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Effect of dietary white ginger powder on the productivity on broiler chickens

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Abstract

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The present study was carried out to determine if dietary white ginger (*Zingiber officinale*) powder can improve the performance of broiler chickens. A total of one hundred and twenty (120) day old *abor acre plus* strain of broiler chicks were randomly allocated to four (4) dietary treatments of 30 birds each with three replicates of ten (10) chicks per replicate. Four experimental diets were formulated in such a way that control diet (T_1) contained no white ginger additive. Birds in group T_2, T_3 and T_4 were fed diets containing 0.20, 0.25 and 0.30 % white ginger respectively. The feeding trial was carried out for 56 days and parameters on growth performance, nutrient digestibility, haematological parameters, serum biochemicals and production cost were evaluated. Growth parameters and nutrient utilization were not significantly difference across the dietary treatment. All value obtained or serum biochemical and haematological parameters were within the normal range for a healthy broiler chicken. Considering the feed cost per weight gain, profit per bird, and cost to benefit ratio, broiler birds in the group fed 0.30 % white ginger powder was more efficient. It is concluded that supplementation of white ginger up to 0.30 % had no negative effect on broiler chickens performance when added as feed additives.

Keywords: additives; white ginger; performance; cost; nutrient digestibility; blood

Introduction

The latest world's population projection by United Nations suggested that the global population could grow to around 8.5 billion in 2030, 9.7 billion in 2050 and 10.4 billion in 2100 (UN DESAPOP 2022). This alarming rate in the population growth necessitated the need to meet the animal protein need of the masses by intensify the production of livestock such as poultry.

Meat and egg from poultry can play a major role in solving the problem of malnutrition associated to animal protein deficiencies. Despite the efforts to combat the looming malnutrition due to insufficient animal protein intake, high cost of feed materials such as grain has been a major factor militating against production of poultry.

Maize and soybean are the key feedstuff in poultry feed production as a source of energy and protein which takes between 44 – 58 % and 30 - 35 % total compounded feed respectively (Sunmola *et al.* 2018). These grains also formed the major food material for human consumption as well as important raw material for industrial use. This has greatly affected the expansion of poultry industries due to high cost of production associated to the competition between industries, human beings and animals for grains.

In order to reduce this competition and increase the production of the poultry products, researched had been tailored toward searching for alternative feedstuff such as non-convention feed resources and their by-products. Non-conventional feedstuffs refer to all those feeds that have not been traditionally used in animal feeding and or are not normally used in commercially produced rations for animals, they are non-competitive in terms of human and animal consumption, readily and locally available. The nutritional quality of these feed materials is low Devendra (1985) capable of impair the health status of the birds. Growth promoters/feed additives has been used in poultry feed to enhance the nutritive quality of the feed as well to improve the production and health status of the birds (Raeesi *et al.* 2010).

European Union in 2006 banned on-farm use of antibiotics due to it pathogenic resistance, residual effect in the poultry meat and egg which pose biosecurity threat on animals and human health as well as imbalance in the natural gut microflora of the birds (Al-Bahry *et al.* 2006). Also, adoption of intensive system of the poultry to ensure enhanced productivity necessitated supplying the bird's nutritionally balanced diet. Therefore, alternative materials and strategies for growth enhancement and disease management are being investigated among which, phytogenic materials have received increased attention (Toghyani *et al.* 2011). Among the phytogenics materials identified is ginger.

Ginger is an herbaceous plant grown annually for it spicy underground rhizomes widely used as a spice and in treatment of some infectious diseases in poultry (Chrubasik *et al.* 2005). Ginger rhizomes possess several actively biologic compounds such as antioxidation, antimicrobial and pharmacological effects (Ali *et al.* 2008).

Khan *et al.* (2012) reviewed on utilization of ginger as a feed additive in poultry production; the reports showed that ginger has also been used in the treatment of certain ailment such as gastrointestinal and respiratory disorders. Depressed growth rate was reported by Al-Homidan (2005) in broiler birds at 4 and 6th week when ginger was added at the rate of 6 g/kg diet. This was attributed to the toxic effect of the antinutritional compound associated with the ginger. Onu *et al.* (2010) observed that addition of ginger at 0.25 % in the basal diet of broiler chickens resulted in improved weight gain and feed utilisation. Report of Al-Khalaifa *et al.* (2022) also showed that ginger improved nutrient utilisation and absorption due of the positive influence of the phytochemical properties present in the ginger on gastric secretion and digestive enzyme activities.

