Open Access Library Journal
2025, Volume 12, e14190
ISSN Online: 2333-9721
ISSN Print: 2333-9705

Effect of *Irvingia* Supplement Based Meal on Some Haematological and Biochemical Parameters of Broilers

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How to cite this paper: Ben-Eledo, V.N., Etebu, E. and Eledo, B.O. (2025) Effect of *Irvingia* Supplement Based Meal on Some Haematological and Biochemical Parameters of Broilers. *Open Access Library Journal*, **12**: e14190.
https://doi.org/10.4236/oalib.1114190

Received: August 29, 2025
Accepted: October 17, 2025
Published: October 20, 2025

Abstract

This study investigated the effect of *Irvingia* fruit waste supplement (IFWS) on the blood parameters of broiler chickens. Three experimental diets were formulated to contain IFWS at 5% 10% and 15%, with 0% the control diet with no IFWS. Blood samples were collected from the wing vein of sixteen experimental birds by bleeding for haematological and serum biochemical studies. The results of some of the haematological parameters packed cell volume, haemoglobin, and white blood cells (PCV, HB and WBC) ranged from 23.25% - 28.25%, 7.35 - 9.40 g/dl and 12.28 - 17.60 $\times 10^3/\mu l$ respectively. These parameters showed a significant decrease among broilers fed with 10% and 15% IFWS when compared with the control treatment ($P < 0.05$). The biochemical parameters total protein and globulin (TP and GLO) ranged from 3.63 - 4.4 g/dl and 2.1 - 2.5 g/dl respectively, and showed no significant difference ($P > 0.05$) among broilers fed with IFWS. But there is a significant decrease ($P < 0.05$) in albumin and total cholesterol (ALB and TC) among broilers fed with 10% and 15% IFWS when compared with the control group. The highest cholesterol level was recorded in birds fed with the control diet (105.0 mg/dl) and the lowest was recorded in birds fed 15% IFWS (87.3 mg/dl). This study revealed that *Irvingia* fruit waste supplement, can be used as a valuable source of protein. The significant reduction in albumin and total cholesterol among birds fed with IFWS supplement is a strong indication that consuming IFWS can help reduce cholesterol intake, thereby improving the heart conditions of the consumers.

Subject Areas

Hematology

Keywords

Irvingia, Haematological, Biochemical Parameters

1. Introduction

Feed formulation has been a challenge facing broiler production in developing countries such as Nigeria. The cost of broiler production has increased due to the high cost of feed ingredients because of their higher demand by humans as food and for industrial purposes [1]. These feed ingredients include maize, which remains the source of energy as well as soy meal which is also the main protein source. This high cost of feed is a major factor affecting broiler production [2], making it necessary to seek an alternative feed ingredient in place of maize as an energy source [3], with emphasis on agro-industrial by-products which are safe, cheap and locally available especially in developing countries that cannot afford an expensive diet for livestock. A lot of researchers are emphasizing the use of agro-industrial by-products that have been shown to positively affect broilers growth [4]. Broilers are an excellent source of animal protein and can help to meet human society's protein needs. Broiler chicken flesh is therefore prized in many cultural culinary traditions. It is a balanced and healthy diet because of its nutrient-dense makeup [5]. Additionally, because of its high polyunsaturated fatty acid (PUFA) and low saturated fatty acid (SFA) content, chicken meat has become a popular product among health-conscious consumers [6]. Globally, over 72 billion broilers are produced annually, making the meat more affordable than other meats, relatively less expensive to produce [7] and ever rising global consumer demand [8].

[9] recommended that agro-industrial by-products (AIBs) be incorporated into poultry diets at a 10% level without negatively impacting performance. Additionally, this inclusion was noted to reduce the cost of feed for the broilers. [10] reported that broilers fed with kola nut testa meal (KTM) at 5% level of replacement for maize had a significant increase in the weight gain, whilst reducing the cost of feed for poultry production. Presently, a lot of emphasis is being placed on research on the use of agro-industrial by-products. Several researchers have called for the need to investigate the possibility of supplementing broiler feed with products of African shrubs and trees that are less known, neglected and under-utilized as sources of protein and/ or energy [11]. Among such categories of trees yet to be investigated in this regard is bush mango (*Irvingia gabonensis*). Thus, this study focused on *Irvingia* fruits, a non-conventional plant with edible mango like fruits with fleshy pericarp, valued for its nutritional and health benefits. Biologically active substances like tannins, alkaloids, terpenoids, steroids, saponins, and glycosides are found in *Irvingia gabonensis* kernels, according to studies on phytochemical screenings. These compounds are known to support antimicrobial activities [12] [13]. Given their biological characteristics (antioxidant, anti-stress,

