

Effects of Dietary White Ginger (*Mondia Whitei*) Root Meal on Growth Performance and Haemato-Biochemical Indices of Broiler Chickens

*¹Ajeigbe Olusegun Michael, ²Muhammad Sulaimon Babatunde, ¹Adeyeye Emmanuel Abiodun,
³Ogunseitan Taiwo Olusola, ⁴Odutayo Olusola Joshua, ¹Adebowale Tolulope Oluwadamilare,
¹Adebayo Kafayat Omowumi and ¹Sobayo Richard Abayomi

¹Department of Animal Nutrition, Federal University of Agriculture, Abeokuta, Ogun State, Nigeria.

²Department of Animal Science, Federal University Lokoja, Kogi State, Nigeria.

³Department of Agricultural Extension Technology, Federal University of Technology, Ilaro, Ogun State, Nigeria.

⁴Department of Animal Production and Health Federal University of Agriculture, Abeokuta, Ogun State, Nigeria.

*Corresponding authors' email: ajeigbeom@funaab.edu.ng Phone No.: +2348060986825

Orcid ID: <https://orcid.org/0000-0002-5664-9074>

ABSTRACT

A 56-day feeding trial was conducted using 150-day-old broiler chicks to evaluate the effects of dietary white ginger root meal (WGRM) on growth performance, haemato-biochemical parameters. The birds were randomly allotted to five dietary treatments, consisting of 30 birds with three replicates of 10 birds, in a Completely Randomized Design (CRD). The experimental diets were supplemented with WGRM at 0 g/kg, 1.0 g/kg, 1.5 g/kg, 2.0 g/kg, and 2.5 g/kg, respectively. Inclusion of WGRM had no significant ($P>0.05$) effect on most growth performance parameters except for FCR, which was significantly better ($P<0.05$) in birds fed 2.0 g/kg 2.67 ± 0.60 and poorer 3.59 ± 0.55 at 2.5 g/kg inclusion levels. PCV, haemoglobin concentration, and RBC count were significantly ($P<0.05$) higher in birds receiving 1.0 and 1.5 g/kg WGRM than those on the other treatments. Birds fed diets with 2.5 g/kg WGRM recorded a significantly ($P<0.05$) lower WBC count than those fed 1.5 and 2.0 g/kg diets. Lymphocyte count was significantly ($P<0.05$) higher at 1.0 g/kg WGRM inclusion. Monocyte count was significantly ($P<0.05$) reduced in birds fed the control and 2.0 g/kg diets. Serum total protein, triglyceride, and VLDL concentrations increased with dietary inclusion of WGRM, with the highest ($P<0.05$) values observed at 2.5 g/kg. Birds fed 1.0 g/kg and 2.5g/kg WGM exhibited the highest ($P<0.05$) globulin concentration (1.80 ± 0.40 g/dl and 2.50 ± 0.40). Alanine aminotransferase activity was significantly ($P<0.05$) elevated in birds receiving 2.5 g/kg WGRM. Therefore, for growth performance, haematological parameters and serum biochemistry, the dietary inclusion of *Mondia whitei* meal up to 2.0 g/kg feed is recommended among the treatments evaluated.

Received: 16 Sep. 2026

Accepted: 13 Oct. 2026

Published: 15 Oct. 2026

Keywords: White Ginger, Herbs, Antimicrobial, Haematological and Serum

INTRODUCTION

In response to the public demand for poultry products void of antibiotic residue, poultry researchers and producers are adopting different nutritional means to substitute antibiotics with phytochemical feed additives (PFAs) in poultry nutrition. Microbial resistance is a major global health concern that has been a top global threat in the 21st century (Muhammad *et al.*, 2014). Bacterial resistance in poultry production has encouraged researchers to reduce the dependence on antibiotics by identifying potential feed additives, such as essential oils, bacteriophages, antimicrobial peptides, probiotics, prebiotics, organic acid, and enzymes that improve the immune system functions, reduce morbidity and mortality, improve the growth performances of poultry, and preserve consumer health (Karou *et al.*, 2011, Muhammad *et al.*, 2014). According to World Health Organization (WHO) estimates of 2002, the majority of the rising antimicrobial resistance problems in human medicine is due to the overuse, misuse as well as abusive use of antibiotics in livestock production. Addition of organic products or phytochemical to feeds may be a viable alternative to eliminate or reduce specific or general bacterial populations in a preventive manner and to also improve feed utilization and profit maximization (Flint and Garner, 2009). It has been reported

that dietary inclusion of these PFAs imparted good health and posed no deleterious effects on the growth of broiler chickens (Oso *et al.*, 2019, and Fafiolu *et al.*, 2020). Most of the identified phytochemical, *Allium sativum* (garlic), *Zingiber officinale* (ginger), *Piper nigrum* (pepper), eggplant (*Solanum* species) and *Garcinia kola* (bitter kola) have been extensively investigated and their properties as well as effects on poultry production are well documented (Sobayo *et al.*, 2013, Yusuf *et al.*, 2017; Adeyeye *et al.*, 2025).

However, another root plant which has not been widely explore and utilized as phytochemical feed additive in poultry is white ginger (*Mondia whitei*) root, it is an aromatic plant of the Periplocaceae family (Watcho *et al.*, 2005; Sanwo *et al.*, 2020), and widely known as Isirigun by the Yoruba ethnic group of Nigeria. White ginger has a mild laxative effect, it eases abdominal pains, alleviate nausea as well as used for the treatment of fever, bilharzia and sexual dysfunction (Crouch *et al.*, 1998). Phytochemically, white ginger root contains notable levels of fat-soluble vitamins (A, D, E, and K), essential minerals (magnesium, zinc, iron, and calcium), and digestible protein (Youkeu, 2008; Sanwo *et al.*, 2020). However, despite the nutritional, mineral and phytochemical composition, it has not been well researched as potential phytochemical. It is therefore hypothesized that white ginger root

powder should be able to influence the performance and haemato-chemical indices of broiler chickens. The aim of the study was to determine the effect of white ginger (*Mondia whitei*) root meal on the performance and blood parameters of meat type chicken.

