



**GROWTH PERFORMANCE, CARCASS CHARACTERISTICS AND
COST BENEFITS OF BROILER CHICKENS FED DIETARY LEVELS OF
RICE OFFAL AS SUBSTITUTE FOR WHEAT OFFAL**

¹Haruna, I. M., ²Bello, K. M., ²Doma, U. D., ²Egbo, M. L., ²Jamaa, N. A., Ambore, C. B.,
¹Apeh, D., ¹Gukut, M. Y. and ³Rukayya, Y. L.

¹Veterinary Extension Services Department, National Veterinary Research Institute Vom,
Jos Plateau State Nigeria.

²Department of Animal Production, Abubakar Tafawa Balewa University, Bauchi-Nigeria.

³College of Agriculture Bauchi. Bauchi State - Nigeria

Corresponding Author's Email: malgwiharuna@yahoo.com, **GSM:** 08063183226

ABSTRACT

The study evaluated the growth performance, carcass characteristics, and cost-effectiveness of replacing wheat offal with rice offal in broiler chicken diets. A total of 300 unsexed broiler chicks were randomly assigned to four dietary treatments containing 0%, 33.33%, 66.67% and 100% level of rice offal as substitute for wheat offal coded as Diet 1, 2, 3 and 4 respectively. The experimental design was a completely randomized design with 75 birds per treatment (18 birds per replicate) and the feeding trial lasted for 56 days. Feed and water were supplied *ad libitum*. Results showed no significant differences in growth performance parameters across treatments. However, plucked weight was significantly affected ($P < 0.05$), with the highest value observed on diet 1. Dressing percentage (71.31–76.18%) remained unaffected. Economic analysis revealed that feed cost decreased as rice offal inclusion increased, with the lowest feed cost per kg weight gain (₦944.43) and highest cost savings (₦58.32) recorded on diet 3 (66.67% rice offal). The study concludes that rice offal can fully replace wheat offal without adverse effects on broiler performance, with 66.67% inclusion being the most economic diet and is recommended for broiler chicken production in the study area.

Keywords: Growth, Performance, Carcass, Cost, Broiler

INTRODUCTION

The global search for affordable and nutritionally adequate alternatives to high-cost conventional poultry feed ingredients has intensified, with studies focusing on local plant and animal protein sources such as moringa leaf meal, locust bean meal, watermelon seed meal, and sorrel seed meal (Abi-Miku *et al.*, 2020). Proper nutrition, essential for poultry health and productivity, requires a balance of at least 38 nutrients (Steve and Bruce, 2016), and feed formulation must consider nutrient profile, palatability, cost, and the absence of anti-nutritional factors. Given that feed accounts for 75–80% of total poultry production costs and economic viability of poultry farming is highly dependent on reducing feed expenses. In Nigeria, where high production costs have forced many farmers out of the poultry industry (Aremu *et al.*, 2010), the need for affordable, locally available feed alternatives is critical. With a growing population of approximately 200 million people (FAO, 2011) and an average daily animal protein intake of just 15 g far below the recommended 35 g (FAO, 2010) boosting animal protein production, particularly from poultry, is essential. Nigeria's poultry sector is expanding faster than those of neighbouring countries (FAO, 2015) and plays a vital role in food security and economic development. Poultry is favoured in tropical climates due to its efficient feed-to-protein conversion and high return on investment (Oluyemi and Roberts, 2007). Despite extensive systems making up 85% of production, poultry provides a major source of meat and eggs, offering high-quality protein and essential micronutrients. Globally, per capita poultry meat consumption has grown from 3.0 kg in 1960 to 14.5 kg in 2011 (FAO, 2009), and in developing countries, it is projected to reach 14 kg by 2030.



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).

Treatments and Experimental Design

Four experimental diets were formulated in which rice offal replaced wheat offal at 0,33.33, 66.67 and 100% levels designated as diets D₁, D₂, D₃ and D₄. Respectively. Fish meal was the main animal source. Other feed ingredients used include; palm oil, groundnut cake, 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% (finisher phase).

