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THE EFFECT OF CARROT ADDITION ON THE CHARACTERISTICS AND QUALITY OF STARRY TRIGGERFISH (*ABALISTES STELLARIS*) NUGGETS

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ABSTRACT

Starry triggerfish (Abalistes stellaris) is a fishery resource with a relatively high protein content and considerable potential for development into processed products such as fish nuggets. Processing fish into nuggets aims to increase added value, extend shelf life, and improve consumer acceptance. The addition of carrots in fish nugget production may provide a golden color and a softer texture to the product. This study aimed to determine the effect of carrot addition on the chemical characteristics and panelist acceptance of starry triggerfish nuggets and to identify the best formulation. This study employed an experimental method using a completely randomized design (CRD) consisting of four carrot-addition treatments, namely K (0%), A (10%), B (20%), and C (30%). The observed parameters included proximate analysis, consisting of moisture, protein, fat, ash, and carbohydrate contents, as well as hedonic evaluation of appearance, odor, taste, and texture. The results showed that carrot addition affected the chemical characteristics of starry triggerfish nuggets. Increasing carrot concentration tended to increase moisture and carbohydrate contents, while decreasing protein and fat contents. The hedonic test results indicated that treatment B, with 20% carrot addition, was the most preferred treatment by the panelists based on appearance, odor, taste, and texture. Therefore, it can be concluded that carrot addition influences the characteristics and acceptance level of starry triggerfish (Abalistes stellaris) nuggets, with the best formulation obtained at 20% carrot addition.

KEYWORDS: Proximate Analysis; Starry Triggerfish; Fish Nuggets; Hedonic Test; Carrot.

1. INTRODUCTION

Indonesia is a maritime country with abundant fishery resources. One fish species commonly found in Indonesian waters is starry triggerfish (Abalistes stellaris). Production of starry triggerfish in several Indonesian fishing areas is relatively high, indicating substantial potential for development into value-added processed products. This is supported by studies stating that starry triggerfish remains classified as a Least Concern (LC) species [9]. Therefore, its utilization may still be increased through innovation in the processing of starry triggerfish (Abalistes stellaris) so that it can compete in the processed-food industry.

Starry triggerfish has a relatively high protein content and low fat content, making it a potential raw material for nutritious food products. The macronutrient composition of starry triggerfish meat includes 16.44% protein and 2.08% fat. Its ash content is 1.52%, with a moisture content of 78.98% [12]. However, the utilization of starry triggerfish is still limited to traditional products such as smoked fish and grilled fish. One diversified product that is widely accepted by the public is fish nuggets because they are practical, easy to serve, and have a taste preferred by various age groups.

Improving the nutritional quality of fish nuggets can be achieved through the addition of plant-based food ingredients. Vegetables are often associated with a less favorable image among many people, particularly children and adolescents, partly because of their relatively bland taste and slight grassy odor. Carrots are vegetables rich in dietary fiber. Carrots contain beta-carotene, which is beneficial as a source of vitamin A, retinol, and zinc required by the body [21]. Therefore, research on the addition of carrots to starry triggerfish nuggets is necessary to determine its effect on quality characteristics and consumer acceptance. This study aimed to determine the effect of carrot addition on the characteristics and quality of starry triggerfish (Abalistes stellaris) nuggets and to identify the best formulation based on proximate analysis and hedonic testing.

2. MATERIALS AND METHODS

2.1 Materials and Equipment

The main material used in this study was fresh starry triggerfish obtained from Superindo. Additional ingredients included tapioca flour, salt, flavor enhancer, white pepper, eggs, bread crumbs, and fresh carrots. The materials used for analysis were fish nugget samples with four levels of carrot addition, namely K (0%), A (10%), B (20%), and C (30%), which were used for protein, moisture, ash, carbohydrate, fat, hedonic, and FTIR analyses.