antibacterial, and immunomodulatory), several of the phytochemicals present in *Irvingia* fruits are being considered for use as growth boosters in animal production [14]. The beneficial effects of *Irvingia* fruits on health suggest their use in commercial animal farming including chicken production. This study was therefore conducted to examine the haematological and serum biochemical indices of broilers fed with varying levels of *Irvingia* fruit waste-based diets.

2. Materials and Methods

2.1. Location and Duration of the Study

The experiment was carried out at the poultry unit of Niger Delta University Teaching and Research farm, Niger Delta University, Wilberforce Island, Amassoma for a period of eight weeks.

2.2. Sources of Ingredients

Irvingia fruits for the study were picked from a natural forest in Agudama-Ekpetiama town in Yenagoa Local Government Area of Bayelsa state.

2.3. Processing of *Irvingia* Fruit Waste

The fleshy pericarp of the fruits was carefully sliced and sterilized with a 10% hypochlorite solution. After oven drying at 60°C for 5days, the dried *Irvingia* fruits were ground into fine particles with a homogenizer and kept in a dry place. Samples were taken to the laboratory for proximate analysis (Table 1).

Table 1. Comparative proximate composition of maize and *Irvingia* fruit supplement.

	Irvingia Fruit	Maize
Parameters		
Moisture Content %	9.3	8.26
Crude Protein%	8.96	8.71
Crude Fiber%	5.2	2.25
Ether Extract% (Lipid content)	22.8	4.2
Crude Ash %	8	1.9
Nitrogen Free Extract%	58.41	75.28
Calorific value Kcal/kg	3885.95	3315

2.4. Management of Experimental Birds and Design

The experiment involved Eighty (80) day-old broiler chickens. On arrival they were given Vitalite mixed with glucose to reduce the stress of transportation from the hatchery. The chickens were acclimatized for a period of seven days. Following their brooding period, the birds were randomized into four treatments, each treatment was replicated 4 times, with 5 birds per replicate. The birds were given diets made of maize-soybean meal that included varied amounts of IFWS inclusions;

control, IFWS 5%, IFWS 10% and IFWS 15% (Table 2). The birds were provided water and food *ad libitum*.To ensure proper ventilation, the birds were raised on deep litter in a chicken house with open sides and wire mesh. For the first four weeks, the birds were fed a starter diet; from the fifth to the eighth week, they were fed a finisher diet. Routine medication, vaccination and other management practices were carried out throughout the duration of the experiment.

Table 2. Experimental diet comprising *Irvingia* fruit waste supplemented feed for broilers.

Ingredients (%)	Starter Diet				Finisher Diet			
	Control	5%	10%	15%	Control	5%	10%	15%
Maize	61.55	56.55	51.55	46.55	65	60	55	50
Irvinga	-	5	10	15	-	5	10	15
Soya bean meal	15	15	15	15	14	14	14	14
Groundnut cake	16	16	16	16	10	10	10	10
Fish meal	2	2	2	2	2	2	2	2
Wheat offal	2	2	2	2	5	5	5	5
Bone meal	2.5	2.5	2.5	2.5	3	3	3	3
DL-Methionine	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
DL-Lysine	0.15	0.15	0.15	0.15	0.2	0.2	0.2	0.2
Salt (NaCl)	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Vitamin/Mineral Premix	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Total (%)	100	100	100	100	100	100	100	100
Calculated Nutrient Composition								
Crude protein (%)	25.52	23.48	23.5	23.52	19.68	19.7	19.72	19.74
Crude Fiber (%)	3.51	3.97	4.5	5.03	3.43	3.96	4.49	5.02
Ether Extract (%)	4.22	4.17	4.12	4.07	4	3.95	3.9	3.85
Calcium (%)	1.04	1.09	1.13	1.17	1.21	1.25	1.29	1.34
Phosphorus (%)	0.86	0.84	0.82	0.8	0.9	0.88	0.86	0.85
Lysine (%)	1.18	1.1	1.03	0.95	1.05	0.97	0.9	0.82
Methionine (%)	0.45	0.43	0.41	0.39	0.42	0.4	0.38	0.35
M.E. (Kcal/kg)	3005.67	3034.73	3048.15	3061.57	3024.8	3038.22	3051.64	3065.06

