RESEARCH ARTICLE

Effects of Varying Levels of Shrimp Meal on Production Performance, Sensory Attributes, and Meat Quality of Broiler Chickens

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Abstract

The study was aimed to evaluate the impact of different levels of shrimp meal inclusion on the growth performance, sensory attributes, and meat quality of broiler chickens. Three groups of 56 chicks each were randomly selected from a total of 168 day-old mixed-sex broiler chicks and divided into 7 replicates of 8 chicks. The experimental groups included SM1 (2.5% shrimp meal), SM2 (5% shrimp meal), and a control group fed a diet without shrimp meal. Body weight gain, feed intake, and feed conversion ratio were measured on days 0, 7, 14, 21, 28, and 35. At the end of the trial, muscle pH, water holding capacity, colour, flavour, tenderness, cooking loss and biochemical parameters were assessed. The study found that final body weights and average daily gain in SM2 group were significantly higher compared to control group and overall FCR showed better in SM2 group compared to SM1 and control groups. There were no significant effects on blood-biochemical profile, sensory qualities, excepting flavour, muscle pH and WHC value but there was significant difference in cooking loss among the treatments. The study findings show that incorporating up to 5% shrimp meal into a broiler diet primarily composed of maize and soybeans is safe and does not adversely impact the birds' performance.

Key words: Broiler chickens, Growth performance, Meat quality, Sensory attributes, Shrimp meal.

Ind J Vet Sci and Biotech (2026): 10.48165/ijvsbt.2026.22.06.17

Introduction

The animal farming sector has seen significant growth, particularly in broiler chicken production to meet the rising demand for poultry meat (Khan *et al.,* 2018). Farmers must consider the time needed for broiler chickens to reach harvesting age and the nutritional ratios for optimal weight gain (Widjastuti *et al.,* 2020). Soybean meal is a common protein source in chicken feed (Saki *et al.,* 2011), but using animal waste as an alternative could benefit the industry and promote sustainability. Shrimp meal is a valuable protein source with high nutritional value, making it a suitable feed ingredient to improve growth and gut health in poultry (Brito *et al.,* 2020). By incorporating shrimp meal into feed formulations, farmers can reduce reliance on soybean meal, which is prone to price fluctuations. Developing an environmentally friendly livestock subsector by utilizing waste products can optimize natural resources and enhance feed efficiency in animal production (Cunha *et al.,* 2006). Shrimp meal is a sustainable nutrient source for chicken farming, especially in regions seeking local protein feed alternatives to soybean meal. Rahman and Koh (2014) has shown that shrimp heads have higher levels of ether extract and crude protein compared to shells, but lower levels of chitin, total ash, and crude fiber. Ducks fed with shrimp hydrolysate had higher weight gain, and lower feed intake was observed in experimental diets (Nha and Thuy, 2021). Feed conversion ratio remained consistent with increasing treated shrimp meal in the diet (Rahman and Koh, 2018). Meat quality characteristics like color, pH, water-holding capacity, and cooking losses did not differ significantly across treatments (Pieterse *et al.,* 2013). However, flavour

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How to cite this article: Mahata, P., Shee, A., Santra, B., Saha, D., Biswas, S., Biswas, P., & Roy, A. (2026). Effects of Varying Levels of Shrimp Meal on Production Performance, Sensory Attributes, and Meat Quality of Broiler Chickens. Ind J Vet Sci and Biotech, 22(6), 99-104.

Source of support: No specific funding was received for this study.

Conflict of interest: None

Submitted 17/06/2026 **Accepted** 02/08/2026 **Published** 10/11/2026

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and odor of the carcass were notably different from the control group (Shaviklo *et al.*, 2021). This study investigated the effects of replacing soybean meal with shrimp meal in broiler chicks' diets on meat quality and production efficiency.

Materials and Methods

Experimental Design and Diets

The experiment was carried out in accordance with the guidelines and with prior approval from the Institutional Animal Ethics Committee of West Bengal University of Animal & Fishery Sciences (No. 763/GO/Re-S/ReRc-L/03/CCSEA/77/2024-25 dated 12.02.2025). A total of 168 mixed-sex broiler chicks (Vencobb 400, Venkys, Pune, India) were used in a 35-day trial period and divided into three groups based on their diet: 1) basal diet without shrimp meal (CON), 2) basal diet with 2.5% shrimp meal (SM1), and 3) basal diet with 5% shrimp meal (SM2). The shrimp meal was locally sourced in West Bengal. Each group was divided into seven replicates (n=7) with eight chicks in each replicate, totalling 21 pens. The chicks were housed in 2.5-feet pens with litter and provided mash diet containing maize and soybeans to meet their nutritional requirements at different growth stages (starter @ 0-14 days, grower @ 15-28 days, and finisher @ 29-35 days). The experimental diets were delivered weekly in high-density polyethylene bags with inner liners, and the chicks had *ad libitum* access to water.