MATERIALS AND METHODS

Study Area

The experiment was carried out at the Poultry unit of the Directorate of University Farms (DUFARMS), Federal University of Agriculture Abeokuta, Ogun State, Nigeria. The area is located in the humid tropical zone of south-western Nigeria with the minimum and maximum temperatures of 20.66 ° and 35.48 ° C respectively. It lies in the region 76m above sea level and falls within latitude 7°13'49.46''N and longitude 3°26'11.98''E. it receives a mean precipitation of 1037mm per annum.

Sourcing and Processing of Test Ingredients

The white ginger root (*Mondia whitei*) was obtained from the local market within Owode-Yewa Ilaro, Ogun State Nigeria; after identification with the assistance of forestry, pasture and rangeland professionals. The roots were chopped into smaller pieces with the use of cutlass, after which it was sun-dried for 14 days on a black nylon and milled (1 mm sieve) using grinding machine to obtained white ginger root meal (WGRM) which was stored in an air tight container at room temperature until needed.

Animal Care Approval or Ethical Authorization

The animal ethics guidelines of federal university of Agriculture Abeokuta (Funaab 2014) were strictly followed throughout of the durations of the experiment.

Experimental Bird's Management and Design

A total of one hundred and fifty (150) unsexed day-old chicks were used for the experiment that lasted for fifty-six (56) days. The birds were allotted on weight equalization and divided into five experimental treatments of thirty birds each with ten birds per replicate in a Completely Randomized Design. The birds were housed under similar conditions of temperature and humidity in double open sided pen deep litter wood shaven as bedding. The experimental diets were assigned to each of the five treatment groups at day-old till fifty-six days, feed and water were made available *ad-libitum*.

Management of Experimental Birds and Diets

The birds were sourced from a reputable hatchery and allotted to five dietary treatments on arrival. Basal starter and finisher diets were formulated to meet the nutritional requirements of the birds according to the recommendations by National Research Council (NRC, 1994) Table 1. The white ginger root meal was added to the basal diets at 0 g/kg, 1g/kg, 1.5g/kg, 2g/kg and 2.5g/kg to form five experimental diets.

Protocol for Phytochemicals

The antinutritional factors were determined according to standard procedures: tannin by Makkar and Goodchild (1996), saponin by Obadoni and Ochuko (2001), alkaloid and steroid by Harborne (1973) and flavonoid by Bohm and Kocipai-Abyazan (1994)

Minerals Analysis Content

Mineral analysis was carried out using standard methods of AOAC (2005). Two grams of sample was ashed at 550°C in a muffle furnace for 6 hours. The ash was dissolved in 2M HCl and filtered. Calcium, Magnesium, Iron, Zinc, Copper and Manganese were determined using Atomic Absorption Spectrophotometer (AAS Bulk Scientific Model 205), Sodium and Potassium by Flame photometry, and Phosphorus by vanadomolybdate colorimetric method. Minerals were expressed as mg/100g dry matter.

Proximate Analysis

The proximate chemical composition of the test ingredient was determined according to AOAC (2005) and the results is presented in Table 1.

Growth Performance

Records of weight gain (g)/bird: final weight - initial weight
Feed intake (g)/bird: feed supplied – left over/ number of birds.

Mortality: number of dead birds/total number of birds × 100

Feed conversion ratio: total feed intake/total body weight gain

Blood Collection and Analysis

At day 56 of the experiment, 6 ml blood samples were collected from two birds (the birds with average weight from each replicate were selected) per replicate through brachial vein puncture and 3 ml was placed into tubes containing ethylene-diamine-tetra-acetate (EDTA) for haematological indices. While the other 3 ml was collected into plain bottles without an anti-coagulant, which was centrifuged for 15 minutes to collect the serum for serum biochemicals indices. Haemoglobin concentration (Hb) was estimated using the cyanmethaemoglobin method (Cannan, 1958). Packed cell volume (PCV), red blood cell (RBC), and white blood cell (WBC) counts were determined using the Wintrobe haematocrit tube according to the method of Schalm *et al.* (1975), while mean corpuscular volume (MCV), mean corpuscular haemoglobin (MCH), and mean corpuscular haemoglobin concentration (MCHC) were calculated using the appropriate formulae. Neutrophils (N), Eosinophils (E), lymphocytes (L), and monocytes (M) will be determined (Mitraka and Rawnsley, 1997). Total serum protein, serum albumin, serum globulin (Varley *et al.*, 1980), serum uric acid concentration (Wootton, 1964), and serum creatinine (Bonsnes and Tausky, 1945) were measured according to standard procedures. Serum enzymes such as alanine aminotransferase (ALT), aspartate aminotransferase (AST) were estimated with commercial Kits (Randox test Kits, Randox Laboratories, Antrim, UK).

Statistical Analysis

The data obtained were subjected to a one-way analysis of variance in a completely randomized design and the significant means were separated using Duncan Multiple Range test.

Statistical Model

$$Y_{ij} = \mu + T_i + \epsilon_{ij}$$

Y_{ij} = Observed value of the dependent variable

μ = Population means

T_i = Effects of white ginger additive

ϵ_{ij} = Random error

Table 1: Gross Composition of Starter and Finisher Basal Diets

Ingredients	Starter	Finisher
Maize	48.50	54.00
Wheat offal	8.00	10.00
Soyabean meal	23.00	16.00
Groundnut cake	13.50	9.30
Fish Meal (72%)	2.00	3.00
Bonemeal	2.00	2.00
Oyster shell	2.00	2.00
Lysine	0.25	0.10
Methionine	0.25	0.10
Premix	0.25	0.25
Salt	0.25	0.25
PKC	-	3.00
Total	100	100

Calculated Chemical Composition (%)

Met. Energy (Kcal/Kg)	2825.75	2900
Crude protein	23.00	20.02
Crude fiber	4.40	4.34
Ether Extract	3.50	3.48
Ash	3.25	3.20

RESULTS AND DISCUSSION**Proximate Composition of White Ginger (*Mondia Whitei*) Root Meal (%)**

Table 3, shows that the white ginger root meal had high dry matter (95.23%) and NFE (59.12%), with moderate crude protein (12.38%), crude fibre (17.50%), ether extract (5.00%)

and ash (6.00%). The mineral analysis indicated that potassium was abundant, while iron was the least abundant. The phytochemical results showed appreciable levels of saponin, flavonoid and tannin, with smaller quantities of alkaloid and steroid.