Blood Sample Collection and Preparation: Blood samples were collected from the wing vein of sixteen experimental birds by bleeding from 4 randomly selected birds per treatment for haematological and serum biochemical studies. A total of 4mls of blood was collected by pricking the bronchial vein under the wing. 2mls was dispensed into a tube containing EDTA and used for estimation of Haemoglobin concentration (Hb), Red blood cells count (RBC), White blood cells count (WBC), Packed cell volume (PCV), Mean Corpuscular Volume, Mean Corpuscular

Haemoglobin and Mean Corpuscular Haemoglobin Concentration using TC Hemaxa 1000 Auto Hematology Analyzer. The remaining 2 mls were dispensed into plain sample bottles and allowed to clot. It was spun at 300 rpm for 10 minutes and the serum obtained was used for the analysis of total protein, albumin, globulin and total cholesterol using colorimetric method as prescribed by the Chrono lab commercial kits (Barcelona, Spain) and according to the procedure prescribed by the manufacturer.

2.5. Statistical Analysis

All the data collected were subjected to analysis of variance (ANOVA), and differences between means and treatments were separated using Duncan's Multiple Range Test (DMRT) at 5 percent level of probability. All statistical procedures were according to (Steel and Torrie, 1990) using SPSS version 20.

3. Results and Discussion

Some of the haematological parameters (PCV, HB and WBC) investigated in this study (Table 3) showed a significant decrease among broilers fed with 10% and 15% *Irvingia* supplement compared to the control treatment and 5% IFWS. PCV was significantly low ($P \leq 0.05$) among birds fed with 15% *Irvingia* fruit waste supplement compared to those fed with 5% IFWS and the control diet. Across the different treatments it was shown that PCV values in this study reduced as the inclusion level of IFWS increased. This is in agreement with the values obtained by [15]. [16] reported anaemia as a consequence of lower PCV value while [17] observed high PCV as an indicator of high feed conversion ratio. Low PCV could mean reduced red blood cell function which could result to poor oxygen delivery, weakness and slowed physical activity. Although, lower PCV levels were observed with IFWS in this study but it still fell within the normal range. Heamoglobin concentration and total Red Blood Cells are very important indicators of delivery of oxygen and nutrients to tissues and organs for oxidative activities in order to release energy [15]. The Hb values obtained in the present study are within normal reference range values as reported by [18]. This showed that the broilers had good aerobic activity and were not anaemic. Also, it was observed that IFWS reduced the Hb level of broilers, this can be an added advantage to use I*rvingia* fruit waste supplement to reduce thrombosis in birds. No significant difference ($P \geq 0.05$) was observed in RBC, MCV, MCH, and MCHC between the test groups and the control. This confirmed the conclusions in similar studies drawn by [19] where no significant differences ($P \geq 0.05$) were found in MCV, MCH, or MCHC in broilers fed leaf meals supplemented with *Persicaria odorata* and *Moringa oleifera*, respectively. But results disagreed with a study by [20] with a higher MCHC value. The non-significant values for RBC, MCV, MCH and MCHC despite increasing levels of IFWS showed that IFWS is of good quality and free from antinutrients that have detrimental effects on broilers. IFWS contains tannin which has antibacterial, antioxidant, and, anti-parasitic properties and also improve gut health. The MCH number found in this investigation, however, was below the typical range

of 33 - 47 pg as stated by [18]. Wherein the protein quality of the experimental diet affects the haemoglobin, a departure from the usual range might be the consequence of that protein's quality. The study then showed that the *Irvingia* fruit waste supplement decreased the RBC's blood carrying capacity, which is shown by MCH.

