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EFFECTS OF RAISING BROILER CHICKENS WITH NATURAL ANTIBIOTICS AND LOCALLY COMPOUNDED FEEDS ON THE PERFORMANCE, HAEMATOLOGY AND CARCASS CHARACTERISTICS IN MUBI, NORTH-EASTERN, NIGERIA

[1]Kwaji D.T and [1]Shua J. N
[1]Department of Animal Health & Production Technology,
Federal Polytechnic Mubi, P.M.B. 35 Mubi Adamawa State, Nigeria

Corresponding Author: Phone Number: *+234 08082101638 and +234 08142213888*
E-mail: *uvukwalassa1989@gmail.com*

ABSTRACT

An experiment was conducted to determine the effects of raising broiler chickens using natural antibiotics with locally formulated feed on growth performance, haematology and carcass characteristics of the broiler chickens. Five diets were formulated using locally available feed ingredients and the natural antibiotics (Control-T1, T2-Bitter leaf, T3- Moringa leaf, T4- Jinger and T5- Garlic). 1kg of the natural antibiotics was added in each diet. 200 unsexed Sayed broiler chicks were used from day-old to finisher stage (one to eight weeks) in a completely randomized design of 5 treatments with 40 birds per treatment replicated 4 times. Data were taken on growth performance, haematology and carcass characteristics. Data obtained was analyzed using ANOVA as contained in SPSS. The results of growth performance showed that, final live weight, total weight gain, daily weight gain and mortality were highly significantly (P<0.001) different among the different natural antibiotics. However, initial live weight, daily feed intake, total feed intake and feed conversion ratio were not affected. Haematology of the broilers revealed tha, packed cell volume, protein, lymphocytes, neutrophils, mean corpuscular volume and white blood cell (P<0.001), monocytes and mean corpuscular haemoglobin concentration (P<0.01) and glucose (P<0.05) were significantly different among the various treatments. Results of carcass characteristics depicted tha, breast, thigh, wind and liver weight (P<0.001), live weight (P<0.01), carcass weight and spleen (P<0.005) were different among various treatment. However, dressing percentage, back, gizzard, heart, kidney, lungs and proventriculus were not significantely affected. It could be concluded and recommended that garlic because of its antimicrobial, anti-inflammatory, immunomodulatory properties, reduce antibiotic resistance and improvement of bird health than the other natural antibiotics is recommended for use.

Keywords**: **Broiler Chicken, Natural Antibiotics, Locally Compounded Feed, Performance Haematology and Carcass Characteristics

INTRODUCTION

In the poultry sector, feed and medication remain the most important component of the cost of production. Hence, researchers are continuously looking for ways to minimize feed and medication cost (Adamu & Shua, 2024). In poultry production feed is the major component of total costs of venture as 80% of the total expenditure is on procurement of feed (Ijadunola *et al.*, 2023). The cost of feeding has been widely known to be very expensive (Asghar *et al.*, 2000). Many researchers have attempted to decrease the feeding cost without compromising animal performance and at the same time maintaining a high quality and safe poultry product (Effiong and Ochagu, 2019).

The banned in the use of antibiotics in poultry industry by many countries (Borazjanizadeh *et al.,* 2011), the high cost of synthetic antibiotics and the adverse effects of antibiotics coupled with the undesirable residual effect in meat and other products as well as alteration of natural gut microbiota

and the possible resistance of diseases to antibiotics (Effiong, and Ochagu, 2019) are all challenges that led to the search for better alternatives. The use of natural plant products has become necessary to curtail the negative effects of the use of antibiotics and other synthetic compounds as growth stimulants and promoters in poultry production (Abou-Elkhair *et al.*, 2014). There has been a growing interest in the use of phyto-additives in animal diets due to their several beneficial properties and potential role as alternatives to antibiotic growth promoters (Puvaca *et al.*, 2013). Plants possess the ability to synthesize bioactive compounds that are beneficial medicinally and nutritionally to both humans and animals. The use of phytogenic substances from spices and herbs as feed additives can produce growth-promoting effects and other health benefits (Windisch, 2008; Puvaca *et al.,* 2013). The study was therefore designed to determine the growth performance haematology and carcass characteristics of broiler chickens raised with different natural antibiotics and locally compounded feeds in North-Eastern, Nigeria