Table 2: Chemical Composition of White Ginger (*Mondia Whitei*) Root Meal Contains in Percentage on Dry Matter Bases

Proximate	Quantity (%)	Minerals	Quantity(mg/g)	Phytochemicals	Quantity (mg/100g)
Dry matter	95.23	Magnesium	9.34	Tannin	0.840
Ether extract	5.00	Potassium	10.31	Steroid	0.362
Crude protein	12.38	Calcium	9.12	Saponin	1.043
Crude fibre	17.50	Phosphorus	6.85	Flavonoid	0.872
Ash	6.00	Sodium	5.61	Alkaloid	0.451
NFE	59.12	Iron	0.20		

NFE= Nitrogen free extract

Growth Performance of Broiler Chickens Fed Diets Containing White Ginger (*Mondia Whitei*) Root Meal

Table 3 shows the performance characteristics of broiler chickens fed diets containing varying inclusion levels of white ginger root meal. The results showed that the dietary inclusion of white ginger root meal significantly ($P < 0.05$) affected feed conversion ratio of the broiler chickens. Birds

fed 2.5 g/kg had a significantly poorer feed conversion ratio (3.59 ± 0.55^a) compared with those fed 0, 1.0 and 1.5 g/kg (2.97 ± 0.07^b , 2.86 ± 0.31^b and 2.98 ± 0.23^b , respectively), while birds fed 2.0 g/kg recorded the significantly better feed conversion ratio (2.67 ± 0.60^c) the other parameters were not significantly affected.

Table 3: Growth Performance of Broiler Chickens Fed Diet Containing White Ginger (*Mondia Whitei*) Root Meal at 0 – 56 Days

Dietary levels of white ginger root meal (g/kg)					
Parameters	0	1.0	1.5	2.0	2.5
Initial weight (g/bird)	39.10±0.00	42.00±0.00	39.10±0.00	39.10±0.00	42.00±0.00
Final live weight (g/bird)	1883.37±131.94	2055.83±233.81	1834.30±180.72	1907.20±167.12	1650.70±167.68
Total Weight Gain (g/bird)	1845.17±131.94	2015.83±233.81	1794.33±180.78	1869.00±167.12	1612.50±167.68
Daily Weight Gain (g/bird)	32.97±2.37	36.23±4.58	32.03±3.27	33.52±3.16	28.77±2.97
Daily Feed Intake (g/bird)	97.87±7.52	102.60±3.68	94.90±2.66	89.20±7.13	102.20±5.11
Feed Conversion Ratio	2.97±0.07 ^b	2.86±0.31 ^b	2.98±0.23 ^b	2.67±0.60 ^c	3.55±0.55 ^a
Mortality (%)	18.67±18.04	6.67±11.55	10.00±17.32	10.00±10.00	16.67±15.28

*Values are presented as mean ± standard error of mean, ^{a,b,c}. Means within the same row with different superscripts are significantly different ($P < 0.05$)

Effect of White Ginger (*Mondia Whitei*) Root Meal on Haematological Parameters of Broiler Finisher Chicken

The results of the haematological parameters (Table 4) shows that packed cell volume (PCV), red blood cell (RBC) and haemoglobin (Hb) were significantly ($P<0.05$) higher in birds fed diets containing 1 and 1.5g WGRM when compared with other treatment groups. White blood cell (WBC) was least ($P<0.05$) for birds on 2.5g/kg WGRM and other treatments

were similar. Lymphocyte was highest ($P<0.05$) in bird fed diet containing 1g of WGRM and lowest in birds on 2g/kg, other treatments were similar. Birds on 1 and 1.5g/kg WGRM recorded higher ($P<0.05$) monocyte when compared with other treatments. Mean corpuscular haemoglobin concentration (MCHC) and mean corpuscular haemoglobin (MCH) were higher in the control group. These parameters reduced ($P<0.05$) as WGRM was added into the diets.

Table 4: Effect of White Ginger (*Mondia Whitei*) Root Meal on Haematological Indices of Broiler Finisher Chicken

Dietary Levels of White Ginger Root Meal (g/kg)					
Parameters	0	1	1.5	2.0	2.5
Packed cell volume (%)	35.00 ^c ±2.38	40.50 ^a ±0.00	40.00 ^a ±1.00	35.50 ^c ±0.50	37.50 ^b ±0.50
Haemoglobin (g/dl)	11.85 ^c ±0.15	13.50 ^a ±0.20	13.35 ^a ±0.35	11.85 ^c ±0.15	12.40 ^b ±0.10
Red blood cell (x10 ²)	2.75 ^b ±0.15	3.40 ^a ±0.10	3.30 ^a ±0.00	2.95 ^b ±0.05	3.05 ^b ±0.05
White blood cell (x10 ⁹)	14.80 ^{ab} ±1.60	12.55 ^{ab} ±0.05	15.35 ^a ±2.85	15.50 ^a ±2.50	11.45 ^b ±0.65
Heterophil (%)	28.50±3.50	23.0±1.00	28.50±1.50	37.00±1.00	29.50±1.50
Lymphocyte (%)	70.50 ^{ab} ±4.50	74.0 ^a ±1.00	69.50 ^b ±0.50	62.00 ^c ±2.00	68.50±0.50
Eosinophil (%)	1.00±1.00	0.50±0.50	0.00±0.00	0.50±0.50	0.00±0.00
Basophil (%)	0.00±0.00	0.50±0.50	0.50±0.50	0.50±0.50	1.50±1.55
Monocyte (%)	0.00 ^b ±0.00	2.00 ^a ±0.00	1.50 ^a ±1.55	0.00 ^b ±0.00	0.50 ^{ab} ±0.50
MCV (fl)	127.65±6.95	117.45±3.15	121.30±3.10	120.35±0.35	123.05±3.65
MCH (pg)	43.25 ^a ±2.95	39.15 ^b ±1.15	40.45 ^{ab} ±1.05	40.15 ^b ±0.15	40.70 ^{ab} ±1.00
MCHC (g/dl)	33.85 ^a ±0.45	33.35 ^b ±0.05	33.35 ^b ±0.05	33.35 ^b ±0.05	33.05 ^b ±0.15

*Values are presented as mean ± standard error of mean, ^{a,b,c}. Means within the same row with different superscripts are significantly different ($P<0.05$).

