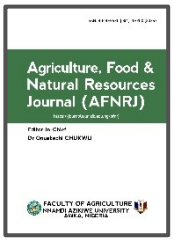
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Original Article

Growth performance and immune response of broiler chickens to oral administration of *Parquetina nigrescens* leaf extracts

OPEN ACCESS

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ABSTRACT

The study was to determine the effect of Parquetina nigrescens leaf extract on the performance, health status and immunological response of broiler chickens. Fresh leaves of Parquetina nigrescens were harvested and blended, using 10 g of leaves in 200 ml of water, this was administered in the first 5 days in the starter and finisher phases. Two-hundred-day old Arbor acres plus strains of broilers were assigned to five dietary treatments, four replicates with forty birds per treatment. The treatments were as follows: treatment 1: positive control – commercial antibiotics was used, treatment 2: negative control without commercial antibiotics while treatments 3, 4, 5 birds were administered 0.2, 0.4 and 0.6 ml of Parquetina nigrescens leaf extract per bird respectively. The design of the experiment was completely randomized design (CRD). Performance, hematological, serum biochemical and immunological responses as well as the relative organ weights were investigated using standard procedures. Data were subjected to one-way Analysis of Variance while significant differences were determined using Duncan's multiple range tests. The results showed that there were significant differences ($p<0.05$) in the final weight and average feed intake of the birds administered with the leaf extract with T5 (0.6 ml) having the highest values (1.84 kg and 3.26 kg respectively) while T4 (0.4 ml) had the lowest value (1.58 kg and 2.97 kg respectively). However, there was no significant among the treatments for other parameters. The study concluded that Parquetina nigrescens leaf extract had no detrimental effect on growth performance and immune response of broiler.

KEYWORDS: *Antibiotics, Biochemical, Growth, Haematological, Serum*

INTRODUCTION

In Nigeria, poultry production is one of the most important animal industries. It is a source of income for farmers in the country who raise poultry birds. Poultry products are a good source of protein in the diet. Chicken meat consumption is growing faster than any other livestock, with feed accounting for roughly 70-80% of total poultry production costs (Adegbola, 1998).

Due to its high turnover rates and quick return on investment, broiler production is one of the most popular chicken industries. Broilers are specifically bred to produce meat. Very high growth rate is required in broiler chicken production if maximum productivity is to be achieved, which will reflect in the gross margin (Oluyemi & Roberts, 2000).

Antibiotic use is prohibited in many regions of the world. However, antibiotics and growth boosters are used to feed about 80 percent of all produced animals (Van *et al*., 2020).

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Antibiotics' growth-promoting impact was discovered in the 1940s, when it was revealed that animals fed dried Streptomyces aureofaciens mycelia containing chlortetracycline residues grew faster. Antibiotics' growth-promoting function is linked to interactions with the gut bacteria community (Dibner & Richards, 2005; Niewold, 2007). Because only antibiotics that are not absorbed in the digestive tract are approved as growth promoters, the chances of antibiotic residues in edible tissues and products causing allergic or harmful reactions in consumers are known to be small (Donoghue, 2003). The increased use of antibiotics as feed additives may eventually lead to the evolution of microbes resistant to antibiotics. If these bacteria with resistant genes are passed from person to person, they pose a risk to humans (Manyi-Loh *et al*., 2018). As a result, the World Health Organization (1997) and the European Union's Economic and Social Committee (1998) concluded that antimicrobial usage in food animals constituted a public health concern.

Herb extract has been utilized in place of growth boosters and antibiotics as an unconventional feed additive (Lee *et al.*, 2001; Olumide *et al.*, 2022). In the extensive livestock system, herbal extracts were employed to boost the general performance of the animals (Horton *et al*., 1991; Bakhiet & Adam, 1995; Skrabka *et al.*, 1997; Manzanilla *et al.*, 2001; William & Losa, 2001; Gill *et al.*, 2002; Abo Omar *et al.*, 2016). Medicinal plants and their products, such as plant extracts or essential oils, were added into broiler diets as phytogenic feed additives and their favorable effects were demonstrated (Bölkbaşi & Erhan, 2007; Soltan *et al.*, 2008; Dalkiliç & Guller, 2009; Olumide *et al.*, 2022). The maintenance of normal gut microbiota, the prevention of pathogen colonization (Tekeli *et al*., 2006), and the improvement of digestive enzyme synthesis and activity are the key effects of such substances on poultry productivity and health (Lee *et al.*, 2004).

Parquetina nigrescens is a shrub native to equatorial West Africa, and its leaves, roots, and latex have all been used in traditional medicine for millennia (Gill, 1992). Bullock is another name for it. It's a perennial with twinning stems and a woody base that taper to 10-15 cm in length and 6-8 cm in width, with a smooth long stem on the leaves. Bullock is a member of the Asclepiadaceae family. The leaf extract of *Parquetina nigrescens* has been demonstrated to help in hemorrhagic anemia (Agbor & Odetola, 2005). *Parquetina nigrescens* leaf extract has been shown to have analgesic, anti-inflammatory, and antipyretic properties (Owoyele *et al.*, 2009). Haematinic, antidiabetic, cardio tonic, anti-ulcerative, and antioxidant characteristics have been discovered in the plants (Datté & Ziegler, 2001; Saba *et al.*, 2010; Ozaslan, 2011; Ayoola *et al.*, 2011).

There is however paucity of information on the use of *Parquetina nigrescens* as it relates to animal health and livestock production. The study is therefore aimed at determining the growth performance, utilization and immunological response of broiler chickens to the administration of *Parquetina nigrescens* leaf extracts.

MATERIALS AND METHOD

The study was conducted at the poultry unit of Babcock University farmhouse, Ilishan-Remo, Ogun State, Nigeria. Ilishan Remo is in the rain forest zone of Nigeria with an annual rainfall of about 1500mm, a mean temperature of 27^0 Celsius.

Fresh leaves of *Parquetina nigrescens* were collected from Ibadan in Oyo State, Nigeria and identified by an agronomist in the Department of Agriculture and Industrial Technology, Babcock University, Ilishan-Remo, Ogun State, Nigeria. The harvested leaves were then washed with fresh water to remove debris and sands. Ten grams of the fresh leaves harvested were blended with 200 ml of water using a blender. The blended samples were well filtered using standard filter papers. The filtrates were then measured according to the treatment groups and administered orally to each bird.

Two-hundred-day-old broiler chicks were purchased from a commercial hatchery in Ibadan, Nigeria. The chicks were allotted in a completely randomized design (CRD) to five treatment groups designated as T1, T2, T3, T4 and T5 (0ml with antibiotics, 0ml without antibiotics, 2ml without antibiotics, 4ml without antibiotics and 6ml without antibiotics of the extract of *Parquetina nigrescens* leaf respectively). Each treatment group had four replicates with 10 chicks per replicate.

The extracts were administered in the first 5 days at the starter phase and first 5 days at the finisher phase.

The house was washed, disinfected and left to dry for two weeks before the arrival of the chicks. Drinkers and feeders were thoroughly washed and disinfected before the arrival of the chicks. On arrival, the initial weights of the birds were taken before they were randomly allotted to five treatments (T_1, T_2, T_3, T_4, and T5) with four (4) replicates of 10 birds each in a completely randomized design. Feed and water were supplied to the bird's *ad-libitum* throughout the experimental period which was 6 weeks.