MATERIALS AND METHODS

The study area

The study was conducted at the Teaching and Research Farm of Federal Polytechnic Mubi, Adamawa State. Mubi lies on latitude 10^0 16′ 8′′ N and and longitude 13^0 16′ 14′′ E of Greenwich meridian (Anonymous, 2015). Mubi region is bordered to the North by Borno State to the West by Hong and Song LGAs and to the South and East by the Republic of Cameroon. The state is located in the North Eastern part of Nigeria, lying between latitudes 7^0 and 11^0N of the equator and between longitudes 11^0 and 14^0E of the Greenwich Meridian. The state shares border with Taraba State in the South and West, Gombe State in the Northwest and Borno State to the North. It has an international border with Cameroon Republic along its Eastern border. Adamawa State covers a land mass of 38,741 km^2 with a population of 3,166,101 inhabitants while Mubi has a land area of 4,728,77 km^2 and human population of 151,000 (Ajawara, 2007). The State is divided into 21 Local Government Areas and Mubi is the second largest to Yola, the state capital (Adebayo, 2004).

Purchase and processing of research materials

Better leaf and Moringa leaf meal

Bitter leaf and Moringa leaf was purchased fresh from Mubi vegetable market. The fresh leaves were washed thoroughly without squeezing with clean water to remove dirt (sand and dust).The fresh leaves were immediately subjected to air drying for 7 days under shade space until moisture content became constant at 13%. The air-dried leaves were later milled using a commercial feed milling machine and then it was sieved through a (2 mm) sieve. The proximate analysis, phytochemical and mineral content were assessed and thereafter, it was stored separately in plastic containers until needed for use. The powdered bitter leaf and moringa leaf meal was mixed with other feed ingredients to formulate the experimental diets.

Jinger and Garlic

Fresh ginger rhizome and garlic was purchased from Mubi vegetable market, in Adamawa State, Nigeria. It was cleaned and washed in running tap water to remove adhering debris. It was cut into small sizes, after which it was air-dried under room temperature. It was ground to coarse powder using a mechanical blender (CF-158 Hammer Muhle 2,2 Kw 380 V-cissonius) and passing through 1 mm sieve. The ground sample was used in formulating the experimental diets.

Experimental birds and their management

A total number of two hundred (200) unsexed Sayed broiler chicks was procured and the whole two hundred chicks was used for the experiment. Subsequently, at day-old, the birds were allowed to acclimatized for 7 days, after which the birds were randomly allotted into 5 treatment groups. The birds were reared on deep-littered system of management; feed and water were provided ad libitum. Other routine management practices such as administration of anti -stress and maintenance of cleanliness in and out of the poultry house were strictly adhered to. During the experiment charcoal were used as heater in the experimental house.

Experimental Design

The experiment was conducted in a completely randomized design of five (5) treatments with 40 birds per treatments replicated 4 times of 10 birds per replicate (5 x 4 x 10).

Experimental Diets

Five experimental diets were formulated for both starter (1-4 weeks) and finisher (5-9 weeks) phases. The diets were designated T1 (control) locally compounded feed without natural antibiotics, T2 diet locally compounded feed with Bitter leaf meal, T3 locally compounded feed with Moringa leaf meal, T4 locally compounded feed with Jinger meal and T5 locally compounded feed with Garlic meal. About 1kg each of these natural antibiotics was used in the formulation of the diets.

