Journal of Animal Science and Veterinary Medicine
Volume 11(3), pages 169-174, June 2026
Article Number: BB75140C3
ISSN: 2536-7099
https://doi.org/10.31248/JASVM2026.651
https://integrityresjournals.org/journal/JASVM

Full Length Research

Evaluating the nutritional profile of swimming crab meal (*Callinectes amnicola*) as an alternative feed ingredient in poultry diet

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Received Date: 30 March 2026 | Accepted Date: 20 May 2026 | Published Date: 30 June 2026

ABSTRACT: The increasing demand for high-quality poultry products, coupled with rising costs and sustainability concerns associated with conventional feed ingredients, has necessitated the exploration of alternative feed resources. This study evaluated the nutritional profile of swimming crab meal as a potential alternative feed ingredient in poultry nutrition. Crabs were sourced, processed into a meal, and subjected to comprehensive laboratory analyses, including proximate composition, mineral content, amino acid profile, and fatty acid composition using standard analytical procedures. Results showed that swimming crab meal contained 28.88% crude protein, 30.35% carbohydrates, 19.45% crude fibre, 4.80% fat, 2.94% ash, and 13.59% moisture, indicating a balanced nutrient composition with good storage stability. Mineral analysis revealed a high concentration of magnesium (74.70%), along with appreciable levels of calcium (11.50%), zinc (1.09%), manganese (0.978%), copper (0.372%), and low phosphorus (0.30%). The amino acid profile demonstrated the presence of essential amino acids such as leucine (7.82%), arginine (7.14%), and lysine (4.48%), although methionine (2.38%) and tryptophan (0.97%) were relatively low. Fatty acid analysis indicated a predominance of unsaturated fatty acids (62.73%), particularly oleic acid (47.80%), with minimal omega-3 fatty acids (0.04%). The findings suggest that swimming crab meal is a nutritionally valuable and sustainable feed resource with the potential to partially replace conventional protein sources in poultry diets. However, its high fibre content, low phosphorus level, and limited essential amino acids necessitate careful dietary formulation and supplementation. Overall, swimming crab meal represents a promising alternative ingredient that supports both poultry productivity and environmental sustainability.

Keywords: Alternative feed ingredient, nutritional composition, poultry nutrition, sustainable feed resources.

INTRODUCTION

Poultry nutrition remains a critical determinant of flock health, growth performance, and overall productivity (Korver, 2023). As global demand for high-quality poultry products continues to rise, there is increasing pressure on the feed industry to identify ingredients that are not only nutritionally adequate but also cost-effective and environmentally sustainable. Conventional feed resources such as maize and soybean meal are increasingly constrained by price instability, competition with human consumption, and environmental concerns associated with their production (Korver, 2023; Shastak and Pelletier, 2023). These challenges have intensified the search for alternative feed ingredients capable of meeting the nutritional requirements of poultry while supporting sustainable production systems.

One promising alternative is swimming crab meal, a by-product derived from the processing of crabs, including shells, limbs, and other residual components. Traditionally regarded as waste, these materials are now gaining attention due to their rich nutritional composition. Swimming crab meal contains appreciable levels of protein, essential amino acids, minerals, lipids, and chitin, all of which are important for poultry growth and physiological functions (Ozogul *et al*., 2021; Esmaeili *et al*., 2024). Protein, in particular, plays a fundamental role in tissue development and metabolic processes, while chitin has been linked to enhanced immune responses and improved gut health in poultry (Aaqillah *et al*., 2021).

Beyond its nutritional value, the utilisation of swimming crab meal aligns with principles of environmental sustainability and resource efficiency. The seafood industry generates significant volumes of waste, much of which is underutilised or improperly disposed of, contributing to environmental degradation (Cooney *et al*., 2023). Converting these by-products into animal feed not only reduces waste but also supports a circular economy by transforming low-value materials into valuable feed resources. This approach can help lower the ecological footprint of poultry production while providing a viable alternative to conventional feed ingredients.

Despite its potential, the adoption of swimming crab meal in poultry diets requires careful evaluation. Factors such as variability in nutrient composition, digestibility, palatability, and the presence of possible antinutritional components may influence its effectiveness as a feed ingredient (Babatunde *et al*., 2021). Therefore, a comprehensive assessment of its nutritional profile is essential to determine its suitability and optimal inclusion levels in poultry diets.

