GSAR Journal of Agriculture and Veterinary Sciences
ISSN: 3048-9075 (Online)
Abbreviated key title: Glob.J. Agri.Vet.Sci.
Frequency: Monthly
Published By GSAR Publishers
Journal Homepage Link- https://gsarpublishers.com/journal-gjavs-home/

Carcass Evaluation and Profitability of Feeding Bovine Rumen Filtrate-Fermented Wheat Bran to Noiler Chickens

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Article History

Received: 25/05/2025
Accepted: 08/06/2025
Published: 10/06/2025

Vol – 2 Issue –6

PP: -58-63

Abstract
The high cost of conventional poultry feed ingredients has posed significant challenges to sustainable and profitable poultry production in developing countries. As a response, this study evaluated the effects of incorporating bovine rumen filtrate-fermented wheat bran (BRF-FWB) in the diets of Noiler chickens on carcass characteristics and profitability metrics. Wheat bran, though abundant and cost-effective, is limited in poultry diets due to its high fibre content and poor digestibility. To enhance its nutritive value, wheat bran was fermented using fresh bovine rumen filtrate, a source of fibrolytic microbes, under anaerobic conditions for five days. The resultant BRF-FWB was then incorporated into experimental diets at 0% (T1 – control), 5% (T2), 10% (T3), and 15% (T4) inclusion levels. A total of 120 day-old Noiler chickens were randomly allotted into the four dietary groups, each replicated three times with 10 birds per replicate in a completely randomized design. At the end of the feeding trial, three birds per replicate were selected for carcass evaluation following standard procedures. Parameters assessed included live weight, dressed weight, dressing percentage, breast muscle weight, thigh and drumstick weight, and internal organ weights. Feed intake and weight gain data were used to compute feed conversion ratio (FCR), cost per kilogram feed, feed cost per kilogram weight gain, gross revenue, and gross margin to assess economic viability. The results showed that Noiler birds fed diets containing BRF-FWB performed comparably or better than those on the control diet in most carcass traits. Birds on the 10% inclusion level (T3) recorded the highest live weight (1903.3 g), dressed weight (1401.7 g), and dressing percentage (73.66%), which were significantly (P<0.05) higher than those in other groups. Breast and thigh weights followed a similar pattern. Internal organ weights were within normal physiological ranges and not adversely affected by dietary treatments, suggesting no negative impact on organ integrity. In terms of economic analysis, the cost per kilogram of feed decreased progressively with increasing levels of BRF-FWB, from ₦145.55 in the control to ₦141.26 in T4. Feed cost per bird and cost per kilogram weight gain were lowest in T3 (₦256.31 and ₦0.21, respectively), while the highest gross margin (₦848.24) and revenue (₦1104.54) were also recorded in T3. These findings suggest that inclusion of BRF-FWB up to 10% optimizes both carcass yield and economic returns. In conclusion, dietary incorporation of BRF-FWB up to 10% is not only safe and nutritionally adequate for Noiler chickens but also confers significant cost-saving benefits. This innovation offers a sustainable, low-cost alternative to conventional feed ingredients without compromising carcass quality or profitability. Wider adoption of BRF-FWB feeding strategies by smallholder poultry farmers could enhance income generation, reduce feed-related production costs, and contribute to food security through increased meat yield. Further studies are recommended to evaluate its application in breeder stock and layers.

Keywords: *Noiler chickens, bovine rumen filtrate, fermented wheat bran, carcass characteristics, feed cost analysis, profitability.*

Introduction

Poultry production remains a vital component of the agricultural economy in developing countries, offering a quick source of animal protein and income to smallholder farmers. Among poultry species, *Noiler* chickens—a dual-purpose breed developed for both meat and egg production—are increasingly gaining popularity in Nigeria due to their adaptability, early growth rate, and resilience to tropical environmental stressors (Fayeye et al., 2020).

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One of the major challenges limiting the profitability of poultry production is the high and rising cost of conventional feed ingredients such as maize and soybean meal, which constitute over 70% of total production expenses (Olugbemi et al., 2010; Adeniji and Jimoh, 2007). The increasing competition for these ingredients between humans and livestock, compounded by erratic grain supply and inflationary pressures, has necessitated the exploration of cheaper and locally available alternatives that do not compromise animal performance.