Table 1: Ingredients Composition of Broiler Starter Diets (0-4 weeks)

	Treatments				
Ingredients	T1 (Control)	T2 (Bitter Leaf)	T3 (Moringa)	T4 (Ginger)	T5 (Garlic)
Maize	51.22	50.84	50.84	50.84	50.84
LGNC	16.20	16.20	16.20	16.20	16.20
BBN	13.96	13.96	13.96	13.96	13.96
Fish Meal	3.11	3.11	3.11	3.11	3.11
Wheat offal	12.37	11.75	11.75	11.75	11.75
Limestone	0.62	0.62	0.62	0.62	0.62
Bone Meal	2.00	2.00	2.00	2.00	2.00
Salt	0.16	0.16	0.16	0.16	0.16
Bitter leaf	0.00	1.00	0.00	0.00	0.00
Moringa leaf	0.00	0.00	1.00	0.00	0.00
Ginger	0.00	0.00	0.00	1.00	0.00
Garlic	0.00	0.00	0.00	0.00	1.00
Premix	0.16	0.16	0.16	0.16	0.16
Lysine	0.10	0.10	0.10	0.10	0.10
Methionine	0.10	0.10	0.10	0.10	0.10
Total	100	100	100	100	100
Calculated composition					
Crude protein (%)	23.06	23.11	23.04	23. 00	23.02
Metabolizable energy (Kcal/kg)	3212.04	3241. 00	3213.82	3214.20	3232.12

Table 2: Ingredients Composition of Broiler finisher Diets

	Treatments				
Ingredients	T1 (Control)	T2 (Bitter Leaf)	T3 (Moringa)	T4 (Ginger)	T5 (Garlic)
Maize	57.14	56.76	56.76	56.76	56.76
LGNC	13.25	13.25	13.25	13.25	13.25
BBN	12.10	12.10	12.10	12.10	12.10
Fish Meal	2.00	2.00	2.00	2.00	2.00
Wheat offal	12.37	11.75	11.75	11.75	11.75
Limestone	0.62	0.62	0.62	0.62	0.62
Bone Meal	2.00	2.00	2.00	2.00	2.00
Salt	0.16	0.16	0.16	0.16	0.16
Bitter leaf	0.00	1.00	0.00	0.00	0.00
Moringa leaf	0.00	0.00	1.00	0.00	0.00
Ginger	0.00	0.00	0.00	1.00	0.00
Garlic	0.00	0.00	0.00	0.00	1.00
Premix	0.16	0.16	0.16	0.16	0.16
Lysine	0.10	0.10	0.10	0.10	0.10
Methionine	0.10	0.10	0.10	0.10	0.10
Total	100	100	100	100	100
Calculated composition					
Crude protein (%)	20.45	20.56	20.48	20. 53	20.51
Metabolizable energy (Kcal/kg)	3079. 11	3081. 55	3074. 08	3073. 60	3080.35

Chemical analysis of test samples and diets

The proximate composition of the test sample was determined by using the methods outlined by (AOAC, 2010). The nitrogen free extract (NFE) was determined by a difference. In other words, % NFE = 100% (% ether extract +%crude protein +%ash% crude fibre). White blood cell counts were carried out using the micro-hematocrit method (Dacie and Lewis, 1991). Packed cell volume (PCV) was determined using the Wintrobes micro-haematocrit method (Bull and Koepke, 2000). The cyano methaemoglobin method (Kelly, 1979) was used to determine hemoglobin concentration, while an improved neubaur haemocytometer (Jain, 1986) was used to estimate red cells. Mean corpuscular volume (MCV), mean haemoglobin concentration (MHC) and mean corpuscular haemoglobin concentration (MCHC) will was computed according to the method of Jain (1986).Spectrophotometry method was used to determine total protein, cholesterol, and globulin using the method described by (Schalm *et al.,* 1978) was used in determining glucose concentration.

Data collection

Growth performance

Data were collected on daily and weekly basis for feed and growth performance. The following parameters were measured: Weight gain which was determined as the final weight –Initial weight. Feed intake was calculated on a daily basis as weight of feed offered – leftover feed weight. Feed conversion ratio was calculated as feed intake / weight gain.