Determination of Performance Traits and Serum Biochemical Analyses

Birds' body weight was measured before feeding and watering, and then weekly throughout the experiment. Body weight, feed intake, and feed conversion ratio were recorded for each replicate. On day 35 of the experiment, two birds were randomly selected from each pen to collect blood samples from their wings veins without anticoagulants. The serum was extracted by centrifuging at 1650 g for 10 min and stored in dry, clean Eppendorf tubes at -20°C until analysis. The concentrations of serum metabolites were analysed using DiaSys Diagnostic Systems GmbH in Holzheim, Germany

Assessment of Meat Quality

At the end of the feeding trial, 42 birds were selected for sensory analysis. Breast meat was collected, skinned, vacuum-sealed, labelled, and stored at -20°C for a day before evaluation. The pH of fresh chicken was measured using a digital pH meter (Systronics pH System 362) following the method described by Troutt *et al.* (1992). Following the procedure outlined by Yang *et al.* (2006), cooking loss was determined by boiling the sample at 70°C and measuring its weight. As recommended by Grau and Hamm (1953), water holding capacity was determined using the filter paper press method with modifications.

Sensory Evaluation

The cooked chicken pieces were evaluated using a standard sensory assessment method (Keeton, 1983) on an 8-point descriptive scale with modifications. The scale ranged from very poor quality (1) to excellent quality (8). Raw chicken pieces, seasoned with 1% salt, were pressure cooked until reaching an internal temperature of 80°C±2°C. Time-temperature data was recorded prior to the trials. A panel of 12 faculties and PG students from the Department of LPT, WBUAFS assessed the sensory attributes of the chicken, including appearance, flavour, tenderness, juiciness, and overall acceptability. Panelists were briefed on the experiment without knowledge of the sample identities or treatments.

Statistical Analysis

The study utilized SPSS's one-way analysis of variance for data analysis. The pen was considered the experimental unit for FCR, feed intake, and body weight, while a single bird was the experimental unit for other parameters. Duncan's test was used to compare treatment means in case of a significant treatment effect, with significance set at $p<0.05$.

Results and Discussion

Body Weight, Feed Intake, Feed Conversion Ratio

The findings on body weight, feed intake, feed conversion ratio of broilers fed different diet are presented in Table 1. There were no significant differences in body weight variations during weeks 1, 2, and 3 ($p>0.05$). However, significant differences were observed between weeks 4 and 5. In the 4th week, the SM2 and SM1 groups showed a significant increase compared to the CON group. By the end of week 5, the SM2 group had significantly higher body weights than the CON group, while no significant difference was found with the SM1 group. The SM2-supplemented group exhibited a significant increase in body weight during the 4th and 5th weeks compared to other groups. The SM2 group exhibited a significantly higher average daily weight gain compared to the other groups over the 35-day experiment period. Previous studies by Okonkwo *et al.* (2012) showed that incorporating shrimp waste meal into broiler feed improved growth rate significantly ($p<0.01$). Lokman *et al.* (2019) found that broiler growth performance was more effectively enhanced by cricket chitin at a concentration of 0.5 g/kg compared to chitosan. However, Rahman and Koh (2016) reported poor growth performance in broilers fed diets with more than 5% shrimp meal. In contrast,

Table 1: Effect of shrimp meal on weekly body weight (g/bird), feed intake (g) and FCR (g intake/g gain) of broiler chickens