Ginger varieties differ according to the size of the rhizome, flavour, aroma, colour and fibre content (Greathead, 2003). Generally, ginger effects had been extensively investigated in broiler chickens; there is paucity of information on the varietal characterization based on the colour of ginger as feed additive in broiler chickens. Therefore, this study carried out to investigate if white ginger powder can improve the performance of finisher broiler chickens.

Materials and Methods

Experimental site

The research was conducted at the Poultry unit of the Livestock, Teaching and Research Farm, Joseph Sarwuan Tarka University Makurdi, (JOSTUM). Makurdi is the state capital of Benue State in north central geopolitical region of Nigeria. Makurdi is located between latitude 7^{0}44′ 1.50" N and longitude 8^0 31′ 17.00" E in the Guinea Savanna Zone of Nigeria with an annual rainfall of between 6 - 8 months (March - October) ranging from 508 to 1016 mm with minimum and maximum temperatures of 22.8^{0}C and 40.03 ^{0}C respectively. The relative humidity ranges between 37.3 and 59.2 % (Audu et al., 2022).

Collection and processing of white ginger

Fresh white ginger root (Rhizomes) was procured from the local market within Makurdi town, Benue State, Nigeria. The rhizomes were soaked in water to clean them and remove adhering soil; the long roots were removed as well as leaf scales which later chopped into smaller pieces using sharp knives to reduce drying time and to yield turmeric chip with lower moisture content. The chopped rhizomes were sun-dried for 6 days on a flat and clean concrete floor to a moisture content of less than >10 %. It was spread in about 4-6 cm thick layer to minimize direct sunlight that result in surface discoloration (Anandaraji et al., 2001). Dried rhizomes were ground using a hammer mill of 2 mm to obtained white ginger powder. The powder was airtight in a polyethylene bag, placed inside a well-covered plastic and properly kept for subsequent use in feed mixing as feed additive.

Management and disease control

The poultry house and all other equipment used were thoroughly washed, disinfected and fumigated 10 days before the arrival of the chicks. Wide newspapers were spread in each pen and used as litter for the first 7 days before exposed them to the mould free and evenly spread litter material (wood shavings). Newspapers were used for the first 7 days to prevent the chicks from picking coarse wooden materials which may be injurious to their gastrointestinal tract. The pen kept warm with 200 watt heat generating bulbs 24 hours before the chicks' arrival to keep temperature at the range of 85 to 90 ^{0}F which is the ideal temperature range for the brooding of new chicks in the Guinea Savanna Zone of Nigeria. The brooder temperature was adjusted according to the needs of the birds as observed in their behaviours. The birds were kept intensively and stocked at 10 birds/ m^2. They were fed on formulated experimental starter (0 - 4 weeks) and finisher (5 - 8 weeks) diets. Experimental feed and clean-saved water were supplied *ad-libitum* throughout the experimental period. Medication and vaccination was done according to the consulting veterinarian directions.

Experimental design and diets formulation

One hundred and twenty (120) mixed sex day old *Abor acre plus* strain broiler chicks were obtained from a reputable hatchery in Ibadan Oyo state, South Western part of Nigeria. The birds were all weighted using the sensitive scale (Metler scale), the total weight was divided by the number of birds to have the average initial weight of the chicks. The birds were randomly distributed into four dietary groups each having three replicates with ten (10) birds per replicate. Birds were housed in deep litter compartments walled with wire mesh. All the diets were isonitrogenous-isocaloric and are maize-soybeans based diets with the white ginger powder added at 0, 0.20, 0.25 and 0.35 representing T_1, T_2, T_3 and T_4 respectively. T_1 is the control which did not contain ginger. Micro ingredients (methionine, premix, lysine and salt) were fixed at 0.25

Table 1. Gross composition of the experimental starter and finisher broiler diets

	Experimental diets	
	Broiler starter diet (1-28 days)	Broiler finisher diet (29-56 days)
Ingredients		
Yellow maize	53.00	56.60
Soya bean meal	30.30	24.90
Groundnut cake	4.00	4.40
BDG	2.50	4.00
Rice bran	2.00	2.00
Bone meal	3.00	3.00
Blood meal	3.00	2.80
Palm oil	1.00	1.50
L-Lysine	0.15	0.15
*Herbo-Methionine	0.20	0.20
Premix	0.25	0.25
Common salt	0.25	0.20
Total	100	100
Calculated analysis		
ME (kcal/kg)	2941	2994
Crude protein (%)	23.24	21.28
Crude fibre (%)	4.00	4.08
Ether extract (%)	4.84	5.26
Lysine (%)	1.48	1.19
Methionine (%)	0.54	0.52
Calcium (%)	1.29	1.38
Available Ph (%)	0.71	0.68

