INDONESIAN HEALTH ISSUE

E-ISSN: 2828-2809

Formulation of Telur Gabus *Snack* Substituting Tuna (*Euthynnus affinis*) Protein Concentrate: Sensory, Proximate, and Amino Acid Characteristic

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No HP: 085258348542

ARTICLE INFO

Article History:

Received:
13 Januari 2026

Accepted:
28 Februari 2026

Published:
29 Februari 2026

Kata Kunci:
asam amino;
snack telur gabus;
ikan tuna;
protein;
konsentrat;

Keywords:
amino acids;
telur gabus snack;
tuna fish;
protein;
concentrate;

ABSTRAK

Latar Belakang: Ikan tuna merupakan ikan yang diketahui mengandung protein dan banyak dikonsumsi oleh masyarakat. *Snack telur gabus* menjadi makanan ringan yang sering dikonsumsi masyarakat berbagai kalangan**. Tujuan**: Tujuan penelitian ini adalah mengetahui daya terima, kandungan zat gizi, dan profil asam amino formulasi *telur gabus* dengan substitusi konsentrat protein ikan tuna. Penelitian ini menggunakan jenis eksperimental. **Metode**: Subjek yang digunakan pada pengujian organoleptik sebanyak 25 panelis semi terlatih.Tahapan penelitian ini meliputi pembuatan konsentrat protein ikan tuna, dan pembuatan *snack telur gabus*. Analisis yang dilakukan meliputi analisis organoleptik, kandungan zat gizi, dan profil asam amino. Data dianalisis secara deskriptif. **Hasil**: F4 sebagai formula terbaik melalui penilaian versi De Garmo berdasarkan uji organoleptik dan kandungan protein. F4 diketahui memiliki energi total sebesar 496,86 kkal, kadar abu sebesar 2,35%, kadar air sebesar 2,51%, karbohidrat sebesar 50,97%, dan kadar lemak total sebesar 23,26%. Selain itu, jenis asam amino yang paling banyak ditemukan pada F4 ialah L-asam glutamat. **Kesimpulan**: F4 merupakan formulasi *snack telur gabus* terbaik dan jenis asam amino L-asam glutamat banyak ditemukan pada F4.

ABSTRACT

Background*: Tuna is a fish known for its high protein content and is widely consumed by the community. "Telur gabus snacks" are popular among people from diverse backgrounds.* ***Purpose****: This study was to determine the acceptability, nutritional content, and amino acid profile of "telur gabus snack" formulations with tuna protein concentrate substitution.* ***Methods****: This study used an experimental design. The subjects used in the sensory testing were 25 semi-trained panelists. The stages of this study included the production of tuna protein concentrate and the production of telur gabus snack. The analyses conducted included sensory analysis, nutritional content analysis, and amino acid profile analysis. The data were* *analyzed descriptively.* ***Results****: F4 was the best formula based on the De Garmo assessment of sensory testing and protein content. F4 was found to have a total energy of 496.86 kcal, ash content of 2.35%, moisture content of 2.51%, carbohydrates of 50.97%, and total fat content of 23.26%. In addition, the most abundant amino acid found in F4 was L-glutamic acid.* ***Conclusion****: F4 is the best telur gabus snack formulation, and L-glutamic acid is the most abundant amino acid found in F4.*

BACKGROUND

Inadequate intake of animal protein remains one of the major nutritional challenges in Indonesia and is closely associated with chronic malnutrition problems such as stunting. Stunting is defined as growth failure in children under five years of age caused by prolonged insufficient nutrient intake, which adversely affects cognitive development and long-term human capital quality (Haryani et al., 2023). Recent national dietary surveys indicate that Indonesian dietary patterns are still heavily dominated by carbohydrate-based foods, particularly rice, which contributes more than 40% of total energy intake. In contrast, the contribution of animal protein sources—especially fish, meat, milk, and eggs—remains relatively low in overall protein consumption patterns (Sabarella et al., 2024). This imbalance highlights the need for food-based strategies to increase animal protein intake through affordable and culturally acceptable products.

