

Efficacy of *Ocimum gratissimum* leaf meal on growth performance, carcass characteristics, and blood profiles of broiler chickens

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ABSTRACT: This study was conducted to determine the effect of *Ocimum gratissimum* as a phyto-genic feed additive (PFA) on growth performance, carcass, and blood profile of broiler chicken. One hundred and sixty day old broiler chickens were used for the study. Four diets were formulated to incorporate *Ocimum gratissimum* at 0, 50, 100 and 150 g per 100 kg of feed to form T₁, T₂, T₃, and T₄ respectively. The birds were divided into four groups of forty birds and each group was assigned one of the diets in a completely randomized design. Each group was further divided into four replicates of 10 birds each. Feed and water were supplied *ad libitum* and data collected were statistically analyzed. The result obtained showed significant ($p < 0.05$) differences in the final weight gain (FWG), daily weight gain (DWG) and feed conversion ratio both at the starter and finisher phases. T₄ had the highest significant ($p < 0.05$) final weight gain (FWG), and daily weight gain (DWG) values. The lowest significant ($p < 0.05$) feed conversion ratio (FCR) values were observed in T₄. The feed intake of the birds was statistically similar ($p > 0.05$) at both the starter and the finisher phases. Significant ($p < 0.05$) increases were observed in dressed weight, dressing percentage, and cut-up parts (wing, thigh, drumstick, and breast) of the birds. T₄ had the highest significant values for the carcass parameters. The haematological parameters analyzed showed significant ($p < 0.05$) differences in the value for red blood cell (RBC), haemoglobin (Hb) and packed cell volume (PCV) values with T₄ recording the highest significant ($p < 0.05$) values for those parameters. All the serum biochemical parameters analyzed were not significantly affected ($p > 0.05$) by the treatments. It can be concluded that *Ocimum gratissimum* could be added to broiler diet at 150 g/100kg as feed additive without any deleterious effect on the growth performance, carcass, and blood profiles of the birds.

Keywords: Broilers, carcass, haematology, serum, *Ocimum gratissimum*.

INTRODUCTION

Feed additives have been widely used to increase the performance of animals and are now used in poultry feeding extensively. Feed additive help to stimulate growth, feed efficiency, and also improve the health and performance of birds (Fadlalla et al., 2010). High quality and adequate quantity of feed may be provided to the birds, the amount of feed digested, nutrients absorbed and utilized is very important. Therefore, there is need to formulate diet that will have a positive effect on gut health, and function thereby enhancing better digestibility of feeds.

Feed additives like antibiotics have been used for this

purpose at sub-therapeutic doses in poultry diets (Engberg et al., 2000). They act directly against pathogens in the gut creating a favourable environment for protein and energy digestion, absorption and metabolism (Puyalto and Mesia, 2002). The potential side effect which includes host and cross drug resistance has led to the ban of these products by many countries (Cardozo et al., 2004; Kehinde et al., 2011).

The search for natural and safe alternatives to antibiotics growth promoters (AGPs) that will ensure animal health performance and safeguard public health has resulted to

the introduction of many herbal product in livestock diet. Several non-therapeutic growths such as enzymes, inorganic acids, probiotics, prebiotics, phytogetic products etc. have been used as alternatives (Dibner, 2004; Dijk, 2004; Adam, 2005). Spices and herbal products have been found to be useful to man because of their nutritional and medicinal functions (Czarra et al., 2009). These products are beginning to gain ground in livestock production as more reliable Orthodox drug alternatives due to their low-cost of administration, limited side effects, and low residues on livestock products (Kamel, 2001). Spices and herbal products are in form of bulb, rhizome, knot and leaves, which improve food palatability through their aroma, increased digestibility and impact some medicinal functions when consumed by man or animals as part of their food (Tian, 2008). Examples include *Allium sativum* (garlic), *Piper migrum* (black pepper), *Zingiber officinale* (ginger), *Ocimum gratissimum* (African basil) and many others.

Ocimum gratissimum is a perennial plant and widely distributed in the tropics of Africa and Asia. It is known and used for both medicinal and nutritional purposes. Njoku et al. (2011) reported that *Ocimum gratissimum* contains some bioactive substances such as alkaloids, tannins, flavonoid, steroid and phenol acid oils which could be responsible for its varied biological and pharmacological properties. *Ocimum gratissimum* could be used in the management of many ailments such as malaria, cold, diarrhea, catarrh, aches, colon pains, dysentery, cholera, vomiting and convulsion (Ilori et al., 1996). The leaves of the plants have been reported to contain thymol and eugenol (El said et al., 1969).

Thymol, chemically known as 2-isopropyl -5-methyl phenol is a colourless crystalline menoterpene phenol. It is an important dietary constituent in thyme. Thymol has been used in traditional medicine and has shown to possess various pharmacological properties including antioxidant, free radical scavenger, anti-inflammatory, analgesic, antispasmodic, antibacterial, antifungal, antiseptic, anti-tumor, and anti-hyperlipidemic activities (Ajibaiye et al., 2018).

Eugenol is a colorless or pale yellow liquid compound present in oil of cloves and other essential oil used in perfumery. Orally, it can be used to treat gastro intestinal and respiratory complaints. The objective of this work was to determine the effect of *Ocimum gratissimum* as a phytogetic feed additive on the performance, carcass/organ and blood profiles indices of broiler chickens.