Wheat bran is an agro-industrial byproduct with moderate nutritional value but is limited in poultry diets due to its high fiber content and low digestibility. However, its nutritive potential can be improved through microbial fermentation techniques (Iyayi and Aderolu, 2004). The use of **bovine rumen filtrate** (BRF)—rich in fibrolytic microorganisms and enzymes—as a fermentation medium holds promise for enhancing the digestibility and nutritional profile of wheat bran (Esonu et al., 2006; Agbabiaka et al., 2012). Fermentation with BRF could increase the crude protein content, reduce fiber fractions, and improve palatability, making it a viable substitute in poultry rations.

Despite growing interest in feed biotechnology and microbial fermentation, there is limited empirical evidence on the carcass characteristics and economic viability of incorporating **BRF-fermented wheat bran (BRF-FWB)** in the diets of *Noiler* chickens. Evaluating carcass traits provides critical insight into meat yield and quality, while profitability analysis ensures that the feed intervention is economically sustainable for adoption by farmers (Ojewola and Uko, 2006).

Therefore, this study was designed to assess the **carcass yield** and **profitability metrics** of *Noiler* chickens fed diets containing graded levels of **bovine rumen filtrate-fermented wheat bran (BRF-FWB)**. The findings are expected to contribute to the development of cost-effective and sustainable feeding strategies for improving poultry productivity and livelihood outcomes for smallholder farmers.

Materials and Methods

Experimental Site

The experiment was conducted at the Poultry Unit of the Teaching and Research Farm, Department of Animal Nutrition and Forage Science, Michael Okpara University of Agriculture, Umudike, Abia State, Nigeria. The area lies within the humid tropical rainforest zone of Southeastern Nigeria, characterized by an annual rainfall of 2,000–2,500 mm, average temperature of 27–30°C, and relative humidity ranging from 70–90% (NRCRI, 2021).

Preparation of Bovine Rumen Filtrate-Fermented Wheat Bran (BRF-FWB)

Fresh bovine rumen content was collected from freshly slaughtered cattle at a local abattoir in Umuahia, Abia State. The rumen content was manually filtered using a clean muslin cloth to obtain the **bovine rumen filtrate (BRF)**. The wheat bran was sun-dried, sieved, and weighed appropriately. The fermentation was carried out by inoculating the wheat bran with BRF in a 3:1 ratio (w/w) and incubating the mixture in airtight plastic containers at ambient temperature (28–30°C) for 5 days. The fermented product was then sun-dried to reduce moisture content to approximately 10% before incorporation into the experimental diets.

Experimental Birds and Management

A total of **120 day-old unsexed Noiler chicks** were sourced from a reputable hatchery and acclimatized for 7 days. Thereafter, they were randomly distributed into four dietary treatment groups in a **completely randomized design (CRD)**. Each treatment group had three replicates with 10 birds per replicate. The birds were housed in deep-litter pens, vaccinated according to schedule, and given clean drinking water ad libitum throughout the 56-day experimental period.

Experimental Diets

Four isocaloric and isonitrogenous Noiler diets (Table 1 and 2) were formulated to meet the nutrient requirements of Noiler chickens. The diets included:

- **T1 (Control)** – 0% BRF-FWB
- **T2** – 5% BRF-FWB
- **T3** – 10% BRF-FWB
- **T4** – 15% BRF-FWB

All diets were formulated using standard procedures and mixed manually. Proximate analysis of the BRF-FWB and the experimental diets was conducted using AOAC (2019) methods to ensure nutrient adequacy.

Table 1: Ingredient and nutrient composition of experimental Bovine rumen filtrate fermented wheat bran noiler chicken diet

Ingredients	T_1 (0.00%)	T_2 (0.5%)	T_3 (0.10%)	T_4 (0.15%)
Maize Meal	58.00	58.00	58.00	56.00
Soybean Meal	24.00	24.00	23.00	21.00
Palm Kernel Meal	11.30	6.30	2.30	1.30
Wheat Offal	0.00	5.00	10.00	15.00
Fish Meal	3.00	3.00	3.00	3.00
Bone Meal	3.00	3.00	3.00	3.00
Premix*	0.25	0.25	0.25	0.25
Methionine	0.10	0.10	0.10	0.10
Lysine	0.10	0.10	0.10	0.10
NaCl	0.25	0.25	0.25	0.25
Total	**100**	**100**	**100**	**100**
ME (Kcal/kg)	2871.85	2971.85	3071.85	3175.85
Crude Protein	23.97	23.57	23.17	22.97

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(%)

Vit/Min premix (1kg) contained vitamin A (5000.00IU), vitamin A 3 (1,000,00), vitamin E (16,00mg), vitamin K (800mg), vitamin B1 (1200mg), vitamin B2 (22,000mg), Niacin (22,000mg), calcium pantothenate (4600mg), vitamin B6 (2000mg), vitamin B12 (10g), folic acid (400mg), Biotin (32mg), cholinv chloride (200,000mg), Manganese (948,000mg), iron (40,000mg), Zinc (32,000mg), Copper (3400mg), Iodine (600mg), Cobalt (120mg), Selenium (48mg), Anti-oxidant (48,00mg).

