

HEMATOLOGY AND SERUM BIOCHEMISTRY OF WEANER RABBITS FED GRADED LEVEL OF RICE OFFAL AS A REPLACEMENT FOR WHEAT OFFAL

¹Patrick. C. J., ²Hassan. M., ³Nyako. H.D., ³Mukhtar M.Y., ³Zubairu S.Y., ⁴Doma U. D

¹Ministry of Livestock Development Adamawa State

²Federal University Gashua, Yobe State, Nigeria

³Modibbo Adama University Yola, Adamawa State

⁴Abubakar Tafawa Balewa University Bauchi, Bauchi State

Corresponding Authors email: Patrickchristyjika431@gmail.com

Abstract

Due to increase in animal protein consumption and underutilization of agro-industrial by-products, necessitated this research to determine the hematological and serum biochemistry of a weaner rabbits fed graded levels of rice offal as a replacement for wheat offal. The experiment lasted for fifty-six (56) days which involve 48 weaner rabbits six weeks of age with average weight of 1.5kg. Standard management, feed and water were given to the experimental animals following their arrival to the point of terminating the feeding trial. Blood of the rabbits were collected through the ear vein using syringe and needle and stored in an EDTA container for hematology and plain container for serum biochemistry. The proximate composition of the experimental diets was conducted using standard procedures of (AOAC, 2023). The hematology and serum biochemistry analysis were carried out using Martino *et al.*, (2012). Adopted procedures the results of proximate composition show no significant ($P>0.05$) difference in all the parameters except in crude fiber and ash which significant ($P>0.05$) difference. The hematological parameters results revealed no significant ($P>0.05$) difference in all the parameters tested except in neutrophils and mean corpuscular volume were significantly ($P>0.05$) difference. A non-significant ($P<0.05$) difference serum biochemistry in all the parameters tested except in urea and globulins were there were significant ($P>0.05$) difference. In conclusion the rice offal revealed a higher crude fiber and an elevated white blood cell, mean corpuscular volume and moderate serum biochemistry of the parameters tested which has no effect in in cooperation into the diets of monogastric especially Rabbits.

Keywords: Rice, offals, biochemistry, serum, rabbits, composition, diets

Introduction

Intake of low fibre and its quality in post-weaning diets have been implicated in the incidence of gastro intestinal disorders such as diarrhea that showed up as dilation of the caeco-colic segment and watery intestinal and caecal digesta Hagen *et al.*, (2026). However, inclusion of starch or digestible fibre at the finishing period of rabbit fattening was found to be beneficial as it enhances digestive security against disorders Xiccato *et al.*, (2011). Dietary fibre sources in the commercial rabbit pellets are usually agro- industrial by products that had undergone some level of processing with reduced particle size such as bran and offal which are keenly competed for by monogastrates that do not have digestive physiological advantage when compared to herbivores or pseudo-ruminant Akinsami *et al.* (2017) and Menon *et al.* (2023). The need to reduce the competition on the processed agro by-product fibre sources that continue to have corresponding increase in price with the main cereal and the dearth of information on the beneficial browse plant fibre that could replace the agro-wastes motivated the investigation of different dietary plant fibre sources in the diets of growing rabbit (Gidenne and Pinheiro, 2016). Therefore, the study will be aimed to determine the Performance, hematology and of feeding different types of fibre sources to weaner rabbits.

One major nutritional problem facing the developing countries like Nigeria is inadequate consumption of animal protein. An average Nigerian for instance consumes less than 10g of animal protein daily which fall short of the food and Agricultural Organization recommendation of 27g as the animal protein daily requirement for human beings FAO (2021). Rabbits are monogastric herbivores which feed on grains hay and Agro by-product Lidfors *et al.*, (2021). They are micro livestock with short generation interval of 30-33 days and exceed ruminant in terms of growth and rank close to modern broiler chicken Jayasooriya *et al.*, (2023). It supersedes other animal because of their biological qualities like prolificacy and high feed efficiency especially feed that are not directly utilized by man Patrick and Pascal (2019).