MATERIALS AND METHODS

Experimental site

The experiment was carried out at the Poultry and Research Unit of the Department of Animal Science, Akwa

Ibom State University Obio-Akpa Campus. Obio-Akpa is located between latitude 5°17'N and 7°27'N, Longitude 7°27'E and 7°58'E with an annual rainfall ranging from 3500-5000 mm and average monthly temperature range of 24 to 26°C and relative humidity between 60-90% in the tropical rainforest zone of South-South Nigeria (Wikipedia, 2021).

Source and preparation of experimental leaf meal

Fresh leaves of *Ocimum gratissimum* were collected from Obio Akpa village in Oruk Anam Local Government Area of Akwa Ibom State, Nigeria. The leaves were air-dried for five to seven days until they became crispy to touch. The air-dried leaves were ground into fine particle size to produce *Ocimum gratissimum* leaf meal and were thoroughly mixed with the feed at the rate of 0, 50, 100, and 150 g / 100 kg of feed respectively.

Proximate and phytochemical analysis of *Ocimum gratissimum* leaf meal

Sample of grounded *Ocimum gratissimum* were subjected to proximate analysis for the determination of crude protein, lipids, crude fibre, ash and phytochemical analysis using the guide provided by AOAC (1995). While phytochemical analysis for tannin, saponin, flavonoid, alkaloid and phenol were determined by the method of Harborne (1973 and 1998).

Experimental diets

Four (4) experimental diets were formulated at starter and finisher phases. The diets were labeled T₁, T₂, T₃, and T₄. T₁ the control had no *Ocimum gratissimum*, while T₂, T₃, and T₄ contained 50, 100 and 150 g per 100 kg *Ocimum gratissimum* respectively. Ingredients and nutrient composition of the experimental broiler diet is represented in Table 1. The diets were formulated to meet the nutrient requirements for poultry as recommended by NRC (1994).

Management of experimental birds and layout of the experiment

A total of 160 day old (*Abore acre*) broiler chickens were purchased from a reputable poultry distributor in Abak, Abak Local Government Area of Akwa Ibom State and used for the research. On arrival, the initial weight of the birds were taken before they were randomly allotted to their treatment diets. The birds were divided into four groups of 40 birds and each group was assigned to one of the treatment diet in a completely randomized design. Each group was subdivided into four replicates of 10 birds

Table 1. Gross composition of experimental broiler starter and finisher diet ingredients.

Ingredients	Broiler starter diet				Broiler finisher diet			
	T ₁	T ₂	T ₃	T ₄	T ₁	T ₂	T ₃	T ₄
Maize	50.00	50.00	50.00	50.00	55.00	55.00	55.00	55.00
Soyabean Meal	31.00	31.00	31.00	31.00	30.00	30.00	30.00	30.00
Fish Meal	4.00	4.00	4.00	4.00	3.00	3.00	3.00	3.00
Palm Kernel cake	10.00	10.00	10.00	10.00	7.00	7.00	7.00	7.00
Bone Meal	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00
Premix	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Common Salt	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
L-lysine	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
L-methionine	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Total	100	100	100	100	100	100	100	100
Calculated chemical composition (% DM)								
Crude Protein	23.61	23.61	23.61	23.61	21.44	21.44	21.44	21.44
Ether Extract	4.08	4.08	4.08	4.08	3.97	3.97	3.97	3.97
Crude Fibre	4.51	4.51	4.51	4.51	4.24	4.24	4.24	4.24
Ash	3.61	3.61	3.61	3.61	3.36	3.36	3.36	3.36
NFE	64.19	64.19	64.19	64.19	66.99	66.99	66.99	66.99
ME (Kcal/kg)	2862.81	2862.81	2862.81	2862.81	2973.36	2973.36	2973.36	2973.36

and housed in a pen measuring 2 m by 2 m. Feed and water were supplied *ad libitum* in suitable drinkers and tray feeders. The birds were kept on the starter diet for 4 weeks and another 4 weeks for finisher diets. All routine medications and vaccines were administered as at when due. Strict sanitation practices were adopted (drinkers were washed daily and litter materials changed weekly).

Data collection

The body weights of the birds were obtained weekly. The weight gain was calculated by subtracting the initial weight from the final weight. Feed intake of the birds was calculated by subtracting the quantity of the leftover feed from the quantity of the feed fed the previous day. Feed conversion ratio was calculated by dividing the daily feed intake by daily weight gain.

Carcass and organ weight evaluation

After the end of the eight weeks, two birds were randomly selected from each of the replicates for carcass analysis. The birds were starved overnight of feed, weighed, slaughtered and allowed to bleed thoroughly before scalding in hot water. The birds were defeathered, eviscerated and weighed to determine the carcass yield. The dressed weight, thigh, drumstick, breast and internal organ (liver, heart, gizzard, and kidney) weight were expressed as percentage of live weight.