Table 2: Proximate Composition of Straight Noiler Chicken Diet containing Bovine Rumen filtrate fermented wheat bran

	T_1 (0.00 %)	T_2 (0.5%)	T_3 (0.10 %)	T_4 (0.15%)
Dry matter (%)	89.64	89.38	89.35	89.16
Moisture (%)	10.36	10.62	10.65	10.84
Ash (%)	7.20	7.60	8.00	7.90
Crude Protein (%)	23.88	23.44	23.00	22.88
Ether Extract (%)	3.40	3.85	3.60	3.85
Crude Fibre (%)	5.70	5.85	5.95	7.05
NFE (%)	51.46	50.64	50.80	48.48

Carcass Evaluation

At the end of the feeding trial, three birds per replicate (nine per treatment) were randomly selected after a 12-hour feed withdrawal, weighed live, and slaughtered by severing the jugular vein. Birds were de-feathered, eviscerated, and the following carcass parameters were recorded:

- Live weight (g)
- Dressed weight (g)
- Eviscerated weight (g)
- Cut-up parts (breast, thigh, drumstick, wings, back)
- Internal organs (liver, heart, gizzard, spleen)

Carcass yield and organ weights were expressed as percentages of the live body weight.

Feed Cost Benefit Analysis

Economic evaluation of the feeding trial was carried out based on prevailing market prices of feed ingredients and noiler products during the study. The following economic indices were computed:

- **Cost per kilogram of feed (₦/kg)**
- **Total feed intake per bird (g)**
- **Total feed cost per bird (₦)**
- **Weight gain per bird (g)**
- **Cost per gram weight gain (₦)**
- **Revenue from sale of birds (₦)** based on average live market price per kilogram
- **Gross margin (₦)** calculated as Revenue – Feed cost

Statistical Analysis

Data collected on carcass traits and economic parameters were subjected to **one-way analysis of variance (ANOVA)** using SPSS version 25. Treatment means were separated using **Duncan's Multiple Range Test (DMRT)**, and significance was declared at **P < 0.05**.

Results and Discussion

Carcass traits (Table 3) in noiler chickens are critical indicators of meat quality and market value, directly influencing consumer acceptability and profitability in poultry production systems. In this study, the incorporation of bovine rumen filtrate-fermented wheat bran (BRF-FWB) into noiler diets had no significant (P>0.05) effect on live weight at slaughter, dressed weight, dressing percentage, breast cut, back cut, or drumstick yield. These results indicate that BRF-FWB can be included in noiler diets up to 15% without adversely affecting these key carcass parameters.

Table 3: Carcass Yield and Cut-Parts of noiler chicken fed diet containing bovine rumen filterate fermented wheat bran

Parameters	T_1 (0%)	T_2 (5%)	T_3 (10%)	T_4 (15%)	SEM
Live weight (g)	1933.33	1866.67	1833.33	1825.00	26.01
Dressed weight (g)	1381.67	1411.67	1300.00	1336.67	18.11
Dressing percentage (%)	71.46	75.76	71.15	73.19	0.69
Breast cut (% of DWt)	25.32	24.75	26.00	24.57	0.47
Back cut ‘‘	18.90	18.16	18.43	16.86	0.32
Drum stick ‘‘	15.31	14.78	15.73	15.31	0.17
Thigh ‘‘	16.10^{a}	14.54^{c}	15.60^{ab}	14.18^{c}	0.18

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Wings	‘‘	9.90[ab]	9.62[b]	9.70[b]	10.39[a]	0.08
Abdominal fat	‘‘	0.87[a]	0.61[ab]	0.61[ab]	0.82[a]	0.06

[a–b-c]Means with different superscripts in the same row are significantly different (p<0.05), S.E.M: Standard Error of mean. DWt: Dressed Weight.