Protein plays a critical role in providing energy, forming body tissues, enzymes, hormones, and supporting immune function. However, protein quality varies depending on its amino acid composition and digestibility. High-quality proteins are characterized by the presence of complete essential amino acids that cannot be synthesized by the human body and must be obtained from dietary sources (Ajomiwe et al., 2024). Animal-based foods, particularly fish, are recognized as superior sources of essential amino acids compared to plant-based proteins (Connolly et al., 2023). Fish protein is also known for its high biological value and digestibility, attributed to its shorter muscle fibers and lower connective tissue content, making it more efficiently utilized by the body (Damongilala, 2021).

Fish protein concentrate (FPC) is a stable, high-protein ingredient produced through processing methods such as defatting and deodorization, resulting in protein contents exceeding 80%. This form enhances shelf life, reduces undesirable fishy odors, and improves its applicability as a fortificant in various food products (Kumoro et al., 2022; Asfar et al., 2025). Among marine resources, tuna is recognized for its high crude protein content and favorable amino acid profile, making tuna-derived FPC a promising ingredient for protein enrichment strategies (Asfar et al., 2025).

Telur gabus is a popular traditional Indonesian *snack* made primarily from starch and eggs, valued for its crunchy texture and broad consumer acceptance. However, its nutritional profile is generally characterized by high carbohydrate and fat content with relatively low protein levels, limiting its potential as a functional or protein-enriched food (Mustofa, 2013; Jamaluddin et al., 2023; Yulia et al., 2024). Improving the nutritional quality of *telur gabus* without compromising sensory attributes remains a significant challenge, as excessive protein substitution may negatively affect texture, flavor, and overall acceptability.

Previous studies on the application of fish protein concentrate (FPC) have predominantly focused on its physicochemical properties or its incorporation into powdered foods and composite products (Kumoro et al., 2022). The utilization of tuna-derived FPC in traditional starch-based *snack* products, such as *telur gabus*, has received limited attention in the literature (Warkey et al., 2023). Furthermore, most fortification studies primarily emphasize increasing total protein content, while comprehensive evaluations that simultaneously consider amino acid composition and consumer hedonic acceptance remain scarce in the current literature (Simeunović et al., 2025; Salampessy et al., 2023). This indicates a clear research gap in identifying formulations that achieve a balance between improved nutritional quality and sensory acceptability.

Therefore, this study aims to develop a protein-enriched *telur gabus* fortified with tuna fish protein concentrate and to determine the optimal formulation based on proximate composition, amino acid profile, and hedonic sensory evaluation. The novelty of this research lies in the application of tuna-derived FPC in a traditional *snack* product such as *telur gabus* and in the selection of the best formulation based on a balanced consideration of nutritional quality and consumer preference, rather than relying solely on total protein content.

RESEARCH METHOD

This study employed a single-factor experimental design without replication to develop and evaluate food product formulations. The investigated factor was formulation composition, consisting of different proportions of the main ingredients. Each formulation was prepared once and treated as an independent experimental unit.

The research was conducted at the Food Technology Laboratory and the Nutritional Biochemistry Laboratory of Politeknik Negeri Jember. Sensory testing was performed at the Culinary and Organoleptic Laboratory, while protein content analysis of tuna protein concentrate was carried out at the Bioscience Laboratory of Politeknik Negeri Jember. Chemical quality and amino acid analyses were conducted at SIG Surabaya.

Seven formulations were developed in this study, namely F0, F1, F2, F3, F4, F5, and F6. Sensory evaluation was conducted using 25 untrained panelists recruited from the academic community of Politeknik Negeri Jember. Panelists assessed the samples based on their personal preferences. The sensory evaluation comprised hedonic and hedonic quality tests. Panelists were selected using purposive sampling based on predefined inclusion criteria, which included prior participation in sensory testing, absence of allergies to allergenic substances, and good health status.