The generation of antibodies by white blood cells, a crucial component of the body's immunological defence mechanism, helps shield the body against external invaders and infectious illnesses [21]. A rise in WBC levels may be brought on by stress, bacterial infections, or adverse circumstances [15]. WBC was significantly ($P \leq 0.05$) different among the IFWS treatments. The WBC value recorded in this study is greater than the values reported by [15] but in agreement with the values reported by [22]. However, it fell within the normal range as reported by [18]. Erythrogram constituent levels across the several dietary treatments showed that the dietary supplement of *Irvingia* fruit waste had no detrimental effects on the experimental birds' hematopoiesis [23].

Therefore, the normal values found in this study showed that the broilers received enough nutrients. Lower levels of these parameters are associated with malnutrition [24]. It also indicates that the broilers' immune systems are functioning normally [25]. This suggests that erythrocytosis and anaemia are not common in birds fed *Irvingia* fruit waste.

On the biochemical indices (**Table 4**), results showed no significant ($p \geq 0.05$) differences among the treatments except cholesterol that showed a significant ($p \leq 0.05$) decrease among birds fed with I*rvingia* supplementation. TP and GLO showed no significant difference ($P \geq 0.05$) among broilers fed with *Irvingia* Fruit Supplement. Although, there is a significant decrease ($P \leq 0.05$) in ALB and TC among broilers fed with 10% and 15% *Irvingia* fruit supplement when compared with the control group but there is no significant difference between the two test groups. The highest cholesterol level was recorded in birds fed with the control diet (105.0 mg/dl) and the lowest was recorded in birds fed 15% *Irvingia* (87.3 mg/dl), while the highest albumin concentration was recorded in birds fed with control diet (2.5 g/dl) and lowest was recorded in birds fed with 15% *Irvingia* (2.1 g/dl). The highest globulin was recorded in birds fed with the control (2.1 g/dl) and the lowest was recorded in birds fed with 15% *Irvingia* (1.55 g/dl). The highest total protein was recorded in birds fed with the control (4.4 g/dl) and the lowest was recorded in birds fed with 15% *Irvingia* (3.6 g/dl). Serum biochemistry can be used to evaluate the progression of disease in broilers [15], and the protein quality of feeds. The values for Total protein, Albumin and Total cholesterol obtained in this study increased with an increase in the levels of *Irvingia* fruit waste supplement. Based on the quality of the feed ingredient and the test material's safety, TP did not reveal any significant differences ($P \leq 0.05$) across the dietary regimens. The food treatments had no discernible effect on the total protein values, indicating that the birds were able to consume and utilize the dietary protein regardless of its varied presence in the *Irvingia* fruit waste supplement. Albumin and total cholesterol values showed a significant

difference among the broilers fed with the different inclusions of *Irvingia* fruit supplement. Across all regimens, cholesterol levels dropped as the IFWS diet increased. This aligns with a study conducted by [23]. The presence of bioactive chemicals in IFWS, which have been shown to have hypolipidemic, antibacterial, and antioxidant qualities, is responsible for this notable decline [13] [26]. A high serum cholesterol level encourages the buildup of cholesterol on the arterial walls, forming plaques that restrict the artery lumen and lower the heart's blood flow rate [27]. Based on the fact that abnormally high serum cholesterol concentrations have been linked to arteriosclerosis and sudden death syndrome in broiler chickens, the observed decreased serum cholesterol concentration in the birds fed with 15% *Irvingia*-supplemented diets in this study is therefore beneficial to their health [28]. This suggests that an increased level of *Irvingia* fruit waste supplementation in the diets of broiler chickens has a hypo-cholesterol properties and could help to reduce heart related problems as reported by [29].

Albumin is responsible for controlling osmotic pressure in the body [30] while globulin acts in immune defenses and enzymatic processes [31]. The ratio of albumin to globulin provides information about an animal's immunological and nutritional health and over production of albumin in the liver, severe dehydration can cause a high albumin/globulin ratio [32]. According to [31] [33], it can also be used to diagnose specific illnesses, such as renal disease and other chronic infections. A low albumin/globulin ratio is indicative of pancreatitis, malnourishment, and other long-term illnesses. Reduced globulin levels have also been linked to higher mortality in pigs, according to [34]. He believes that this may also be the case for the monogastric (broiler chicken) sample utilised in this investigation. The A/G ratio in this study was within the normal range as recorded by [21]. This indicated that the broilers used in this study have neither a low nor a high A/G ratio and the birds had no liver or chronic disease.