In light of these considerations, this study focuses on evaluating the nutritional profile of swimming crab meal as an alternative feed ingredient. By analysing its proximate composition, mineral content, and overall nutritional quality, the research aims to establish its potential as a sustainable and efficient component in poultry feed formulation. The findings are expected to contribute to the growing body of knowledge on alternative feed resources and provide practical insights for improving poultry nutrition and sustainability.

MATERIALS AND METHODS

Crabs used for this study were obtained from Creek Road Market in Port Harcourt, Rivers State, Nigeria. The samples were thoroughly cleaned to remove adhering dirt and impurities, after which they were air-dried for 24 hours. The dried crabs were subsequently milled using a broiler starter mesh milling machine to produce swimming crab meal (SCM). The processed samples were then transported to the laboratory for comprehensive nutritional analysis.

Laboratory analyses focused on determining the proximate composition, amino acid and fatty acid profiles, and mineral content of the SCM. Proximate parameters assessed included dry matter, moisture content, ash, crude protein, crude fibre, ether extract (crude fat), and carbohydrate content. These analyses were conducted in accordance with standard procedures outlined by the Association of Official Analytical Chemists (AOAC, 1990). Mineral elements, including zinc, phosphorus, copper, magnesium, manganese, and calcium, were determined using an Atomic Absorption Spectrophotometer (GBC XplorAA) following acid digestion of ash samples, in line with APHA (1999) guidelines. Amino acid and fatty acid compositions were analysed using high-performance liquid chromatography (HPLC).

Moisture content was determined by oven-drying a known weight of the sample at 105°C for 4 hours until a constant weight was achieved, and calculated as percentage weight loss relative to the original sample weight. Ash content was obtained by incinerating a pre-weighed sample in a muffle furnace at 550°C for 3 hours and expressing the residue as a percentage of the initial sample weight. Crude fat was determined through solvent extraction using hexane, followed by evaporation of the solvent and measurement of the residual fat content. Crude protein content was estimated using the Kjeldahl method, involving digestion with concentrated sulphuric acid, distillation of liberated ammonia, and titration, with nitrogen content converted to protein using a factor of 6.25.

Crude fibre was determined through sequential acid and alkaline digestion, followed by drying, incineration, and calculation of the loss in weight after ashing. Carbohydrate content was estimated by difference, subtracting the sum of moisture, ash, crude fat, crude protein, and crude fibre percentages from 100. All analyses were carried out using standard laboratory procedures to ensure the accuracy and reliability of results.

The data generated from the proximate composition, mineral analysis, amino acid profile, and fatty acid composition of swimming crab meal were subjected to descriptive statistical analysis. All analyses were performed in triplicate, and results are presented as percentages. Statistical evaluation showed that variations among the nutritional components indicate consistency and reliability of the analytical procedures employed.

RESULTS

The proximate composition of the swimming crab meal (SCM) is presented in Table 1. The results showed that the moisture content of the sample was 13.59%, while the ash content was 2.94%. The crude fat (ether extract) content was 4.80%, and crude protein was recorded at 28.88%. The crude fibre content was relatively high at 19.45%, whereas carbohydrate content constituted the largest proportion at 30.35%. These findings indicate that SCM possesses a balanced nutrient profile with appreciable levels of protein, fibre, and carbohydrates.

The mineral composition of SCM is shown in Figure 1. Magnesium was the most abundant mineral, accounting for 74.7%, followed by calcium at 11.5%. Zinc and manganese were present at 1.09% and 0.978%, respectively, while copper and phosphorus were recorded

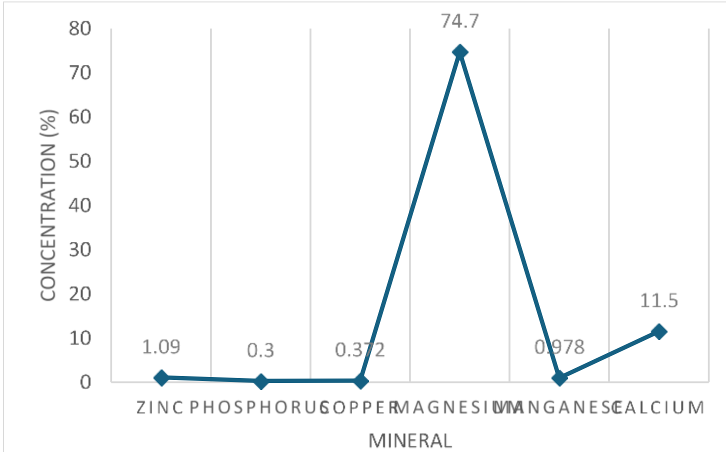

Figure 1. Mineral composition of swimming crab meal.