The data collected in this study included analyses of tuna protein concentrate, specifically ethanol residue and protein content. Evaluation of *telur gabus* snack formulations substituted with tuna fish protein concentrate included sensory testing (hedonic and hedonic quality) and total protein analysis. The best formulation was determined using the De Garmo method, which is an approach for selecting the optimal treatment or formulation based on predetermined criteria and assigned weights. In this study, the evaluation criteria included protein content and sensory attributes, namely aroma, taste, color, and texture. The weighting priorities from highest to lowest were protein content, taste, texture, color, and aroma.

The selected best *telur gabus* snack formulation was further analyzed for proximate composition (total energy, ash, moisture, carbohydrates, and total fat) and amino acid profile. All data were analyzed descriptively. Sensory data were evaluated using a Likert scale, while protein content, proximate composition, and amino acid profiles were presented using descriptive analysis.

RESULT AND DISSCUSSION

Analysis of Ethanol Residue and Total Protein Content in Tuna Fish Protein Concentrate

Ethanol residue analysis was conducted to ensure that the tuna fish protein concentrate (FPC) contained no residual ethanol solvent from the extraction process.

In addition, the total protein content of the concentrate was determined. The results of ethanol residue and total protein analyses are presented in Table 1.

Table 1. Residual Ethanol and Total Protein in Tuna Fish Concentrate

Parameter	Result
Ethanol Solvent Residue (mg/kg)	Not Detected
Total Protein (%)	82,513

The results indicate that ethanol residues were not detected in the tuna protein concentrate (Table 1). This finding suggests that the processing method successfully removed the ethanol solvent, resulting in a residue-free product that is safe for use as a substitution ingredient in *telur gabus* snack formulations.

Laboratory analysis showed that the tuna FPC had a total protein content of 82.513% (Table 1). This value is substantially higher than the protein content of fresh tuna, which has been reported to range from approximately 18.5% to 21.7% on a wet weight basis (Lujuo et al., 2025). Fish protein concentrate (FPC) is produced from whole fish, fish parts, or other aquatic organisms through the removal of most fat and moisture, thereby increasing the protein concentration relative to the raw material. The protein content of one part of FPC is equivalent to that of approximately five parts of fresh fish. According to Kumoro et al., (2022), high-quality FPC is characterized by a minimum protein content of 67.5%.

Sensory Analysis and Protein Content of *Telur gabus Snack* Formulations with Tuna FPC

Sensory attributes and protein content were used to determine the optimum formulation of the *telur gabus* snack. Sensory evaluation was conducted using a hedonic test (Table 2).

Table 2. Hedonic Test Results of *Telur gabus Snack* Formulations

Formulation	Hedonic score			
	Aroma	Color	Taste	Texture
F0	94	102	102	108
F1	69	71	76	79
F2	85	76	100	98
F3	78	71	77	75
F4	90	71	98	94
F5	82	67	93	93
F6	84	62	97	93

Hedonic score: 0-24,99 (really dislike)
25-49,99 (dislike)
50-74,99 (neutral)
75-99,99 (like)
100-125 (really like)

The hedonic test results indicate that taste and texture were generally well accepted across all formulations, with F0, F2, and F4 showing the highest preference scores. Aroma was also accepted in most formulations, except for F1. Color received the lowest preference scores, with the exception of the control formulation (F0). These findings suggest that the incorporation of tuna FPC negatively affected color preference compared to the control. Nevertheless, substitution with tuna FPC resulted in acceptance levels comparable to the standard quality of *telur gabus*, particularly at substitution levels of 30% (F2) and 40% (F4). However, color remained a limiting factor in overall acceptance, indicating the need for further improvements to enhance the visual appeal of the product.