Vitamins were administered from day one to six for all treatments. 1st Gumboro vaccination was administered orally at day 7 to birds in T1 and T2. 1st Lasota vaccination was administered orally at day 9 to birds in T1 and T2, 2nd Gumboro vaccination was administered at day 17 to birds in T1 and T2 and 2nd lasota vaccine was administered orally at day 19 to birds in T1 and T2

Data were collected on performance (feed intake, weight gain, feed conversion ratio (FCR) and livability), immunological response (serum biochemistry, haematology, and histopathology), relative organ weight (liver, kidney, heart,).

Feed intakes were calculated daily. This was done by deducting the amount of feed left in the feeders from feed given in the previous day as feed intake for the day.

Feed intake (g) = feed given (g) – feed left (g) (1)

Table 1: Gross composition of experimental starter and finisher diet (g/100g)

Ingredient (kg)	Broiler starter	Broiler finisher
Maize	52.0	58.00
Soya bean meal	38.00	27.00
Wheat offal	4.59	9.64
Palm oil	2.00	2.00
Dicalcium phosphate	1.50	1.50
Oyster shell	1.00	1.00
Salt	0.25	0.25
Broiler premix	0.25	0.25
Methionine	0.30	0.25
Lysine	0.05	0.05
Avatec	0.06	0.06
Total	**100.00**	**100.00**
Determined analysis		
Crude protein (%)	20.50	18.00
Crude fibre (%)	4.02	5.80
Ether extract (%)	3.00	4.50
Metabolizable energy (kcal kg)	2,962.29	2,911.63

The weights of all the birds in each replicate were taken. This was done on the day of arrival and was subsequently done weekly until the end of the experiment.

Feed Conversion Ratio (FCR) = feed intake (g) ÷ body weight (g) (2)

Mortalities were recorded against the respective replicates as and when they occurred throughout the experimental period. Percentage mortality was calculated as:

Percentage mortality = Number of dead birds ÷ Number of birds per treatment ×100 (3)

On the 42nd day, the birds were fasted prior to blood collection but water was provided *ad-libitum*. 4.0 ml blood was collected from the wing vein of birds (3 birds were randomly selected per replicate) into heparinized bottles to determine serum biochemical components: Total Protein (TP), Globulin, Albumin, Urea, Creatinine, Aspartate aminotransferase (AST) and Alanine aminotransferase (ALT) and labeled sterile universal bottles containing Ethylene Diamine Tetra Acetate (EDTA) as anticoagulant for the determination of haematological parameters. Red blood cells (RBC), white blood cells (WBC), platelet, mean corpuscular volume (MCV), mean corpuscular haemoglobin concentration (MCHC), mean corpuscular haemoglobin (MCH), basophil, neutrophil, eosinophil, heamoglobin concentration (HB), packed cell volume (PCV), monocytes, lymphocytes and heterophils were determined according to the procedure of Howlett and Jamie (2008).

Fifteen birds were randomly selected from all the treatments, three (3) birds per treatment for relative organ weight at the end of the experiment. The selected birds were starved overnight and their live weight was recorded. The birds were de-feathered after scalding and their plucked weights were taken. The birds were eviscerated and the eviscerated weight was recorded. The organs were harvested and the following parameters were recorded; liver, heart, kidney, spleen. Relative organ weight is gotten by dividing each bird's organ weight by their body weight.

Blood samples were collected 24 hours after the vaccination days (3 samples/treatment) and at the end of the feeding trial to examine the immune response to Newcastle Disease Virus (NDV) and Infectious Bronchitis Virus (IBV) by measuring the titer values against these viruses using Hemagglutination-inhibition (HI) test and commercial Enzyme Linked Immunosorbent Assay Kits respectively

Data collected on performance, relative organ weight and immunological response were subjected to analysis of variance (ANOVA) (SAS Institute, 1999) and the treatment means were separated using Duncan Multiple range test where significant (Steel & Torries, 1990).

RESULTS AND DISCUSSION

As presented in Table 2, there was significant difference ($P<0.05$) in the final weight, weight gain and feed intake of birds administered the leaf extract. With T5 (0.6 ml) having the highest final weight, weight gain and feed intake; 1.882 kg, 1.844 kg and 3.256 kg respectively while the least values were obtained from T4 with 1.620 kg, 1.581 kg and 2.793 kg respectively. There was no significant difference in the FCR and mortality ($p>0.05$) however the feed conversion rate (FCR) values ranged from 1.697 - 1.771.

Table 3 showed that there was no significant difference ($P>0.05$) between the antibody titre value of the treatments when tested against IBD Gumboro and NDV lasota.

Table 4 showed the haematological response of the birds to the administration of *Parquetina nigrescens* leaf extract. The oral administration of *Parquetina nigrescens* leaf extracts did not have significant effects ($p>0.05$) on the haematological parameters of birds. The values obtained for packed cell volume ranged from 15.50 – 27.50% , haemoglobin ranged from 5.15-9.15 g/dl, the values obtained for total white blood cell ranged from 6250- 11250 mm^3, the value gotten for the red blood cell count ranged from 1.85- 3.20 (µ) *10^6 , platelets value ranged from 116000- 156000, MCH value ranged from 2.77- 2.86%, MCV ranged from 8.32-8.59%, MCHC ranged from 33.16-33.27%, lymphocytes ranged from 53.50-62.50%, heterophils ranged from 27.50 - 37.50%, monocytes ranged from 4.00-6.00%, eosinophils ranged from 0-1.5%, and basophils ranged from 0.50- 30%.

Table 2: Performance characteristics of broiler birds given *Parquetina nigrescens* leaf extract

Parameter (kg)	T1 (Positive control)	T2 (Negative control)	T3 (0.2ml/bird)	T4 (0.4ml/bird)	T5 (0.6ml/bird)
Initial weight	0.04 ± 0.00	0.04 ± 0.00	0.04 ± 0.00	0.04 ± 0.00	0.04 ± 0.00
Final weight	1.83 ± 0.05^{ab}	1.75 ± 0.07^{ab}	1.75 ± 0.05^{ab}	1.62 ± 0.11^{a}	1.88 ± 0.09^{b}
Weight gain	1.79 ± 0.05^{ab}	1.71 ±0.072^{ab}	1.72 ± 0.05^{ab}	1.51 ± 0.11^{a}	1.84 ± 0.09^{b}
Feed intake	3.10 ± 0.09^{ab}	2.91 ±0.18^{ab}	2.92 ± 0.12^{ab}	2.79± 0.19^{a}	3.26 ± 0.09^{b}
Mortality (%)	0.50 ± 0.29	1.50 ± 0.29	1.25 ± 0.48	0.75 ± 0.48	1.00 ± 0.63
FCR	1.73 ± 0.04	1.70 ± 0.04	1.70 ± 0.04	1.77 ±0.06	1.77 ± 0.04

a, b: Means along the same row with different superscript are significantly different (P<0.05). Group mean and standard error of samples (x±sem) shown, FCR – Feed Conversion Ratio

Table 3: Immunological response of broilers chickens given Parquetina nigrescens leaf extract