Blood collection and analysis

At the end of the experiment, 10 ml of blood samples were drawn from two birds per replicate making it a total of 32 birds through a jugular vein. 5 ml of blood collected for haematological analysis were transferred into a universal bottle containing ethylene diamine tetra acetic acid (EDTA) and shaken thoroughly to prevent the blood from clotting. Haemoglobin concentration (HB) was determined using sahl method and the value recorded in g/100mls (WHO, 1980). Red blood cell (RBC) and white blood cell (WBC) were determined using the improved Neubauer haemocytometer as described by Dacie and Lewis (1991). Packed cell volume (PVC) was determined by the micro-haematocrit method, while Mean Corpuscular Volume (MCV), Mean Corpuscular Haemoglobin (MCH) and Mean Corpuscular Haemoglobin Concentration (MCHC) were calculated as shown below:

$$\text{MCV (\%)} = \text{PVC} \times 10/\text{RBC}$$

$$\text{MCH (\%)} = \text{HB} \times 10/\text{RBC}$$

$$\text{MCHC (\%)} = \text{HB} \times 100/\text{PVC}$$

Another 5 ml of blood sample was transferred into anticoagulant free bottles and was used to determine blood biochemical components such as total protein, albumin, globulin, cholesterol, triglyceride and liver enzymes aspartate aminotransferase (AST), alanine aminotransferase (ALT) and alkaline phosphatase (ALP) using Cobas Mira Automatic Analyzer (Roche Diagnostic System, Basel, Switzerland) at 37°C with the aid of

commercial kits (Lab Test Diagnostica Lagoa Santa, MG, Brazil). Samples reading were performed using spectrophotometer (Lasany Single Beam Visible Spectrophotometer (Li-720), Lasany International Panchkula) with light wave length adequate for each test.

Statistical analysis

Data collected from the various parameters measured were subjected to one-way analysis of variance using the SPSS software (2002), where analysis of variance indicated significant treatment effects, means were compared using Duncan New Multiple Range Test (DNMRT, 1955).

RESULTS AND DISCUSSIONS

The results of the proximate and phytochemical composition of *Ocimum gratissimum* are shown in Table 2. The result of the proximate analysis of *Ocimum gratissimum* showed that it contains ash, ether extract, crude fibre and crude protein while the result of the phytochemical analysis determined showed that *Ocimum gratissimum* contain alkaloids, tannin, phenol, saponin and flavonoids are a group of plant metabolites that provide health benefit through cell signaling pathways and antioxidant effects. Flavonoids are found in variety of fruits and vegetables. It helps to lower the levels of triglycerides and cholesterol in the blood by inhibiting the oxidation of low-density lipoprotein, thereby reducing the risk of atherosclerosis development (Robertson, 2018). The author further reported that flavonoid can bind to nonheme iron thereby decreasing its absorption in the intestine.

Tannins have been reported to enhance physiological activities such as stimulation of phagocytic cells, host-mediated tumor activity, wide range of anti-injective actions, inactivation of microbial adhesins enzymes (Haslam, 1995; Ya et al., 1988). Saponins have been reported to have anti-microbial ability and a bitter taste, anti-carcinogenic, decreases cholesterol level in the blood, immune modulating as well as anti-inflammatory (Mohan and Daffodil, 2016). Alkaloids show anti-inflammatory, antimicrobial, anti-fungal effects. They are present in stimulant drugs. Alkaloids are huge group of naturally occurring organic compounds which contain nitrogen atoms (Stephen, 2008).

The results of the performance of starter broiler chickens fed *Ocimum gratissimum* leaf meal as feed additive is shown in Table 3. There were significant ($p < 0.05$) differences in the final body weight (FBW) and average weight gain (AWG) values of the birds in the starter phase. Birds in T₄ recorded the highest significant ($p < 0.05$) values for FBW and AWG followed by birds in T₃ whose values for FBW and AWG were also significantly higher than birds in T₂ and T₁. The feed intake of the birds in the starter

Table 2. Proximate and phytochemical composition of *Ocimum gratissimum* leaf meal.

Parameters	Amount (%Dm)
Moisture	16.30
Dry matter	83.70
Ash	3.61
Crude protein	7.51
Crude fibre	8.01
Ether extract	2.78
Anti-nutrients (mg/100g)	
Alkaloid	1.21
Phenol	3.03
Saponin	1.57
Flavonoid	2.46
Tannin	1.87

phase were statistically similar. The feed conversion ratio (FCR) indicated significant ($p > 0.05$) values. The results of the performance of finisher broiler chickens fed *Ocimum gratissimum* leaf meal as feed additive is shown in Table 4. There were significant ($p < 0.05$) differences in the final body weight (FBW) and average weight gain (AWG) values of the birds in the finisher phase. Birds in T₄ recorded the highest significant ($p < 0.05$) values for FBW and AWG. The result obtained in this study for FBW and AWG showed that the birds were able to utilize the nutrients in the feed. The result tends to highlight the functions of feed additives that they act directly against pathogens in the gut, creating a favourable environment for protein and energy digestion, absorption and metabolism. Puyalto and Mesia (2002) and Windisch et al. (2007) also reported that some spices indigenous to Africa has positive influence on nutrient utilization by chickens.

The feed intake of the birds across the treatments were statistically similar ($p > 0.05$). The results obtained in this study for feed intake is in consonance with the report of Duwa et al. (2019) where broilers fed diet containing garlic meal recorded a non-significant ($p > 0.05$) feed intake values.