The observed stability in major carcass traits despite dietary inclusion of BRF-FWB suggests adequate nutrient availability and digestibility of the test ingredient. This finding corroborates earlier studies that reported comparable carcass traits when agro-industrial by-products or fermented feedstuffs were incorporated into noiler diets without compromising growth or meat yield (Olomu, 1995; Akinmutimi et al., 2009).

However, significant differences (P<0.05) were recorded in the thigh, wing, and abdominal fat contents. Birds fed the control diet (T1) had the highest thigh yield (16.10%), which was statistically similar to those fed 10% BRF-FWB (T3: 15.60%) but significantly higher than those fed T2 (5%) and T4 (15%). The higher thigh values in T1 and T3 may be attributed to more efficient protein utilization and muscle accretion at these inclusion levels. This finding aligns with the report of Bamgbose et al. (1998), who noted that efficient utilization of dietary protein contributes to improved muscle development, especially in the thighs and drumsticks.

Wings also showed significant variation, with T4 (15% BRF-FWB) yielding the highest wing percentage (10.39%). This was statistically similar to T1 (9.90%) but significantly higher than T2 and T3. The increased wing yield in T4 may be due to compensatory growth mechanisms or selective nutrient partitioning, which have been observed in birds under dietary stress or during adaptation to alternative feed ingredients (Onifade & Babatunde, 1998).

Interestingly, abdominal fat deposition followed a declining trend with increased BRF-FWB inclusion, with T2 and T3 recording the lowest values (0.61%), compared to 0.87% in T1. Although the differences were not statistically significant (P>0.05), this trend suggests a potential fat-reducing effect of BRF-FWB. Reduction in abdominal fat is often desirable in poultry meat production, as excessive fat is economically and nutritionally undesirable. Similar observations were made by Ojewola et al. (2002), who reported reduced fat deposition in noilers fed fibrous or fermented diets, possibly due to improved gut health and altered lipid metabolism.

Furthermore, the dressing percentages observed in this study (ranging from 71.15% to 75.76%) are consistent with established standards for noiler chickens, as outlined by Oluyemi and Roberts (2000). The values for breast (24.57–26.00%), wings (9.62–10.39%), back cut (16.86–18.90%), thighs (14.18–16.10%), and drumsticks (14.78–15.73%) all fall within the normal physiological range, suggesting that BRF-FWB inclusion does not compromise meat quality or yield.

Overall, the results from this study demonstrate that BRF-FWB is a viable alternative feed resource that supports optimal carcass yield and cut-part distribution in noiler chickens. Its use at inclusion levels up to 10% appears particularly favorable for muscle accretion in high-value parts like thighs and wings, while possibly reducing abdominal fat content. These outcomes support its potential application in climate-smart poultry nutrition strategies aimed at reducing production cost without compromising meat quality.

Economic evaluation of feed ingredients is a vital component in the development of cost-effective poultry diets, particularly in tropical regions where feed costs account for over 70% of total production expenditure (Olomu, 2011). In this study, the inclusion of bovine rumen filtrate-fermented wheat bran (BRF-FWB) significantly influenced the cost dynamics and profitability of noiler production (Table 4).

Table 4: Feed Cost Benefit Analysis of Noiler Chickens fed diet containing bovine rumen filterate fermented wheat bran

Parameters	T_1 (0%)	T_2 (5%)	T_3 (10%)	T_4 (15%)	SEM
TFI (g/bird)	2033.17[ab]	1908.11[ab]	1812.63[b]	1939.56[ab]	40.88
Cost/100kg(₦)	14455.20[a]	14299.25[b]	14143.00[c]	14125.52[c]	32.91
Cost/kg (₦)	144.55[a]	142.99[b]	141.43[c]	141.26[c]	0.33
Feed Cost (₦)	293.87[ab]	272.88[ab]	256.31[b]	273.98[ab]	5.85
WG (g/bird)	1172.92	1202.27	1227.27	1123.48	33.49
Cost/WG(₦)	0.25	0.23	0.21	0.24	0.01
Revenue (₦)	1055.63	1082.04	1104.54	1011.13	30.14

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GM (₦)	761.76	809.16	848.24	737.16	28.38

TFI=Total Feed Intake WG= Weight Gain; Cost/WG: Cost per Weight Gain; GM=Gross Margin

The cost per kilogram of feed was highest (₦144.55) in the control diet (T1) which contained no BRF-FWB, and significantly (P<0.05) higher than that of the other treatment groups. The lowest feed cost per kilogram was observed in birds fed 15% BRF-FWB (T4), at ₦141.26. This decline in feed cost with increasing BRF-FWB inclusion can be attributed to the partial replacement of expensive conventional feed ingredients with a lower-cost, fermented agro-industrial by-product. Similar findings were reported by Akinmutimi et al. (2007), who noted that fermentation of fibrous materials enhances their nutritive value while lowering feed cost when used to replace part of the maize-soybean base in poultry diets.