2.2 Fish Nugget Production Process

The formulation of fish nuggets was based on Syadiah et al. (2022), with modifications. Starry triggerfish was cleaned and steamed for 15 minutes at 70°C [19]. The fish meat was then mixed with the additional ingredients according to the treatment formulations, namely K (0%), A (10%), B (20%), and C (30%), and homogenized using a blender (Table 1). The dough was molded in a tray and steamed for 30 minutes. After cooling, the dough was cut, dipped in egg white, coated with bread crumbs, and prepared for analysis.

Table 1. Formulation of Starry Triggerfish Nuggets.

Ingredient (%)	K	A	B	C
Tapioca flour	30	30	30	30
Starry triggerfish	100	100	100	100
Salt	2	2	2	2
Flavor enhancer	1	1	1	1
White pepper	2	2	2	2
Egg	180	180	180	180
Carrot	0	10	20	30

Note: K = nugget without carrot addition; A = nugget with 10% carrot addition; B = nugget with 20% carrot addition; C = nugget with 30% carrot addition.

2.3 Protein Content

Protein content was determined based on SNI 01-2354.4-2006 (BSN, 2006). A 2 g sample was placed in a digestion flask, followed by the addition of two catalyst tablets, 15 mL H_2SO_4, and 3 mL H_2O_2. The sample was digested for 2 hours at 410°C, allowed to cool to room temperature, and then diluted with 50 mL distilled water. An Erlenmeyer flask containing 25 mL of 4% H_3BO_3 solution was prepared, and distillation was carried out until the distillate turned yellow. The distillate was then titrated with 0.2 N HCl until the color changed from green to neutral gray.

Protein content (%) = ((VA − VB) × N × 14.007 × 6.25) / W × 100%

Where:

VA = mL HCl used for sample titration

VB = mL HCl used for blank titration

N = normality of the HCl standard used

14.007 = atomic weight of nitrogen

6.25 = protein conversion factor for fish

W = sample weight

2.4 Moisture Content

Moisture content was determined based on AOAC (2007). A 5 g sample was weighed and placed in a dish, then dried in an oven for 12 hours at 105°C. The dish was cooled in a desiccator for 30 minutes and then weighed. Moisture content was calculated using the following formula:

Moisture content (% wet basis) = (B1 − B2) / B × 100%

Where:

B = sample weight

B1 = weight of sample and dish before drying

B2 = weight of sample and dish after drying

2.5 Ash Content

Ash content was determined based on AOAC (2007). Ash analysis was performed by incinerating the sample in a furnace. First, a porcelain ash dish was dried in an oven for 1 hour at 105°C, cooled for 15 minutes in a desiccator, and weighed. A 5 g homogenized sample was placed in the porcelain ash dish. The dish was then placed in a furnace at 600°C for 6 hours until the ash turned white and reached constant weight. The porcelain ash dish was subsequently cooled in a desiccator and weighed.

Ash content (%) = (C − A) / (B − A) × 100%

Where:

A = weight of empty porcelain dish (g)

B = weight of porcelain dish with sample before ashing (g)

C = weight of porcelain dish with sample after ashing (g)

2.6 Fat Content

Fat content was determined based on AOAC (2007) using the Soxhlet method. This analysis was performed by extracting the sample with an organic solvent. The extraction aimed to remove fat from the sample by heating at the boiling point of the solvent. The test began by weighing an empty round-bottom flask (A). A 2 g homogenized sample (B) was wrapped in filter paper and placed in a Soxhlet extractor positioned above the condenser, with the fat flask below it. Hexane solvent was first refluxed until the solvent flowed into the fat flask. The sample was extracted at 60°C for 8 hours. The solvent in the fat flask was then distilled and collected. The fat flask containing the extract was dried in an oven at 105°C for approximately 5 hours. The flask was subsequently cooled for 30 minutes in a desiccator and weighed until constant weight (C). Fat content was calculated using the following formula:

Fat content (%) = (C − A) / B × 100%

Where:

A = weight of empty round-bottom flask (g)

B = sample weight (g)

C = weight of round-bottom flask and extracted fat (g)

2.7 Carbohydrate Content

Carbohydrate content was determined based on AOAC (2007) using the by-difference method, namely by subtracting moisture, ash, protein, and fat contents from 100%. Therefore, carbohydrate content depends on the subtraction factors because it is strongly influenced by other nutrient components. Carbohydrate content was calculated using the following formula:

Carbohydrate (%) = 100% − (ash % + moisture % + fat % + protein %)

2.8 Functional Groups by FTIR

Functional group analysis was conducted based on Nurdiansyah et al. (2021) using Fourier Transform Infrared spectroscopy (Thermo Fisher Scientific, USA) [15]. Infrared radiation was emitted through an interferometer and then transmitted through the sample. Part of the infrared radiation was absorbed by the sample, while the remaining radiation was retransmitted and detected by the detector. Vibrations occur because the energy from infrared radiation is not strong enough to cause atomization or electronic excitation in the irradiated compound molecules. The vibrational energy of each atom or molecule differs depending on the atoms and the bond strengths connecting them, resulting in different frequencies. The magnitude of infrared radiation captured by the detector was then converted into a spectrum by the interferogram.

2.9 Sensory Analysis

Sensory analysis was conducted based on SNI 01-2346-2006 (BSN, 2006) using a hedonic test involving 30 semi-trained panelists and a 9-point scale for the parameters of appearance, odor, taste, and texture.

2.10 Data Analysis

This study used a completely randomized design with one factor, namely differences in carrot concentration added to starry triggerfish nuggets. The data obtained were analyzed using ANOVA. When significant differences were found, the analysis was continued with Tukey's test.

3. RESULTS AND DISCUSSION

Table 2. Chemical Characteristics of Starry Triggerfish Nuggets.

Parameter	Protein (%)	Moisture (%)	Ash (%)	Fat (%)	Carbohydrate (%)
K	18.45±0.24^{d}	59.32±0.32^{d}	1.44±0.02^{b}	3.48±0.28^{c}	17.51±0.48^{a}
A	16.66±0.33^{c}	60.76±0.14^{c}	1.37±0.01^{a}	2.85±0.01^{b}	18.35±0.41^{a}
B	14.15±0.15^{b}	62.45±0.27^{b}	1.48±0.02^{b}	2.64±0.02^{ab}	19.28±0.20^{b}
C	13.27±0.08^{a}	65.36±0.23^{a}	1.35±0.01^{a}	2.35±0.04^{a}	17.67±0.13^{a}

Note: Data followed by different lowercase letters indicate significant differences at the 5% level. K = nugget without carrot addition; A = nugget with 10% carrot addition; B = nugget with 20% carrot addition; C = nugget with 30% carrot addition.

3.1 Protein

The highest protein content was observed in the control treatment, at 18.45±0.24, whereas the lowest value was found in treatment C (30% carrot addition), at 13.27±0.08. The protein contents in treatments A (10%) and B (20%) were 16.66±0.33 and 14.15±0.15, respectively. The protein content in all treatments remained relatively high and met the fish nugget quality standard based on SNI 7758:2013, which requires a minimum of 5%. Thus, starry triggerfish nuggets with carrot addition still had good protein nutritional value.

The decrease in protein content of starry triggerfish nuggets as carrot concentration increased may be attributed to the partial replacement of fish raw material with carrots. Starry triggerfish is a food ingredient with relatively high protein content, whereas carrots have relatively low protein content. Therefore, the higher the carrot addition in the nugget formulation, the lower the protein content of the resulting product tends to be. The greater the amount of fish used, the higher the energy and protein contents, although vitamin A content is lower; conversely, the use of less fish due to carrot addition reduces energy and protein contents [21]. Processing steps such as steaming may also affect the protein content of food products. Heating during steaming may cause protein denaturation, namely changes in protein structure due to heat, which may result in partial damage or structural alteration of proteins. This may contribute to a slight decrease in protein content in the final product. During steaming, protein content decreases compared with fresh fish. The decrease in protein content in processed fish is caused by heat-induced protein denaturation [7].