Attributes	Age (weeks)	Treatment CON	SM1	SM2	SEM (n=7)	P-Value
Body weight (g/bird)	0	46.54	45.95	45.79	0.357	0.687
	1	166.09	162.84	160.04	1.726	0.378
	2	437.04	445.18	460.36	4.528	0.098
	3	948.32	962.45	970.71	7.435	0.485
	4	1389.14^{b}	1462.48^{a}	1483.09^{a}	14.929	0.017
	5	1901.15^{b}	1970.36^{ab}	2020.57^{a}	17.625	0.012
	ADG (D 1-35)	**52.99^{b}**	**54.98^{ab}**	**56.42^{a}**	**0.503**	**0.011**
Feed intake (g)	1	123.59	122.93	119.27	1.139	0.260
	2	332.48	333.16	326.29	3.550	0.706
	3	573.31	572.50	560.46	5.632	0.604
	4	735.38^{b}	825.52^{a}	788.80^{a}	11.157	0.001
	5	946.73	949.76	948.73	8.321	0.990
	ADFI (D 1-35)	**77.47**	**80.11**	**78.39**	**0.489**	**0.074**
FCR (g intake/ g gain)	1	1.034	1.056	1.044	0.010	0.705
	2	1.230^{a}	1.180^{ab}	1.096^{b}	0.021	0.023
	3	1.126	1.107	1.104	0.017	0.872
	4	1.673	1.653	1.557	0.030	0.241
	5	1.884	1.881	1.806	0.056	0.821
	FCR (D 1-35)	**1.464^{a}**	**1.457^{a}**	**1.390^{b}**	**0.013**	**0.028**

CON- control diet, SM1- diet containing 2.5 % Shrimp meal, SM2- diet containing 5 % Shrimp meal; Means bearing different superscripts in the same row differ significantly ($p \leq 0.05$).

Khempaka *et al.* (2006) observed worst performance in broilers fed higher quantities of shrimp waste meal. The variation in results may be due to differences in the quality of shrimp waste, influenced by factors such as the shell or exoskeleton proportion, shrimp species, and processing and storage methods (Oduguwa *et al.*, 1998).

Significant differences ($p<0.05$) in weekly feed intake were observed in week 4 (Table 1). During week 4, SM1and SM2 had significantly higher weekly feed intake compared to CON. However, there were no significant variations ($p>0.05$) in weekly feed intake during weeks 1, 2, 3, and 5. Birds fed the SM2 diet had lower feed intake during the initial phase (up to 3 weeks) compared to the control group, possibly due to the 5% inclusion of shrimp meal being less appetizing to young birds. Findings of Okoye *et al.* (2005) showed higher feed consumption ($p<0.05$) in broilers fed shrimp waste meal and Ingweye *et al.* (2008) also found higher feed intake in broiler fed diets containing increased levels of shrimp waste. Khempaka *et al.* (2006) showed inconsistent results in broiler performance with shrimp meal inclusion.

There was no significant difference ($p>0.05$) in FCR between the treatments in weeks 1, 3, 4, and 5 (Table 1). However, in week 2, there was a significant improvement ($p<0.05$) in FCR in SM2 compared to CON, but no significant difference compared to SM1. The SM2 group exhibited significantly better FCR ($p<0.05$) than the SM1 and CON groups throughout the entire experiment (day 1-35) with broilers. Similarly, Aktar *et al.* (2011) observed an improved FCR when shrimp and marine waste meal were used to replace fish meal in broiler diets. Ingweye *et al.* (2008) noted better FCRs with shrimp waste in broiler rations, suggesting that higher shrimp waste content leads to improved FCR. However, Mahata *et al.* (2008) reported that birds on a high SWM diet had a lower FCR. Okoye *et al.* (2005) also found that birds on high SWM diets had higher feed-to-gain ratios during the starter phase, but similar ratios during the finisher phase.

Serum Biochemical Profile

Dietary interventions did not have a significant effect on the levels of serum glucose, total protein, albumin, uric acid, triglycerides, and cholesterol in groups CON, SM1, and SM2 ($p>0.05$). However, the total protein and albumin concentrations were higher in shrimp meal supplemented groups than in the CON group (Table 2). Similar results showed that broilers treated with chito-oligosaccharide (COS) had higher serum total protein (STP) levels compared to other treatment groups, which is consistent with the findings of Li *et al.* (2007). Adeyeye *et al.* (2023) found that serum cholesterol levels increased with higher levels of SWM substitution in turkey poults. Ajafar *et al.* (2024) reported a decrease in serum uric acid levels in birds receiving shrimp liquid extract, consistent with our study. Adeyeye *et al.* (2022) observed a significant decrease ($p<0.05$) in serum total protein levels with increasing SWM inclusion in diets.