The treatment diets had significant impact on the feed conversion ratio (FCR) of the birds. Birds in T₄ had the best and the lowest significant FCR values. Alabi and Chime (2007) reported that *Ocimum gratissimum* has high mineral and vitamin content and can increase the digestibility of diets and consequently increase the utilization of the feed as indicated by the better FCR as in the case in T₄. Similarly, Hassan et al. (2004) have reported the efficiency of spices in improving the performance of poultry species. This could be attributed to their antimicrobial properties and impact on gut function (Lee et al., 2004) leading to a more stabilized intestinal health, as the animals are less exposed to microbial toxins and other undesired microbial metabolites such as

Table 3. The performance of starter broiler chickens fed *Ocimum gratissimum* as feed additive

Parameters	T ₁	T ₂	T ₃	T ₄	SEM
Av. initial body wt (g/b)	301.21	305.00	310.40	308.11	0.04
Av. final body wt (g/b)	1010.01 ^a	1111.05 ^a	1124.15 ^a	1224.05 ^b	0.15
Av. body weight gain (g/b)	708.80 ^a	806.05 ^b	813.75 ^b	915.94 ^c	0.23
Av. daily weight gain (g/b)	25.31 ^a	28.79 ^b	29.06 ^c	32.71 ^d	0.17
Av. feed intake (g/b)	51.03	51.81	51.73	52.01	0.03
Feed conversion ratio	2.05	1.80	1.78	1.59	0.02
Mortality (%)	0.00	0.00	0.00	0.00	0.00

^{abcd} - means on the same row with different superscript are significantly different ($p < 0.05$).

Table 4. The performance of finisher broiler chickens fed *Ocimum gratissimum* as feed additive

Parameters	T ₁	T ₂	T ₃	T ₄	SEM
Av. initial body wt (g/b)	980.01	981.00	990.61	990.23	0.02
Av. final body wt (g/b)	2414.18 ^a	2424.31 ^a	2550.51 ^b	2813.01 ^c	0.17
Av. body weight gain (g/b)	1434.17 ^a	1443.31 ^a	1559.90 ^b	1822.78 ^c	0.15
Av. daily weight gain (g/b)	51.22 ^a	51.55 ^a	55.71 ^b	65.10 ^c	0.13
Av. feed intake (g/b)	130.01	130.03	131.01	129.00	0.18
Feed conversion ratio	2.54 ^c	2.52 ^c	2.35 ^b	1.98 ^a	0.02
Mortality (%)	0.00	0.00	0.00	0.00	0.00

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

Table 5. Carcass/cut part of broilers fed *Ocimum gratissimum* as feed additive

Parameters	T ₁	T ₂	T ₃	T ₄	SEM
Live weight (kg)	2.40	2.31	2.33	2.20	0.32
Dressed weight (kg)	1.54 ^b	1.53 ^b	1.60 ^a	1.70 ^a	0.11
Dressing percent (%)	64.16 ^a	66.23 ^b	68.67 ^c	77.27 ^d	0.45
Cut-up parts in (%dw)					
Breast	17.36 ^a	17.24 ^a	16.98 ^a	19.12 ^b	0.11
Thigh	7.37 ^a	7.52 ^a	8.20 ^b	9.55 ^c	0.49
Wing	4.84 ^a	4.94 ^a	5.09 ^a	6.42 ^b	0.42
Drumstick	6.14 ^a	6.21 ^a	6.13 ^a	7.01 ^b	0.45
Abdominal fat	0.92 ^c	0.62 ^c	0.41 ^b	0.20 ^a	0.01

^{abcd} means on the same row with different superscript are significantly different ($p < 0.05$).

ammonia and biogenic amines.

The result of the carcass characteristics of the broiler birds are shown in Table 5. Significant differences ($p < 0.05$) were observed in live weight, dressed weight and dressing percent of broilers fed diets containing *Ocimum gratissimum* leaf meal. Birds in T₄ recorded the highest significant ($p < 0.05$) live weight, dressed weight and dressing percent values. The results for live weight, dressed weight and dressing percent of the birds were reflected in the FBW and AWG values, suggesting a positive relationship between them (heavy weight animals produced greater dressed weight). The dressing percent of the experimental birds fed *Ocimum gratissimum* and the

control fall within the range 60.30 to 74.65% recommended for broiler chickens (Onibi et al., 2009). The primal cut parts (breast, thigh, drumstick and wing) values indicated significant ($p < 0.05$) difference in their values. Birds in T₄ recorded the highest significant ($p < 0.05$) values. There were significant variation ($p < 0.05$) in abdominal fat values. The birds in the control group recorded the highest significant abdominal fat values ($p < 0.05$), while the least weight was obtained in T₄. The values for abdominal fat reduced significantly ($p < 0.05$) with increase in *Ocimum gratissimum* levels in the diet. This result agrees with the findings of Saya and Eltazi (2004), Ademola et al. (2009) and Valiollahi et al. (2013) who reported that the addition

Table 6. Haematological indices of broiler chickens fed *Ocimum gratissimum* as feed additive.

Parameters	T ₁	T ₂	T ₃	T ₄	SEM
RBC (x10 ^{12/l})	2.56 ^b	2.55 ^b	3.01 ^b	3.75 ^a	0.22
PCV (%)	40.80 ^b	39.51 ^b	41.56 ^a	48.51 ^a	1.02
HB (g / dl)	10.51 ^b	10.32 ^b	12.51 ^a	13.62 ^a	0.11
WBC (x 10 ^{9/l})	20.31	20.34	19.61	19.81	0.40
MCH (P9)	29.48	28.69	29.54	29.81	0.05
MCV (fl)	84.40	83.51	85.11	84.61	0.51
MCHC (%)	46.38	47.10	46.78	47.15	1.07

^{ab} means on the same row with different superscript are significantly different (p<0.05).

of ginger reduced significantly the abdominal fat of broilers. These findings confirmed the report of Elsaid et al., (1970) that *Ocimum gratissimum* contains thymol, an active ingredient that possesses antilipidemic and hypolipidemic properties.