	T1 (Positive control)	T2 (Negative control)	T3 (0.2ml/bird)	T4 (0.4ml/bird)	T5 (0.6ml/bird)
IBD	234.38 ± 78.13	97.66 ± 58.59	332.03 ± 92.97	312.50 ± 89.00	29.30 ± 9.77
ND	175.78 ± 136.72	117.19 ± 39.06	468.75 ± 156.25	97.66 ± 58.59	117.188 ± 39.06

Group mean and standard error of samples (x±sem) shown, IBD – Infectious Bursa Disease, ND – Newcastle Disease

Table 4 Haematological response of broiler chickens given *Parquetina nigrescens* leaf extract

	T1 (Positive control)	T2 (Negative control)	T3 (0.2ml/bird)	T4 (0.4ml/bird)	T5 (0.6ml/bird)
PCV (%)	17.00 ± 7.00	23.00 ± 4.00	27.50 ± 2.50	26.00 ± 2.00	15.50 ± 6.50
HB (g/d)	5.65 ± 2.35	7.65 ± 1.35	9.15 ± 0.85	8.65 ± 0.65	5.15 ± 2.15
TWBC (mm3)	7950.00 ± 25.00	6250.00 ± 75.00	11250.00±25.00	8750.00±1.00	9050.00±55.00
RBC COUNT (µ) *10^6	2.00 ± 0.80	2.70 ± 0.50	3.20 ± 0.30	3.05 ± 0.25	1.85 ± 0.75
Platelet	125000.00 ± 20000.00	142000.00 ± 12000.00	156000.00 ± 9000.00	147500.00±7500.00	11600.00 ± 26000.00
MCH (%)	2.80 ± 0.05	2.84 ± 0.03	2.86 ± 0.00	2.84 ± 0.02	2.77 ± 0.04
MCV (%)	8.45 ± 0.12	8.54 ± 0.10	8.59 ± 0.03	8.53 ± 0.04	8.32 ± 0.14
MCHC (%)	33.16 ± 0.17	33.25 ± 0.09	33.26± 0.07	33.27± 0.06	33.25 ± 0.08
Lymphocytes (%)	53.50± 5.50	56.00 ± 6.00	59.00 ± 6.00	62.50 ± 7.50	58.50 ± 1.50
Heterophils (%)	37.50 ± 7.50	36.00 ± 4.00	34.50 ± 9.50	27.50 ± 2.50	35.00 ± 0.00
Monocytes (%)	6.00 ± 2.00	6.00 ± 1.00	5.00 ± 3.00	6.00 ± 2.00	4.00 ± 0.00
Eosinophils (%)	0.00 ± 0.00	1.50 ± 1.50	0.00 ± 0.00	1.50 ± 1.50	0.00 ± 0.00
Basophils (%)	3.00 ± 0.00	0.50 ± 0.50	1.50 ± 0.50	2.50 ± 1.50	2.50 ± 1.50

Group mean and standard error of samples (x±sem), packed cell volume (PCV), RBC (Red Blood Cells), mean corpuscular volume (MCV), mean corpuscular haemoglobin (MCH) and mean corpuscular haemoglobin concentration (MCHC)

From Table 5, it was observed that the administration of the leaf extracts of Parquetina nigrescens did not significantly influence (p>0.05) all the serum biochemical parameters measured. The parameters measured were alanine transaminase, aspartate transaminase, alanine phosphatase, creatinine, albumin, globulin, total protein and cholesterol. The values obtained for relative organ weight are shown in Table 6. The obtained values were not significantly influenced (P>0.05) by the administration of the leaf extracts of *Parquetina nigrescens.*

Table 5 Serum biochemical responses of broiler chickens given Parquetina nigrescens leaf extract

	T1 (Positive control)	T2 (Negative control)	T3 0.2ml/bird)	T4 0.4ml/bird)	T5 0.6ml/bird)
ALT (U/I)	62.00±10.00	68.50 ± 6.50	64.00± 10.00	65.00 ± 5.00	70.50 ± 6.50
AST (U/I)	67.00 ± 8.00	61.00 ± 6.00	71.50 ± 4.50	65.00 ± 9.00	69.00 ± 9.00
Creatinine (mg/dl)	0.16 ± 0.04	0.165 ± 0.08	0.18± 0.08	0.20 ± 0.15	0.23±0.17
Albumin (g/dl)	7.55 ± 0.65	7.55 ± 0.55	7.70 ± 0.50	7.45 ± 0.35	7.60±0.70
Globulin (g/dl)	5.05 ± 0.45	5.05 ± 0.35	5.10 ± 0.3	4.95 ± 0.25	5.10 ± 0.40
Urea (mg/dl)	56.50 ± 0.50	57.00 ±7.00	59.50 ± 7.50	55.00 ± 5.00	57.50±4.50
Total protein (g/dl)	12.60 ± 1.10	12.60 ± 0.90	12.80 ± 0.80	12.40 ± 0.60	12.70±1.10
ALP (U/I)	32.50 ± 4.50	32.50 ±7.50	37.50 ± 7.50	33.50 ± 1.50	29.00±4.00
Cholesterol (mg/dl)	367.00±23.00	357.00±37.00	360.00±20.00	348.00±30.00	353.00±29.00

Group mean and standard error of samples (x±sem), aspartate transaminase (AST), alanine transaminase (ALT), alkaline phosphatase (ALP)

Table 6 Organ Weights and Relative Organ Weights of Broiler Chickens Administered *Parquetina nigrescens* Leaf Extract

Organs (g)	T1 (Positive control)	T2 (Negative control)	T3 (0.2ml/bird)	T4 (0.4ml/bird)	T5 (0.6ml/bird)
Liver	34.00±0.03	31.00±1.00	31.00±2.00	33.00±2.00	33.00±2.00
Kidney	1.00±0.00	1.00±0.00	1.00±0.00	1.00±0.00	1.00±0.00
Heart	1.00±0.00	1.10±0.00	1.10±0.01	1.10±0.00	1.00±0.01
Spleen	2.00 ±0.01	1.00±0.01	1.00±0.01	1.00±0.01	2.00±0.01
Rel. Liver (%)	1.60±0.02	1.50±0.01	1.50±0.01	1.60±0.01	1.50±0.01
Rel. Kidney (%)	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00
Rel. Heart (%)	0.05±0.00	0.05±0.00	0.05±0.01	0.05±0.00	0.05±0.01
Rel. Spleen (%)	0.01±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.01±0.00

DISCUSSION

Administration at the highest dose (0.6ml) improved body weight gains and feed intake but no significant difference was observed in FCR. The performance results, on the other hand, were in contrast to those of Arslan *et al.* (2017), who looked at the effects of turmeric (*Curcuma longa*) supplementation on broiler development, immunological response, carcass features, and cholesterol profile. Supplementation at a rate of 0.5 percent improved FCR and reduced feed consumption, but comparable findings were made in the current investigation, with birds receiving the highest percentage of the supplement having the best ultimate live weight and body weight gain. Al-Jaleel (2012) showed enhanced body weight gain at the maximum turmeric dosage without affecting feed consumption, which is similar to these findings. The feed conversion ratio (FCR) ranged from 1.697 to 1.771, which is within the broiler industry's acceptable range. The results were higher than the optimum value of 2.0 reported for broilers by Prakbakaran (2003). This indicates that giving the birds *Parquetina nigrescens* leaf extract had no negative impact on their diet intake. Also, the mortalities rate, were not significantly different (P>0.05) among treatments and fall within the best ranges for mortalities in well managed birds especially less than 3% as reported by Atteh (2015).