Similar trends have been reported in previous studies, where the substitution of fish-based ingredients in snack products led to reduced sensory acceptance compared to control formulations. Mardiyah et al., (2022) and Breemer et al., (2023) reported decreased consumer preference in snack bars and tortilla chips fortified with fish flour. Setyarini et al., (2024) observed that catfish FPC substitution levels above 10% resulted in decreased biscuit preference, while Warkey et al., (2023) reported that tuna FPC substitution negatively affected consumer acceptance only at levels exceeding 20%.

Overall, the incorporation of FPC requires further formulation optimization to improve sensory quality, particularly with respect to taste, aroma, and color. These results are consistent with Breemer et al., (2023), who reported that fish flour substitution above 10% reduces sensory quality due to decreased crispiness and increased fishy aroma. The characteristic fishy odor and flavor of FPC are primarily associated with volatile compounds such as trimethylamine and oxidative aldehydes formed during thermal processing (Wu et al., 2022). In addition, reduced crispiness may be attributed to the functional properties of proteins with high water absorption capacity, which can adversely affect the texture of dry snack products (Ramadhani et al., 2022). Furthermore, Amalia et al., (2023) reported that the addition of scads (*Decapterus* spp.) flour at levels above 5% significantly darkened the final product and intensified fishy flavor due to the darker color of the raw fish flour. During processing, food products may also experience color changes or pigment formation as a result of ingredient type and substitution level (Setyarini et al., 2024).

Protein Content of *Telur gabus Snack* Formulations Substituted with Tuna FPC

Table 3 shows that the addition of tuna fish protein concentrate (FPC) significantly increased the protein content of *telur gabus* snacks. The control formulation (F0), which contained no FPC, exhibited the lowest protein content, reflecting the basic nutritional characteristics of the product without animal protein fortification.

In this study, the optimal formulation determined using the De Garmo method was F4, which contained 80 g of tuna FPC. The selection of the best formulation was based on a combined consideration of nutritional value and consumer sensory acceptance. Although formulations F5 and F6 exhibited higher total protein contents, sensory evaluation results indicated that F4 achieved superior hedonic scores, reflecting higher overall acceptability among panelists. Sensory attributes such as flavor, texture, and overall liking are critical determinants of consumer preference and product success and cannot be adequately assessed through protein content alone. Therefore, formulation F4 was identified as the best formulation due to its balanced combination of adequate protein content and favorable sensory acceptance (Mosikyan et al., 2024). Consequently, formulation F4 was subjected to proximate composition analysis (Table 4) and amino acid profile determination (Table 5).

Table 3. Protein Content of *Telur gabus Snack* Formulations Substituted with Tuna FPC

Formula	Protein Content ± SD (%)
F0	1,33 ± 0,02
F1	12,95 ± 0,04
F2	14,64 ± 0,17

F3	17,09 ± 0,42
F4	18,49 ± 0,02
F5	21,06 ± 0,07
F6	24,84 ± 0,35

As shown in Table 3, the progressive increase in protein content from F1 to F6 demonstrates that tuna FPC is an effective protein source for improving the nutritional value of *telur gabus* snacks. Increasing levels of FPC resulted in a consistent rise in protein content, attributable to the high protein concentration and high-quality amino acid profile of tuna. This finding is supported by Rieuwpassa & Karimela (2024), who reported that FPC can contain protein levels exceeding 80%, making it a highly effective fortification ingredient. Setyarini et al., (2024) also reported that FPC substitution in biscuits significantly increased protein content without compromising product stability. Similarly, Asriani et al., (2021) observed a comparable trend in cracker formulations, where higher FPC concentrations led to greater increases in protein content.

Proximate Analysis and Amino Acid Identification of the Best Formulation (F4)

Formulation F4 yielded a total energy of 496.86 kcal/100 g, ash content of 2.35%, moisture content of 2.51%, carbohydrate content of 50.97%, and total fat content of 23.26%. The ash content of the tuna FPC–substituted snack was lower than that reported for *telur gabus* snacks produced using tapioca flour, white glutinous rice flour, and cornstarch.

