



## HAEMATOLOGICAL AND SERUM BIOCHEMICAL INDICES OF BROILER CHICKEN FED VARYING LEVELS OF RICE OFFAL AS SUBSTITUTE FOR WHEAT OFFAL BASED DIETS

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### ABSTRACT

An eight-week study was conducted on 300 broiler chickens to assess the effects of replacing wheat offal with rice offal on their haematological and serum biochemical parameters. Four diets were formulated with rice offal replacing wheat offal at 0, 33.33, 66.67, and 100%. Birds were fed *ad libitum*, and blood samples were analysed at the end of the trial. Results showed that increasing rice offal levels significantly ( $p < 0.01$ ) affected mean corpuscular haemoglobin (MCH), with higher value at 66.67% inclusion (71.20 pg). Other blood parameters pack cell volume (PCV), haemoglobin (Hb), red blood cell (RBC), white blood cell (WBC), mean Corpuscular haemoglobin concentration (MCHC), mean Corpuscular volume (MCV), and leukocyte counts) showed no significant differences. Serum biochemical analysis revealed a significant increase ( $P < 0.001$ ) in urea levels at higher rice offal inclusion (7.80 mmol/l at 66.67% and 7.75 mmol/l at 100%), though still within normal ranges. Other parameters such as glucose (umol/l), albumin (g/dl), bilirubin (umol/l), total protein (g/dl), and cholesterol (mmol/l) remained unaffected. Overall, rice offal can be used as a complete substitute for wheat offal in broiler diets without health risks. However, kidney function and immune response should be monitored at higher inclusion levels. Additionally, dietary components like fibre or omega-3s should be considered to regulate lipid metabolism. Regular monitoring of kidney function, platelet count, and immune response are recommended, particularly at higher inclusion levels.

**Keywords:** Haematology, Biochemistry, Broilers, Rice Offal, Treatments

### INTRODUCTION

The poultry industry plays a significant role in global food production, providing a major source of protein through broiler chickens. The cost of poultry feed, particularly the grain-based ingredients such as wheat, often constitutes a substantial portion of the total production cost (Smith *et al.*, 2023). As a result, researchers and producers are constantly exploring alternative feed ingredients to reduce costs while maintaining or improving the growth performance and health of poultry (Jones *et al.*, 2022). Rice offal, a by-product of rice milling, has gained attention as a potential alternative to wheat offal in poultry diets. Utilization of dietary fibre like rice milling waste has been reported to reduce fat deposition in the body and increase carcass yield of the birds (Iheukwumere *et al.*, 2001). Rice milling waste is readily available, cheap and usually discarded as waste products by burring to reduced pollution (Akinusi, 1999). Rice offal is abundant in many rice-producing regions and offers a promising solution to reduce the dependency on conventional feed ingredients. It is rich in fibre, carbohydrates, and various nutrients, which may provide a cost-effective and sustainable option for broiler diets (Lee *et al.*, 2024). This study investigates the growth performance of broiler chickens fed diets with varying levels of rice offal as a substitute for wheat offal. By evaluating key parameters such as weight gain, feed conversion ratio, and overall health, this research aims to determine the viability of rice offal as an alternative feed ingredient for broiler chickens and its potential to contribute to more sustainable poultry production systems (Chen and Zhao, 2023).



## **MATERIALS AND METHODS**

### **Study Area**

The study was conducted at the Poultry Unit of the Teaching and Research Farm of the Department of Animal production, Abubakar Tafawa Balewa University, Bauchi, Bauchi State. The area is situated within the geographical coordinates of 10° 18' 37.2" N and 9° 50' 38.0" E. It is 616 metres above sea level with an average annual rainfall of about 1009 mm. Its ambient temperature falls between 13 - 17° C (December – January) and 36 – 37° C (March – April) (Geodatos, 2019).

### **Statistical Analysis**

Data generated were subjected to analysis of variance (ANOVA) techniques as outlined by Steel and Torrie (1980). And significant difference between treatment means were compared using the least significant difference (LSD).

### **Treatments and Experimental Design**

Four experimental diets were formulated where rice offal replaced wheat offal at 0,33.33, 66.67 and 100% levels designated as diets A, B, C and D. respectively. Fish meal was the main animal source. Other feed ingredients used include; rice offal, wheat offal, limestone, bone meal, vitamin/mineral premixes, lysine, methionine and salt. The diets had a mean crude protein content of 23% CP (starter phase) and 20% (Tables 1 and 2)

### **Experimental Birds and their Management**

Three hundred (300) day-old broiler chickens weighing between 95.36 and 98.07g were allotted to the four diets in replicates of 4 containing 18 birds each in a Completely Randomized Design. Feed and water were supplied *ad libitum* and the experiment lasted for a period of 56 days.