Furthermore, Olumide *et al.* (2022) discovered that the administration of *Ocimum gratissimum* leaf extracts had no effect on the feed conversion ratio. The findings are also consistent with Basit *et al.* (2020) study on the effects of different doses of *Pericardia odorata* leaf meal (POLM) in broiler chicken feed on biochemical and haematological blood markers, as well as liver histomorphological changes. They concluded that supplementing broiler chicks with POLM improved their growth performance. They also discovered that the phytobiotics greatly increased body weight, but that dietary supplementation with POLM had no effect on feed intake or FCR. The findings are also consistent with the findings of Aroche *et al.* (2018), who found that adding phytobiotics to the diet in the form of a 0.5 percent mixed powder of *Morinda citrifolia*, *Psidium guajava* and *Ageratina occidentalis* boosted feed efficiency and body weight gain. Nouzarian *et al.* (2011) found better FCR at 1.0 percent supplementation, contrary to the findings of this study. Variations in this study could be attributed to the varied test ingredients employed.

Other investigations have discovered that probiotic bacteria have no effect on the amount of serum immunoglobulins Y, IgM, or IgA, and the immunological parameters revealed no significant difference (Balevi *et al.*, 2001; Mountzouris *et al.*, 2010; Talebi *et al.*, 2015). When turmeric was added at 0.33, 0.66, and 1.0 percent to the diet of broiler chickens, Nouzarian *et al.* (2011) found no significant effect on the titer against ND. When turmeric was supplemented at the rates of 1.0, 1.2, 1.8, and 2.0 percent, Qasem *et al.* (2015) found no favorable results on IBD titer, which is consistent with the current investigation.

Animals' physiological status can be determined by haematological measures (Khan & Zafar, 2005; Akintunde *et al.*, 2019). The status of animals exposed to toxicants and other situations is reflected in their blood (Olafedehan *et al.*, 2010; Oloruntola *et al.*, 2016). According to Isaac *et al.* (2013), animals with a healthy blood composition are more likely to perform well. Isaac *et al.* (2013) further reported that packed cell volume has a role in oxygen and nutrient absorption. Increased packed cell volume indicates improved transportation, preventing anemia (Coles, 1986). This finding is consistent with the findings of Chineke *et al.* (2006), who found that packed cell volume can easily indicate an increase in the number of red blood cells or a decrease in the volume of circulating plasma. Toxic chemicals in feed have been shown to decrease haemopoietic tissues, resulting in lower white blood cell production (Fakunle, 2021).

This finding suggests that the extract helped haemopoietic tissue produce enough white blood cells. Because white blood cells serve largely as a defensive system in the body (Eroschenko, 2000), this result showed that the birds' immune systems were not affected. In this investigation, the haematological blood markers were found to be within normal ranges (Thrall *et al*., 2012). The broiler hens administered *P. nigrescens* leaf extracts had normal blood haematology values, indicating adequate nutrition and improved immunological condition. However, the current study findings contrasted with those of Basit *et al.* (2020), who found significant increases in RBC and WBC counts, as well as Hb and PCV values. Reis *et al.* (2018) found that adding phytobiotics like cinnamic aldehyde, thymol, and carvacrol to broiler chicks dramatically boosted erythrocyte counts and haemoglobin in comparison to the control. Krauze *et al.* (2020) demonstrated improvements in the immune system and parameters including RBCs and Hb after feeding probiotic *Bacillus subtilis* (0.25 g/L), *Enterococcus faecium* (0.25 g/L), and phytobiotics with cinnamon oil (0.25 mL/L) to broiler chickens. Gilani *et al.* (2018) investigated the efficacy of organic acids and phytobiotics (including flavonoids) in poultry feed as alternatives to AGPs, finding substantial increases in RBC, WBC, and PCV in broiler chickens. Contrarily, broiler chicks fed Garden cress (*Lepidium satvium*) seed powder (Shawle *et al.*, 2016), cayenne pepper (*Capsicum frutescens*) and turmeric (*Curcuma longa*) powders (Adegoke *et al.*, 2018), and pawpaw leaf and seed meal (Oloruntola, 2019) had higher Hb, PCV, and RBC values.

The current findings were consistent with those of Basit *et al.* (2020), who found no significant differences in MCV, MCH, or MCHC in experimental broiler chicks fed POLM supplements. These findings were also consistent with those of Oghenebrorhie & Oghenesuvwe (2016), who found no significant differences in MCV, MCH, or MCHC among broilers fed *Moringa oleifera* leaf meal (MOLM). Finally, the lack of significance of haematological markers in broiler hens administered *Parquetina nigrescens* leaf extracts suggests that dietary nutrients are effectively utilized.

Serum biochemical parameters depict nutrient metabolism in the body and highlight potential alterations caused by intrinsic and external causes (Liu *et al.*, 2015; Hu *et al.*, 2016; Akintunde *et al.*, 2021). The liver is one of the largest and most important organs in living creatures, and it is responsible for detoxification, metabolism, and removal of both endogenous and foreign chemicals (Paul *et al.*, 2016). Alkaline phosphatase (ALP), aspartate transaminase (AST), and alanine transaminase (ALT) activity levels are regarded diagnostic measures that can be used to assess hepatotoxicity (Króliczewska, 2016). Any clinical manifestation or toxicity causes an increase in AST and ALT activity (Toghyani *et al.*, 2011). Furthermore, their levels of activity are thought to be specific indications of liver injury or impairment (Alhidary *et al.*, 2016). The current study found no significant differences in all serum biochemical parameters, in contrast to Basit *et al.* (2020), who found that increasing the *Pericardia odorata* Leaf Meal (POLM) supplementation dosage decreased serum activity of AST and ALT, but in agreement with Basit *et al.* (2020), who found that serum activity of ALP was not influenced by *Pericardia odorata* Leaf Meal (POLM) supplementation in experimental animals. The lack of importance of ALT and AST indicated that the extracts of *Parquetina nigrescens* were better utilized without affecting the birds' liver function. The findings of this study contrasted with those of Odetola *et al.* (2019), who found that graded supplementation of *Petiveria alliacea* root meal in broiler chicks significantly reduced AST activity. In a recent study, Oloruntola *et al.* (2018) discovered that feeding pawpaw and bamboo leaf meal to broiler hens reduced ALT activity considerably. The liver produces the majority of serum proteins, and their concentrations reflect the health of hepatocytes. Hepatic insufficiency, malnutrition, and active inflammation, which can be caused by recurrent infections and immunological deficiencies, can all cause a drop in blood protein levels (TP, albumin, and globulin) (Tothova *et al.*, 2016). Furthermore, the levels of serum protein in birds are key indications for determining their health status. Broiler chickens have a relatively short fattening stage, and there is a rapid buildup of building proteins in the body tissues, which may have a major impact on protein quantities and composition in the blood (Scanes, 2014). This rapid development pattern necessitates extensive erythropoiesis and haemoglobin synthesis, which might lead to increased globulin production, potentially altering blood protein concentrations in growing chickens (Roman *et al.*, 2009; Tothova *et al.*, 2019). In contrast to Akintunde *et al.* (2021a) for *Moringa oleifera* seed inclusion and Akintunde *et*