Experimental Birds and their Management

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

Data Collection and Statistical Analysis

Data was collected for daily feed intake (DFI), daily weight gain (DWG), feed conversion ratio (FCR), feed cost per kg, feed cost per kg gain and cost saving among others. Data pertaining to growth performance were subjected to ANOVA (SAS, 2002), SPSS statistics 25 for windows (SPSS, 2017). Where significant effect of diet was observed, the means were separated using the Duncan Multiple Range Test (DMRT, 1955).

Table 1: Ingredients and Composition (%) of 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
Total	100.00	100.00	100.00	100.00
Chemical composition (%)				
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 D₃, 3,000, 000iu, Vitamin E, 30,000mg, Vitamin K₃, 2,500mg, VitaminB₁,2,000mg, VitaminB₂, 5,000mg, VitaminB₆, 3500mg, VitaminB₁₂, 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 Diets Containing Dietary Levels Rice Offal 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
Total	100.00	100.00	100.00	100.00
Chemical composition (%)				
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 D₃, 3,000, 000iu, Vitamin E, 30,000mg, Vitamin K₃, 2,500mg, VitaminB₁,2,000mg, VitaminB₂, 5,000mg, VitaminB₆, 3500mg, VitaminB₁₂, 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.

RESULTS AND DISCUSSION

Growth Performance of Broiler Chickens Fed Rice Offal Diets

The performance revealed that most of the parameters were not significantly affected by the dietary levels of rice offal as a substitute for wheat offal, indicating that it can completely replace wheat offal with no detrimental effect. This observation is in agreement with the findings of Esonu *et al.* (2004), who reported that rice offal can be used as an alternative fibre source in broiler diets without adversely affecting growth performance. Initial weights were statistically similar across all diets, indicating uniformity at the start of the trial. However, significant differences were observed on fourth week body weights, with birds fed diet 3 (66.67% rice offal) recording the highest weight (845.49 g), followed by diet 2 (785.67 g), while the diet 4 inclusion had the lowest (714.60 g) ($P <$

0.001). Despite these differences, final body weights at 8 weeks were not significantly affected by dietary treatments. During the starter phase (1–4 weeks), broilers fed diet 3 rice offal diet exhibited the highest daily weight gain (26.79 g) and the most efficient feed conversion ratio (FCR) (1.46), while the diet 4 rice offal showed the poorest FCR (1.68) ($P < 0.01$). These results support previous findings by Oke *et al.* (2018), who found improved performance with up to 60% inclusion of rice offal in broiler diets. Similarly, Esonu *et al.* (2001) found that moderate inclusion of agro-industrial by-products like rice offal enhanced growth and feed efficiency without negatively affecting performance. In the finisher phase (5–8 weeks), no significant differences ($P > 0.05$) were recorded in feed intake, daily weight gain, or FCR across the diets, aligning with the observations of Ani and Okorie (2009), who reported minimal performance differences in finisher broilers fed alternative fiber-based ingredients. Likewise, during the overall experimental period (1–8 weeks), there were no significant differences ($P > 0.05$) among treatments in terms of feed intake, weight gain, or FCR. Mortality was negligible across all diets, with only one bird lost per group during the starter phase and none in the finisher phase, suggesting no adverse health impacts associated with rice offal inclusion.

Table 3: Performance of Broiler Chickens Fed Dietary Levels of Rice Offal as Substitute for Wheat Offal Based Diet