**To provide the following per kg of diet vitamin A – 15,000.00IU, Vitamin D3 - 3, 000,000IU, Vitamin E- 30,000IU, Vitamin K3,000mg, Vitamin B1 3000,mg Vitamin B2-6000mg, Vitamin B6- 5,000mg, Vitamin B12-40mg, Biotin 200mg, Niacin-40,000mg, Pantothenic acid 15,000mg, Folic acid 2,000mg, choline 300,000mg, Iron 60,000mg, manganese 80,000mg, copper 25,000mg, Zinc 80,000mg cobalt 150mg, Iodine 500mg. (feed formulation was done using the feedwin software application) BDG - Brewer dried grain; Ph – Phosphorus; Vit./min. – vitamin/mineral*

% of the total diet. The diets were formulated using feedwin software application, the nutrient composition of the macro feed ingredients (maize, soybean meal, groundnut cake, brewer dried grain, rice bran, blood meal and palm oil) used in formulating the experimental diets were analysed for the proximate composition before inputted into feed ingredient spread sheet of the software application for the feed formulation. The diets were formulated to meet the standard nutrient requirements of broiler birds according to the NRC (1994) for both starter and finisher's as shown in Tables 1. The minimum (0.20 %) and maximum (0.30 %) inclusion level was based on the recommended level (0.25 %) reported by Onu (2010) for optimal performance of broiler chickens.

Growth data collection

Data were collected weekly on body weight, weight gain, feed intake and feed conversion ratio estimated according the formulas below;

$$Average\ initial\ weight\ (g) = \frac{Total\ weight\ of\ birds\ at\ initial}{Total\ no\ of\ birds}$$

$$Average\ final\ weight\ (g) = \frac{Total\ weight\ of\ birds\ in\ a\ replicate}{Total\ no\ of\ birds\ in\ the\ replicate}$$

Average weight gain = average final weight – average initial weight

$$Average\ daily\ weight\ gain = \frac{Average\ final\ weight - Average\ initial\ weight}{Experimental\ period}$$

Feed Intake = feed supplied – feed left over

$$\text{Average feed intake} = \frac{\text{Total feed intake}}{Number\ of\ birds}$$

$$\text{Average daily feed intake} = \frac{\text{Average feed intake}}{Number\ of\ the\ experimental\ days}$$

$$FCR = \frac{Average\ daily\ feed\ intake\ (g)}{Average\ daily\ weight\ gain\ (g)}$$

Production cost

Cost of feed was calculated from the cost of ingredients used in feed preparation. The cost of each experimental diet was calculated according to the prices of the ingredients, based on quotes obtained in October 2022 when the study was carried out. The prices of ingredients used to establish feed costs per kg were: yellow maize, ₦250.00k; soybean meal, ₦325.00k; groundnut cake, ₦250.00k; brewer dried grain, ₦170.00k; rice bran, ₦100.00k; bone meal, ₦100.00k; blood meal, ₦180.00k; palm oil ₦650.00k; L-lysine, ₦1000.00k; vitamin and mineral supplement for the starter phase, ₦1800.00k; vitamin and mineral supplement for the finisher's phase, ₦1700.00k and white ginger powder, ₦2300.00k. Feeding cost was determined based on total feed intake per bird multiplied by the cost of the diet used. The unit price per day-old chick was ₦220.00k. The final value for each bird was obtained by multiplied the final weight of the bird by the price per kg live weight (₦1200.00k), as practiced in Makurdi, Benue state, North-central Nigeria in October 2022. All the production cost indices considered were estimated using the following formula:

$$Cost/kg\ feed = \frac{Cost\ of\ Ingrediets\ for\ 100\ kg\ feed + cost\ of\ test\ ingredients}{100}$$

$$Feed\ cost\ per\ kilogram\ live\ weight = Feed\ cost\ per\ kilogram\ x\ Feed{:}\ gain\ ratio$$