al. (2021b) for *Chromolaena odorata* leaf meal, the current investigation found that administration of *Parquetina nigrescens* leaf extract had no significant effect on TP, albumin, or globulin levels. The current findings contrast with those of George *et al.* (2015), who found greater blood TP levels in broilers fed a ginger-powder-supplemented diet at both the beginning and end of their lives. In contrast to the current investigation, Abudabos *et al.* (2018) showed serum TP and globulin trends for broilers given anise and thyme essential oils. The typical range of serum glucose in birds is 200 to 500 mg/dL. (Thrall *et al.*, 2012). The present investigation found that oral administration of *Parquetina nigrescens* leaf extracts had no effect on serum glucose concentrations, which is consistent with Basit *et al.* (2020) findings on POLM supplementation in broiler chickens. The current findings are consistent with those of Abudabos *et al.* (2018), who found that serum glucose levels in experimental broilers treated with phytogenic feed additives did not differ significantly. Cholesterol and triglyceride levels in the blood are thought to be indications of lipid metabolism (He *et al.*, 2015; Akintunde *et al.*, 2021a). The current investigation found that administering *Parquetina nigrescens* leaf extracts had no effect on serum triglyceride and cholesterol levels. Similar findings have been documented in other investigations (Amad *et al.*, 2011). The kidneys are the second organ that might be harmed as a result of metabolic problems. Kidney function is crucial in determining the potential toxicity of any compound. The increase or decrease in serum levels of urea and creatinine can be used to assess kidney function (Akintunde, 2018). Reduced glomerular filtration results in higher creatinine levels, which suggests kidney damage (Rhiouani *et al.*, 2008), but an elevated serum urea level indicates cardiac and renal tissue injury. The current investigation found that the ingestion of the test components had no significant effect on serum creatinine and urea levels. These findings suggested that the test substances had no negative impact on kidney function when administered. These findings showed that giving *Parquetina nigrescens* leaf extracts to broiler chickens improved liver and kidney function and was safe up to 0.6 ml.

The relative internal organ weights were used as a predictor of animal reactions to any harmful substance in the feed that could cause a rise or reduction in internal organ weights (Ayodele *et al.*, 2016; Akintunde *et al.*, 2021a). There were no macroscopic changes in any internal organs in the current investigation, such as hypertrophy or atrophy, damage, or swelling. Furthermore, administration of *Parquetina nigrescens* leaf extracts had no effect on relative organ weights in experimental broiler chickens, which was consistent with Baist *et al.* (2020) findings. The findings of this study correspond with those of Oloruntola (2019), who found that the inclusion of seed meal and pawpaw leaf meal had no effect on the relative internal organ weights of broilers. Similar findings were reported by Rubio *et al.* (2019) and Vispute *et al.* (2019), who found that adding phytobiotics to the diet had no effect on the relative organ weights of broiler chickens. Finally, the stable relative internal organ weights of the broilers throughout experimental groups revealed that administration of *Parquetina nigrescens* leaf extracts had no negative impact on the internal organs of the broiler chickens.

CONCLUSION AND RECOMMENDATION

The findings of this study indicate that oral administration of *Parquetina nigrescens* leaf extract at 0.6 ml per bird resulted in enhanced feed intake, weight gain, and body weight. The administration of *Parquetina nigrescens* leaf extract up to 0.6 ml did not have any deleterious effect on the health, immunology and general wellbeing of broiler chickens. For enhanced productivity, *Parquetina nigrescens* leaf extract could be administered to broiler chickens up to 0.6 ml per bird.

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Authors Contributions

Authors LCN, AOA, TO and IO: Management of experimental animals, data collection. LCN, AOA and MDO: Conceptualization, design of the experiments, data management, data analysis, visualization, manuscript review and final approval of manuscript.

Ethical Statement

Not Applicable.

REFERENCES

Abo Omar, J., Hejazi, A. & Badran R. (2016). Performance of broilers supplemented with natural herb extract. *Open Journal of Animal Science*, 6(1), 68- 74. https://doi.org/10.4236/ojas.2016.61009

Abudabos, AM., Alyemni, AH., Dafalla, YM. & Khan, RU. (2018). The effect of phytogenics on growth traits, blood biochemical, and intestinal histology in broiler chickens exposed to *Clostridium perfringens* challenge. *Journal of Applied Animal Research*, 46, 691–695. https://doi.org/10.1080/09712119.2017.1383258

Adegbola, TA. (1998). Sustainable Ruminant Production for Human and Nutrition and National Development. Inaugural lecture series no 7. University Inaugural Lecture Delivered on 21st January 1998 at A.T.B.U Bauchi, Nigeria.

Adegoke, AV., Abimbola MA., Sanwo, KA., Egbeyale LT., Abiona, JA., Oso, AO. & Iposu, SO. (2018). Performance and blood biochemistry profile of broiler chickens fed dietary turmeric (*Curcuma longa*) powder and cayenne pepper (*Capsicum frutescens*) powders as antioxidants. *Veterinary and Animal Science*, 6, 95–102. https://doi.org/10.1016/j.vas.2018.07.005

Agbor, GA. & Odetola, AA. (2005). Effect of *Parquetina nigrescens* on erythrocyte indices and serum electrolytes of rats following acute blood loss. *Pakistan Journal of Biological Sciences*, 8, 527-531. https://doi.org/10.3923/pjbs.2005.527.531

Akintunde, AO. (2018). Response of chicken genotypes to dietary levels of *Moringa oleifera* (Lamarck) seed meal. A Doctor of Philosophy (PhD) thesis submitted to the Department of Animal Production, University of Ilorin, Ilorin, Nigeria. https://uilspace.unilorin.edu.ng/handle/20.500.12484/7676

Akintunde, AO., Toye, AA. & Ogundere, AA. (2019). Genetic differences in the body weight and haematological traits of Local and Exotic chickens fed graded levels of *Moringa oleifera* seed meal. *Wayamba Journal of Animal Science*, 11, 1836-1849.