### **Data Collection**

At the end of each experiment, blood samples from eighteen (18) randomly selected birds, two per replicate, were collected to determine some haematological and biochemical parameters of the chickens. Prior to this, the birds were fasted overnight to avoid the temporary elevation of blood metabolites through feeding (Bush, 1991). Early in the morning, syringe and needle sets of 2 ml capacity were used to draw blood from the left-wing veins. Samples for haematological study were collected in properly labelled sterilized non vacuum tubes containing a potassium salt of ethylenediamine tetra-acetic acid (K3EDTA) as an anti-coagulant thinly spread along the inner walls while, samples for serological analysis were collected in plain non-vacuum tubes (K3EDTA-free). Blood samples were analysed for haematological parameters according to routine clinical methods (Baker *et al.*, 1998). The serum metabolites which include total protein, albumin, total cholesterol, bilirubin, glucose, conjugal bilirubin and urea were analysed using the UV Visible Spectrophotometer as described by Ogwuegbu *et al.*, 2024. Biochemical constituents were calculated according to the manufacture's (Thermo Scientific, WI, U.S.A) instruction.



**Table 1:** Ingredients and Composition (%) of Experimental Diets Containing Dietary Levels of Rice Offal as Substitute for Wheat Offal Fed to Broiler Chicks (1- 4weeks)

Ingredients	Diets			
	1 (0%)	2 (33.33%)	3 (66.7%)	4 (100%)
White Sorghum	48.85	48.85	48.85	48.85
Groundnut Cake	31.65	31.65	31.65	31.65
Wheat offal	8.00	5.33	2.67	0.00
Rice offal	0.00	2.67	5.33	8.00
Palm oil	2.00	2.0	2.00	2.00
Fish meal	5.00	5.0	5.00	5.00
Limestone	1.50	1.50	1.50	1.50
Bone meal	2.00	2.00	2.00	2.00
Premix	0.25	0.25	0.25	0.25
Salt	0.25	0.25	0.25	0.25
Methionine	0.30	0.30	0.30	0.30
Lysine	0.20	0.20	0.20	0.20
<b>Total</b>	<b>100.00</b>	<b>100.00</b>	<b>100.00</b>	<b>100.00</b>
<b>Chemical composition (%)</b>				
ME (kcal/kg)	2902.21	2928.64	2928.64	2902.21
Crude Protein (%)	23.47	23.34	23.34	23.47
Crude Fibre (%)	3.29	3.01	3.01	3.29
Ether Extract (%)	5.86	6.10	6.10	5.86
Calcium (%)	1.79	1.79	1.79	1.79
Phosphorous (%)	0.94	0.92	0.92	0.94
Methionine (%)	0.61	0.61	0.61	0.61
Lysine (%)	0.89	0.90	0.90	0.89

\*Vitamin-Mineral. Premix (Bio-mix) provided per Kg the following: Vitamin A 12,000,000iu, Vitamin D<sub>3</sub>, 3,000, 000iu, Vitamin E, 30,000mg, Vitamin K<sub>3</sub>, 2,500mg, VitaminB<sub>1</sub>,2,000mg, VitaminB<sub>2</sub>, 5,000mg, VitaminB<sub>6</sub>, 3500mg, VitaminB<sub>12</sub>, 20mg Folic acid 1,000mg,Nacin, 40,000mg, Calpan, 10,000mg, Biotin, 80mg, Antioxidant, 25,000mg, Cobalt, 250mg, selenium, 250mg, Iodine, 1,200mg, Iron, 40,000mg, Manganese, 70,000mg, Copper, 8,000mg, Zinc, 60,000mg. Choline chloride, 2000, 000mg.