MCV= Mean corpuscular volume, MCHC = Mean corpuscular haemoglobin concentration, MCH = Mean corpuscular haemoglobin.

Effect of White Ginger (*Mondia Whitei*) Root Meal on Serum Biochemistry of Broiler Finisher

The results of serum biochemistry presented in (Table 5), indicating that dietary inclusion of white ginger root meal significantly ($P<0.05$) influenced total protein, globulin, triglyceride, ALT, urea and VLDL concentrations. The 2.5

g/kg treatment significantly increased total protein and globulin, the treatment also produced significantly higher triglyceride and VLDL concentrations. The 2.0 g/kg treatment recorded the lowest ALT concentration, while urea was generally higher in the supplemented groups than in the control.

Table 5: Effect of White Ginger (*Mondia Whitei*) Root Meal on Serum Biochemistry of Broiler Chickens

Dietary Levels of White Ginger Root Meal (g/kg)					
Parameters	0	1.0	1.5	2.0	2.5
Total protein (g/dl)	4.05 ^b ±0.15	3.90 ^c ±0.20	4.20 ^b ±0.15	3.80 ^c ±0.30	5.55 ^a ±0.85
Albumin (g/dl)	2.45 ^b ±0.15	2.10 ^b ±0.20	2.55 ^b ±0.15	2.20 ^b ±0.30	3.05 ^a ±0.85
Globulin (g/dl)	1.60 ^b ±0.40	1.80 ^b ±0.40	1.65 ^a ±0.05	1.60 ^b ±0.10	2.50 ^a ±0.40
Glucose (g/dl)	132.50±60.50	87.50±5.50	69.00±3.00	92.00±7.50	113.00±35.00
Triglyceride (mg/dl)	82.50 ^b ±1.50	90.50 ^b ±9.50	91.50 ^b ±2.50	83.00 ^b ±8.00	143.00 ^a ±1.50
Aspartate amino (μ/l)	40.50±4.50	62.50±6.50	63.0±24.00	50.50±5.50	56.00±3.00
Alanine amino (μ/l)	30.50 ^a ±1.50	32.50 ^a ±2.50	31.50 ^a ±1.50	25.50 ^b ±3.50	33.00 ^a ±2.00
Urea (mg/dl)	3.30 ^b ±1.00	5.30 ^a ±0.30	4.75 ^a ±0.85	5.65 ^a ±0.75	4.45 ^{ab} ±0.50
HDL (mg/dl)	65.00±5.20	71.45±8.95	68.85±9.35	74.20±12.70	66.90±8.50
VLDL (mg/dl)	16.50 ^b ±0.30	18.10 ^b ±1.90	18.30 ^b ±0.50	16.60 ^b ±1.60	29.70 ^a ±0.30
LDL (mg/dl)	25.50±0.10	33.45±6.15	39.85±4.15	39.20±6.90	39.40±20.00
Cholesterol (mg/dl)	107.00±10.15	123.00±5.00	127.00±14.00	130.00±18.00	136.00 ^{abc} ±20.00

*Values are presented as mean ± standard error of mean, ^{a,b,c}. Means within the same row with different superscripts are significantly different ($P<0.05$) Aspartate aminotransferase (μ/l), Alanine aminotransferase (μ/l), HDL- High Density Lipoprotein, VLDL- Very Low-Density Lipoprotein, Low Density Lipoprotein.

Discussion

The values of proximate composition of white ginger (*Mondia whitei*) powdered recorded in this work is similar to the study reported by Aremu *et al.*; (2011) and also higher than that reported by Ngbolua *et al.*; (2018). The differences could be as a result of the type, area, time of harvesting and methods of preparation. The ash content was also high compared to the two authors. The result of chemical properties indicated that the test ingredients contain all the

tested phytochemicals. This shows high levels of its possible medicinal and dietary values (Oloyede, 2005). Although, some of these analysed constituents of the vegetable species may be completely harmful to both man and animals and some are specific as observed in the case of tannins (Odebiyi and Sofowora, 1979). Phytochemicals are bioactive, non-nutrient, naturally occurring compounds found in vegetables, fruits and spices (Okarter *et al.*; 2009). Purified alkaloids as well as their synthetic derivatives are used as medicinal

agents as analgesic, antimalaria, antiseptic and bactericidal (Evans, 2002). Saponins produced by this plant serve as a defence mechanism to stop attacks by foreign pathogen, which makes them antibiotics (Okwu and Emenike, 2006). Saponin binds dietary cholesterol and reduces its absorption in the intestine, leading to decreased blood cholesterol levels. However, Amaechi and Egesi (2018) reported the presence of tannins, phenol, phytate, sterol, carotenoid, oxalate, saponin, flavonoids, and alkaloids and even measure the hydrogen cyanide. Inkoto *et al.*; (2018) reported the presence of phenolic compounds, coumarins, anthraquinones, anthocyanin, tannins, irridoids in the roots of *Mondia whitei*. The presence of flavonoids in white ginger root meal show that the plant has biological functions such as protection, against allergies, inflammation, free radicals, platelet aggregation, microbes, ulcers, hepatoxins and tumor (Okwu, 2004). Flavonoids are potent water-soluble antioxidants and free radical scavengers which prevents oxidative cell damage, have strong anticancer activity and protect against the different levels of carcinogenesis (Okwu, 2004). In general, the presence of these phytochemicals could account for the much-touted medicinal properties of these spices in various disease conditions such as fight against malaria infection, eradicate worm infestations and cure male infertility (Hermans *et al.*, 2004; Odugbemi *et al.*, 2007, Focho *et al.*, 2009 and Idu *et al.*, 2010) and also cure skin diseases, stomach worms, heart diseases and asthma (McGeoch, 2004). The mineral content in this study was in line with report of (Iji *et al.*, 2001) who reported that white ginger root contains calcium, magnesium, iron and zinc as well as protein. The minerals content can stimulate appetite as reported by (Stafford *et al.*, 2011), this means that the white ginger can improve the feed intake of the animals as well as improve their wellbeing.