Parameter	1 (0%)	2 (33.33%)	Diets 3 (66.67%)	4 (100 %)	SEM
Productive performance					
Initial weight (g)	98.07	97.70	95.36	96.71	1.53 ^{NS}
Week 4 weight (g)	746.52 ^{bc}	785.67 ^b	845.49 ^a	714.6 ^c	16.62 ^{***}
Final weight (g)	1719.97	1669.83	1752.08	1613.69	48.61 ^{NS}
Starter phase (1-4 weeks)					
Daily feed intake (g)	34.02	36.39	39.24	37.14	1.36 ^{NS}
Daily weight gain (g)	23.16 ^{bc}	24.68 ^b	26.79 ^a	22.05 ^c	0.59 ^{***}
Feed conversion ratio	1.47 ^b	1.47 ^b	1.46 ^b	1.68 ^a	0.04 ^{**}
Mortality (Number)	1	1	1	1	
Finisher phase (5- 8 weeks)					
Daily feed intake (g)	103.92	104.27	102.39	101.53	7.54 ^{NS}
Daily weight gain (g)	46.36	42.10	43.17	42.84	2.21 ^{NS}
Feed conversion ratio	2.26	2.53	2.37	2.38	0.22 ^{NS}
Mortality (Number)	0	0	0	0	-
Overall phase (1-8 weeks)					
Daily feed intake (g)	68.92	70.33	70.82	69.34	4.22 ^{NS}
Daily weight gain (g)	34.76	33.88	34.98	32.45	1.13 ^{NS}
Feed conversion ratio	1.87	2.0	1.92	2.03	0.11 ^{NS}
Mortality (Number)	1	0	1	1	-

abc Mean bearing different superscript within the same row differ; * = ($p < 0.05$); ** = ($p < 0.01$), *** = ($p < 0.001$); NS = Not significant; SEM = Standard error of Means

Carcass Characteristics of Broiler Chickens Fed Rice Offal Based Diets

The carcass and organ characteristics of broiler chickens fed dietary levels of rice offal (RO) based diets (Table 4) showed live weight, eviscerated weight, and carcass weight showed no statistically significant differences ($P > 0.05$) across treatments, indicating that rice offal inclusion up to 100% did not adversely affect overall body mass. However, plucked weight was significantly reduced ($P < 0.05$) in birds fed the 100% rice offal diet (1.65 kg) compared to the control group (1.85 kg), suggesting a mild reduction in feathered mass at higher inclusion levels. This trend is consistent with the findings of Oke *et al.* (2018), who reported reduced carcass yield at higher inclusion levels of fibrous feed ingredients due to lower digestibility. The dressing percentage ranged from 71.31% to 76.18%, with the highest value observed in the 100% rice offal group, though differences were not

statistically significant. This implies that rice offal did not negatively impact the proportion of usable meat relative to live weight. Similar results were reported by Ani and Okorie (2009), who observed no significant effect on dressing percentage when wheat offal was replaced with rice milling by-products. Among the visceral organs, only lung weight showed a significant decrease ($P < 0.05$) as rice offal inclusion increased, dropping from 0.77% in the control to 0.55% on diet 4 (100% RO) group. The physiological implications of reduced lung weight at higher fiber levels require further investigation but may be linked to reduced metabolic load or feed density, as noted by Esonu *et al.* (2001). Other organs, including the heart, gizzard, liver, kidneys, pancreas, intestines, and abdominal fat, did not differ significantly ($P > 0.05$) across treatments, indicating that rice offal inclusion did not adversely affect internal organ development or function. Notably, gizzard weights tended to increase with higher rice offal levels (1.26–1.53%), reflecting a typical physiological adaptation to fibrous diets, as birds require more mechanical digestion to process such feeds (Tona *et al.*, 2019).

Table 4: Carcass and Organ Characteristics of Broiler Chickens Fed Varying Levels of Rice Offal-based Diets