**Table 2:** Ingredients and Composition of Experimental Diets Containing Dietary Levels of Rice Offal as a Substitute for Wheat Offal Fed to Broilers Chickens (5-8weeks)

Ingredients	Diets			
	1 (0%)	2 (33.33%)	3 (66.67%)	4 (100%)
White sorghum	49.73	49.73	49.73	49.73
GNC	25.76	25.76	25.76	25.76
WO	13.00	8.67	4.33	0.00
RO	0.00	4.33	8.67	13.0
Palm oil	2.00	2.00	2.00	2.00
FM	5.00	5.00	5.00	5.00
Limestone	1.50	1.50	1.50	1.50
Bone meal	2.00	2.00	2.00	2.00
Premix	0.25	0.25	0.25	0.25
Salt	0.25	0.25	0.25	0.25
Methionine	0.30	0.30	0.30	0.30
Lysine	0.20	0.20	0.20	0.20
<b>Total</b>	<b>100.00</b>	<b>100.00</b>	<b>100.00</b>	<b>100.00</b>
<b>Chemical composition (%)</b>				
M(kcal/kg)	2869.25	2912.11	2912.11	2869.25
Crude Protein (%)	21.77	21.54	21.54	21.77
Crude Fibre (%)	3.44	3.61	3.61	3.44
Ether Extract (%)	5.71	6.07	6.07	5.71
Calcium (%)	1.74	1.74	1.74	1.74
Phosphorous (%)	0.93	0.94	0.94	0.93
Methionine (%)	0.59	0.59	0.59	0.59
Lysine (%)	0.79	0.81	0.81	0.79

\*Vitamin-Mineral. Premix (Bio-mix) provided per Kg the following: Vitamin A 12,000,000iu, Vitamin D<sub>3</sub>, 3,000, 000iu, Vitamin E, 30,000mg, Vitamin K<sub>3</sub>, 2,500mg, VitaminB<sub>1</sub>, 2,000mg, VitaminB<sub>2</sub>, 5,000mg, VitaminB<sub>6</sub>, 3500mg, VitaminB<sub>12</sub>, 20mg Folic acid 1,000mg, Nacin, 40,000mg, Calpan, 10,000mg, Biotin, 80mg, Antioxidant, 25,000mg, Cobalt, 250mg, selenium, 250mg, Iodine, 1,200mg, Iron, 40,000mg, Manganese, 70,000mg, Copper, 8,000mg, Zinc, 60,000mg. Choline chloride, 2000, 000mg.

### Data Analysis

Data collected were subjected to One Way Analysis of Variance (ANOVA) using IBM SPSS statistical package 30.0.0 for windows (SPSS, 2024). Means were separated using Duncan's Multiple Range Test (DMRT) of the same software at P<0.05 level of significance.

## RESULTS AND DISCUSSION

### Haematological Indices

Haematology of broiler chickens fed graded levels of rice offal-based diets is shown in Table 3. The study found no significant ( $p<0.05$ ) differences in various haematological parameters across the different rice offal inclusion groups. Key parameters such as pack cell volume (PCV), haemoglobin (Hb), red blood cell (RBC), white blood cell (WBC), mean Corpuscular heamoglobin (MCHC), mean Corpuscular volume (MCV), Heamatocrite (HCT), platelets, and differential white blood cell counts (including neutrophils and lymphocytes) do not substantially affect these parameters within the tested dietary range. However, the group with 66.67% rice offal showed a significant ( $P<0.05$ ) increase in MCH, indicating that this level of rice offal may enhance the oxygen-carrying capacity of red blood cells by increasing haemoglobin content. Although PCV values increased progressively with higher rice offal levels (from 32.50% at 0% rice offal to 38.00% at 100% rice