Table1. Proximate composition of swimming crab meal.

Component	Percentage (%)
Moisture	13.59
Ash	2.94
Fat	4.80
Protein	28.88
Crude Fibre	19.45
Carbohydrates	30.35

Table 2. Amino acid composition of swimming crab meal.

Amino Acid	Concentration (%)
Leucine	7.82
Lysine	4.48
Isoleucine	3.40
Phenylalanine	4.35
Tryptophan	0.97
Valine	4.33
Methionine	2.38
Proline	3.45
Arginine	7.14
Tyrosine	2.92
Histidine	3.13
Cystine	1.33
Alanine	3.83
Glutamic Acid	13.78
Glycine	4.06
Threonine	3.69
Serine	3.86
Aspartic Acid	9.67

Table 3. Fatty acid composition of swimming crab meal.

Fatty Acid	Concentration (%)
Palmitic	1.80
Palmitoleic	0.04
Stearic	32.39
Oleic	47.80
Linoleic	13.88
Linolenic	0.04
Arachidic	0.77
Eicosanoic	0.69
Eicosadienoic	0.28
Docosanoic	2.31
Total Saturated	37.27
Total Unsaturated	62.73
Omega-9	48.52
Omega-6	14.16
Omega-3	0.04

at 0.372% and 0.30%, respectively. These results demonstrate that SCM contains both macro- and micro-minerals, with magnesium contributing the highest proportion.

The amino acid composition of SCM is presented in Table 2. Glutamic acid had the highest concentration at 13.78%, followed by aspartic acid at 9.67%. Among the essential amino acids, leucine (7.82%) and arginine (7.14%) were the most prominent. Lysine, phenylalanine, and valine were moderately present at 4.48%, 4.35%, and 4.33%, respectively. Isoleucine and threonine were recorded at 3.40% and 3.69%, while methionine and cystine were present at 2.38% and 1.33%. Tryptophan had the lowest concentration at 0.97%. Non-essential amino acids such as alanine (3.83%), glycine (4.06%), serine (3.86%), and proline (3.45%) were also observed, along with tyrosine (2.92%) and histidine (3.13%). This profile indicates a fairly balanced distribution of amino acids.

The fatty acid composition of SCM is presented in Table 3. Total unsaturated fatty acids (62.73%) were higher than saturated fatty acids (37.27%). Oleic acid was the most abundant fatty acid at 47.80%, followed by stearic acid at

32.39%. Linoleic acid was present at 13.88%, while palmitic acid accounted for 1.80%. Minor fatty acids included docosanoic (2.31%), arachidic (0.77%), eicosanoic (0.69%), and eicosadienoic (0.28%) acids, while palmitoleic and linolenic acids were present in trace amounts (0.04% each). In terms of fatty acid classes, omega-9 fatty acids were dominant at 48.52%, followed by omega-6 at 14.16%, and omega-3 at 0.04%.

DISCUSSION

The proximate composition of swimming crab meal (SCM) obtained in this study provides deeper insight into its nutritional relevance and how it compares with existing literature. The moisture content (13.59%) falls within the acceptable range for dried feed ingredients and closely agrees with the findings of Olgunoglu and Olgunoglu (2017), who reported values below 15% for *Portunus pelagicus* and *Portunus segnis*. This consistency suggests that drying methods applied across studies yield comparable moisture levels, reinforcing the suitability of crab meal for storage and feed stability. In line with Saifullah *et al*. (2023), such low moisture content reduces the risk of microbial proliferation and nutrient degradation, confirming SCM as a shelf-stable ingredient.