Akintunde, AO., Toye, AA. & Ademola, AA. (2021a). Effects of dietary *Moringa Oleifera* seed meal on obesity, liver and kidney functional parameters of local and exotic chickens. *Aceh Journal of Animal Science*, 6 (3), 97 – 103. https://doi.org/10.13170/ajas.6.3.20641

Akintunde, AO., Ndubuisi-Ogbona, LC., Ajayi, OA., Chioma, C., Jimoh, WA. & Afodu, OJ. (2021b). Utilization of *Chromolaena odorata* leaf meal as a supplement in broiler chickens' diet. *Nigerian Journal of Animal Science*, 23 (1), 189-198. https://www.ajol.info/index.php/tjas/article/view/212029

Al-Jaleel, RAA. (2012). Use of turmeric (*Curcuma longa*) on the performance and some physiological traits on the broiler diets. *Iraqi Journal of Veterinary Medicine*, 36, 51– 57. https://doi.org/10.30539/iraqijvm.v36i1.548

Alhidary, IA., Abdulrahman, MM., Uallh Khan, R. & Harron, RM. (2016). Antioxidant status and immune responses of growing camels supplemented a long-acting multi-trace minerals rumen bolus. *Italian Journal of Animal Science*, 15, 343–349. https://doi.org/10.1080/1828051X.2016.1186502

Amad, AA., Männer, K., Wendler, KR., Neumann, K. & Zentek, J. (2011). Effects of a phytogenic feed additive on growth performance and ileal nutrient digestibility in broiler chickens. *Poultry Science*, 90, 2811–2816. https://doi.org/10.3382/ps.2011-01515

Aroche, R., Martínez, Y., Ruan, Z., Guan, G., Waititu, S., Nyachoti, CM., Más, D. & Lan, S. (2018). Dietary inclusion of a mixed powder of medicinal plant leaves to enhance the feed efficiency and immune function in broiler chickens. *Journal of Chemistry*, 1–6. https://doi.org/10.1155/2018/4073068

Arslan, M., Haq, A., Ashraf, M., Iqbal, J. & Mund, MD. (2017). Effect of turmeric *(Curcuma longa*) supplementation on growth performance, immune response, carcass characteristics and cholesterol profile in broilers. *Veterinaria*, 66(1), 16-20.

Atteh, JO. (2015). Theory and practice of poultry production (2nd Edition). Graphcom Publishers. 207pp

Ayodele, SO., Oloruntola, OD. & Agbede, JO. (2016). Effect of *Alchornea cordifolia* leaf meal inclusion and enzyme supplementation on performance and digestibility of rabbits. *World Rabbit Science*, 24, 201–206. https://doi.org/10.4995/wrs.2016.3933

Ayoola, AO., Akinloye, O., Oguntibeju, OO., Oke, JM. & Odetola, AA. (2011). Antioxidant activities of *Parquetina nigrescens*. *African Journal of Biotechnology*, 10, 4920-4925. https://doi.org/10.5897/AJB10.1622I

Bakhiet, AO. & Adam, SEI. (1995). Therapeutic utility, constituents and toxicity of some medicinal plants: a review. *Veterinary and Human Toxicology*, 37, 255-258. https://pubmed.ncbi.nlm.nih.gov/7571361/

Balevi, T., Ucan, US., Coskun, B., Kurtoglu, V. & Cetingul, IS. (2001). Effect of dietary probiotic on performance and humoral immune response in layer hens. *British Poultry Science*, 42, 456–461. https://doi.org/10.1080/00071660120073133

Basit, MA., Kadir, AA., Loh, TC., Abdul Aziz, S., Salleh, A., Kaka, U. & Idris, SB. (2020). Effects of inclusion of different doses of *Persicaria odorata* leaf meal (POLM) in broiler chicken feed on biochemical and haematological blood indicators and liver histomorphological changes. *Animals*, 10, 1-18. https://doi.org/10.3390/ani10071209

Bolukbasi, S. & Erhan, M. (2007). Effect of dietary thyme (*Thymus vulgaris*) on laying hen's performance and *Escherichia coli* (*E. coli*) concentration in feces. Atatürk University, The Faculty of Agriculture, Department of Animal Science, 25240, Erzurum, Turkey. http://www.ijnes.org/index.php/ijnes/article/download/346/317/

Chineke, CA., Ologun, AG. & Ikeobi, CON. (2006). Haematological parameters in rabbit breeds and crosses in humid tropics. *Pakistan Journal of Biological Sciences*, 9(11), 2102-2106. https://doi.org/10.3923/pjbs.2006.2102.2106

Coles, EH. (1986). Veterinary clinical pathology (4th Ed.). Philadelphia, Pa. Saunders

Dalkiliç, B. & Güler, T. (2009). The Effects of clove extract supplementation on performance and digestibility of nutrients in broilers. *Fırat Üniversitesi Sağlık Bilimleri Dergisi*, 23, 161–166. http://veteriner.fusabil.org/pdf/pdf_FUSABIL_677.pdf.

Datté, JY. & Ziegler, A. (2001). Pharmacological investigation on nigrescigenin-a cardenolide from *Parquetina nigrescens* (Afzel.) Bullock: comparative studies on cardiotonic effects of *Parquetina nigrescens*, gastrophanthin and noradrenaline in guinea-pig isolated atria. *Journal of Pharmacy and Pharmacology*, 53, 859-866. https://doi.org/10.1211/0022357011776018

Dibner, JJ. & Richards, JD. (2005). Antibiotic growth promoters in agriculture: History and mode of action. *Poultry Science*, 84, 634–643. https://doi.org/10.1093/ps/84.4.634

Donoghue, DJ. (2003). Antibiotic residues in poultry tissues and eggs: Human health concerns? Poult. Sci. 82, 618–621. https://doi.org/10.1093/ps/82.4.618.

Economic and Social Committee of the European Union (1998). Economic and Social Committee of the European Union. Opinion on resistance to antibiotics as a threat to publichealth.No.ESC-98-016-EN

Eroschenko, VP. (2000). Di Fiore's Atlas of histology with functional correlations, 9th ed. Lippincott Williams and Wilkins, USA.

Fakunle, J. (2021). Evaluation of *Pterocarpus mildbraedii* leaf meal supplementation on health status of broiler chickens. A Bachelor of Agriculture (B. Agric.) project submitted to the Department of Agriculture and Industrial Technology, Babcock University, Ilishan-Remo, Ogun State, Nigeria.

George, OS., Kaegon, SG. & Igbokwe, AA. (2015). Feed additive effects of graded levels of ginger (*Zingiber Officinale*) on serum metabolites of broilers. *Journal of Agriculture and Veterinary Science*, 8, 59–62. https://www.iosrjournals.org/iosr-javs/papers/vol8-issue3/Version-2/L08325962.pdf

Gilani, SMH., Zehra, S., Galani, S. & Ashraf, A. (2018). Effect of natural growth promoters on immunity, and biochemical and haematological parameters of broiler chickens. *Tropical Journal of Pharmaceutical Research*, 17, 627–633. https://doi.org/10.4314/tjpr.v17i4.9

Gill, LS. (1992). Ethnomedical uses of plants in Nigeria. University of Benin Press Publisher 80-181. https://www.scirp.org/(S(351jmbntvnsjt1aadkposzje))/reference/referencespapers.aspx?referenceid=2437678

Gill, A., Delaquis, P., Russo, P. & Holley, R. (2002). Evaluation of anti-listeria action of cilantro oil on vacuum packed ham. *International Journal of Food Microbiology*, 73, 83-92. https://doi.org/10.1016/s0168-1605(01)00712-7

He, J., Dong, L., Xu, W., Bai, K., Lu, C., Wu, Y. & Wang, T. (2015). Dietary tributyrin supplementation attenuates insulin resistance and abnormal lipid metabolism in suckling piglets with intrauterine growth retardation. *PLoS ONE*, 10, e0136848. https://doi.org/10.1371/journal.pone.0136848

Horton, GMJ., Fennell, M. & Prasad, BM. (1991). Effect of dietary garlic (*Allium sativum*) on performance, carcass composition and blood chemistry changes in broiler chickens. *Canadian Journal of Animal Science*, 71, 939 - 942. https://cdnsciencepub.com/doi/pdf/10.4141/cjas91-113

Howlett, JC. & Jamie, S. (2008). Avian medicine. Mosly Elevier (2nd) pp.46.