Table 2: Effect of shrimp meal on blood biochemical profile of broiler chickens

Attribute	Treatment			SEM (n=7)	P-Value
	CON	SM1	SM2		
Glucose (mg/dL)	199.57	204.71	216.00	5.411	0.470
Total protein (mg/dL)	4.39	4.59	4.50	0.132	0.839
Albumin (mg/dL)	2.11	2.28	2.29	0.102	0.781
Uric acid (mg/dL)	2.51	2.24	2.20	0.120	0.537
Triglyceride (mg/dL)	40.57	39.71	44.14	2.436	0.753
Cholesterol (mg/dL)	142.14	135.43	164.29	6.824	0.201

CON- control diet, SM1- diet containing 2.5 % Shrimp meal, SM2- diet containing 5 % Shrimp meal

Table 3: Effect of shrimp meal on meat quality of broiler chickens

Attribute	Treatment			SEM (n=7)	P-Value
	CON	SM1	SM2		
Muscle pH	5.44	5.72	5.90	0.309	0.865
Cooking loss (%)	21.28[a]	19.32[b]	18.89[b]	0.432	0.021
Water holding capacity (%)	61.30	63.35	67.44	1.157	0.060

CON- control diet,SM1- diet containing 2.5 % Shrimp meal, SM2- diet containing 5 % Shrimp meal; Means bearing different superscripts in the same row differ significantly ($p \leq 0.05$).

However, the results of serum total protein during the grower phase did not align with this observation, possibly due to age and maturity, as suggested by Okoye *et al.* (2005).

Meat Quality

Birds fed the shrimp meal diet had the highest pH in the SM2 group and slightly lower pH in the SM1 group compared to the SM2 group, while the CON group had the lowest muscle pH. There were no significant differences in pH values among the treatments ($p>0.05$). The cooking loss of meat in the CON group was significantly higher ($p<0.05$) than that of SM2 and SM1 groups. The highest water holding capacity (WHC) was observed in the groups that received 5% and 2.5% SM-treated diets compared to the CON group though there was no significant difference observed among the treatment groups (Table 3). Similar results were observed in a study by Hardini and Djunaidi (2010), where the addition of hydrolyzed shrimp waste to broiler diets improved meat's WHC and reduced cooking loss without affecting muscle pH. Shaviklo *et al*. (2021) found the highest WHC in broilers fed a diet with 7.5% fish protein hydrolysate-based supplement (FPHS). In another study by Prematilaka *et al.* (2020), birds fed a diet with 2% FM and 3% fermented soybean meal (FSBM) showed a significant increase ($p<0.05$) in WHC compared to the CON group. However, Pieterse *et al*. (2013) did not observe any differences in muscle pH, WHC, or cooking losses when comparing meat quality parameters among groups fed diets with 10% FM, 10% house fly larvae, and a control group.

Sensory Evaluation

The results (Table 4) indicated a significant difference in flavour, with the highest value observed in the SM2 group compared to SM1 and CON groups. Tenderness did not show significant differences among the groups, scoring highest in 5% SM-treated diets and lowest in diets without SM treatment. Juiciness also did not differ significantly among the treatment groups. Overall acceptability value was significantly ($p<0.05$) higher in SM2 group as compared to CON group, while in SM1 group it was intermediate. Similar findings were observed by Shaviklo *et al.* (2021), who fed broilers with different levels of FPHS and showed significant differences in carcass flavour, odor, and meat color compared to the control group. Incorporating fish meal in poultry diets can lead to the development of strong off-flavours in stored meat due to oxidation. In contrast, Kjos *et al.* (2000) found reduced the sensory quality of poultry meat by adding fish oil and fish silage oil to feed. Al-Marzooqi *et al*. (2010) observed breast meat with a fishy taste in chickens fed with high levels of fish meal, while meat did not have a fishy or unpleasant odor when fish silage was included in the diet at lower levels.

Conclusion

Promoting environmental sustainability involves recycling animal waste. The current research showed that including 5% shrimp meal in the diet of broiler chickens can enhance their production outcomes, meat quality, and sensory

Table 4: Effect of shrimp meal on sensory evaluation of broiler chickens

Attribute	Treatment			SEM (n=7)	P-Value
	CON	SM1	SM2		
Appearance/ Colour	2.81	3.66	3.90	0.242	0.150
Flavour	2.54[b]	3.81[a]	4.06[a]	0.251	0.002
Tenderness	3.52	3.61	3.76	0.112	0.732
Juiciness	3.23	3.35	3.44	0.086	0.668
Overall acceptability	3.04[b]	3.45[ab]	3.90[a]	0.162	0.047

CON- control diet,SM1- diet containing 2.5 % Shrimp meal, SM2- diet containing 5 % Shrimp meal; Means bearing different superscripts in the same row differ significantly ($p \leq 0.05$).

evaluation without any adverse effects. This approach not only utilizes a waste product but also contributes to environmental conservation.

Acknowledgement

The authors are grateful to the Dean of the Faculty of Veterinary and Animal Sciences at West Bengal University of Animal and Fishery Sciences, Kolkata for providing essential facilities.

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