The study also observed that there was no effect of the white ginger root meal on the final live weight and feed intake of the broiler chickens. These results were in consistent with the studies of Jang *et al.* (2007) and Erdogan *et al.* (2010), which reported that there was no effect on the use of different phytogetic plants on broiler growth performance. The superior FCR at 2 g/kg indicates that birds utilized feed more efficiently, requiring less feed per unit of weight gain and this showed that the birds effectively converted feed to flesh. This was in tandem with the findings of Jamroz *et al.* (2005) who reported improved FCR due to the addition of a plant extract, containing cinnamaldehyde, carvacrol and capsaicin, to a maize or wheat and barley-based diet, the superiority of FCR at 2 g/kg indicates that birds utilized feed more efficiently, requiring less feed per unit of weight gain. The differences in the results of these experiments could be due to numerous factors such as type and parts of plants used, their physical properties, time of harvest, the preparation method of PFA (phytogenic feed additives) and their compatibility with other feed components (Jang *et al.*, 2007). Conversely, the poor FCR at 2.5 g/kg suggests reduced feed efficiency, possibly due to anti-nutritional compounds or reduced nutrient availability at higher supplementation levels of white ginger root meal. The lower mortality observed in birds receiving white ginger root meal supplementation may suggest a potential health-promoting or immunomodulatory effect of the plant.

Haematological indices are important indicators of physiological status, immune competence, oxygen-carrying capacity, and overall health of birds. Ewuola *et al.*, (2004) reports that haematological indices are a reflection of the effects of dietary treatments on the animal in terms of the type, quality and amounts of the feed ingested and available

for the animal to meet its physiological, biochemical and metabolic necessities. The PCV value obtained ($35.00 \pm 2.38\%$ - $40.50 \pm 0.00\%$) in all treatments were higher than the normal range of 22-33% reported by Banerjee (2009; Adeyemo and Sani 2013) the higher PCV suggests a tendency towards improved red blood cell production and oxygen transport capacity, although the effect was not statistically confirmed. Isaac *et al.* (2013) stated that since PCV is responsible for transporting absorbed nutrients and oxygen, an increased level could lead to better transportation and thus resulting in an increased primary and secondary polycythemia. Also, Edosein and Switzer (2001), observed that when packed cell volume exceeds the maximum of the normal range it leads to increase in the red blood cell concentration arising from decreased body fluid due to lowered intake of water or excess loss of water. Banerjee (2005), observed the normal range for Haemoglobin (Hb) in broiler birds to be 7-13g/dl which was in line with the values obtained in this study to be (11.85 g/dl-13.50g/dl). Haemoglobin is responsible for oxygen transportation in the blood. The significant increase in Hb concentration at 1 g/kg and 1.5g/kg suggests enhanced erythropoiesis and improved oxygen-carrying capacity. This may contribute to better metabolic activity and growth performance observed in birds receiving moderate supplementation. The result indicates that white ginger root may possess haematinic properties capable of stimulating blood formation and also implies that the inclusion of white ginger root meal in dietary treatments did not suppress intake and impair dietary availability that could cause anaemic conditions. The value observed ($2.75 - 3.40 \times 10^{12}/l$) was within the values $2 - 4 \times 10^{12}/l$ reported by Banerjee (2005) for RBC while WBC were below range of $19-34 \times 10^9/l$ according to the findings of Banerjee (2005). The range of values obtained for RBC was also in agreement with the findings of Mitruka and Runsley (1977) with values of $2.9-4.1 \times 10^{12}/l$, Swenson (1970) and Campbell *et al.* (2003), where they both reported $2.88-4.12 \times 10^6$ mm. The increase in RBC count indicates improved red blood cell production and enhanced oxygen transport to tissues. Higher RBC counts are generally associated with better physiological performance and health status. The results suggest that white ginger root supplementation may stimulate erythropoietic activity. And the lack of significant differences in WBC indicates that white ginger root meal did not induce stress, infection, or inflammatory responses. The values obtained suggest that birds remained healthy throughout the experiment, meaning that there were effective transportation of oxygen and carbon dioxide within the system of the animals (Isaac *et al.* 2013). Heterophils are indicators of stress and innate immune response in poultry. Lymphocytes are responsible for adaptive immune responses. Increased lymphocyte levels suggest enhanced immune competence and disease resistance. The result indicates that white ginger root may possess immunostimulatory properties that improve immune function. Also, the heterophil-to-lymphocyte ratio is a recognized indicator of stress in poultry. Lower ratios indicate reduced stress and better adaptation to environmental conditions. Therefore, supplementation with ginger root meal appears to improve stress tolerance and welfare of broiler chickens. MCHC results ranges ($33.05 \pm 0.45\%$ - $33.85 \pm 0.45\%$) this value was similar to reported values by (Ilo *et al.*, 2019) who reported 33.72% to 34.54% and also agree with the findings of Adeyemo and Sani (2013), this reflects the concentration of haemoglobin within red blood cells. The increase in MCHC suggests improved haemoglobin synthesis and enhanced oxygen-carrying efficiency of erythrocytes. This further supports the positive influence of