Many researchers (Maidalla, 2015; Sudik *et al.*, 2019) recommended policy is to identify and use locally available feed resources to formulate diets that are as balance as possible. The utilization of Agro-industrial by-products such as rice offal, has been neglected as animal feeds because it contains high level of fibre and low protein and energy (Maidalla, 2015)

Materials and Methods

Study Area

The study was conducted at the Modibbo Adama University, Department of Animal Science and Range Management Teaching and Research Farm Yola, Adamawa State. Yola is located at latitude 7° 11' north and longitude 11° 14' east, at an elevation of 364m above sea level in north east Nigeria. Relative humidity ranges from 30 to 40% between the months of March and February which can subsequently drop to as low as 10%. Maximum humidity is observed in the month of August with up to 90%. Average annual rainfall is about 945mm and average temperature is 34°C (maximum) and minimum 21.6°C (Adebayo *et al.*, 2020).

Experimental materials

Wheat and rice offals were sourced from Jimeta market. The offals were collected and sundried for three (3) days to reduce moisture content to about 10%. The experimental diets with 16% CP were formulated in which rice offals replaced wheat offal at 50%, 75% and 100%. Respectively. The diets were formulated and crude protein and metabolizable energy were calculated.

Experimental Design and Management

A total of 48, weaner rabbits aged five (5) weeks old of different sexes were used for the study. The experiments lasted for 56 days. Each dietary treatment group has nine (9) rabbits, four replicates with three rabbits per replicate arranged in a Completely Randomized Design (CRD); feeding trough and drinkers were provided. Prophylactic treatment was administered prior to the commencement of the experiment, to get rid of endo and ecto-parasites. Routine sanitation was carried out weekly to avoid any incidence of diseases due to poor management. Feed and water were provided *ad-libitum*.

Proximate composition of test Materials

Proximate composition of wheat and rice offals was carried out, using Standard Procedure of Analysis as described by (AOAC 2010). This is presented in Table 1

Experimental Diets

Two (2) experimental diets were formulated using wheat and rice offals. T₁ 100% wheat offal was used as the control diet, while the rice offal was included at 50%, 75% and 100% in T₂, T₃ and T₄ respectively (Table 2).

Table 1: Proximate Composition of Test Materials (% Dry matter)

Parameters	Rice offal	Wheat offal	SEM
Moisture	10.98	11.08	1.23 ^{NS}
Dry Matter	89.02	88.92	0.12 ^{NS}
Crude Protein	5.43	15.14	0.16 ^{NS}
Crude Fibre	26.18	11.16	1.65 [*]
Ash	6.72	3.94	1.11 [*]
Nitrogen Free Extract	45.48	55.50	0.45 ^{NS}
Lipid	5.21	3.18	0.06 ^{NS}

Mean bearing different superscript differ significantly.

SEM: Standard Error Mean

Blood collection, serum biochemical and hematological studies

At the end of the feeding trial, (56 days), blood was collected via the ear vein of the rabbit (5ml), the blood was collected from four rabbits per treatment; 5mls of blood were collected using five ml syringes and needle, the blood was put into labelled sterile universal bottle containing 1.0mg 1ml Ethyl Diamine Tetracetic Acid (EDTA) as anti-coagulant to determine the hematological parameters packed cell volume, haemoglobin, red blood cell, white blood cell, monocyte, neutrophils, lymphocytes, MCV, MCH, MCHC according to method described by Ajabonna *et al.*, (1999). Sterile bottles without anticoagulant were used to collect blood for biochemical analysis that is the: Urea, creatinine, cholesterol, total protein albumin, globulin and glucose were determined.

Statistical Analysis

The Statistical design that was use is completely randomized design as described by Steel and Torrie (1980). The data was subjected to one-way analysis of variance (ANOVA). Mean separation was carried out using least significant difference using SPSS Statistical Analysis System Software (2013).