3.2 Moisture

The moisture-content analysis of starry triggerfish nuggets with carrot addition showed different values among treatments. The highest moisture content was found in treatment C (30%), at 65.36±0.23, whereas the lowest value was found in the control treatment, at 59.32±0.32. Treatment A (10%) had a moisture content of 60.76±0.14, while treatment B

(20%) had a moisture content of 62.45±0.27. Based on the fish nugget quality standard according to SNI 7758:2013, the maximum moisture content for nugget products is 60%. In this study, the control treatment still met this standard, while treatments with carrot addition showed slightly higher values. This indicates that carrot addition in large amounts can increase product moisture content and should therefore be considered carefully in product formulation.

The increase in moisture content in starry triggerfish nuggets was presumably caused by the high water content of carrots. Carrots are known to contain a considerable amount of water on a fresh-weight basis, so increasing carrot addition will increase the moisture content of the resulting nugget product. The use of carrots in chicken sausage has been reported to have a significant effect on moisture content [16], thereby increasing the water content of the resulting sausage along with the addition of carrot paste. Increased moisture content may also be influenced by the water-holding capacity of the ingredients during processing. Carrots contain dietary fiber that can absorb and retain water during mixing and steaming, causing the moisture content of nuggets to increase as carrot concentration rises. The higher the fortification level of carrot powder, the higher the moisture content of white bread. This occurs because carrot powder contains substantial fiber; therefore, the greater the soluble fiber content in carrot powder, the greater its water-binding capacity [13].

3.3 Ash

The ash-content analysis of starry triggerfish nuggets with carrot addition showed values that were relatively similar among treatments. The highest ash content was found in treatment B (20%), at 1.48±0.02, whereas the lowest value was found in treatment C (30%), at 1.35±0.01. The ash contents in the control and A (10%) treatments were 1.44±0.02 and 1.37±0.01, respectively. Based on the fish nugget quality standard according to SNI 7758:2013, the maximum ash content is 2.5%. The results showed that all treatments had ash contents below this maximum limit and therefore still met the established quality standard.

Ash content is a parameter indicating the total mineral content of a food material. The ash content of starry triggerfish nuggets in this study was relatively low and stable across treatments. This indicates that carrot addition did not exert a substantial effect on the mineral content of the nugget product. Minerals in starry triggerfish nuggets are derived from the main raw material, namely fish, as well as from additional ingredients such as salt, eggs, and carrots. Fish is a good source of minerals such as calcium, phosphorus, and iron. Meanwhile, carrots also contain several minerals, although in relatively small amounts [1].

3.4 Fat

The fat-content analysis of starry triggerfish nuggets with carrot addition showed that fat content decreased as carrot concentration increased. The highest fat content was found in the control treatment, at 3.48±0.28, whereas the lowest value was found in treatment C (30%), at 2.35±0.04. Treatments A (10%) and B (20%) had fat contents of 2.85±0.01 and 2.64±0.02, respectively. Based on the fish nugget quality standard according to SNI 7758:2013, the maximum fat content for nugget products is 15%. The results showed that all treatments had fat contents far below this maximum limit; therefore, starry triggerfish nuggets with carrot addition still met the applicable quality standard.

The decrease in fat content of starry triggerfish nuggets was presumably caused by the low fat content of carrots. Carrots have a very low fat content, approximately 0.2–0.3%; therefore, the addition of carrots in the nugget formulation lowers the fat proportion in the product. In treatment P1, fat content was higher because there was no carrot addition and mackerel contains 18 g fat per 100 g fish, whereas P5 contained less fat due to the substitution of 40 g carrots, and carrots contain 0.30 g fat [10]. Processing such as steaming may also cause some fat to melt and be lost during heating. Fat may be released from the tissue during cooking, causing a decrease in fat content in the final product. Steaming can reduce the fat content of nuggets because fat melts during the steaming process [4].