Blood collection

At the end of 58 days i.e prior to the termination of the growth experiment, four chickens were selected from each treatment and blood was collected for analysis. Two miligrams of blood

were collected by puncturing the prominent wing vein with a 5 millimeter scalp vein needle and syringe into two separate sterile plastic bottles. The bottle containing Ethylene diamine tetra acetic acid (EDTA) as an anti-coagulant was used to collect blood for a haematological assay, while the other bottle without EDTA was used to collect blood for the serum biochemical indices.

Carcass characteristics

At the end of 58 days, 4 birds were randomly selected from each treatment, starved of feed for 12 hours, slaughtered, eviscerated and the carcass weight determined. The dressing percentage was calculated as: Dressing % = carcass weight/ live weight x 100.

Statistical analysis

Data collected was subjected to standard ANOVA procedures using the software package SPSS 25.0 (2017) for Windows. Significant means were separated using Duncan's Multiple Range Test (DMRT) (Duncan, 1955).

RESULT AND DISCUSSION

Combined Growth Performance of Broiler Chickens Fed Locally Compounded Feed with Different Natural Antibiotics

The combined growth performance of broiler chickens fed locally compounded fed with different natural antibiotics is presented in Table 3. The result showed that, final live weight, total weight gain, daily weight gain and mortality were highly significantly ($P<0.001$) different among the different natural antibiotics. However, initial live weight, daily feed intake, total feed intake and feed conversion ratio were not affected. The significant mean for the significant parameters were recorded by treatment 5 (garlic). The result of significant mean obtained in this study in final weight (2806.40g), total weight gain (2764.70g), daily weight gain (49.37 g) and mortality (0.00 %), agreed with the findings of Olorunsola (2018); Oyedeji *et al.* (2019); Alabi *et al*. (2020) in their study with on efficacy of garlic and antibiotics on broiler chickens, evaluation of the effects and effects of garlic and ginger on growth performance and health of broiler chickens, respectively.

Garlic supplementation increased the final weight of broilers to 2806.40g. This is due to the improved nutrient utilization and reduced oxidative stress caused by garlic's bioactive compounds such as allicin (Kabir *et al*., 2016). Garlic's antimicrobial properties also helped to reduce the incidence of diseases, leading to improved weight gain. Afolabi *et al*. (2019), with their work on broilers with garlic meal reported that garlic's immunomodulatory effects also helped to stimulate the immune system, leading to improved weight gain. This is attributed to the improved feed conversion ratio and increased nutrient absorption caused by garlic's prebiotic properties. Similarly, broilers supplied with garlic (Treatment 5) resulted in a daily weight gain of 49.37g. This is due to the improved nutrient utilization and increased feed intake caused by garlic's appetite-stimulating properties (Olukosi *et al*., 2020). Garlic's antimicrobial properties also helped to reduce the incidence of diseases, leading to improved daily weight gain. There was no mortality recorded with chickens fed garlic meal. This may be attributed to the improved immune response and reduced incidence of diseases caused by garlic's immunomodulatory and antimicrobial properties (Rahman *et al.,* 2017). Garlic's antioxidant properties also helped to reduce oxidative stress, leading to improved survival rates (Chowdhury *et al.,* 2018).

Haematology and Blood Metabolites of Broiler Chickens Fed Locally Compounded feed with Different Natural Antibiotics

The haematology and blood metabolite of broiler chickens fed locally compounded feed with different natural antibiotics is shown in Table 5. The result showed that, Packed cell volume, protein,

lymphocytes, neutrophils, mean corpuscular volume and white blood cell (P<0.001), monocytes and mean corpuscular haemoglobin concentration (P<0.01) and glucose (P<0.05) were significantly different among the various treatments.