Table 2: Ingredients and Percentage Composition of Experimental Diets

Ingredients	Replacement levels of Rice offal with Wheat offal			
	T1 (100%)	T2 (50%)	T3 (75%)	T4 (100%)
Maize	36	34	33	32
Soymeal	15	17	18	19
Wheat offal	30	15	7.5	0
Rice Offal	0	15	22.5	30
Groundnut haulms	15	15	15	15
Bone meal	3	3	3	3
Salt	0.5	0.5	0.5	0.5
Premix	0.5	0.5	0.5	0.5
	100.00	100.00	100.00	100.00

Calculated analysis

CP %	16	16.19	16.53	16.87
ME/Kcal/kg	2604	2871	2940.3	3009.8
CF %	10.50	10.12	9.70	9.20
EE %	3.65	3.48	3.55	3.62
Ash %	4.45	4.65	4.68	4.95

Vitamin-mineral premix will provide per kg the following: Vit. A 1500 IU; Vit.D₃ 3000 IU; Vit.E 30 IU; Vit.K 2.5 mg; Thiamine B₁ 3 mg; Riboflavin B₂ 6 mg; Pyridoxine B₆ 4 mg; Niacin 40 mg; Vit. B₁₂ 0.02 mg; Pantothenic acid 10 mg; Folic acid 1mg; Biotin 0.08 mg; Chloride 0.125 mg; Mn 0.0956 g; Antioxidant 0.125 g; Fe 0.024 g; Cu 0.006 g; Se 0.24 g; Co 0.240 g. ME: Metabolizable Energy. Metabolizable energy calculated according to Pauzenga (1985)

Results

Hematological Parameters of Weaner Rabbits Fed Rice Offal as Replacement for wheat offal

Hematological parameters of weaner rabbits fed rice offal replacing wheat offal is presented in Table 3. Most of the hematological parameters evaluated were not significantly affected ($P > 0.05$) by the dietary treatments, indicating that the experimental diets did not adversely influence the health status of the rabbits. Packed cell volume (PCV) showed no significant difference ($P > 0.05$) among treatments. The values recorded across all dietary groups were within the normal physiological range for rabbits, suggesting adequate erythropoiesis and absence of anemia across treatments. Similarly, hemoglobin concentration did not differ significantly ($P > 0.05$) among the treatments. The observed values fell within the normal reference range, indicating that oxygen-carrying capacity of the blood was not compromised by the inclusion of rice offal in the diets. There was no significant dietary effect ($P > 0.05$) on red blood cell (RBC) counts.

The comparable RBC values among treatments further confirm that replacing wheat offal with rice offal had no detrimental effect on red blood cell production or overall blood integrity. White blood cell (WBC) counts were also not significantly influenced ($P > 0.05$) by dietary treatments. Although numerical variations were observed. The percentage of monocytes did not differ significantly ($P > 0.05$) among treatments and remained within the normal reference range, indicating no evidence of inflammatory or pathological conditions attributable to the diets. A significant difference ($P < 0.05$) was observed in neutrophil percentage. Rabbits fed diets T3 and T4 recorded higher neutrophil values compared to those on T1 and T2. However, all recorded values were within the normal physiological range, suggesting that the differences were not indicative of health impairment but rather normal variation in leukocyte distribution. Lymphocyte percentages were not significantly affected ($P > 0.05$) by dietary treatments. The consistently high lymphocyte values across all treatments indicate stable immune status and absence of dietary stress. A significant dietary effect ($P < 0.05$) was observed for mean corpuscular volume (MCV). Rabbits fed T1 recorded the highest MCV value, which was significantly higher than those fed T3, while T2 and T4 recorded intermediate values. Despite this variation, most values remained within or close to the normal reference range for rabbits. No significant differences ($P > 0.05$) were observed among treatments for mean corpuscular hemoglobin (MCH) and mean corpuscular hemoglobin concentration (MCHC). These parameters remained within normal ranges, indicating that erythrocyte size and haemoglobin concentration were not adversely affected by the dietary treatments.