The effect of the *Ocimum gratissimum* on the haematological parameters of the experimental birds is presented in Table 6. Significant (p<0.05) differences were observed in values of packed cell volume (PCV), Red blood cell (RBC) and Haemoglobin (Hb) of the experimental birds. Birds in T₄ was significantly (p<0.05) higher in the values of PVC, RBC and Hb while birds in T₁ and T₂ had the lowest values. Their values increased with increase in the level of *Ocimum gratissimum* in the diet. PCV and Hb are major indices for evaluating circulatory erythrocytes and are significant in the diagnosis of anaemia (Peters et al., 2011).

PCV reading is an indication of either an increase in the number of red blood cells or a reduction in circulating plasma volume which might be due to a physiological adaptation to high altitudes or pathological response to chronic respiratory disease (Chineke et al., 2006). Pendl (2001) reported that PCV value greater than 56% is an indication of dehydration in most birds. In the present study, no PCV value was above 35%, and the value obtained were within the reference ranges for broilers 22 to 25 percent (Jain, 1993) and 25 to 45 percent (Al-Nedawi, 2018). Edozien and Switzer (1977) reported that Hb and PCV are sensitive to level of protein intake of the birds. This suggested an adequate protein levels in the diets. The result obtained in this study is in consonance with the reports of Aikpitanyi and Egweh (2020), where broilers recorded significant (p<0.05) differences in the values of PCV, Hb and RBC when fed diet containing ginger and black pepper. However, the significant (p<0.05) differences obtained in this study for the three parameters were indications that the oxygen carrying capacity of the experimental birds were enhanced which could suggest that the nutritional profile of the diet was enriched when the herbal feed additive was added.

The diet did not have any significant (p>0.05) effect on the white blood cells (WBC) counts of the birds. These results suggest reduction of pathogenic microbes in blood,

thereby allowing the body to channel available nutrients for RBC production other than for immunoglobulin which could trigger or raise the leucocyte count. Animals with low white blood cells are exposed to high risk of disease infection, while those with moderate counts are capable of generating antibodies in the process of phagocytosis and have a high degree of resistance to diseases and enhance adaptability to local environmental and disease prevalent conditions (Isaac et al., 2013; Soefan et al., 2013). An overwhelming high WBC count in the peripheral blood is often observed in stress, inflammatory conditions due to generalized or localized infections, trauma, toxicities, neoplasms and so on (Doneley and Doneley, 2010). However, the results obtained in this study for white blood cells agrees with the report of Akinola and Eqwuanumku (2017) who reported a non-significant white blood cells value when broiler chickens were fed diets containing red pepper (*Capsicum annum* L.) as feed additive.

The experimental diets did not have any significant (p>0.05) impact on the mean corpuscular haemoglobin (MCH), mean corpuscular volume (MCV) and mean corpuscular haemoglobin concentration (MCHC) of the birds. MCH and MCHC are used to determine the presence and severity of anaemia. The result of MCH and MCHC of the birds obtained in this study suggests the ability of the birds to withstand stress. It has been reported that low MCHC values can be attributed to iron and other trace element deficiency (Howlett, 2000). The mean corpuscular volume of the birds were not significantly (p>0.05) affected by the diet.

The serological profile of the experimental birds is presented in Table 7. The serum biochemical parameters determined in this study did not show significant (p>0.05) difference in their values except cholesterol and triglyceride. The serum enzymes aspartate aminotransferase (AST), alanine aminotransferase (ALT) and alkaline phosphatase (ALP) were not significantly (p>0.05) affected by the diet. AST, ALT and ALP are known as liver enzymes (Ugwu et al., 2020). Liver is the centre of several digestive, metabolic, and productive activities, and as such, is susceptible to a varying degree of chemical and biological damages. Such damages are made obvious by the serum levels of specific enzymes

Table 7. Serum biochemical indices of broilers fed *Ocimum gratissimum* as feed additives.

Parameters	T ₁	T ₂	T ₃	T ₄	SEM
Total Protein (g/dl)	5.18	5.21	5.08	5.16	0.05
Albumin (g/dl)	3.47	3.35	3.41	3.38	0.03
Globulin (g/dl)	1.71	1.86	1.67	1.78	0.01
AST (u/l)	33.13	32.56	33.32	34.10	0.31
ALT (u/l)	65.15	66.32	65.16	65.49	0.43
ALP (u/l)	70.58	72.10	71.45	70.76	0.56
Cholesterol (mmol/l)	137.20 ^a	111.01 ^b	108.41 ^b	95.21 ^c	1.13
Triglyceride (mmol/l)	74.54 ^a	62.03 ^b	56.45 ^c	52.56 ^c	0.62

^{abc} means on the same row with different superscript are significantly different ($p < 0.05$). AST – Aspartate aminotransferase; ALT – Alanine aminotransferase; ALP – Alkaline phosphatase.

originating from the liver. These enzymes, depending on their levels may cause some disruptions to body functions which might result in poor health and production performance (Ugwu et al., 2020).