The crude protein content (28.88%) observed in this study is moderately high and aligns with the general protein range (25–35%) reported for crab meals, particularly those derived from *Scylla serrata* (Sese *et al*., 2013; Essien, 2021). However, it exceeds the lower values (19.03–20.16%) reported by Olgunoglu and Olgunoglu (2017) for *P. segnis*, while slightly falling short of the 33.55% reported by Vijayalingam and Rajesh (2020). These variations may be attributed to differences in species, anatomical composition (whole crab versus shell-dominated samples), and processing techniques. The relatively higher protein content compared to some swimming crab species strengthens the argument for SCM as a viable alternative protein source, particularly in regions where conventional protein feeds are expensive or limited.

In contrast, the crude fibre content (19.45%) recorded in this study is substantially higher than values reported in most previous studies, including Adeyeye *et al*. (2010), where lower fibre levels were typical of crab-derived meals. This divergence likely reflects a higher inclusion of exoskeletal material in the present sample, as chitin contributes significantly to fibre content. While this finding partially disagrees with earlier reports of lower fibre fractions, it aligns with studies emphasising the functional role of chitin in improving gut health and acting as a prebiotic (Harris, 2018). Nonetheless, the elevated fibre level suggests a need for cautious dietary inclusion, especially for monogastric animals like poultry, where excessive fibre can impair nutrient digestibility.

The crude fat content (4.80%) observed in SCM is notably higher than the <1% reported by O lgunoglu and Olgunoglu (2017), indicating a clear deviation from those findings. However, it is consistent with values reported by Vijayalingam and Rajesh (2020) for whole-body crab meal, suggesting that lipid content is highly dependent on whether soft tissues are included during processing. This agreement supports the notion that SCM in the present study likely contained a higher proportion of muscle tissue, contributing to increased lipid levels. The moderate fat content is advantageous, as it enhances energy density and may improve feed palatability.

Carbohydrate content (30.35%) was relatively high, which is somewhat higher than typically reported for crustacean-based feed ingredients. While this may appear to diverge from the conventional understanding that animal-based feeds are low in carbohydrates, it is consistent with Adeyeye *et al*. (2010), who highlighted the contribution of glycogen and structural polysaccharides in crustaceans. This suggests that SCM can provide both protein and energy, enhancing its versatility as a feed ingredient.

The ash content (2.94%) is considerably lower than values reported for crab shell meals, which often exceed 20% (Cueto *et al.,* 2021). This represents a notable deviation and suggests that the SCM in this study contained less exoskeletal material. This aligns with the relatively high protein and moderate fat contents observed, further supporting the likelihood that soft tissues dominated the sample composition. While lower ash content may reduce total mineral concentration, it may also improve mineral bioavailability, as excessive ash can sometimes limit nutrient utilisation.

The mineral composition of SCM both aligns with and diverges from previous studies. The exceptionally high magnesium content (74.7%) supports earlier findings that crustaceans can accumulate significant levels of this mineral (Sese *et al*., 2013). This strong agreement highlights SCM as a valuable source of magnesium, which is essential for enzyme function, energy metabolism, and neuromuscular activity in poultry. Similarly, the presence of zinc, manganese, and copper aligns with Adeyeye *et al*. (2010), confirming that crab meals are reliable sources of trace minerals that support immune function and antioxidant defence.

However, the relatively low phosphorus (0.30%) and moderate calcium (11.5%) levels contrast with findings from Cueto *et al*. (2021), where shell-based crab meals exhibited significantly higher concentrations of these macro-minerals. This discrepancy is likely due to differences in sample composition, particularly the proportion of shell material included. While this study's findings suggest that SCM is not a primary source of calcium and phosphorus, they align with the understanding that tissue-dominated crab meals tend to have lower macro-mineral content. This reinforces the need for mineral supplementation when SCM is incorporated into poultry diets.

The amino acid profile of SCM shows strong agreement with established crustacean protein patterns. The dominance of glutamic acid (13.78%) and aspartic acid (9.67%) closely matches the findings of Vijayalingam and Rajesh (2020), confirming their abundance in crab-derived proteins. The relatively high levels of leucine and arginine also align with previous studies, supporting their role in promoting growth, immune function, and metabolic activity. The lysine content (4.48%) is particularly significant, as it compares favourably with values reported in similar studies and addresses a common limitation in cereal-based diets.