Table 4. Proximate Analysis of the Best Formulation (F4) of *Telur gabus Snack*

Parameter	Result
Total Energy (kkal/100g)	496,86 ± 3,73
Ash Content (%)	2,35 ± 0,02
Moisture Conrent (%)	2,51 ± 0,07
Carbohydrates (%)	50,97 ± 0,61
Total Fat Content (%)	23,26 ± 0,67

The ash content of formulation F4 was lower than that reported by Ramadhani & Murtini (2017), who observed ash contents of 4.90%, 5.16%, and 5.80% in *telur gabus* products prepared with various flour types. Ash content is commonly included in proximate analysis to estimate total mineral content, evaluate nutritional quality, and indicate processing conditions and ingredient composition (Aloka et al., 2025).

The moisture content of the tuna FPC–substituted snack was also lower than that reported for flour-based formulations, which ranged from 4% to 11% in the study by (F. Ramadhani & Murtini, 2017). According to Fikriyah and Nasution (2021), lower moisture content is associated with extended shelf life due to reduced microbial activity. Additionally, Zhang et al., (2020) reported that the frying process promotes dehydration as a result of water evaporation from the food matrix, contributing to the low moisture content observed in fried snack products.

Amino Acid Profile Identification of the Best Formulation (F4)

Based on the amino acid profiling presented in Table 5, formulation F4 exhibited the highest concentration of L-glutamic acid among all detected amino acids, reaching 36,915.86 mg/kg. This high level is a characteristic feature of fish protein concentrates, in which glutamic acid typically represents the most abundant non-essential amino acid. The predominance of L-glutamic acid in this formulation not only contributes to the nutritional density of the *telur gabus* snack but also indicates the presence of high-quality protein derived from tuna. These findings are consistent with previous studies on fish-based protein concentrates, which have consistently identified glutamic acid as a major component of the total amino acid profile.

Table 5. Amino Acid Profile Identification of the Best Formulation (F4)

Amino Acid	Result (mg/kg)	Amino Acid	Result (mg/kg)
L-Alanine	13383,19	L-Lysine	20998,13
L-Arginine	22965,65	L-Methionine	5227,11
L-Aspartic Acid	22520,41	L-Tryptophan	2379,72
Glycine	20794,06	L-Valine	16992,45
L-Glutamic Acid	36915,86	L-Phenylalanine	10637,06
L-Histidine	5548,81	L-Proline	9977,97
L-Isoleucine	12471,21	L-Serine	13346,90
L-Cystine	7095,85	L-Threonine	11891,87
L-Leucine	20802,35	L-Tyrosine	11776,39

The dominance of L-glutamic acid in formulation F4 is consistent with the findings of Setyarini et al., (2024), who reported high concentrations of non-essential amino acids, particularly glutamic acid, in catfish fish protein concentrate. Non-essential amino acids play an important role in maintaining normal cellular function and can be synthesized endogenously from other amino acids. During digestion, amino acids released from dietary proteins serve as essential substrates for protein synthesis and support various metabolic processes, including growth, tissue repair, and maintenance of structural proteins (Loveday, 2023).

Furthermore, the amino acid composition of protein-based food products can be influenced by processing conditions. Zhang et al., (2023) reported that the duration and intensity of heat treatment may alter protein structure and amino acid composition through protein unfolding and modification of amino acid side chains, which may affect both nutritional quality and functional properties.

CONCLUSION AND RECOMMENDATION

Tuna protein concentrate contained 82.513% protein and showed no detectable ethanol solvent residues. Formulation F4 was identified as the optimum *telur gabus* snack formulation. The dominant amino acid in formulation F4 was L-glutamic acid. Proximate analysis indicated that formulation F4 had a total energy content of 496.86 kcal/100 g, ash content of 2.35%, moisture content of 2.51%, carbohydrate content of 50.97%, and total fat content of 23.26%. Further research is recommended to evaluate the antioxidant capacity and bioactive compounds present in the product.

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