The activities of AST, ALT and ALP in the blood are bio-indicators of liver function and damage (Yildirim et al., 2011). The results obtained in this study suggest that *Ocimum gratissimum* leaf meal did not affect the function and integrity of the liver, since the activity of this liver enzymes serves as sensitive biomarkers of hepatotoxicity. Alkaline phosphatase (ALP) is an enzyme produced mainly by the intestinal mucosa, liver, bone, kidney, and placenta. A reduction in its activity may be an indication of a slowdown of bone growth (Szabo et al., 2005). Higher serum levels of ALP are observed when there is increased osteoblastic activity, involving the formation and mineralization of bone associated with increased skeletal growth (Lumeji, 2008). The result obtained in this study for ALP showed that it enhances bone formation and mineralization.

Birds in the control group was significantly ($p < 0.05$) higher in the values of cholesterol (137.20 mmol/l) and triglyceride (74.54 mmol/l). The values for triglyceride and cholesterol of the birds fed *Ocimum gratissimum* leaf meal reduced in the diet. The reductions observed in this study may be attributed to the presence of thymol and eugenol in *Ocimum gratissimum* which may inhibit lipid peroxidation. The inhibition of lipid peroxidation takes place when the major regulatory enzyme, hydroxyethylglutaryl coenzyme A reductase (HMG – COA) in the liver is inhibited (Crowell, 1999). Case et al. (1995) also reported that a five percent (5%) inhibition of HMG-COA reductase is capable of lowering serum cholesterol in poultry up to two percent (2%). The significant reductions observed in the values for triglyceride agrees with the reports of Ciftci et al. (2010) that the hypertriglyceridemia effects not seen in chickens fed with herbs and spices may be due to active ingredients in these products that leads to a decrease in the activity of lipogenic enzymes in the liver. The result obtained in this study suggests that *Ocimum gratissimum* is capable of lowering the cholesterol and triglyceride levels in the carcass of

broilers which by implication may be useful in the reduction of cardiovascular disease in human (Saeid et al., 2010).

The serum total protein did not vary significantly ($p > 0.05$) in all the treatment groups. Serum protein measures the amount of protein in the blood. The result obtained for total protein in this study showed that the protein in the diets was adequate. The albumin and globulin were not significantly ($p > 0.05$) affected by the diet. Albumin is made mainly in the liver. It helps blood from leaking out of blood vessels. Albumin help carry some medicine and other substances through the blood and its importance for tissue growth and healing. Globulin is made up of different proteins called – Alpha, beta and gamma types. Some globulins are made by the liver, while others are made by the immune system. Some globulin binds with haemoglobin while others transport iron in the blood and help fight infections (Pioneer et al., 2020). The result obtained in this study for albumin and globulin showed that addition of scent leaf did not obstruct or temper with the functions of the two parameters mentioned.

Conclusion and recommendation

This study revealed that the inclusion of *Ocimum gratissimum* in broiler diets has been found to enhance growth performance, carcass traits, and blood profile of broiler chickens when fed up to 150 g per 100 kg in their diets. The use of *Ocimum gratissimum* may be useful in organic poultry production and poultry production in rural areas where there is reduced accessibility to conventional medications.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

REFERENCES

Adam, C. (2005). Nutrition-based Health. *Feed International*, 2, 25-28.