Hu, Y., Wang, Y., Li, A., Wang, Z., Zhang, X., Yun, T. & Yin, Y. (2016). Effects of fermented rape seed meal on antioxidant functions, serum biochemical parameters and intestinal morphology in broilers. *Food and Agricultural Immunology*, 27, 182–193. https://doi.org/10.1080/09540105.2015.1079592

Isaac, LJ., Abah, G., Akpan, B. & Ekaette, IU. (2013). Haematological properties of different breeds and sexes of rabbits. Proceedings of the 18th Annual Conference of Animal Science Association of Nigeria, 24-27. https://www.scirp.org/(S(i43dyn45teexjx455qlt3d2q))/reference/ReferencesPapers.aspx?ReferenceID=2016538

Janssen, AM. (1989). Antimicrobial activities of essential oils: a Pharmacognostical study. *Journal of Essential Oil Research*, 10, 618-627.

Khan, TA. & Zafar, F. (2005). Haematological Study in Response to Varying Doses of Estrogen in Broiler Chickens. *International Journal of Poultry Science*, 4(10), 748-751. https://doi.org/10.3923/ijps.2005.748.751

Krauze, M., Abramowicz, K. & Ognik, K. (2020). The effect of the addition of probiotic bacteria (*Bacillus subtilis* or *Enterococcus faecium*) or phytobiotic containing cinnamon oil to drinking water on the health and performance of broiler chickens. *Annals of Animal Science*, 191–205. https://doi.org/10.2478/aoas-2019-0059

Króliczewska, B., Mi´sta, D., Króliczewski, J., Zawadzki, W., Kubaszewski, R., Wincewicz, E. & Szopa, J. (2016). A new genotype of flax (*Linum usitatissimum L.*) with decreased susceptibility to fat oxidation: Consequences to hematological and biochemical profiles of blood indices. *Journal of the Science of Food and Agriculture*, 97, 165–171. https://doi.org/10.1002/jsfa.7705

Lee, MH., Lee, HJ. & Ryu, PD. (2001). Public health risks: chemical and antibiotic residues review. *Asian-Australasian Journal of Animal Science*, 14, 402-413. https://doi.org/10.5713/ajas.2001.402

Lee, JW., Shin, JG., Kim, EH., Kang, HE., Yim, IB. & Kim, JY. (2004). Immunomodulatory and antitumor effects in vivo by the cytoplasmic fraction of *Lactobacillus casei* and *Bifidobacterium longum*. *Journal of Veterinary Science,* 5, 41–48. https://pubmed.ncbi.nlm.nih.gov/15028884/

Liu, QW., Feng, JH., Chao, Z., Chen, Y., Wei, LM., Wang, F., Sun, RP. & Zhang, MH. (2015). The influences of ambient temperature and crude protein levels on performance and serum biochemical parameters in broilers. *Journal of Animal Physiology and Animal Nutrition*, 100, 301–308. https://doi.org/10.1111/jpn.12368

Manyi-Loh, C., Mamphweli, S., Meyer, E. & Okoh, A. (2018). Antibiotic use in agriculture and its consequential resistance in environmental sources: Potential public health implications. *Molecules,* 23(4), 795. https://doi.org/10.3390/molecules23040795

Manzanilla, EG., Baucells, F., Kamel, C., Morales, J., Perez, JF. & Gasa, J. (2001). Effects of plant extracts on the performance and lower gut microflora of early weaned piglets. *Journal of Animal Science*, 1, 473.

Mountzouris, KC., Tsitrsikos, P., Palamidi, I., Arvaniti, A., Mohnl, M., Schatzmayr, G. & Fegeros, K. (2010). Effects of probiotic inclusion levels in broiler nutrition on growth performance, nutrient digestibility, plasma immunoglobins, and cecal microflora composition. *Poultry Science*, 89, 58–67. https://doi.org/10.3382/ps.2009-00308

Niewold, TA. (2007). The nonantibiotic anti-inflammatory effect of antimicrobial growth promoters, the real mode of action? A hypothesis. *Poultry Science*, 86, 605–609. https://doi.org/10.1093/ps/86.4.605

Nouzarian, R., Tabeidian, SA., Toghyani, M. & Ghalamkari, G. (2011). Effect of turmeric powder on performance, carcass traits, humoral immune responses, and serum metabolites in broiler chickens. *Journal of Animal and Feed Sciences*, 20, 389–400. https://doi.org/10.22358/jafs/66194/2011

Odetola, OM., Adejinmi, OO., Owosibo, OA., Banjo, OT. & Awodola-peters, OO. (2019). Growth response, serum biochemistry and organ histopathology of broilers fed diets supplemented with graded levels of *Petiveria alliacea* root meal. *International Journal of Poultry Science*, 18, 45–50. https://doi.org/10.3923/ijps.2019.45.50

Oghenebrorhie, O. & Oghenesuvwe, O. (2016). Performance and haematological characteristics of broiler finisher fed *Moringa oleifera* leaf meal diets. *Journal of Northeast Agricultural University*, 23, 28–34. http://dx.doi.org/10.1016/S1006-8104(16)30029-0

Olafedehan, CO., Obun, AM., Yusuf, MK., Adewumi, OO., Oladefedehan, AO., Awofolaji, AO. & Adeniji, AA. (2010). Effects of residual cyanide in processed cassava peal meals on haematological and biochemical indices of growing rabbits. Proceedings of 35th Annual Conference of Nigerian Society for Animal Production. p 212.

Oloruntola, OD., Ayodele, SO., Agbede, JO. & Oloruntola, DA. (2016). Effect of feeding broiler chickens with diets containing *Alchornea cordifolia* leaf meal and enzyme supplementation. *Archivos de zootecnia*, 65, 489–498. https://www.redalyc.org/pdf/495/49549091003.pdf

Oloruntola, OD., Agbede, JO., Ayodele, SO. & Oloruntola, DA. (2018). Neem, pawpaw and bamboo leaf meal dietary supplementation in broiler chickens: Effect on performance and health status. *Journal of Food Biochemistry*, 43, e12723. https://doi.org/10.1111/jfbc.12723

Oloruntola, OD. (2019). Effect of pawpaw leaf and seed meal composite mix dietary supplementation on haematological indices, carcass traits, and histological studies of broiler chicken. *Agroforestry Systems*, 43, 129. https://doi.org/10.1186/s42269-019-0172-0

Olumide, MD., Akintunde, AO. & Ndubuisi-Ogbonna, LC. (2022). Performance and carcass characteristics of broiler chickens to oral administration of aqueous extracts of *Ocimum gratissimum*. Proceedings of the 47th Annual Conference of the Nigerian Society for Animal Production at University of Jos and Federal College of Forestry, Jos, Nigeria. Pp 1331-1335.

Oluyemi, JA. & Roberts, FA. (2000). Poultry production in warm wet climates. 2nd Edn. Spectrum Books Ltd., Ibadan, 244 pp.