Table 3: Hematological parameters of Weaner Rabbits Fed Rice as Replacement for wheat offal

Parameters	Treatments				SEM
	T1(100%)	T2(50%)	T3(75%)	T4(100%)	
Packed cell volume (%)	33.33	35.31	35.93	35.9	7.29 ^{NS}
Hemoglobin (g/dl)	10.56	10.06	10.73	10.46	0.24 ^{NS}
Red blood cell (×10⁶/uL)	4.66	4.11	4.25	40.04	1.04 ^{NS}

White blood cell	2.46	2.47	1.06	2.02	0.92 ^{NS}
($\times 10^4/L$)					
Monocyte	1.50	1.16	1.40	1.56	1.11 ^{NS}
Neutrophils (%)	20.00 ^b	20.00 ^b	21.33 ^a	24.33 ^a	6.97 [*]
Lymphocytes (%)	68	69	66.33	67.33	7.51 ^{NS}
MCV	77.39 ^a	74.66 ^{ab}	69.00 ^b	72.66 ^{ab}	2.66 [*]
MCH	21.66	21.66	23.00	22.83	0.81 ^{NS}
MCHC	31.33	30.66	31.66	30.33	1.53 ^{NS}

Mean bearing different superscript differ significantly. ($P > 0.05$).

SEM: Standard Error Mean

Biochemical Parameters of Weaner Rabbits Fed Rice Offal Replacing Wheat Offal

Table 4 presents the serum biochemical indices of weaner rabbits fed diets in which rice offal partially replaced wheat offal. There were no significant differences ($P > 0.05$) among the dietary treatments for all the biochemical parameters evaluated, indicating that inclusion of rice offal did not adversely affect the metabolic or physiological status of the rabbits. Serum urea concentration was not significantly influenced ($P > 0.05$) by the dietary treatments. The values recorded across all treatments similarly; serum creatinine levels showed no significant difference ($P > 0.05$) among treatments. The observed values fell within the normal reference range, indicating normal kidney function and muscle metabolism irrespective of dietary treatment. There was no significant dietary effect ($P > 0.05$) on serum cholesterol concentration. The comparable cholesterol values among treatments suggest that lipid metabolism was not altered by the inclusion of rice offal in the diets. Total serum protein did not differ significantly ($P > 0.05$) across dietary treatments. Likewise, serum albumin concentration showed no significant difference ($P > 0.05$) among treatments. Albumin values remained within normal physiological limits. Serum globulin levels were also not significantly affected ($P > 0.05$) by dietary treatments. Although numerical variations were observed, the values were within acceptable physiological ranges, indicating stable immune protein synthesis. Blood glucose concentration did not differ significantly ($P > 0.05$) among treatments. The glucose values remained within the normal reference range for rabbits of rice offal.

Table 4: Biochemical Parameters of Weaner Rabbits Fed Rice Offal as Replacement for Wheat Offal

Parameters	Treatments				SEM
	T1(100%)	T2(50%)	T3(75%)	T4(100%)	
Urea (mg/dL)	15.6 ^a	17.63 ^c	16.5 ^b	15.62 ^a	1.37 [*]
Creatinine (mg/dL)	1.22	1.7	1.32	1.31	7.14 ^{NS}
Cholesterol (mg/dL)	52.83	55.53	53.73	52.85	1.43 ^{NS}
Total Protein (g/dl)	5.48	5.49	5.46	5.67	0.28 ^{NS}
Albumin (g/dl)	3.92	3.76	4.00	3.67	0.22 ^{NS}
Globulin (g/dl)	1.55 ^a	1.73 ^a	1.46 ^a	2.67 ^b	0.26 [*]
Glucose (mg/dL)	75.36	76.2	75.9	75.93	0.58 ^{NS}

Mean bearing different superscript differ significantly. ($P > 0.05$).