- Ademola, S. G., Farinu, G. O., & Babatunde, G. M. (2009). Serum lipid, growth and haematological parameters of broilers fed garlic, ginger and their mixtures. *World Journal of Agricultural Science*, 5(1), 99-104.
- Aikpitanyi, K. U., & Egweh, N. O. (2020). Haematological and biochemical profile of broiler chickens fed diets containing ginger and black pepper additives. *Nigerian Journal Animal Science*, 22(2), 114-125.
- Ajibaiye, O. E., Onimisi, A., & Moses, O. (2018). Effects of a commercial blend of essential oils and organic acids on the performance of broiler chickens. *Nigerian Journal of Animal Production* 45(3), 218-227.
- Akinola, L. A. F., & Egwuanumku, J. O. (2017). Haematology and Serum Biochemistry of laying Hens fed Red Pepper (*capsicum annum L.*) as feed additive. *Nigerian Journal Animal Science*, 19(1), 127-133.
- Alabi, R. A., & Chime, C. C. (2007). Impact of food production on food importation. Interim report presented to African Economic Research Consortium (AERC) Nairobi.
- Al-Nedawi, A. M. (2018). Reference Hematology for commercial ross 308 broilers. *Online Journal of Veterinary Research*, 22(7), 566-570.
- AOAC (1995) *Association of Official Method of Analysis*. 15th Edition. Association of Official Analytical Chemists. Washington DC. Pp. 68-69.
- Cardozo, P. W., Calsamiglia, S., Ferret, A., & Kamel, C. (2004). Effects of natural plant extracts on ruminal protein degradation and fermentation profiles in continuous culture. *Journal of Animal Science*, 82(11), 3230-3236.
- Case, G. L., He, L., Mo, H., & Elson, C. E. (1995). Induction of geranyl pyrophosphate pyrophosphatase activity by cholesterol-suppressive isoprenoids. *Lipids*, 30(4), 357-359.
- Chineke, C. A., Olugun, A. G., & Ikeobi, C. O. N. (2006). Haematological parameters in rabbit breeds and crosses in humid tropics. *Pakistan Journal of Biological Sciences*, 9(1), 2102-2106.
- Ciftci, M., Simsek, U. G., Yuçe, A., Yilmaz, O., & Dalkilic, B. (2010). Effects of dietary antibiotic and cinnamon oil supplementation on antioxidant enzyme activities, cholesterol levels and fatty acid compositions of serum and meat in broiler chickens. *Acta Veterinaria Brno*, 79, 33-40.
- Crowell, P. L. (1999). Prevention and therapy of cancer by dietary monoterpenes. *The Journal of Nutrition*, 129(3), 775S-778S.
- Czarra, J., & Fred, M. (2009). *Species: A global history*. Reaction books. p.128.
- Dacie, J. V., & Lewis, S. M. (1991). *Practical Haematology Churhill*. Living-stone, New York.
- Dibner, J. (2004). Organic acids: Can they replace antibiotic growth promoters. *Feed International*, 25(12), 14-16.
- Dijk, A. V. T. (2004). Testing acidifiers and other AGP alternative. *Feed International*, 5, 10-12.
- Doneley, B., & Deneley, R. (2010). *Avian medicine and surgery in practice: Companion and aviary birds*. Manson Publishing Ltd, London, UK.
- Duncan, D. B. (1995). Multiple range and multiple F-tests. *Biometrics*, 11(II), 1-42.
- Duwa, H., Saleh, B., Chana, Z. M., & Crigiri, A. Y. (2019). Influence of varying dietary energy levels supplemented with ginger or probiotics on performance of broiler chickens under a semi-arid environment. *Nigeria Journal of Animal Science*, 21(1), 56-62.
- Edozien, J. C., & Switzer, B. R. (1977). Effects of dietary protein, fat and energy on blood hemoglobin and hematocrit in the rat. *The Journal of nutrition*, 107(6), 1016-1021.
- El-Said, F., Sofowora, E. A., Malcolm, S. A., & Hofer, A. (1969). An investigation into the efficacy of *Ocimum gratissimum* as used in Nigerian native medicine. *Planta Medica*, 17(02), 195-200.
- Eltazi, S. M. A. Mohamed, K. A. & Mukhtar, M. A. (2014). Effect of using ginger powder as natural feed additive on performance and carcass quality of broiler chicks. *Assiut Veterinary Medical Journal*, 60(141), 87-95.
- Engberg, R. M., Hedemann, M. S., Leser, T. D., & Jensen, B. B. (2000). Effect of zinc bacitracin and salinomycin on intestinal microflora and performance of broilers. *Poultry Science*, 79(9), 1311-1319.
- Fadlalla, I. M. T., Mohammed, B. H., & Bakhiet, A. O. (2010). Effect of feeding garlic on the performance and immunity of broilers. *Asian Journal of Poultry Science*, 4(4), 182-189.
- Harborne, J. B. (1973). *Phytochemical methods. A guide to modern techniques of plant analysis*. Chapman and Hall Limited. London. p. 279.
- Harborne, J. B. (1998). *Phytochemical methods. A guide to modern techniques of plant analysis*. Chapman and Hall Limited. London. p. 279.
- Haslam, E. (1996). Natural polyphenols (vegetable tannins) as drugs: possible modes of action. *Journal of Natural Products*, 59(2), 205-215.
- Hassan, I. I., Askar, G., & El-Shourbagy, A. (2004). Influence of some medicinal plants on performance. Physiological and meat quality traits of Broiler Chicks. *Egypt Poultry-Science*, 24, 247-266.
- Howlett, J. C. (2000). Clinical and diagnostic procedures. In: Samour, J. H. (ed.) *Avian Medicine*, London, Harcourt Publishers Ltd. Pp. 28-50.
- Ilori, M. O., Sheteolu, A. O., Omonigbehin, E. A., & Adeneye, A. A. (1996). Antidiarrhoeal activities of *Ocimum gratissimum* (Lamiaceae). *Journal of Diarrhoeal Diseases Research*, 14(4), 283-285.
- Isaac, L. J., Abah, G., Akpan, B., & Eketi, I. U. (2013). Haematological properties of different breeds and sexes of rabbits. Proceedings of the 18th Annual Conference of Animal Science Association of Nigeria. Pp. 24-27.
- Jain, N. C. (1993). *Essentials of Veterinary Haematology*. Lea and Febiger, Philadelphia, USA. Pp. 19-53.
- Kamel, C. T. (2001). Modes of action and roles of plant extract in non-ruminant. In: Crarassiorthy, P. C., & Wiseman J. (eds.). *Recent advances in animal nutrition*. Nottingham Union Press, Nottingham, U.K. p. 387.
- Kehinde, A. S., Obun, C. O., Inuwa, M & Bobadoye, O. (2011). Growth performance, haematological and some serum biochemical indices of cockerel chicks fed ginger (*Zingiber officinale*) additives diets. Proceedings of 36th Conference of Nigerian Society of Animal Production. 13th – 16th March. University of Abuja, Nigeria Pp. 185-189.
- Lee, K. W., Everts, H., Kappert, H. J. Wouterse, H. Frehner, M. & Beynem, A. C. (2004). Cinnamaldehyde, but not thymol, counteracts the carboxymethyl cellulose-induced growth depression in female broiler chickens. *International Journal of Poultry Science*, 3(9), 608-612.
- Lumeji, J. T. (2008). Avian Clinical Biochemistry (pp. 839-872). In: Kaneko, J. J., Harvey, J. W., & Brussed, M. L. (eds.). *Clinical Biochemistry of domestic animals*. 6th edition. Academic Press, Burlington MA.
- Mohan, V. R., & Daffodil, E. D. (2016). Anti-nutritional factors in legume seeds: Characteristics and determination. *Encyclopedia of Food and Health*. Pp. 211-220.
- Njoku, O. U., Joshua, P. E., Agu, C. V., & Dim, N. C. (2011).

