler chickens. Similar result was reported by Oleruforuh-Okeleh [29]. This study suggested that as farmers are getting increased live weight of birds, the consumers are also benefiting from eating lean and functional or nutraceutical meats (FAO, 2013). Also, consumption of meat from these birds will improve consumer's health and wellness rather than increasing their health risk.

The non-significance difference in WBC, RBC and HGB might indicate that there where no cases of anaemia, there were adequate nutrient release for electropoesis 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, garlic, roselle and their combination where supplemented in the diet of broiler at 1.5% and 3% was recorded [25]. In another result AL-Baghadi [30] observed a significance increase in HGB concentration while RBC was reduced in layers fed roselle flower extract. The present study revealed an increase in WBC might indicate increased immunity in birds; a moderate level might indicate boosting of immunity [31]

while low level might be an indicator of no disease condition or low production of bone marrow. Birds fed with black pepper, resulted in increased immunity of birds, follow by birds fed with roselle compared to other treatment groups. It was also observed from this study that the natural antioxidant does not have significant ($P < 0.05$) on protein metabolism.

Serum protein has been observed to be responsible for the replacement of tissue protein, transportation of blood constituents like vitamins, irons, hormones and also acts as buffer in acid-bass balance (Asaniyan and Akinduro, 2020). Asaniyan and Akinduro (2020) stated also that Serum protein is a reflection of the health, nutrition, climate and management exposure of animals. Hence, serum biochemical parameters can be indicators of the productive performance of the broiler chickens and of metabolic diseases. AST and ALT are the indicators of hepatic function. Total serum protein and albumin serve as a measure of biosynthetic production of plasma proteins by the liver. Therefore, the level of albumin supported the functionality of the liver; hence the non-significance in the serum parameters of the noiler chicken reflect that the inclusion of natural antioxidants in noiler chiken feed does not have negative influence on the serum of the chickens. This result was in consonance with AL-Baghdadi [30] who observed no significance effect of roselle extract on serum protein of layers.

It was observed from this study that black pepper, green tea and combine (roselle + black pepper + green tea) showed increased pH with decreased cooking loss in green tea, black pepper, roselle and combine. The pH directly influence the meat quality attributes like tenderness, colour and juiciness. The amount of glycogen in the muscle prior to slaughter and the rate of its conversion into lactic acid are important determinant of pH. Akinwumi and Odinsi [22] reported that low pH in poultry meat is associated with low WHC and consequently an increased cooking loss, drip loss, and decreased tenderness.

The lowest level of triglycerides in birds fed with black pepper might implies the synergestic effect of black pepper to lower triglycerides levels by its ability of anti-thrombotic, anti-platelet, anti-hypertensive and anti-lipidemia [32]. Birds fed with black pepper have the highest value of HDL. High density lipoprotein cholesterol helps in the reduction of serum cholesterol, ischemic heart disease, stroke and disease, stroke and disease associated with atherosclerosis [33]. Highest triglycerides level in birds fed diet containing roselle agreed with the result of Habibulla et al. [24] and Jimoh et al. [28] which indicate that *Hibiscus sabdariffa* increased the serum cholesterol in laying hens [34]. However, values recorded for all these natural antioxidants sources were not more than the level (>240mg/dl) considered risky to human health [35]. It thus, generally suggested that the usage of these natural antioxidants as additive will not be detrimental but positively affect the blood chemistry of birds by preventing or delaying oxidative deterioration, which is a plus to the quality of meat. Reduced MDA value of meat could imply dietary treatment of roselle, black pepper reduced lipid oxidation in meat compared to green tea, their combination and control.

Natural antioxidants especially roselle and black pepper gives a lighter colour to the meat more than other dietary group. According to Shruthi et al. [36], anthocyanins present in *Hibiscus sabdariffa* mainly dephnidin 3-sambubioside, cyanidin 3-sambubioside, delphnidin 3-glucoside and cyanidin 3-glucoside are good sources of antioxidants as well as food colourant. They are also good sources of lipid soluble antioxidants, particularly γ-tocopherol [37]. The dietary antioxidant capacity of the black pepper was more reflected in all the parameters of eating qualities of meat compare to other having more juiciness, apparent adhension, residue after eating and accepted by the consumers (panelist). This result was expected as black pepper is an antioxidant known to be spices; which were expected to perform better in the eating quality of poultry meat. The highest score in juiciness, residue after chewing and overall acceptability recorded at 0.5g/kg of roselle to feed, might be as a result of roselle being a feed additive in noiler diet thereby improving productive performance [38].

4. CONCLUSION AND RECOMMENDATION

4.1 Conclusion

Considering the results obtained in the current study it could be concluded that the natural antioxidants at 1.0g/kg inclusion level greatly influenced the carcass characteristics above the control [39-45]. Also roselle, black pepper and green tea have a better result with the breast, thigh and drumstick. The natural antioxidants at

1.0g/kg inclusion level significantly improved the primal cut. The physical properties of the birds were greatly improved with the green tea at 1.0g/kg. The natural antioxidants with their inclusion levels had no effect on the heamatological profile and serum of noiler chicken, but improved the lipid profile of the noiler chicken with preferred value at 1.0g/kg inclusion level. The results indicate that meat from birds fed black pepper and roselle had good eating quality compare to others. Generally the inclusion of natural antioxidants boosts endogenous antioxidants against oxidative stress and prevents lipid and protein oxidation. It enriched meat from noiler chickens with healthy promoting bioactive compounds, thereby preventing the tendency towards meat deterioration.

4.2 Recommendations

It could be suggested to farmers and meat producers that both single dietary treatment of roselle and black pepper (0.5g/kg & 1.0g/kg) will improve eating quality could serve as a better meat colourant. The inclusion of natural antioxidants in poultry diet should therefore be advocated for improve performance and meat quality. The use of black pepper and green tea should be cautiously used in noiler diet as the two had hypertrophic activity on crucial organs such as liver and gizzard of the noiler chicken.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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