white ginger root meal on blood quality. The corresponding increase in value of serum protein reflects the overall protein status of the body and the efficiency of protein synthesis. This infers that there was a corresponding increase in the protein level of the blood of the birds as the white ginger root meal inclusion increases, which was in accordance to Sturkie *et al.* (2000) who noted that an increase in protein level of feed of an animal would consequently lead to an increase in protein level of the blood of the animal. According to Iyayi and Tewe (1988), the total serum protein depends on both the quality and quantity of protein supplied in the diet. Blood glucose is an indicator of energy metabolism. The glucose value (69.00 ± 3.00 mg/dl to 132.50 ± 60.50 mg/dl) reported was lower than the values (283.80 mg/dl to 340.80 mg/dl) reported by Ilo *et al.* (2019) but similar to reported values by Muhammed *et al.* (2018). The lower glucose level at 1.5 g/kg suggests efficient glucose utilization and better metabolic regulation. These results are also compatible with those observed by Velasco *et al.* (2010) and Rezaei *et al.* (2010) who observed reduction in blood glucose level in broilers. This may be due to the suppressive effect of herbals plants leaf extracts on glucagon which otherwise increases blood glucose in chickens, thereby maintaining blood glucose homeostasis. Albumin is synthesized in the liver and serves as an indicator of liver function and nutritional status. Increased albumin concentrations in supplemented birds suggest improved hepatic synthetic activity and better protein nutrition indicate that white ginger root meal positively supported liver function. The Globulins are associated with immune function because they include antibodies and other immune proteins. The elevated globulin concentration at 1.5 g/kg suggests enhanced immune responsiveness and supports the earlier observation of increased lymphocyte counts in supplemented birds confirming the earlier observation by Hoffenberg *et al.* (1966). The HDL is commonly regarded as the "good cholesterol" because it facilitates cholesterol transport from tissues to the liver. The LDL is considered the major transporter of cholesterol to body tissues and other lipids. The inclusion of white ginger root meal increase was pronounced between the control and 1 g/kg inclusion level. Studies conducted by (Zhao *et al.*, 2015; Diri *et al.*, 2024) on broilers, demonstrated that dietary treatments can alter LDL concentrations, and the responses depend on the composition and level of the dietary treatment and/or inclusion levels. Though the value obtained was lower ($25.50 - 39.85$ g/dl) compared to the reported values ($47.20 - 77.50$ mg/dl) of Adeyeye *et. al.*, (2026) who fed supplementation of phytogetic blend to broilers. The increase in cholesterol from (107.00 to 136.00 g/dl) may suggests that increasing white ginger inclusion may have influenced lipid metabolism. (Kokore *et al.*, 2021; Alagawany *et al.*, 2021) reviewed that total cholesterol in broilers is affected by several factors, such as age, strain, sex, diet and environmental conditions, also Meluzzi *et al.*, (2019) reported that age, season and interactions involving strain influenced blood biochemical constituents, including cholesterol and triglycerides.

CONCLUSION

Based on the findings of this study, for growth performance, haematological parameters and serum biochemistry, dietary inclusion of *Mondia whitei* meal up to 2g/kg diet is recommended among the treatments evaluated as the most appropriate inclusion level.

REFERENCES

- Adeyemo, I. A. and Sani, A. (2013). Haematological parameters and serum biochemical indices of broiler chickens fed (*Aspergillus niger*) hydrolyzed cassava peel meal-based diet. *IJRRAS* 15 (3) 24.
- Adeyeye, E.A., Adeyeye, O.A. Idowu, O.P.A. Amos, A.T. Kareem, D.U. Lala, A.O. and Oso, A.O. (2025). *Dennettia tripetala* Powder as a Phytogetic Feed Additive for Broilers: Effects on Haemato-Biochemical Status and Carcass Traits Compared to Antibiotics. *Nigerian Agricultural Journal* Vol. 56(2): 649-664. <http://doaj.org/toc/0300-368X>
- Adeyeye, A. E., Adeyeye, O. A., Orbug, A.T., Amos, A.T., Idowu, O.P.A. Kareem, D.K., Ajeigbe, O.M., Lala, A.O. and Oso, A.O. (2026) Dietary Supplementation with Phytogetic Blend on Haematology, Serum Biochemistry, Carcass Traits and Meat Quality of Broiler Chickens. *FUDMA Journal of Sciences (FJS)*. Vol. 10(17). pp 106 – 116 <https://doi.org/10.33003/fjs-2026-1017-5802>
- Alagawany, M., El-Saadony, M. T., Elnesr, S. S., Farahat, M., Attia, G., Madkour, M., and Reda, F. M. (2021). Use of lemongrass essential oil as a feed additive in quail's nutrition: its effect on growth, carcass, blood biochemistry, antioxidant and immunological indices, digestive enzymes and intestinal microbiota. *Poultry Science*. 100:101172. <https://doi.org/10.1016/j.psj.2021.101172>.
- Amaechi N. C., and Egesi, N. M. (2017). Nutritional Evaluation of a Wild Edible Fruit *Mondia white* (Hook. F.) Skeels Consumed by Human Populations in Izzi Clain, Ebonyi State, Nigeria. *Asian Journal of Advances in Agricultural Research*, 3(4):1-9
- AOAC. (2000). Association of Official Analytical Chemists: Official Methods of Analysis. (6th ed). Washington DC, USA, 167.
- AOAC (2005). Official Methods of Analysis. 18th ed. Washington DC.
- Aremu, A. O., Ndhlala A.R., Fawole O.A., Light M.E. Finnie J.F., and Van Staden J. (2010). In vitro pharmacological evaluation and phenolic content of ten South African medicinal plants used as anthelmintics. *South African Journal of Botany*, 76, pp. 558-566.
- Banerjee, G. C. (2005). A Textbook of Animal Husbandry (8th edition) Oxford and IBH Publishing co PVT Ltd New Delhi India.
- Bohm, B. A., and Kocipai-Abyazan, R. (1994). Flavonoid and condensed tannins from leaves of Hawaiian *Vaccinium vaticulatum* and *V. calycinium*. *Pacific Sci.*, 48:458-463.
- Bonsnes, R. W., and Tausky, H. H. (1945). On colorimetric determination of creatinine by the Jaffe reaction. *The Journal of Biological Chemistry*, 158, 581–591.
- Biu, A.A., S.D. Yusuf, and J.S. Rabo. 2009. Studies on the effect of aqueous leaf extract of neem (*Azadirachta indica*) on haematological parameters in chicken, *Journal. African. Sci.* 10:189 192.
- Campell, J. R., Kencally, M.D., and Campbell, K.I. (2003). Anatomy and physiology of farm animals. In: *Animal Sciences. The biology care and the production of domestic animals*, 4th edition. McGraw Hill Company Inc., New York, USA.
- Cannan, R. K. (1958). Proposal for a certified standard for use in haemoglobinometry; second and final report. *Clinical Chemistry*, 4, 246-251.
- Crouch, N.R., Nichols, G., and Hutchings, A., (1998). Umondi: The versatile herb of Africa. *Custos* May 24-25.
- Diri, M., Cruz, C. D., Mas-Claret, E., Sadgrove, N., Prescott, T. A. K., Langat, M. K., Tammela, P., and Schwikkard, S.L. (2024) Effect of graded levels of ginger on the lipid profiles of grower-finisher chickens. *International Journal of Advanced Multidisciplinary Research Studies*, 4(5), 30-32.