$$Feed\ cost\ per\ kg\ weight\ gain\ = \frac{Feed\ cost\ per\ kg\ x\ Total\ feed\ intake}{Total\ weight\ gain}$$

$$Feed\ cost\ per\ chicken = Daily\ feed\ intake\ x\ Experimetal\ days\ x\ feed\ cost\ per\ kg$$

$$Operational\ cost\ = Total\ expenses\ on\ each\ birds - expenses\ on\ feed\ and\ chick\ cost$$

$$Total\ production\ cost\ = Cost\ of\ day\ old\ bird + feed\ cost\ per\ bird + operational\ cost$$

$$Feed\ cost\ (\%\ Total\ production\ cost) = \frac{Cost\ of\ kg\ feed}{Total\ production\ cost}\ x\ 100$$

$$Income\ per\ bird\ = Average\ live\ weight\ x\ selling\ price\ kg\ live\ weight$$

$$Profit\ per\ bird\ = Income - expenses$$

$$Cost{:}\ Benefit\ = \frac{Total\ expenses}{Total\ income}$$

Nutrient digestibility

Nutrient digestibility study was carried out at the end of week seven and terminated at the end of week eight. Two birds per replicate group that had the weight equal the average weight of the entire replicate group were selected, marked and transferred into the metabolic cages. Three days acclimatization period was allowed for the birds to adjust to the condition of the cage and the respective diets were offered to the birds. Data on the daily feed intake and faecal output were recorded for the next four days after the acclimatization period. The droppings were collected per replicate once daily at 8:00 am, weighed and dried in an oven at 70 °C to constant weight. Dried excreta were bulked and ground per replicate using RESCH Hammer mill of 0.8 mm. Experimental diets and feacal samples were used to determine their respective proximate constituent according to the procedure of AOAC (2006). The nutrient digestibility was calculated using the formula below:

$$Nutrient\ digestibility = \frac{Nutrient\ in\ feed - Nutrient\ in\ excreta}{Nutrient\ in\ feed}\ x\ 100$$

Procedures for calculation the nutrient digestibility are as follow;

1. Amount of a nutrient in daily feed intake – the amount of that nutrient in daily feaces excreted = Daily amount of the digested nutrient.

Note:

a. Amount of nutrient in daily feed = (amount of feed consumed daily × % of nutrient in feed)/100.

b. Amount of a nutrient in daily feaces = (Average amount of feaces excreted daily × % of nutrient in feaces)/100.

2. Coefficient of digestibility of any nutrient = (Amount of that nutrient digested daily/amount of the nutrient consumed daily) × 100.

3. % of digestible nutrient in a feed = (Amount of the nutrient in the feed × coefficient of digestibility of that nutrient)/100.

Blood constituent evaluation

Blood evaluation was conducted according to Jain (1986) procedure. Samples were collected from each treatment group at the end of the feeding trail. Three birds per treatment were bled using a sharp knife and blood was collected from the jugular vein during bleeding were analysed. During bleeding, about 5 ml of blood was collected from each bird, 2 ml of the blood collected was put into a well labelled sterilized bijon bottles containing ethylene diamine tetra acetic acid (EDTA) as anticoagulant. These were used for the determination of the haematological indices. The remaining blood samples were allowed to coagulate to produce sera for the determination of serum biochemical indices. Blood samples were analysed within three hours of their collection for total erythrocyte (RBC) and leukocyte (WBC) counts, haematocrit (PCV) and haemoglobin concentration (Hb). The bottles of coagulated blood were centrifuged at 3000 rpm for ten minutes for serum separation. Thereafter, the harvested sera were used for evaluation of total protein, albumen, globulin, glucose and other biochemical constituent such as creatinine, aspartate amino transferase (AST), alanine aminotransferase (ALT) and alkaline phosphatase (ALP) concentration were also assayed.

Statistical analysis

Generated data were subjected to one way Analysis of Variance (ANOVA) using SAS (2002) software package, the means of the parameters that were significantly differed ($p<0.05$) were separated using Duncan's Multiple Range Test (DMRT).