Conversely, the lower levels of methionine, cystine, and tryptophan are consistent with reports by Sese *et al*. (2013) and Essien (2021), indicating a recurring limitation in crustacean meals. This agreement suggests that while SCM provides a broad spectrum of amino acids, supplementation with sulfur-containing amino acids remains necessary for optimal diet formulation. Thus, the amino acid profile both supports and qualifies the use of SCM as a complementary rather than a standalone protein source.

The fatty acid composition of SCM also reflects both similarities and differences with existing literature. The predominance of unsaturated fatty acids (62.73%) aligns with findings by Liu *et al*. (2021), confirming the nutritional advantage of such lipid profiles in poultry diets. The high oleic acid content (47.80%) further supports this alignment, as oleic acid is commonly reported as a major fatty acid in animal-derived feeds. The presence of linoleic acid (13.88%) also agrees with its recognised importance as an essential fatty acid in poultry nutrition.

However, the very low omega-3 fatty acid content (0.04%) contrasts with some marine-based studies, including Olgunoglu and Olgunoglu (2017), which reported higher levels of polyunsaturated fatty acids. This discrepancy may be attributed to environmental differences, dietary sources of the crabs, or processing methods. While this finding suggests a limitation in terms of omega-3 enrichment potential, it does not diminish the overall value of SCM as an energy and protein source.

In summary, the findings of this study largely align with existing literature regarding the nutritional potential of crab meal, particularly in terms of protein quality, amino acid composition, and the presence of essential trace minerals. However, notable differences in fibre, fat, mineral, and fatty acid contents highlight the influence of species variation, environmental conditions, and processing techniques. These comparisons underscore the importance of context-specific evaluation when considering SCM for feed formulation. Overall, SCM demonstrates strong potential as a sustainable and nutritionally valuable alternative feed ingredient, provided that its limitations are addressed through balanced diet formulation and supplementation strategies.

Conclusion

This study evaluated the nutritional profile of the swimming crab meal (SCM) with the aim of determining its suitability as an alternative feed ingredient. The findings revealed that SCM possesses a well-balanced nutrient composition characterised by moderate crude protein (28.88%), appreciable carbohydrate content (30.35%), and a moderate lipid fraction (4.80%). The relatively low moisture content (13.59%) indicates good storage stability, while the crude fibre content (19.45%), largely attributed to chitin, highlights both functional benefits and potential limitations in digestibility.

The mineral analysis demonstrated that SCM is particularly rich in magnesium and contains essential trace elements such as zinc, manganese, and copper, which are important for metabolic, immune, and antioxidant functions in poultry. However, the relatively low phosphorus and moderate calcium levels suggest that SCM alone may not adequately meet macro-mineral requirements. The amino acid profile further supports the nutritional value of SCM, with appreciable levels of key essential amino acids such as leucine, arginine, and lysine, although methionine and tryptophan were comparatively low. Additionally, the fatty acid composition showed a predominance of unsaturated fatty acids, particularly oleic acid, which is beneficial for energy utilisation, although omega-3 fatty acids were minimal. Overall, the results indicate that swimming crab meal is a nutritionally valuable and sustainable feed resource with strong potential as a partial substitute for conventional feed ingredients such as soybean meal and fish meal. However, its effective utilisation requires careful consideration of its limitations, particularly in terms of fibre content, amino acid balance, and mineral composition.

Recommendations

Based on the findings of this study, it is recommended that:

1. Farmers using swimming crab meal should supplement diets with methionine, phosphorus, and enzyme additives such as chitinase or fibre-degrading enzymes to improve nutrient digestibility and optimise bird performance.
2. Feed processing industries should adopt standardised drying and milling procedures for swimming crab waste to ensure consistent nutrient quality, longer shelf life, and reduced microbial contamination during storage.
3. Government agencies and agricultural extension services should encourage the recycling of seafood waste into livestock feed through awareness campaigns and technical training programs for feed producers and poultry farmers.
4. Future feeding trials should evaluate the growth performance, carcass quality, egg production, immune response, and economic profitability of poultry fed different inclusion levels of swimming crab meal under commercial farming conditions.
5. Small-scale seafood processors in coastal communi-

ties should be encouraged to convert crab-processing waste into feed ingredients as a means of reducing environmental pollution while creating additional income opportunities and supporting circular bioeconomy practices.

CONFLICT OF INTEREST

The authors declare that they have no conflict of Interest.

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