3.5 Carbohydrate

The carbohydrate-content analysis of starry triggerfish nuggets with carrot addition showed variation among treatments. The highest carbohydrate content was found in treatment B (20%), at 19.28±0.20, whereas the lowest value was found in the control treatment, at 17.51±0.48. Treatment A (10%) had a carbohydrate content of 18.35±0.41, while treatment C (30%) had a carbohydrate content of 17.67±0.13. Treatment C (30%) showed a slight decrease in carbohydrate content compared with treatment B. This was presumably due to the relatively high increase in moisture content in that treatment, which proportionally reduced the percentage of carbohydrate content in the product.

The increase in carbohydrate content of starry triggerfish nuggets was influenced by the addition of carbohydrate-containing ingredients, such as carrots and tapioca flour. Carrots are known to contain carbohydrates; therefore, their addition to the nugget formulation may increase the carbohydrate content of the product. Tapioca flour, which was used as a binder, is also a high-carbohydrate ingredient. During processing, such as steaming, the starch in tapioca flour undergoes gelatinization, namely the swelling of starch granules due to heating and water absorption, which affects the structure and carbohydrate composition of the nugget product. The interaction of higher tapioca flour addition and longer steaming time increases the moisture content of meat crackers. This occurs because gelatinization proceeds more extensively and for a longer period, thereby increasing water absorption capacity, while starch components become more difficult to release water. Greater tapioca flour addition affects the increase in moisture content [8].