Results and Discussion

Effect of white ginger powder on growth performance of broiler chickens

White ginger powder did not show significant effect ($p>0.05$) on the average final weight, daily weight gain, daily feed intake and feed conversion ratio Table 2. The result could be compared with that of Duwa *et al.* (2020), who did not find significant differences when broiler chickens were fed dietary ginger powder between 0 – 6 % as feed additives. The report of Mahdy *et al.* (2017) on Hubbard strain of broiler chickens showed that diets containing 2 % supplemented red ginger did not have significant influence on body weight of the birds. Sunmola *et al.* (2023) observed non-significant effect when fed broiler chickens turmeric supplemented diets. Non-significant feed conversion ratio obtained in this study is in tandem with the findings of Ahmed *et al.* (2014) and Rebh *et al.* (2014) who revealed that feed conversion efficiency did not differ among the treatment groups fed ginger supplemented diets. However, Rebh *et al.* (2014) observed significant increased in body weight and weight gain of the broiler birds fed ginger supplemented diets. Talukder *et al.* (2017) attributed the higher body weight observed on broiler fed supplemented dietary ginger powder to increase stimulation of digestive fluids which enhanced the nutrient absorption and utilization occasioned by phytogenic properties of the ginger. Different observation by authors may be attributed to factors such as dosage levels, processing method, botanical composition of the rhizome material, geographical location etc.

Economics of production of broiler chickens fed diets containing white ginger powder

Table 3 showed the economics of production on broiler chickens fed diets containing white ginger powder. All the cost was expressed in Naira (₦) value, as at the time of this study from October to December 2022, one dollar ($1) was equal seven hundred and eighty naira (₦780) Nigeria currency. The cost of day old chick was ₦220.00 groups. Feed cost per kilogram (kg) ranged from ₦269 (T_1) to ₦276 (T_4). Cost of the feed per kilogram increased with increase levels of ginger powder. Feed cost/weight gain ranged from ₦546 (T_4) to ₦591 (T_1). Better feed cost per weight gain observed on birds fed T_4 (0.30 % white ginger) showed that the birds in the group efficiently utilized the feed consumed than those in other groups. The major concern of the farmer is how efficient the animals utilised the feed consumed to build the body flesh. Therefore, the lower the feed cost per weight gain, the better it is in terms of profit maximization. Total production cost was lower in the group of birds fed white ginger powder compared to control. This resulted from the higher feeding cost due to higher feed consumed by the birds fed control diet.

Cost saving was observed across the treatment groups, indicated that white ginger powder is economically beneficial in poultry feed as an additive. This finding confirmed the report of Sunmola *et al.* (2022) and Duwa *et al.* (2020) who observed that the profits were made on all the birds fed diet containing turmeric and ginger powder respectively. The higher feed cost when expressed as a percentage of the total cost of production observed for control was attributed to higher feed consumed which lead to higher feed cost per kg. The result of production cost obtained in this study confirm the report of Sa'aci *et al.* (2017) who stated that the use of the phytogenic feed additive in broiler chicken diets had an economic advantage when feed cost is considered. The live weight of the birds determined the income earned per bird, the higher the live weight; the higher the income since the selling price was kept constant and the birds were sold in live per kilogram. Profit per bird showed that the birds in all the groups attracted profit. Cost to benefit ratios were all less than one (1) suggesting the beneficial effect of dietary white ginger

Table 2. Effect of white ginger powder on growth performance of broiler chickens

Experimental Diets						
Parameter	T_1	T_2	T_3	T_4	SEM	P-value
AIW (g)	39.00	39.00	39.00	39.00	0.00	-
AFW (g)	2000	1916	1928	2026	29.81	0.54
AWDG (g)	40.85	39.12	39.36	41.41	0.62	0.54
ADFI (g)	91.46	83.96	88.96	89.31	1.38	0.29
FCR	2.24	2.14	2.26	2.16	0.03	0.50

AIW = average initial weight; AFW = average final weight; ADWG = average daily weight gain; ADFI = average daily feed intake; FCR = feed conversion ratio; SEM = standard error of mean; $T_{1\,=}$ *Control diet;* $T_{2\,=}$ *0.20 % white ginger powder;* $T_{3\,=}$ *0.25 % white ginger powder;* $T_{4\,=}$ *0.30 % white ginger powder*