- Antioxidant properties of *Ocimum gratissimum* (*Ocimum gratissimum*). *New York Science Journal*, 4(5), 98-103.
- NRC (1994). *Nutrient Requirements of poultry*: 9th Revised Edition. National Academy of Science, Washington, DC, p. 176.
- Onibi, G. E. Adebisi, O. E. Fajernisin, A. N. & Adetunji, A. V. (2009). Response of broiler chickens in terms of performance and meat quality to garlic (*Allium sativum*). *African Journal of Agricultural Research*, 4(5), 511-517.
- Pendl, H. (2001) Avian Haematology for practitioner. Proceedings: Association of Avian Veterinary. Pp. 388-400.
- Peters, S. O., Crunn, H. H., Imumorin, I. G., Aqaviezor, B. O., & Ikeobi, C. O. N. (2011). Haematological Studies in frizzled and naked neck genotypes of Nigerian native chickens. *Tropical Animal Health Production*. 43(3), 631-638.
- Poineer, A. C., Gabica, M. J., Thompson, E G., Romito, K., & Husney, A. (2020). Serum Protein Electrophoresis (SPEP). Healthwise. Retrieved from <https://www.healthlinkbc.ca/medical-tests/hw43650>.
- Puyalto, M., & Mesia, J. (2002). Fighting gut pathogens *in-vitro* assessment of organic acids derivatives and combinations. *Poultry International*, 41(2), 19-24.
- Robertson, S. (2018). *What are flavonoids*. News Medical Life Sciences. Retrieved from <https://www.news-medical.net/health/What-are-Flavonoids.aspx>.
- Saeid, J. M., Mohamed, A. B., & Al-Baddy, M. A. (2010). Effect of aqueous extract of ginger (*Zingiber officinale*) on blood biochemistry parameters of broiler. *International Journal of Poultry Science*, 9(10), 944-947.
- Soefan, K. O., Akinrinde, A. S. & Ajibade, T. O. (2013). Preliminary Studies on the haematological parameters of cockerels fed raw and processed guinea corn (sorghum bicolor) (pp. 49-52). *Proceeding of 38th Annual Conference of Nigerian Society of Animal Production*.
- Szabo, A., Mezes, M., Horn, P., Sütő, Z., Bázár, G. Y., & Romvari, R. (2005). Developmental dynamics of some blood biochemical parameters in the growing turkey (*Meleagris gallopavo*). *Acta Veterinaria Hungarica*, 53(4), 397-409.
- Stephen, G. P. (2008) Nitrogen Metabolism. In: *Physiology of Woody Plants*. 3rd Edition. Elsevier Publisher. Pp. 233-254.
- Tian, W. (2008) *Herbs in Africa. A field guide to the natural history of herbs*. NSW department of primary industries. www.wiseselect.com/herbs
- Ugwu, D. O., Jiwuba, P. C., Ubogu, V. & Akazue, R. C., (2020). Phytochemical properties of *Hisbiscus sabdariiffa* Calyx and the effects of its aqueous extract supplementation on haematological and serum biochemical indices of broiler birds. *Nigerian Journal of Animal Science*, 22(3), 165-172.
- Valiollahi, M. R., Rahinian, Y., Miri, Y., & Rafies, A. (2013). Effect of ginger (*Zingiber officinale*) black pepper (*Piper migrum*) powders on performance, some blood parameters and antibody titier against New Castle vaccine on broiler chicks. *Scholarly Journal of Agricultural Science*, 3(12), 535-540.
- WHO (1980). *Manual of basic techniques for a health laboratory*. World Health Organization, Geneva, Pp. 360-406.
- Wikipedia (2021) Akwa Ibom State. Wikipedia. Retrieved 4th December, 2020 from <https://www.wikipedia.org/wiki/Akwabom-State>.
- Windisch, W., Schedle, K., Plitzner, C., & Kroismayr, A. (2008). Use of phytogetic products as feed additives for swine and poultry. *Journal of Animal Science*, 86(suppl_14), E140-E148.
- Ya, C. Craffney, S. H., Lilley, T. H., & Haslam, E. (1988). Carbohydrate polyphenol complexation. In: Hemingway, R. W., & Karchesy, J. J. (eds.). *Chemistry and significance of condemned tannins*. Plenum press, New York, USA. p. 553.
- Yildirim, E., Yalçinkaya, I., Kanbur, M., Çinar, M., & Oruç, E. (2011). Effects of yeast glucomannan on performance, some biochemical parameters and pathological changes in experimental aflatoxicosis in broiler chickens. *Revede Medicine Veterinaire*, 162(8-9), 413-420.