Owoyele, BV., Nafiu, AB., Oyewole, IA., Oyewole, LA. & Soladoye, AO. (2009). Studies on the analgesic, anti-inflammatory and antipyretic effects of *Parquetina nigrescens* leaf extract. *Journal of Ethnopharmacology*,122, 86-90. https://doi.org/10.1016/j.jep.2008.11.027

Ozaslan, M. (2011). *Parquetina nigrescens* checks the ulceration and oxidation. *Pakistan Journal of Biological Sciences*, 14, 1124-1125. https://doi.org/10.3923/pjbs.2011.1124.1125

Paul, S., Islam, M., Tanvir, E.M., Ahmed, R., Das, S., Rumpa, NE. & Khalil, MS. (2016). *Citrus macroptera* fruit protects against acetaminophen-induced hepatorenal toxicity in rats. Evid. Based Complement. *Alternative Medicine*, 9470954. https://doi.org/10.1155/2016/9470954

Prabhakaran, R. (2003). Good practices in planning and management of integrated commercial poultry production in South Asia. FAO Animal Production and Health paper, Food and Agriculture Organization, 159 (159), 97 pages.

Qasem, MAA., Alhajj, MS., Ger El Nabi, AR. & Al-Mufarrej, SI. (2015). Effect of turmeric powder as a dietary supplement on performance indicators and immune responses in broiler chickens. *Journal of Animal and Veterinary Advances*, 14(2), 30-35. https://doi.org/10.36478/javaa.2015.30.35

Reis, JH., Gebert, RR., Barreta, M., Baldissera, MD., dos Santos, ID., Wagner, R. & Mendes, RE. (2018). Effects of phytogenic feed additive based on thymol, carvacrol and cinnamic aldehyde on body weight, blood parameters and environmental bacteria in broilers chickens. *Microbial Pathogenesis*, 125, 168–176. https://doi.org/10.1016/j.micpath.2018.09.015

Rhiouani, H., El-Hilaly, J., Israili, ZH. & Lyoussi, B. (2008). Acute and sub-chronic toxicity of an aqueous extract of the leaves of Herniaria glabra in rodents. *Journal of Ethnopharmacology*, 118, 378–386. https://doi.org/10.1016/j.jep.2008.05.009

Roman, Y., Bomsel-Demontoy, MC., Levrier, J., Ordonneau, D., Chaste-Duvernoy, D. & Saint Jalme, M. (2009). Influence of molt on plasma protein electrophoretic patterns in bar-headed geese (*Anser indicus*). *Journal of Wildlife Diseases*, 45, 661–671. https://doi.org/10.7589/0090-3558-45.3.661

Rubio, MS., Laurentiz, AC., Sobrane, F., Mello, ES., Filardi, RS., Silva, MLA. & Laurentiz, RS. (2019). Performance and serum biochemical profile of broiler chickens supplemented with *Piper cubeba* ethanolic extract. *Brazilian Journal Poultry Science*, 21, 1–8. https://doi.org/10.1590/1806-9061-2018-0789

Saba, AB., Oyagbemi, AA. & Azeez, OI. (2010). Antidiabetic and hematinic effects of Parquetina nigrescens on alloxan induced type-1 diabetes and normocytic normochromic anaemia in Wistar rats. *African Health Sciences*, 10, 276-282. https://doi.org/10.4314/AHS.V10I3.62877

Scanes, CG. (2014). Protein Metabolism. Sturkie's Avian Physiology, 6th ed.; Academic Press, Elsevier Inc.: Waltham, MA, USA, pp. 455–468.

Shawle, K., Urge, M. & Animut, G. (2016). Effect of different levels of *Lepidium sativum* L. on growth performance, carcass characteristics, hematology and serum biochemical parameters of broilers. *Springer Plus,* 5, 1441. https://doi.org/10.1186/s40064-016-3118-0

Skrabka –Blotnicka, T., Rosin'ski, A., Przysie-Zzna-Woloszyn, J. & Elminowska-Wenda, G. (1997). Effect of dietary formulation supplemented with herbal mixture on goose breast muscle quality. Report I. The Effect on the chemical composition. *Archives für Geflügelkunde,* 61, 135-138.

Soltan, MA., Shewita, RS. & El-Katcha, MI. (2008). Effect of dietary anise seeds supplementation on growth performance, immune response, carcass traits and some blood parameters of broiler chickens. *International Journal of Poultry Science*, 7, 1078-1088. https://doi.org/10.3923/ijps.2008.1078.1088

Talebi, A., Amani, A., Pourmahmod, M., Saghaei, P. & Rezaie, R. (2015). Synbiotic enhances immune responses against infectious bronchitis, infectious bursal disease, Newcastle disease and avian influenza in broiler chickens. *Veterinary Research Forum*, 6, 191–197. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4611971/

Tekeli, A., Elik, L., Kutlu, HR. & G♀rgülü, M. (2006). Effect of dietary supplemental plant extracts on performance, carcass characteristics, digestive system development, intestinal microflora and some blood parameters of broiler chicks. Abstract Book of 12th European Poultry Conference, Verona- Italy 10-14th Sept. https://www.cabi.org/Uploads/animal-science/worlds-poultry-science-association/WPSA-italy-2006/10283.pdf

Thrall, MA., Weiser, G., Allison, R. & Campbell, T. (2012). Veterinary Hematology and Clinical Chemistry, 2nd Ed; John Wiley & Sons: Oxford, UK, pp. 582–598.

Toghyani, M., Toghyani, M., Gheisari, A., Ghalamkari, G. & Eghbalsaied, S. (2011). Evaluation of cinnamon and garlic as antibiotic growth promoter substitutions on performance, immune responses, serum biochemical, and haematological parameters in broiler chicks. *Livestock Science*, 138, 167–173. https://doi.org/10.1016/j.livsci.2010.12.018

Tóthová, C., Sesztáková, E., Bielik, B. & Nagy, O. (2019). Changes of total protein and protein fractions in broiler chickens during the fattening period. *Veterinary World*, 12, 598. https://doi.org/10.14202/vetworld.2019.598-604

Van, TTH., Yidana, Z., Smooker, PM. & Coloe, PJ. (2020). Antibiotic use in food animals worldwide, with a focus on Africa: Pluses and minuses. *Journal of Global Antimicrobial Resistance*, 20, 170-177. https://doi.org/10.1016/j.jgar.2019.07.031

Vispute, MM., Sharma, D., Mandal, AB., Rokade, JJ., Tyagi, PK. & Yadav, AS. (2019). Effect of dietary supplementation of hemp (*Cannabis sativa*) and dill seed (*Anethum graveolens)* on performance, serum biochemicals and gut health of broiler chickens. *Journal of Animal Physiology and Animal Nutrition*, 103, 525–533. https://doi.org/10.1111/jpn.13052

William, P. & Losa, R. (2001). The use of essential oils and their compounds in poultry nutrition. *World Poultry*, 17, 14-15.

World Health Organization, 1997. The medical impact of the use of antimicrobials in food animals: Report of a WHO meeting, Berlin, Germany, http://whqlibdoc.who.int/hq/1997/WHO_EMC_ZOO_97.4.pdf