Table 3. Production cost of broiler chickens fed white gingers powder

Experimental Diets				
Economic Indices	T_1	T_2	T_3	T_4
C of DOC (₦/chick)	220.00	220.00	220.00	220.00
FC (₦/kg)	269.00	274.00	275.00	276.00
FC/WG (₦/kg)	591.00	568.00	570.00	546.00
FC (₦/chicken)	1183.00	1090.60	1101.00	1108.00
OPC (₦/chicken)	150.00	150.00	150.00	150.00
TCP (₦/chicken)	1553.00	1461.00	1471.00	1478.00
CS due to spices (₦)	-	92.00	82.00	75.00
FC (% TCP)	76.38	74.88	75.05	75.18
Expenses per bird (₦)	1553	1461	1471	1478
Income per bird (₦)	2200	2107	2121	2241
Profit per bird (₦)	648	647	650	763
Cost: Benefit	0.71	0.70	0.70	0.66

$T_{1\,=}$ *Control diet;* $T_{2\,=}$ *0.20 % white ginger powder;* $T_{3\,=}$ *0.25 % white ginger powder;* $T_{4\,=}$ *0.30 % white ginger powder* $T_{1\,=}$ *Control diet;* $T_{2\,=}$ *0.20 % white ginger powder;* $T_{3\,=}$ *0.25 % white ginger powder;* $T_{4\,=}$ *0.30 % white ginger powder*

powder as feed additive on the birds at inclusion levels up to 0.30 %. Sa'aci *et al.* (2017) observed profit in all the treatment groups fed ginger and turmeric and their combinations. White ginger powder as feed additives is a sustainable and safe solution, allowing for reducing feed cost while maintaining the desired performance standard.

Effect of white ginger powder on nutrient digestibility of broiler chickens

Effect of white ginger powder on nutrient utilization of broiler chickens (Table 4) showed that white ginger did not have significant effect on all the nutrient digestibility parameters observed. This may suggest that the test material did not have deleterious effect up to the highest inclusion level (0.30 %) and the processing method (Sun-dry) that gave rise to the white ginger powder did not have adverse effect on nutrient utilization of broiler chickens. Although, report showed that dietary ginger enhanced digestive enzymes activities such as pancreatic lipase, intestinal lipase and maltase in rat Platel and Srinivasan (1996) which have positive effect on gut function by modifying the gut micro flora to enhance the digestion and nutrient utilization (Windisch *et al.* 2008). In this study, non-significant effect observed across the groups may suggest the low inclusion level of dietary white ginger even up to 0.30 %. The result confirmed the findings of Sunmola *et al.* (2022) who reported no significant effect of turmeric supplemented diets on nutrient digestibility of broiler chicks. Cross *et al.* (2007) did not observe significant differences in crude protein, crude fibre and amino acids when plant extract products containing carvacrol, cinnamaldehyde and capsicum oleoresin added in corn-soybean meal or wheat-barley-soybean meal diets were fed to male Hubbard broiler chickens. Lee *et al.* (2010) did not found significant differences between non-supplemented control and phytoadditive treatments on apparent ileal digestibilities of crude protein and starch on female Cobb broilers fed diet supplemented thyme, cinnamaldehyde and commercial essential oils at 100 mg/kg diet. However, Duwa *et al.* (2020) observed significant differences when broiler chickens were fed diet added ginger powder. The factors that may be responsible for variations in the results by different authors may be attributed to differences in phytogenic material, inclusion levels, processing methods, duration of the study, breeds and age of the birds, season and location of the study and the general management of the experimental birds etc.