SEM: Standard Error Mean

DISCUSSION

Hematological Parameters of Weaner Rabbits Fed Rice Offal Replacing Wheat Offal

Hematological parameters of weaner rabbits fed rice offal replacing wheat offal is Most of the hematological parameters evaluated were not significantly affected ($P > 0.05$) by the dietary treatments, indicating that the experimental diets did not adversely influence the health status of the rabbits. Yaqub *et al.*, (2021) Packed cell volume (PCV) reported by Mitruka and Rawnley (1977) falls within the normal range This is in contrast with findings of Mafimidiwo *et al.*, (2024) who reported a lower PCV values of 29.00%, to 32.50% and for rabbit fed farm waste. However, the values are within the normal range of PCV for rabbits. This report is also similar to result obtained by Adamu *et al.*, (2025) who reported a range of 30.93%, to 32.66%. The values recorded across all the dietary groups were within the normal physiological range for rabbits, suggesting adequate erythropoiesis and absence of anemia across treatment as reported by Amaza *et al.*, (2020).

Haemoglobin concentration did not differ significantly ($P > 0.05$) among the treatments, and fall within normal range as reported by Mitruka and Rawnley (1977) indicating oxygen carrying capacity of the blood was not compromised by the inclusion of rice offal in the diets. However, the result of Adamu *et al.*, (2024) 11.55 to 12.70% were higher than the values obtained in this study: on the other hand, the values obtained from the findings of Mafimidiwo *et al.*, (2024). Concur with the results of this report which had similar values of Hb, 9.85, 10.75, 10.70, 10.70. For the red blood cells the findings of this study agreed with the report of Mafimidiwo *et al.*, (2024) with similar values of RBC 4.90, 4.92, 5.25 and 5.30. Kawu *et al.*, (2019) however, values of RBC 2.53, 2.83, 2.89 and 3.37 RBC for broiler chickens fed ginger and pearl millet as replacement for red sorghum. The comparable RBC values among treatment further reveal that replacing wheat offal with rice offal might have detrimental effect on red blood cell production or overall blood integrity. White blood cell (WBC) counts were also not significantly influenced ($P > 0.05$) by dietary treatments. Although numerical variations were observed, similar values were observed by Kawu *et al.*, (2017) WBC 2.53, 2.83, 2.89 and 3.37. the result of this study were much lower than 5 to 13 reported by Togun *et al.*, (2007). Higher value may indicate presence of antigen. Monocytes did not differ significantly ($P > 0.05$) among treatments and remained within the normal range of 0 to 5%, indicating no evidence of inflammatory or pathological condition attributed to the diets. These findings did not agree with the work of Ogunsipe *et al.*, (2014) who reported higher values of 4.16, 4.19, 4.19 and 4.28 respectively for rabbits fed sorghum offal-based diet. Furthermore, Akinbami *et al.*, (2025) reported lower values of monocytes of 0.75, 1.00, 1.00 and 0.58 for broiler chickens fed garlic and ginger diet. A significant difference ($P < 0.05$) was observed in neutrophil percentage, Rabbit fed T3 and T4 recorded higher neutrophil values compared to those on T1 and T2, but the result fall within the normal range of 20 to 75% reported by Mitruka and Rawnley (1977). However, all recorded values were within normal physiological range, suggesting that the differences were not indicative of health impairment but rather normal variation in leukocyte differential distribution. Higher values of neutrophils were obtained by Haruna *et al.*, (2025) as 56.50, 63.50, 61.25 and 61.75 for broiler chicken fed graded level of rice offal as a substitute for wheat offal. Although, they all fall within the normal range as revealed by Mitruka and Rawnley (1977). The result reported by Ogunsipe *et al.*, (2014) 37.03, 36.48, 36.18, 35.23 and 35.03. was also higher than the findings of this study. The lymphocyte percentage were not significantly affected ($P > 0.05$) by dietary treatments. The consistently high lymphocyte values across all treatments indicate stable immune status and absence of dietary stress. This finding is in contrast with the report of Ogunsipe *et al.*, (2014) who reported lower values of 42.25, 41.78, 42.34 and 41.87. Haruna *et al.*, (2025) also reported a lower value of 38.00, 28.75, 24.00 and 31.00 for broiler chickens fed graded levels of rice offal as substitute for wheat offal.