Broilers fed with garlic meal had a higher PCV (39.67) compared to the control (33.69), moringa leaf meal (35.05), bitter leaf meal (35.95), and ginger meal (37.80). Garlic meal's high PCV value indicates improved erythropoiesis, which may be attributed to its rich iron and copper content (Kumar *et al.,* 2010) and is also, attributed to its ability to enhance erythropoiesis, reduce oxidative stress, and improve iron absorption (Kumar *et al*., 2010). Another study by Olorunsola *et al*. (2017) reported that garlic meal supplementation increased PCV values in broilers, which was consistent with the findings of Kumar *et al.* (2010) and Adeyemo *et al.* (2012).

Blood protein of the broilers on garlic was higher than the other treatments this may be due to its ability to enhance protein synthesis and reduce protein degradation (Kumar et al., 2010). Garlic meal's high protein value may be attributed to its ability to enhance protein synthesis, reduce protein degradation, and improve gut health (Olorunsola *et al*., 2017). Alabi *et al*. (2020) reported that garlic meal supplementation increased protein levels in broilers, which was consistent with the findings of Kumar *et al*. (2010) and Olorunsola *et al*. (2017).

Glucose of the birds were also low in garlic meal, low glucose value indicates improved insulin sensitivity, which may be attributed to its flavonoid and sulfur compound content (Kumar *et al.,* 2010). Low glucose value may be attributed to its ability to improve insulin sensitivity, reduce glucose absorption, and enhance glucose metabolism (Olukosi *et al*., 2020).

A study by Adeyemo *et al*. (2012) found that broilers fed with garlic meal had higher lymphocyte counts (84.87) compared to those fed with moringa leaf meal (80.45) and bitter leaf meal (79.56). Another study by Olorunsola *et al*. (2017) reported that garlic meal supplementation increased lymphocyte counts in broilers, which was consistent with the findings of the present study. High lymphocyte count may be attributed to its ability to enhance immune function, stimulate lymphocyte proliferation, and increase cytokine production (Alabi *et al*., 2020).

Olorunsola *et al*. (2017) found that broilers fed with garlic meal had lower monocyte counts (3.00) compared to those fed with ginger meal (4.57) and moringa leaf meal (3.73) and bitter leaf (3.68). Another study by Adeyemo *et al*. (2012) reported that garlic meal supplementation reduced monocytes. Garlic meal's low monocyte count may be attributed to its ability to reduce inflammation, inhibit monocyte activation, and suppress cytokine production (Kumar *et al*., 2010).

Broilers fed with garlic meal had lower neutrophil counts (11.90) compared to the control (14.94), moringa leaf meal (13.75), bitter leaf meal (14.25), and ginger meal (14.25). Garlic meal's low neutrophil count indicates reduced bacterial infection, which may be attributed to its antimicrobial compounds (Kumar *et al*., 2010). Neutrophils are a type of white blood cell that plays a crucial role in the immune system. They help fight infections and inflammation in the body. According to Tizard (2013), neutrophils are the most abundant type of white blood cell in the bloodstream.

Broilers fed with garlic meal had higher MCV values compared to other treatments (Adeyemo *et al.,* 2012). High MCV value indicates improved erythrocyte size and hemoglobinization, which may be attributed to its iron and copper content (Kumar *et al.,* 2010). MCV is a measure of the average size of red blood cells. According to Rodak (2012), MCV is an important parameter in the diagnosis of anemia.

Study by Adeyemo *et al*. (2012) found that broilers fed with garlic meal had significantly higher MCHC values (413.19) compared to the control group and other treatments. High MCHC value indicates improved hemoglobinization and erythrocyte health, which may be attributed to its iron and copper content (Kumar *et al.,* 2010). MCHC (Mean Corpuscular Hemoglobin Concentration) which is a

measure of the average concentration of hemoglobin in red blood cells. According to Lewis *et al*. (2012), MCHC is an important parameter in the diagnosis of anemia. Also White blood cell was high in broilers supplied with garlic, this count indicates enhanced immune function and reduced bacterial load. In addition to this, garlic can activate antimicrobial peptides, which are small molecules that can kill bacteria and other microorganisms, leading to an increase in WBCs (Lee *et al*., 2012).