Effect of white ginger powder on haematological parameters of broiler chickens

Effect of white ginger powder on haematological parameters of broiler chickens is presented in Table 5. The results of haematological indices showed significant differences ($p<0.05$) on pack cell volume (PCV) ranged 30.50 – 36.50%, mean corpuscular haemoglobin concentration (MCHC) 33.25 – 33.35 g/dL, lymphocytes 48.00 – 51.50 % and eosinophil 0.00 – 1.50 % concentration. Addition of white ginger powder decreased the concentration of PCV at the inclusion above 0.20 %. MCHC show higher concentration in the blood sera of birds fed ginger based diets compared to control. Lymphocytes and eosinophil concentration were lower in the blood sera of broiler birds fed 0.20 % relative to control. The variations observed might not be associated to the negative influence of the phytochemical compound in the ginger since all the values obtained were within the normal range reported by Akinola and Etuk (2015) and Owosibo *et al.* (2013) for a healthy broiler chickens, suggested that addition of white ginger up to 0.30 % is not injurious to the health status of the broiler chickens. The result of the present study is not in line with the findings of Sugiharto *et al.* (2011), who observed no significant differences in RBC, WBC, Hb and MCV when evaluated the effect of turmeric extract on blood parameters in broiler birds. Also, Barazesh *et al.* (2011) reported that supplementation of ginger root powder in the diet of broilers did not affect the blood haematological parameter observed except PCV and MCHC. However, non-significant effect obtained for RBC, WBC, MCV, MCH and lymphocyte count is not in consonant with that of Mahdy *et al.* (2017) who reported significant effect with inclusion of ginger powder in broiler chickens diets. Similarly, Emadi and kermanshahi (2007) observed significant differences for heterophils, lymphocyte, monocytes and basophil concentration when fed turmeric supplemented diets at 0.5 % in broiler diets. The values of PCV, RBC, WBC and Hb obtained in this study are within the normal range of 27.43 % - 37.30 % PCV, 1.97 x 10^{12}L – 3.75 - x 10^{12}L RBC, 3.98 x 10^{9}L - 10.82 x 10^{9}L WBC and 7.50 g/dl to 16.04 g/dl Hb reported by Talebi *et al.* (2005) who compared the haematological values of four broilers strain. This showed that, dietary white ginger powder might have improved the nutritional quality of the diets which consequently improved health of the birds (William *et al.* 1997). Adejumo (2004) in his findings stated that PCV can be used in accessing the toxicity in the blood; high levels above the recommended range usually suggest the presence of toxic factors, which have harmful effect on blood formation results in impaired health status of the birds. Non-significant effect reported on lymphocytes and basophils negate that of Owosibo *et al.* (2013), who observed that heterophils and

Table 4. Effect of white ginger powder on nutrient digestibility of broiler chickens

Experimental Diets						
Parameter (%)	T_1	T_2	T_3	T_4	SEM	P-value
DM	80.15	79.60	79.50	80.81	0.85	0.96
CP	80.88	80.60	80.45	82.95	0.86	0.77
CF	82.82	79.62	76.38	85.85	1.28	0.01
EE	82.76	77.06	76.24	82.95	1.36	0.14
NFE	79.13	79.21	79.33	80.56	0.87	0.95

DM = Dry Matter; CP = Crude protein; CF = Crude Fibre; EE = Ether Extract; NFE = Nitrogen Free Extract; SEM = standard error of mean; $T_{1=}$ Control diet; $T_{2=}$ 0.20 % white ginger powder; $T_{3=}$ 0.25 % white ginger powder; $T_{4=}$ 0.30 % white ginger powder

Table 5: Effect of white ginger powder on haematological parameters of broiler chickens

Experimental Diets						
Parameter	T_1	T_2	T_3	T_4	SEM	P-value
PCV (%)	33.70^{a}	31.20^{ab}	28.50^{c}	30.50^{bc}	0.76	0.00
RBC x $10^{12/L}$	2.20	2.80	1.95	2.25	0.15	0.26
WBC x $10^{9/L}$	6.35	5.60	6.75	5.90	0.15	0.01
Hb (g/dL)	12.15	11.50	10.15	10.85	0.25	0.00
MCV (fL)	166.50	127.90	156.55	163.35	8.83	0.44
MCH (pg)	55.35	42.50	52.10	54.50	2.94	0.43
MCHC (g/dL)	33.25^{b}	33.30^{ab}	33.30^{ab}	33.35^{a}	0.01	0.05
Lymphocytes (%)	51.50^{a}	48.00^{b}	48.50^{ab}	48.50^{ab}	0.58	0.10
Heterophil (%)	45.00	47.00	48.50	47.50	0.84	0.58
Eosinophil (%)	0.00^{b}	1.50^{a}	1.00^{ab}	1.00^{ab}	0.21	0.05
Basophil (%)	0.00	0.00	0.00	0.00	0.00	0.00
Monocytes (%)	3.50	2.50	3.00	3.00	0.18	0.33

^{abc}Means, within each row with different superscripts are significantly different (P< 0.05). SEM = standard error of mean; PCV – Pack Cell Volume; RBC – Red Blood Cell; WBC – white Blood Cell; Hb; Haemoglobin; MCV – Mean Corpuscular Volume; MCH – Mean Corpuscular Haemoglobin; MCHC; Mean Corpuscular Haemoglobin Concentration; SEM = standard error of mean. $T_{1=}$ Control diet; $T_{2=}$ 0.20 % white ginger powder; $T_{3=}$ 0.25 % white ginger powder; $T_{4=}$ 0.30 % white ginger powder

neutrophils constitute the first line of defence with efficient chemotactic response against foreign, viable or innate agents. The result obtained in this study revealed that the nutrients were optimally utilized by the birds; the reason for the healthy, not anaemic and highly resistance.