- Durrani, F.R., Chand, N., Jan, M., Sultanc, A., Durrani, Z. and Akhtar, S. 2008. Immunomodulatory and growth promoting effects of neem (*Azadirachta indica*) leaves infusion in broiler chicks. *Sarhad Journal of Agriculture*. 24(4):655-700.
- Edosein, J.C. and Switzer, B. R. (2001). Effect of Dietary Protein, Fat and Energy on blood haemoglobin and haematocrit in the rats. *Journal of Nutrition*. 107: 1016 – 1021.
- Erdogan, Z.S., Erdogan, S., Aslantas, O. and Elik, S.C. 2010. Effects of dietary supplementation of synbiotics and phytobiotics on performance, caecal coliform population and some oxidant/antioxidant parameters of broilers. *Journal. Anim. Phys. Anim. Nutrition* 94:40-48
- Evans. W.C. (2002). Trease and Evans Pharmacognosy, 15th Ed., W.B. Sanders, London, 182-189.
- Ewuola, E. O., Falayan, O. A., Cibore, F. A., Adebunmi, A. I., Akanji, R. A., Ogunlade, J. T. and Adeneye, J. A. 2004. Physiological response of growing West African Dwarf goats fed groundnut shell-based diets as concentrate supplements. *BOWEN Journal Agric*, 1 (1): 61-69.
- Fafiolu, A. O., Alabi, J. O., Godwin, C. G., Dada, I. D., Orimogunje, A. A., Osinowo, O.A., Bello, Z. O., and Ogunkanmbi, T. O. (2020). Phytogetic (lemon and orange peels) influenced the performance, gut morphology, and blood profile of broiler chickens. *Nigerian Journal of Animal Production*, 47(3), 234–244.
- Flint, J. F., and Garner, M. R. (2009). Feeding beneficial bacteria: A natural solution for *France*, pp. 73–83.
- Focho D.A., Nkeng E.A.P., Lucha C.F. Ndam W.T., and Afegenui A. (2009): Ethnobotanical survey of plants used to treat diseases of the reproductive system and preliminary phytochemical screening of some species of Malvaceae in Ndop Central Sub-division, Cameroon *Journal of Medicinal Plants Research*, 3.301-314.
- Harborne, J. B. (1973). *Phytochemical methods*. London: Chapman and Hall.
- Hermans M., Akoegninou A., and Van der Maesen L.J.G. (2004): Medicinal plants used to treat malaria in southern Benin *Economic Botany*, 58, pp. 239-252.
- Hoffenberg R, Black E., and Black, J.F. (1966). Serum metabolites. *The Journal of clinical investigation*, 45: 143-150.
- Idu M., Erhabor J.O., and Efijumue H.M. (2010). Documentation on medicinal plants sold in markets in Abeokuta, Nigeria *Tropical Journal of Pharmaceutical Research*, 9, pp. 110-118.
- Iji, P.A., A. Saki, and D.R. Tivey. 2001. Body and intestinal growth of broiler chicks on a commercial starter diet. Intestinal weight and mucosal development. *British Poultry Science*, 42: 505 - 513.
- Ilo S.U., Maduneme, F.C., Ogbu, O.C., Okonkwo, M.N., (2019) *Journal of Agriculture and Sustainability*. Vol 12(2):175-184
- Isaac, L.J., Abah, G., Akpan, B., and Ekaette, I.U. 2013. Haematological properties of different breeds and sexes of rabbits (p. 24-27). Proceedings of the 18th Annual Conference of Animal Science Association of Nigeria.
- Iyayi E.A. and Tewe, O.O. (1998). Serum total protein, urea and creatine levels as indices of the quality of compositional cassava diets of pigs. *Tropical veterinary* 36:56-67.
- Jamroz, D., Williczkiewicz, A., Wertelecki, T., Orda, J., and Scorupinska, J. 2005. Use of active substances of plant origin in chicken diets based on maize and domestic grains. *Br. A. poultry Science*. 6: 485-93. <https://doi.org/10.1080/00071660500191056>
- Jang, I.S.; Ko, Y.H., Kang, S.Y. and Lee, C.Y. 2007. Effect of commercial essential oils on M. A 2014. Inhibitory effects of sodium arsenite and acacia honey on acetylcholinesterase in rats. *International Journal of alzheimer's disease* 2015 (7): 1-7.
- Karou D.M Savadogo A., Yameogo., Montesano C., Simpoire J., Colizzi V., Traore A.S. (2006). Antibacterial activity of alkaloids from *Sida acuta*. *African Journal of Biotechnology* 5:195-200.
- Kokore, A. B., Kamagate, S., and Ouattara, H., (2021). Study of Lipid profile in broilers and local chickens in Korhogo, Côte d'Ivoire. *IOSR Journal of Pharmacy and Biological Sciences*, 16(5), 25-29.
- Makkar, A. O. S., and Goodchild, A. V. (1996). Quantification of tannins: A laboratory manual. ICARDA, Aleppo, Syria.
- Meluzzi, A., Primiceri, G., Giordani, R., and Fabris, G. (1992). Determination of blood constituents' reference values in broilers. *Poultry Science*, 71, 337-344.
- McGeoch, L., 2004. Plant ecology in a human context: *Mondia whitei* in Kakamega Forest, Kenya. *Environmental Science*, Brown University. Providence, Rhode Island, USA, pp1-80.
- Mitruka B.M., and Rawnsley H.M. (1977): Chemical, biochemical and haematological references values in normal experimental animal, Mason publishing, USA Inc. N.V. pp.88:142.
- Muhammed, A., Odunola, O.A., Gbadegesin, M.A., Sallau, A.B., Ndidi, U S. and Ibrahim, M.A. 2014. Inhibitory effects of sodium Arsenite and Acacia Honey on Acetylcholinesterase in rats. *International Journal of Alzheimer's Disease* 2015(7):1-7.
- Nabizadeh, A. 2012. The effect of insulin on broiler chicken intestinal microflora, gut morphology and performance. *Journal of Animal feed science*. 21:725-734.
- NRC, National Research Council 1994. *Nutrient Requirements of Poultry*, (9th rev. Ed). National Academy Press. Washing, D. C., U.S.A.
- Ngbolua, K. N, Tshibangu, D. S, Mpiana, P. T, Mudogo V, and Tshilanda, D. D, (2018) Medicinal Plants from Democratic Republic of the Congo as Sources of Anticancer Drugs. *Journal Prev Medical*.
- Obadoni, B. O., and Ochuko, P. O. (2001). Phytochemical studies and comparative efficacy of the crude extracts of some haemostatic plants in Edo and Delta States of Nigeria. *Global J. Pure Appl. Sci.*, 8:203-208.
- Odugbemi T.O., Akinsulire O.R., Aibinu I.E., and Fabeku P.O. (2007). Medicinal plants useful for malaria therapy in Okeigbo, Ondo state, Southwest Nigeria. *African Journal of Traditional, Complementary and Alternative Medicine*, 4, pp. 191-198
- Odebiyi, O.O. and Sofowora, E.A. 1979. Phytochemicals screening of Nigerian Medicinal plants 2nd OAU/STRC Inter-African Symposium on traditional Pharmacopoeia and African Medicinal, pp: 216-220.
- Okarter, N. Liu, C.C. Sorrells M.E., Liu R.H. 2009. Phytochemical content and antioxidant activity of six diverse varieties of whole wheat. *Food chemistry*. 119(1): 249-257.
- Okwu, D.E., and Emenike I.N., 2006. Evaluation of the phytonutrients and vitamin content of citrus fruits. *International Journal, Molecular Medical Advanced Science*. 2(1):1-6
- Okwu D.E. (2004). Phytochemicals and vitamin content of indigenous species of south Eastern Nigeria. *Journal on sustaining Agricultural Environment*, 6:30-34.
- Oloyede, O.I. (2005). A comparative study on the cholesterol content of products fractionated from egg yolk of some birds, *Pakistan Journal of Nutrition*: vol. 4(5).