A significant dietary effect ($P < 0.05$) was observed for mean corpuscular volume (MCV). Rabbit fed T1 recorded the highest MCV value, which was significantly higher than those fed T3 while T2 and

T4 recorded intermediate values. Despite this variation most values remained within or close to the normal range for rabbit as opined by Mitruka and Rawnsley (1977).

The result of this study (MCV) is higher than the values obtained by Ogunsipe *et al.*, (2014) who reported MCV of 63.43, 66.18, 60.83, 56.92, 57.31 for rabbit fed sorghum offal-based diet. This result of these findings agreed with the report of Mu'azu *et al.*, (2024) who fed sun-dried cattle rumen content as replacement for wheat offal: (65.73, 67.55, 66-93, 69.20, and 69.05). there was no significant ($P > 0.05$) difference observed among treatments for Mean Corpuscular Hemoglobin (MCH) this concur with the findings of Muazu *et al.*, (2024) who fed with rabbit sun-dried cattle rumen content as a replacement for wheat offal MCH value of 22.63, 22.65, 22.27, 24.40, 23.15. Mean corpuscular hemoglobin concentration (MCHC) had no significant ($P < 0.05$) difference were observed the parameters remained within normal range, indicating that erythrocyte size and hemoglobin concentration was not adversely affected by the dietary treatment.

Biochemical Parameters of Weaner Rabbits Fed Rice Offal Replacing Wheat Offal

There was no significant ($P > 0.05$) difference among the dietary treatments for the biochemical parameters evaluated. Indicating that inclusion of rice offal did not adversely affect the metabolic or physiological status of the rabbit. The serum urea was not significantly influenced by the dietary treatment. The values were within normal range of urea. This observation did not agree with the findings of Haruna *et al.*, (2025) who reported lower values of 2.85, 4.51, 7.80, 7.08 of urea. In contrary to higher values reported by Ogunsipe *et al.*, (2014) as 10.19, 10.25, 10.55, and 10.98 respectively. The creatinine observed in the present study were significantly lower than 2.39, 3.32, 2.41, 2.47, and 2.51 as reported by Ogunsipe *et al.*, (2014). Serum cholesterol concentration, shows no significant ($P < 0.05$) difference dietary effect on rabbit. The comparable cholesterol values among treatments suggest that lipid metabolism was not altered. The cholesterol values obtained in this study were generally lower than 129.02, 129.21, 129.67, 127.34 values reported by Kawu *et al.*, (2019). However, lower values were obtained by Haruna *et al.*, (2023) as 6.32, 5.72, 5.90 and 5.66 for broiler chickens. Total protein showed significant ($P < 0.05$) difference with lower values than the values reported by Haruna *et al.*, 2023 and Udeh *et al.*, 2009) as 8.25, 8.23, 7.80, 7.08. In a similar report Kawu *et al.*, (2019) reported a much lower value of 3.57, 3.49, 4.19 and 4.52 respectively. Serum albumen concentration showed significant ($P < 0.05$) difference among treatments. which agreed with the of values (2.47, 2.52, 2.85 and 3.23) reported by Kawu *et al.*, (2019). This present finding is in contrast with the report of Adamu *et al.*, (2020) who obtained higher values (51.25, 48.53, 50.22 and 47.92). The report of this finding showed that the globulin levels 1.46 to 2.67 fall within normal range of 2.4-5%g/dl as reported by Mitruka and Rawley, (1977). This agreed with a report of Kawu *et al.*, (2019) who revealed 1.10, 1.07, 0.74 and 0.95 values.

Glucose level observed in this present study had no significant ($P > 0.05$) difference. Values ranging from 75.20 to 76.20 mg/dl were higher than reported values of (Ubali *et al.*, 2025: Mungin *et al.*, 2024 and Haruna *et al.*, 2023) who reported 18.00, 18.55, 19.13 and 18.68. and 6.90, 6.95, 6.55 and 7.75 respectively.

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