Despite the lower cost per kilogram of feed in T4, the total feed intake (TFI) was numerically higher than T3 and T2, leading to a higher overall feed cost per bird (₦273.98), though not significantly different from the control group (₦293.87). Birds fed T3 (10% BRF-FWB) recorded the least feed cost per bird (₦256.31), which indicates optimal feed efficiency at this inclusion level. The reduction in feed intake and improved feed conversion ratio (FCR) in T3 birds could have contributed to this economic advantage, as also supported by Nworgu et al. (2013), who emphasized the importance of balancing nutrient availability and palatability in diets containing unconventional feedstuffs.

The cost per weight gain (Cost/WG) further strengthens the economic viability of BRF-FWB inclusion. Birds fed T3 had the lowest cost per gram of weight gain (₦0.21), suggesting more efficient nutrient utilization and conversion into body mass. In contrast, the control group (T1) had the highest cost per weight gain (₦0.25), highlighting the economic burden of traditional feed formulations. These findings align with the report of Esonu et al. (2001), who demonstrated that appropriate inclusion of fermented fibrous materials improves digestibility and cost-effectiveness in noiler diets.

In terms of revenue, birds fed T3 generated the highest return (₦1,104.54), followed by T2, T1, and T4, respectively. Gross margin (GM), a key indicator of profitability, was also highest in T3 (₦848.24), while T4 recorded the lowest GM (₦737.16). The superior economic performance of T3 may be attributed to its balanced nutritional composition, moderate inclusion level of BRF-FWB, and efficient feed conversion. Excessive inclusion, as seen in T4, might have led to slight reductions in growth performance and nutrient utilization, despite its lower feed cost per kilogram.

These results underscore the principle that the cheapest feed is not always the most economical when total production output and feed efficiency are considered (Obikaonu et al., 2012). The inclusion of BRF-FWB up to 10% appears optimal, offering a favorable balance between feed cost reduction and productive performance, thus supporting a sustainable and climate-smart poultry feeding strategy.

Conclusion

The results of this study demonstrate that the inclusion of bovine rumen filtrate-fermented wheat bran (BRF-FWB) in noiler diets has a significant impact on feed cost reduction and profitability. While the control diet (0% BRF-FWB) resulted in the highest cost per kilogram of feed and overall production cost, diets containing BRF-FWB at 10% (T3) achieved optimal economic performance. Birds fed the 10% inclusion level exhibited the best balance of feed intake, weight gain, cost per weight gain, revenue, and gross margin. Although the 15% inclusion level (T4) further reduced cost per kg of feed, it was associated with slightly lower weight gain and gross margin, suggesting a threshold beyond which economic and biological efficiencies may decline.

Overall, the fermentation of wheat bran with bovine rumen filtrate offers a viable strategy for enhancing the nutritional value of agro-industrial by-products while reducing dependence on costly conventional feed ingredients. This approach aligns with sustainable poultry production practices, especially in regions where feed cost remains a major constraint to profitability.

Recommendations

1. **Optimal Inclusion Level**: Based on the findings, it is recommended that BRF-FWB be included in noiler finisher diets at **10%** for the best economic and growth performance outcomes.
2. **Extension to Smallholder Farmers**: This feeding strategy should be promoted among smallholder poultry farmers as a cost-effective and sustainable means of improving productivity, especially in resource-constrained settings.
3. **Further Research**: Additional studies are recommended to:
   - Assess the long-term health effects and carcass quality of birds fed BRF-FWB.
   - Evaluate the use of BRF-FWB in starter and grower phases.
   - Investigate other agro-industrial by-products that may benefit similarly from rumen filtrate fermentation.
4. **Commercial Scale Testing**: Pilot-scale commercial trials are encouraged to validate the applicability of BRF-FWB diets in large-scale poultry operations, including an analysis of consumer acceptance of meat from birds fed these unconventional diets.

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