3.6 Functional Groups

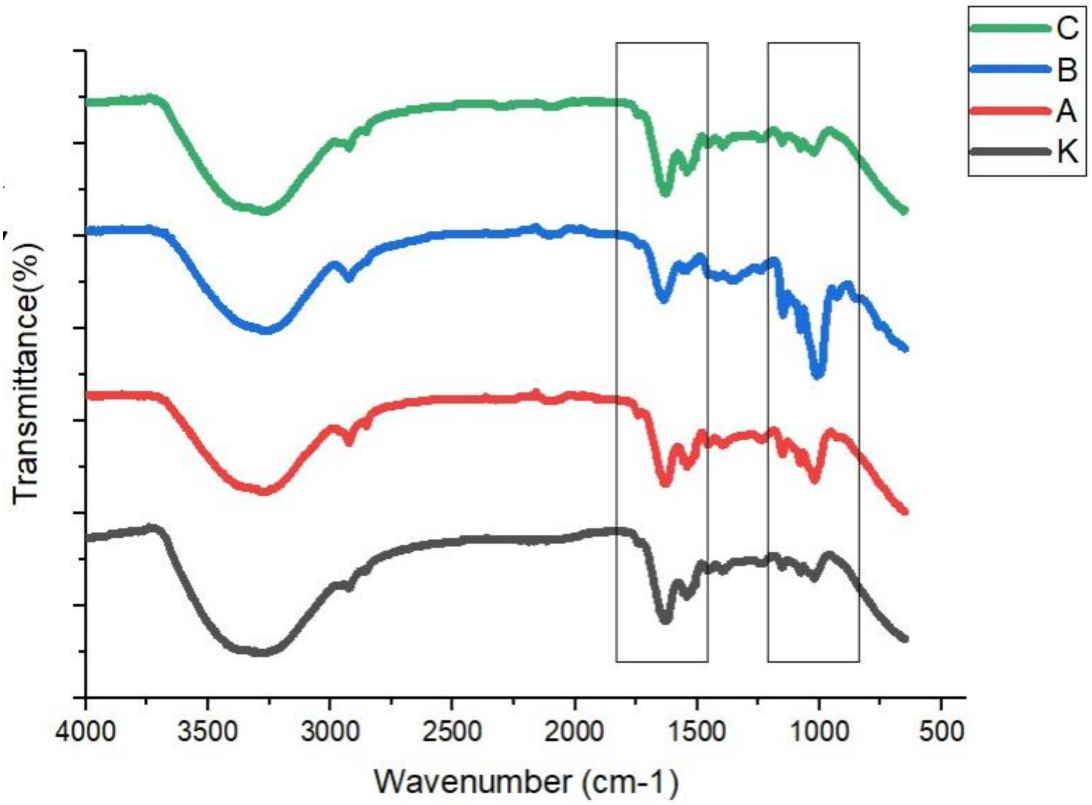

Figure 1. FTIR spectra of starry triggerfish nuggets.

Note: K = nugget without carrot addition; A = nugget with 10% carrot addition; B = nugget with 20% carrot addition; C = nugget with 30% carrot addition.

Based on the FTIR spectral analysis of fish nugget samples consisting of K (control), A, B, and C, several absorption bands were observed in specific wavenumber regions, indicating the presence of functional groups from the food components. The resulting spectra showed relatively similar patterns across samples, but differences in absorption intensity were observed in several regions, indicating compositional variation among samples. In the region around 1650 cm^{-1}, a clear absorption band was observed, corresponding to the amide I group, which is characteristic of C=O bonding in protein structures. This peak indicates that protein is one of the main components in the fish nugget samples. In addition, absorption bands in the

1500–1600 cm^{-1} region were also identified and associated with amide II groups, originating from N–H bending and C–N stretching vibrations in protein structures. The wavenumber region of 1600–1690 cm^{-1} indicates the presence of amide I compounds with C=O stretching vibrations from albumin protein samples. Absorption bands of C–N stretching and N–H bending were observed in the wavenumber region of 1480–1575 cm^{-1}, indicating the presence of amide II compounds [17].

In the 1000–1200 cm^{-1} wavenumber region, several absorption bands were observed and associated with C–O vibrations, which are generally related to the presence of carbohydrate or starch compounds. These components likely originated from additional ingredients such as flour used as a binder in the fish nugget formulation. Glucose is the basic structural unit of amylose and amylopectin, which form starch. The identification of starch functional groups was also supported by the appearance of the C–O–C group absorbed at 1117.80 cm^{-1}. This group represents ether bonds, indicating the presence of an amylose fraction [20]. Overall, the FTIR spectra of samples K, A, B, and C showed similar spectral patterns, indicating that the main product components were relatively the same, namely protein, lipid, and carbohydrate. However, differences in absorption intensity in several wavenumber regions, particularly within 1500–1700 cm^{-1} and 1000–1200 cm^{-1}, indicated differences in the concentration or proportion of components in each sample.

3.7 Sensory Evaluation

Table 3. Panelist Acceptance of Starry Triggerfish Nuggets.

Parameter	Appearance	Odor	Taste	Texture
K	7.43±0.82	7.10±0.96	7.23±0.57	7.97±0.67
A	7.47±0.78	7.37±0.81	7.13±0.63	7.73±0.78
B	7.70±0.79	7.83±0.87	7.78±0.82	7.40±0.89
C	7.63±0.81	7.63±0.61	7.67±0.88	7.20±1.00

Note: Data followed by different lowercase letters indicate significant differences at the 5% level. K = nugget without carrot addition; A = nugget with 10% carrot addition; B = nugget with 20% carrot addition; C = nugget with 30% carrot addition.