Effect of white ginger powder on serum biochemical of broiler chickens

Table 6 presented the effect of white ginger powder on serum biochemical of broiler chickens. The serum is a blood component that consists of all proteins not used in coagulation and all the electrolytes, antibodies, antigens, hormones and any exogenous substances. It is neither a blood cell nor a clothing factor. Dietary white ginger powder did not show significant effect on total protein, globulin, glucose and aspartate amino transferase (AST) whereas; albumin, creatinine, alanine aminotransferase (ALT), and alkaline phosphatase (ALP) were significantly influenced by addition of white ginger in the diets of broiler chickens. Higher concentration of albumin is observed on birds fed control diet (T_1), while the least observed on broiler chickens fed T_2 (0.20 % white ginger). Insignificant effect obtained for total protein, globulin, glucose and may suggest that there was normal nutrients metabolism, as a result of the nutritional adequacy of the diet, which led to the absence of muscle degeneration in birds (Soetal *et al.* 2013) suggested that white ginger powder can safely be used up to 0.30 % in broiler diet as feed additive with no harmful effect on the health of the broiler bird. Significant effect observed for albumin confirmed the findings of Namagirilakshmi (2005), who stated that supplementation of ginger in broiler diet up to 1.0 % significantly affect albumin concentration. Significant lower concentration recorded for albumin, ALP and ALT on birds fed white ginger based diets confirmed the optimal functionality of the liver due to absence toxic substances associated to the diet, it showed the antioxidative potential of the white ginger. Muhammad and Oloyede (2009) observed that albumin value is normally low in the blood, but occurrence of liver damage by toxic substances increased its concentration. Increased activity of aspartate amino transferase (AST), alanine aminotransferase (ALT) and alkaline phosphatase (ALP) is associated to oxidative stress. Lower values of ALP and ALT recorded on broiler chickens fed white ginger based diets compare to control confirmed the findings of Mirbod *et al.* (2017) that ALP and ALT activities decreased with increased levels of *Curcuma longa* in the diet of laying hen. The values recorded for all parameters evaluated fall within the range reported to be normal for a healthy broiler chickens according to Akinola and Etuk (2015), who studied on haematological and serum biochemical responses of broilers fed varying levels of indomie waste-based diets.

Table 6: Effect of white ginger powder on serum biochemical of broiler chickens

Experimental Diets						
Parameter	T_1	T_2	T_3	T_4	SEM	P-value
Total Protein (g/dL)	6.05	4.80	5.20	5.70	0.32	0.61
Albumin (g/dL)	3.30[a]	2.50[b]	2.70[ab]	2.70[ab]	0.13	0.05
Globulin (g/dL)	2.75	2.35	2.50	3.00	0.28	0.89
Glucose (g/dL)	66.00	49.60	99.00	86.80	8.85	0.20
Creatinine (g/dL)	0.84[a]	0.84[a]	0.91[a]	0.61[b]	0.03	0.00
AST (U/L)	178.75	161.40	173.40	174.60	3.20	0.27
ALT (U/L)	104.70[a]	86.75[c]	87.10[c]	98.30[b]	2.31	<.00
ALP (U/L)	104.80[a]	86.40[c]	95.45[b]	98.20[b]	2.16	0.00

[abc]Means within each row with different superscripts are significantly different (P< 0.05); SEM = standard error of mean; aspartate amino transferase (AST), alanine aminotransferase (ALT), and alkaline phosphatase (ALP). T_1 = Control diet; T_2 = 0.20 % white ginger powder; T_3 = 0.25 % white ginger powder; T_4 = 0.30 % white ginger powder

Conclusion

Based on the findings of this study, it is concluded that addition of white ginger powder up to 0.30 % had no adverse effect on broiler chicken's growth performance and nutrient digestibility when added as feed additives. Considering the haematological traits and serum biochemical, all the values obtained were within the range considered normal for healthy chickens. Feed cost to weight gain ratio, income and profit per bird and cost to benefit ratio were all better at 0.30 % inclusion levels, Therefore, supplementation of white ginger powder up to 0.30 % as feed additive in the diet of broiler chickens is recommended.

Conflicts of Interest

The authors declare that they have no conflict of interest.

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