All the biochemical values recorded in this experiment decreased as the level of *Irvingia* inclusion increased across the diets. This is an indication that *Irvingia* fruit waste supplement was within tolerable limits for the birds.

Table 3. Effect of *Irvingia* fruit waste on haematological parameters of broilers.

Treatment	PCV (%)	HB(g/dl)	WBC ($\times 10^3/\mu l$)	RBC $\times$ ($10^6/\mu l$)	MCV (fl)	MCH (pg)	MCHC(g/dl)
Control	28.25 ± 1.26^{c}	9.40 ± 0.49^{b}	17.60 ± 1.74^{c}	2.88 ± 0.22^{a}	98.44 ± 3.13^{a}	32.77 ± 1.79^{a}	33.28 ± 1.15^{b}
IFWS 5%	26.00 ± 1.63^{b}	8.00 ± 0.75^{a}	15.08 ± 1.18^{b}	2.70 ± 0.22^{a}	96.67 ± 8.60^{a}	29.79 ± 3.87^{a}	30.74 ± 1.28^{a}
IFWS 10%	25.00 ± 0.82^{ab}	7.65 ± 0.13^{a}	12.85 ± 1.46^{ab}	2.63 ± 0.19^{a}	95.69 ± 8.62^{a}	29.27 ± 2.29^{a}	30.61 ± 0.54^{a}
IFWS 15%	23.25 ± 0.96^{a}	7.35 ± 0.24^{a}	12.28 ± 0.74^{a}	2.55 ± 0.24^{a}	91.67 ± 7.83^{a}	29.01 ± 2.77^{a}	31.62 ± 0.47^{a}

Values with the same superscript letters within same columns indicate no significant difference at $p \geq 0.05$. Values with different superscripts letters within same columns indicate significant difference at $p \leq 0.05$ IFWS = *Irvingia* Fruit Waste Supplement, PVC = Packed Cell Volume, HB = Haemoglobin, RBC = Red blood cell, WBC = White blood cell, MCH = Mean Corpuscular Haemoglobin, MCV = Mean Corpuscular Volume, MCHC = Mean Corpuscular Haemoglobin Concentration

Table 4. Effects of broiler fed with *Irvingia* fruit waste on the serum biochemical indices of the broilers.

Treatment	TP(g/dl)	ALB(g/dl)	TC (mg/dl)	GLO(g/dl)	ALB/GLO Ratio
Control	4.43 ± 0.22^{b}	2.53 ± 0.17^{c}	105.00 ± 3.39^{b}	2.13 ± 0.42^{a}	1.19
IFWS 5%	4.13 ± 0.41^{ab}	2.35 ± 0.13^{bc}	102.85 ± 15.17^{b}	1.88 ± 0.25^{a}	1.25
IFWS 10%	3.98 ± 0.48^{ab}	2.15 ± 0.13^{ab}	88.73 ± 2.74^{a}	1.78 ± 0.36^{a}	1.21
IFWS 15%	3.63 ± 0.39^{a}	2.08 ± 0.10^{a}	87.33 ± 2.62^{a}	1.55 ± 0.38^{a}	1.34

Values with the same superscript letters within same columns indicate no significant difference at $p \geq 0.05$. Values with different superscript letters within same columns indicate significant difference at $p \leq 0.05$. IFWS = Irvingia Fruit Waste Supplement TP = total protein, ALB = albumin, TC = total cholesterol, GLO = globulin.

4. Conclusion

Overall, the results of this study conclusively suggest that the inclusion of Irvingia Fruit Waste supplement in broilers' diets did not have any detrimental effect on the blood profile of the birds. The significant reduction in albumin and total cholesterol among birds fed with *Irvingia* supplement is a strong indication that consuming *Irvingia* supplement can help reduce cholesterol intake, thereby improving the heart conditions of the consumers.

Conflicts of Interest

The authors declare no conflicts of interest.

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