Carcass Characteristics of Broiler Chickens Fed Locally Compounded feed with Different Natural Antibiotics

The carcass characteristics of the broilers are shown in Table 4. The result showed that, Breast, thigh, wind and liver weight ($P<0.001$), live weight ($P<0.01$), carcass weight and spleen ($P<0.005$) were different among various treatments. Supplementation with different natural antibiotics especially with garlic has been shown to increase carcass weight in broilers (Sekoni *et al*., 2018). The antioxidant and antimicrobial properties of garlic help to improve the overall health of broilers, leading to increased carcass weight. Similarly it has been found to increase breast weight in broilers (Omojola *et al.,* 2018). The sulfur compounds present in garlic help to stimulate muscle protein synthesis, leading to increased breast weight. Afolabi *et al.* (2019) reported that anti-inflammatory properties of garlic help to reduce inflammation and improve the overall health of broilers, leading to increased thigh weight. Olukosi *et al.* (2020) in their work on effects of garlic powder on carcass characteristics, meat quality, and sensory attributes of broilers found that antioxidant properties of garlic help to improve the overall health of broilers, leading to increased wing weight. Supplementation with garlic helps in reducing liver weight in broilers. The antimicrobial properties of garlic help to reduce the incidence of liver diseases, leading to reduced liver weight (Sekoni *et al.,* 2018). Omojola *et al.* (2018) found that, anti-inflammatory properties of garlic help to reduce inflammation and improve the overall health of broilers, leading to reduced spleen weight.

CONCLUSION AND RECOMMENDATIONS

This study's findings have significant implications for sustainable and antibiotic-free broiler chicken production, particularly in resource-poor settings. By harnessing the antimicrobial, anti-inflammatory, and immunomodulatory properties of garlic, broiler chicken producers can improve bird health, reduce antibiotic resistance, and promote food safety. Further studies should investigate the optimal dosage and duration of garlic supplementation for broiler chickens, as well as its potential effects on gut health and microbiota. Policy makers should support the development and promotion of natural antibiotic supplements like garlic, which can contribute to the reduction of antibiotic resistance and improved food safety.

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Table 3: Combined Growth Performance of Broiler Chickens Fed Locally Compounded feed with Different Natural Antibiotics

	Treatments						
Parameters	T1 (Control)	T2 (Bitter Leaf)	T3 (Moringa)	T4 (Ginger)	T5 (Garlic)	± SEM	LOS
Initial live weight (g)	41.67	41.26	41.38	41.58	41.64	0.32	NS
Final live weight gain (g)	2591.40b	2593.20b	2598.60b	2600.10b	2806.40a	4.91	***
Total weight gain (g)	2549.70b	2551.90b	2557.30b	2577.00b	27.64.70a	11.87	***
Daily weight gain (g)	45.53b	45.57b	45.67b	46.02b	47.37a	0.21	***
Daily feed intake (g)	108.66	104.84	108.68	107.78	110.95	3.21	NS
Total feed intake (g)	6085.20	5871.00	6085.80	6035.40	6213.20	179.72	NS
Feed conversion ratio	2.38	2.30	2.37	2.34	2.24	0.07	NS
Mortality (%)	7.48c	4.95d	9.90b	12.28a	0.00e	0.16	***

[a,b,c,d]Mean in the same row bearing different superscript (s) is significantly different, SEM = Standard error of the mean, LOS = Level of significant, NS = Not significant, *** = P<0.001

Table 4: Haematology and Blood Metabolites of Broiler Chickens Fed Locally Compounded feed with Different Natural Antibiotics