offal), the increase was not statistically significant ( $p < 0.05$ ). Hb values also showed a slight increase from 10.83 g/dl in the control group to 12.65 g/dl at 100% rice offal, though these differences were not significant ( $p < 0.05$ ). RBC values decreased slightly in the 33.33% rice offal group ( $1.93 \times 10^6/\mu\text{l}$ ) but remained relatively stable in the other groups (ranging from 2.83 to  $2.96 \times 10^6/\mu\text{l}$ ), with no significant difference observed ( $p < 0.05$ ). WBC counts decreased as rice offal levels increased, from  $5.90 \times 10^3/\mu\text{l}$  in the control group to  $4.40 \times 10^3/\mu\text{l}$  in the 66.67% rice offal group, but again, the differences were not statistically significant ( $p < 0.05$ ). MCH showed a notable increase with rice offal inclusion, with the highest value of 71.20 pg observed in the 66.67% rice offal group, which was statistically significant ( $p < 0.001$ ). MCHC fluctuated without any significant differences between the groups ( $p < 0.05$ ), with values ranging from 42.80 g/dl to 50.65 g/dl. Platelet counts decreased in the groups with higher rice offal levels (from 276.00 to 197.33), but the differences were not statistically significant ( $p < 0.05$ ). Differential white blood cells also showed minor changes, with neutrophils increasing in the rice offal groups, particularly in the 33.33% and 66.67% groups, though this was not statistically significant ( $p < 0.05$ ). Lymphocyte counts decreased as rice offal inclusion increased, from 38.00% in the control group to 24.00% in the 66.67% rice offal group, but again, the difference was not significant ( $p < 0.05$ ). Monocyte levels increased in the 66.67% rice offal group (to 12.00%), but there were no significant differences ( $p < 0.05$ ) across the groups. All the haematological parameters showed non – significant ( $p > 0.05$ ) difference among the treatment means except MCH. However, the value fell within the range for normal haematological parameters of birds Kareem *et al.*, 2024 indicating that the birds were healthy and adequately nourish. This agrees with reports by Abdi-Hacheso *et al.* (2011) and Rasheed and Olusegun (2017) in broiler chickens and Chineke *et al.* (2006) and in rabbits. The PCV and Hb values agrees with that of Oke *et al.* (2007). The significant different obtain in MCH, corroborate the findings of Peters *et al.* (2011) who reported variations in haematological parameters among Nigerian native normal-feathered frizzled and naked neck chicken genotypes. Islam *et al.* (2004) have also previously reported genetic variations in haematological parameters among Nigerian native chickens.

**Table 3: Haematological Value of Broiler Chickens Fed Dietary Level of Rice Offal Based Diets**

Parameters	Diets				SEM	Ref. value
	1 (0%)	2 (33.33%)	3 (66.67%)	4 (100%)		
PCV (%)	32.50	34.50	36.75	38.00	2.06 <sup>NS</sup>	24.00-43.00
Hb (g/dl)	10.83	11.97	12.20	12.65	6.61 <sup>NS</sup>	7.00-13.00J
RBC ( $\times 10^6/\mu\text{l}$ )	2.96	1.93	2.88	2.83	4.67 <sup>NS</sup>	4.21-4.84W
WBC ( $\times 10^3/\mu\text{l}$ )	5.90	4.78	4.40	4.65	7.52 <sup>NS</sup>	4.07-4.32W
MCH (pg)	32.90 <sup>c</sup>	59.95 <sup>b</sup>	71.20 <sup>a</sup>	59.83 <sup>b</sup>	5.22 <sup>**</sup>	27.20-28.90W
MCHC (g/dl)	44.88	42.80	50.65	46.40	5.62 <sup>NS</sup>	26.00-35.00J
MCV (fl)	83.28	91.98	90.28	79.08	3.66 <sup>NS</sup>	81.60-89.10W
HCT (%)	34.35	30.48	31.55	35.18	3.63 <sup>NS</sup>	-
Platelet (%)	276.00	197.33	196.05	220.00	22.38 <sup>NS</sup>	-
Neutrophils (%)	56.50	63.50	61.25	61.75	7.04 <sup>NS</sup>	-
Lymphocytes (%)	38.00	28.75	24.00	31.00	7.27 <sup>NS</sup>	45.00-70.00J
Monophiles (%)	3.75	6.25	12.00	6.00	2.88 <sup>NS</sup>	-
Eosinophiles (%)	1.50	0.75	2.25	0.75	5.64 <sup>NS</sup>	1.50-6.00J
Basophiles (%)	0.25	0.75	0.50	0.50	3.38 <sup>NS</sup>	-

abc Mean bearing different superscript within the same row differ; \*\* ( $p < 0.05$ ); NS = Not significant; SEM = Standard error of Means, PCV = Packed Cell Volume, RBC = Red Blood Cell, Hb = Haemoglobin, MCV = Mean Corpuscular Volume, HCT= Heamatocrite MCH = Mean Corpuscular Haemoglobin, MCHC = Mean Corpuscular Haemoglobin Concentration.

r = Branson *et al.*, (1994), J = Jain (1993), W= Wikivet (2024).