Parameters	Diets				SEM
	1 (0%)	2 (33.33%)	3 (66.67%)	4 (100%)	
Live weight (kg)	2.05	1.94	1.96	1.84	6.40 ^{NS}
Plucked weight (kg)	1.85 ^a	1.71 ^{ab}	1.73 ^{ab}	1.65 ^c	4.35 [*]
Eviscerated weight (kg)	1.66	1.48	1.56	1.50	5.87 ^{NS}
Carcass weight (kg)	1.55	1.38	1.45	1.40	5.96 ^{NS}
Dressing percentage (%)	75.65	71.31	74.42	76.18	2.32 ^{NS}
Head, leg and visceral organs expressed as percentage of live weight					
Lungs weight	0.77 ^a	0.66 ^b	0.59 ^b	0.55 ^{b^c}	4.79 [*]
Head weight	2.84	2.86	2.77	2.66	1.70 ^{NS}
Kidney weight	0.34	0.33	0.35	0.34	4.41 ^{NS}
Spleen weight	0.09	0.06	0.07	0.10	1.05 ^{NS}
Heart weight	0.44	0.42	0.44	0.51	4.14 ^{NS}
Gizzard weight	1.26	1.34	1.53	1.53	1.03 ^{NS}
Small intestine weight	2.99	3.14	3.17	3.24	1.93 ^{NS}
Large intestine weight	0.35	0.13	0.14	0.19	9.74 ^{NS}
Abdominal fat weight	1.04	1.04	1.30	1.30	1.91 ^{NS}
Pancreas weight	0.42	0.20	0.24	0.23	8.07 ^{NS}
Liver weight	1.54	1.58	1.71	1.79	1.29 ^{NS}
Caeca weight	0.65	0.56	0.62	0.65	5.55 ^{NS}
Legs weight	4.03	4.47	4.12	4.18	2.01 ^{NS}

abc Mean bearing different superscript within the same row differ; * = ($p < 0.05$); NS = Not significant; SEM = Standard error of Means

Cost Benefits of using Rice Offal as Replacement for Wheat Offal in Broiler Chicken Diets

The economic assessment of broiler chickens fed diets containing different inclusion levels of rice offal is presented in Table 5. Feed intake across diets remained relatively stable (3.38–3.47 kg), indicating no significant adverse effect of rice offal on feed consumption. Feed cost per kilogram reduced marginally with increasing levels of rice offal, ranging from ₦466.89 in the control diet (0%) to ₦455.61 at 100% inclusion, reflecting the lower cost of rice offal relative to conventional feed ingredients. Total weight gain was highest on diet 1 (0%) and 3 (66.67%), with values of 1.70 kg and 1.71 kg respectively, while the lowest was observed on diet 4 (100%) at 1.59 kg. Consequently, feed cost per kilogram of weight gain was most economical in the control group (₦914.55) and diet 3 (₦944.43), and least economical in diet 2 (₦1002.90). Cost savings analysis indicated that only the 66.67% inclusion level (diet 3) yielded a positive return (₦58.47), whereas partial (33.33%) and full (100%) replacement led to economic losses of ₦88.35 and ₦29.83, respectively. This finding agrees with the report of Ani *et al.*, (2013) who reported that, although the inclusion of enzyme in some of



the diets enhanced the growth rate of birds, such inclusion increased the cost of feed per kg gain, thereby negating the positive effect it had on growth rate of chicks. This result is in conformity with Onuh *et al.* (2015) who reported that feed cost/kg gain was highest with birds fed the control diet and least with birds fed 7.5% urea treated rice offal.

Table 5: Cost Benefit of Broiler Chickens Fed Levels of Rice offal Based Diets

Parameters	Diets			
	1 (0%)	2 (33.33%)	3 (66.67%)	4(100%)
Total feed intake (kg)	3.38	3.44	3.47	3.40
Feed cost (kg/₦)	466.89	47.21	465.41	455.61
Total feed cost (₦)	1554.74	1634.72	1614.97	1549.07
Total weight gain (kg)	1.70	1.63	1.71	1.59
Feed cost per kg gain (₦)	914.55	1002.90	944.43	974.26
Cost saving (₦)	-	-88.35	58.47	-29.83

CONCLUSION AND RECOMMENDATION

Rice offal can replace wheat offal (66.67%) as dietary fibre source in broiler chickens' diets without compromising growth performance and carcass yields. However, 66.67% (Diet 3) was most economical and is therefore recommended as an alternative fibre source in the diets of broiler chickens.

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