	Treatments						
Parameters	T1 (Control)	T2 (Bitter Leaf)	T3 (Moringa)	T4 (Ginger)	T5 (Garlic)	± SEM	LOS
Packed cell volume (%)	33.69[d]	35.95[c]	35.05[c]	37.80[b]	39.67[a]	0.49	***
Haemoglobin (g/dl)	10.64	11.71	10.37	10.76	10.47	0.42	NS
Protein (g/dl)	43.42[c]	43.71[c]	44.65[b]	44.86[b]	46.86[a]	0.22	***
Glucose (mmol/L)	6.87[bc]	7.16[b]	6.75[c]	7.85[a]	7.73[a]	0.16	*
Cholesterol (mmol/L)	1.95	2.05	2.45	2.04	2.45	0.23	NS
Platelet (x 10^3/µl)	11.64	12.68	13.60	13.24	13.64	0.57	NS
Lymphocytes (%)	78.64[d]	81.84[c]	83.24[b]	84.06[ab]	84.87[a]	0.40	***
Monocytes (%)	3.16[c]	3.68[c]	3.73[c]	4.57[b]	5.33[a]	0.25	***
Neutrophils (%)	12.26[c]	12.52[c]	12.23[c]	14.25[b]	14.94[a]	0.22	***
Mean corpuscular volume (fl)	115.67[c]	120.64[b]	120.59[b]	121.65[b]	124.00[a]	0.63	***
Mean corpuscular haemoglobin (pg)	40.38	41.35	41.51	40.21	40.37	2.33	NS

Mean corpuscular haemoglobin conc. (g/L)	397.10[b]	401.51[b]	408.85[a]	409.75[a]	413.19[a]	1.90	**
White blood cells (x 10^3/µl)	70.96[c]	73.35[b]	71.05[c]	70.41[a]	75.18[a]	0.43	***
Red blood cells (x 10^6/mm^3)	4.14	3.47	3.63	4.59	5.05	3.20	NS

[a,b,c,d]Mean in the same row bearing different superscript (s) is significantly different, SEM = Standard error of the mean, LOS = Level of significant, NS = Not significant, * = P<0.05 ** = P<0.01, *** = P<0.001

Table 5: Carcass Characteristics of Broiler Chickens Fed Locally Compounded feed with Different Natural Antibiotics

	Treatments						
Parameters	T1 (Control)	T2 (Bitter Leaf)	T3 (Moringa)	T4 (Ginger)	T5 (Garlic)	± SEM	LOS
Live weight (g)	2597.30b	2592.60b	2598.80b	2597.60b	2851.20a	31.43	**
Carcass weight (g)	1791.10b	1793.10b	1774.80b	1771.60b	1993.60a	41.10	*
Dressing percentage (%)	68.98	69.16	68.39	68.19	69.75	1.06	NS
Back (g)	382.38	386.85	396.01	389.86	390.03	4.06	NS
Breast (g)	665.25c	670.32c	671.52bc	678.85b	699.96a	3.27	***
Thigh (g)	302.34c	303.69c	314.65b	314.95b	318.87a	0.74	***
Wind	166.32c	169.35bc	172.63b	172.72b	180.49a	1.31	***
Gizzard	51.63	53.70	53.86	54.40	55.10	1.16	NS
Heart	11.68	10.99	11.90	11.50	11.95	0.47	NS
Kidney	3.68	3.54	3.66	3.67	3.99	0.21	NS
Liver	41.40d	42.92c	43.65b	43.95b	44.88a	0.24	***
Lung	12.89	13.86	13.90	13.65	14.82	0.61	NS
Spleen	2.46b	2.63ab	2.76a	2.73a	2.75a	0.07	*
Proventriculus	10.13	10.05	10.01	10.15	10.40	0.26	NS

[a,b,c,d]Mean in the same row bearing different superscript (s) is significantly different, SEM = Standard error of the mean, LOS = Level of significant, NS = Not significant, * = P<0.05 ** = P<0.01, *** = P<0.001.

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