### Serum Biochemical Indices

Serum biochemistry of broiler chickens fed graded levels of rice offal-based diets is shown in Table 4. Serum biochemical analysis is used to determine the level of heart attack, liver damage and to evaluate protein quality and amino acid requirements in animals Rasheed and Olusegun (2017). There were non-significant ( $P < 0.05$ ) differences the entire diets except Urea. The highest total protein was recorded in broilers on diets 2, 1 and 3 followed by broilers on diet 4. The values obtained for total serum protein was within range of 3.2-10.55 g/dl reported by Oke *et al.*, (2007) and in line with the report of Aderemi, (2000). Albumen and globulin did not follow a particular pattern. Broiler on diet 3 had the highest urea value of 7.80mg/dl. This could be as a result of good dietary protein content of the feed. Most of the biochemical parameters such as glucose, albumin, total bilirubin, total protein, urea conji. Bilirubin and cholesterol. The result showed non-significant treatment except the urea with (2.85 – 7.80mmol/l) which is highly significant ( $p < 0.001$ ) affected by the dietary levels of rice offal with diet 3 and 4 having a higher value compared to others. Glucose levels were consistently elevated across all diets, ranging from 18.00 to 19.13  $\mu\text{mol/l}$ , well above the normal reference range of 4.0–10.0  $\mu\text{mol/l}$ . This suggests potential stress or altered metabolic activity, although no significant differences were observed between diets. Albumin levels ranged from 2.20 to 3.25 g/dl, falling within or close to the normal range of 2.8–4.0 g/dl, indicating that rice offal substitution had no significant impact on protein metabolism or immune function. Similarly, total bilirubin levels ranged from 10.50 to 13.93  $\mu\text{mol/l}$ , all within the normal reference range (up to 17  $\mu\text{mol/l}$ ), suggesting that liver function was not adversely affected. Total protein levels also remained stable across diets, ranging from 7.08 to 8.25 g/dL, within the normal range of 6.2–8.0 g/dL, with no significant changes that would indicate disruption in protein synthesis. However, urea levels showed a significant increase with higher rice offal inclusion, ranging from 2.85 mmol/l in the control diet to 7.80 mmol/l in the 66.67% rice offal diet. This suggests a potential shift in nitrogen metabolism, possibly due to the lower protein quality of rice offal. Conjugated bilirubin levels were similar across all diets, remaining within the normal range (up to 4.6  $\mu\text{mol/l}$ ), indicating no significant liver dysfunction. Finally, cholesterol levels, which were slightly above the normal reference range of up to 5.17 mmol/l, did not differ significantly between diets, suggesting mild metabolic changes, but these were not statistically significant. Overall, the results indicate that while rice offal substitution did not significantly affect most serum biochemical parameters, it may influence nitrogen metabolism, especially at higher inclusion levels.

**Table 4:** Serum Biochemical Values of Broiler Chickens Counting Different Levels of Rice Offal Based Diet

Parameters	Diets				SEM	Normal range
	1 (0%)	2 (33.33%)	3 (66.67%)	4 (100%)		
Glucose ( $\mu\text{mol/l}$ )	18.00	18.55	19.13	18.68	1.09 <sup>NS</sup>	4.0-10.0
Albumin (g/dl)	2.20	3.25	3.10	2.88	3.52 <sup>NS</sup>	2.8-4.0
Total Bilirubin ( $\mu\text{mol/l}$ )	10.50	11.40	13.93	12.58	1.23 <sup>NS</sup>	up to 17
Total protein (g/dl)	8.25	8.23	7.80	7.08	3.38 <sup>NS</sup>	6.2-8.0
Urea (mmol/l)	2.85 <sup>c</sup>	4.51 <sup>b</sup>	7.80 <sup>a</sup>	7.75 <sup>a</sup>	7.32 <sup>***</sup>	1.7-9.1
Conj. bilirubin ( $\mu\text{mol/l}$ )	3.38	3.10	2.47	2.54	5.51 <sup>NS</sup>	up to 4.6
Cholesterol (mmol/l)	6.32	5.72	5.90	5.66	3.55 <sup>NS</sup>	up to 5.17

NS= Not significant, SEM= Standard Error of Mean, <sup>abc</sup> Means bearing different superscripts within the same row differ, \*\*\* = ( $p < 0.001$ ).

### CONCLUSION AND RECOMMENDATION

Rice offal can be incorporated up to 66.67% in broiler diets without significant metabolic disruptions. However, higher inclusion levels may affect kidney function and oxygen transport, as indicated by increased MCH and urea levels. Most haematological and biochemical parameters were stable, suggesting overall safety for blood health and metabolism. To optimize broiler health and productivity, a balanced protein source should be included to manage nitrogenous waste. Additionally,



dietary components like fibre or omega-3s should be considered to regulate lipid metabolism. Regular monitoring of kidney function, platelet count, and immune response are recommended, particularly at higher inclusion levels.

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