- Onwuka, G. I. (2005). Food analysis and instrumentation. Naphthali Prints, Lagos.
- Oso, A. O., Suganthi, R. U., Manjunatha Reddy, G. B., Malik, P. K., Thirumalaisamy, G., Awachat, V. B., Selvaraju, S., Arangasamy, A., and Bhatta, R. (2019). Effect of dietary supplementation with phytogetic blend on growth performance, apparent ileal digestibility of nutrients, intestinal morphology, and ceca microflora of broiler chickens. *Poultry Science*, 98, 4755–4766.
- Rezaei, M., A. Attar, A. Ghodrathnama and H. Kermanshahi. 2010. Study the effects of different levels of fat and chicory inulin on performance, carcass characteristics and serum composition of broiler chicks. *Int. J. Poul. Sci.* 2: 178-182.
- Sanwo, K. A., Adegoke A. V., Ayo – Ajasa, O. Y., Elegbede, Fagbohun, A. O. and Adeyanju, T. M. Quality and stability of meat obtained from broiler chickens fed diets containing tonic root (*Mondia whitei*) as supplement. *Nig. J. Anim. Prod.* 2020, 47(3):99 – 109.
- Schalm, O.W., Jain N.C., and Carroll, EY.J. (1975) *Veterinary haematology* (3rd ed., p.15-218). USA: Lea and Fabiger, Philadelphia.
- Schemer G.H., and Guri-Fakim (Eds.), *PROTA (Plant Resources of Tropical Africa/Resources vegetables de l'Afrique tropicale)* Wageningen, Netherlands (2010).
- Sobayo R. A., O. A. Adeyemi., A. O. Oso, A. O. Fafolu, J. O. Daramola, G. Sodipe, I. B. Ogunade and O. M. Odetola. Haematological, serum and carcass characteristics of broiler chicken fed graded levels of *Garnia Kola* (Bitter Kola) used as phytobiotics. *Nigerian Journal of animal production*, vol. 40:48-56.
- Stafford G.I., M.E. Pedersen, J. Van Staden, and A.K. Jäger Review on plants with CNS-effects used in traditional South African medicine against mental diseases. *Journal of Ethnopharmacology*, 119 (2008), pp. 513-537.
- Swenson, M.J. (1970). Physiological properties, cellular and chemical constituents of blood, in M. J. (Ed.), *Dukes' physiology of domestic animals* (8th ed., p.75-83). Cornstock Publishing Associates, Cornell University Press, Ithaca, London.
- Varley, H., and Gowenlock, A.H., Bell, Meds. (1980). *Practical clinical biochemistry*, Vol 1(5): 536.
- Velasco, S, L. T., C. Alzueta., A. Rebole, J. Trevino and M.L. Rodriguez. 2010. Study the effects of different levels of fat and chicory inulin on performance, carcass characteristics and serum composition of broiler chicks. *International Journal of Poultry Science* 89:1651-1662.
- Watcho P., Fotsing D., Zeleack F., Hguelefack, T.B., Kamtchouing, P., Tsamo, E., and Kamanyi, A. (2006). Aphrodisiac effect of MH2 and MH6 isolated from hexane extract of *Mondia whitei* in sexually inexperienced male rats. *J.S. Medical*.382-452.
- WHO (2002). World Health Organization: Use of antimicrobials outside human medicine and resultant antimicrobial resistance in humans.
- Wootton, I. D. P. (1964). *Micro analysis in medical biochemistry* (4th ed.). Churchill.
- Youkeu, N.J., 2008. Natural substances and sport performance. In: Mbopi- Kéou, F.-X. (Ed.), *Health and Sports in Africa: A Challenge for Development. John Libbey Eurotext, Montrouge*,
- Yusuf, K. O., Ajeigbe, O. M., Oyebo, A. T., Aderinboye, R.Y. and Onwuka, C.F.I. Nutrient and Anti-Nutrient contents of some crop by-products and residues for Ruminant Feeding in Nigeria. *Journals of animal production research* (2017), Volume 29(1): 321 – 334
- Zhao, P. Y, Li H. L, Hossain M.M, and Kim I.H. 2015. Effect of emulsifier (lysophospholipids) on growth performance, nutrient digestibility and blood profile in weanling pigs. *Anim Feed Sci Technol*. 207:190–195.