Sensory analysis of starry triggerfish nuggets was performed based on panelists' hedonic acceptance. The hedonic test results showed that panelists' preference for the appearance of starry triggerfish nuggets with carrot addition differed among treatments. The appearance of a food product is a visual organoleptic attribute that also influences consumer preference [14]. Based on panelist evaluation, treatment B (20% carrot addition) obtained the highest preference score compared with the other treatments. This indicates that 20% carrot addition produced a more attractive nugget color and appearance for the panelists. The nugget color in this treatment appeared brighter, with a slight orange hue from the carrots, giving the product a fresher and more appealing appearance. Meanwhile, the control treatment (0%) had a paler appearance because no carrot was added. In treatment C (30%), the nugget color became more orange and slightly darker, causing some panelists to consider its appearance less attractive than treatment B. The color of nugget products is influenced by the ingredients and processing. Carrots contain carotenoid pigments, particularly beta-carotene, which gives an orange color to the product. The higher the carrot addition, the more orange the resulting color. The pigment content in carrots with potential as a source of vitamin A is carotene. Beta-carotene is the most active pigment compared with alpha- and gamma-carotene. Carotenoids containing smaller pigments are known as carotenes and xanthophylls. The most beneficial carotenes in human foods are beta-carotene and alpha-carotene, while important xanthophylls include lutein and zeaxanthin [18].

The hedonic test results showed that panelists' preference for the odor of starry triggerfish nuggets with carrot addition differed among treatments. Treatment B (20%) obtained the highest preference score compared with the other treatments. This indicates that moderate carrot addition produced an odor that was more preferred by panelists. Carrot addition may provide a mild vegetable aroma, helping to reduce the fishy odor of the fish. In the control treatment, the fish aroma remained relatively dominant, causing some panelists to consider the odor less appealing. In contrast, in treatment C (30%), the carrot odor became stronger, making it too dominant for some panelists. The odor of nugget products is influenced by raw materials, seasonings, and heating during processing. During steaming, chemical reactions occur in the components of the ingredients, producing volatile compounds that affect product aroma. Nuggets are restructured meat products with distinctive taste and aroma combined with flour, eggs, spices, and bread crumbs, making them appealing to various consumer groups [2].

Based on panelist evaluation, treatment B (20%) was the most preferred treatment in terms of taste. This indicates that the combination of starry triggerfish meat and 20% carrot addition produced a balanced flavor and was more acceptable to panelists. In the control treatment, the fish flavor remained relatively dominant, which made some panelists less favorable toward it. Meanwhile, in treatment C (30%), the carrot flavor became stronger, masking the characteristic fish flavor and causing some panelists to consider the taste less balanced. Nugget taste is influenced by ingredient composition, seasonings, and processing. Carrot addition at an appropriate level can provide a slightly natural sweet taste that improves product flavor. The natural sweetness contained in carrots may enhance their attractiveness as a food ingredient; in addition, the characteristic fresh carrot aroma can mask undesirable aromas or flavors from other ingredients [11].

The hedonic test results showed that panelists' preference for the texture of starry triggerfish nuggets differed among treatments. Treatment B (20%) obtained the highest preference score compared with the other treatments. This was presumably because carrot addition at an appropriate level produced a nugget texture that was softer while remaining compact. The fiber content in carrots may help improve the water-binding capacity of the ingredients, thereby producing a better texture. Carrot roots have an ideal consistency, namely crisp, not too hard, and not too soft [11]. In the control treatment, the nugget texture tended to be denser because no carrot fiber was added. Meanwhile, in treatment C (30%), the nugget texture became softer due to the high moisture content derived from carrots. Nugget texture is also influenced by binders such as tapioca flour, which undergo gelatinization during heating and form a gel structure that affects product chewiness. The interaction of higher tapioca flour addition and longer steaming time increases the moisture content of meat crackers. This occurs because gelatinization in crackers proceeds more extensively and for a longer period, thereby increasing water absorption capacity, while starch components become more difficult to release water [8].

4. CONCLUSIONS

Based on the results of this study on the production of starry triggerfish nuggets with carrot addition, it can be concluded that carrot addition in starry triggerfish nugget production affected the chemical characteristics, namely protein, moisture, ash, fat, and carbohydrate contents. Higher carrot addition tended to decrease protein and fat contents, while increasing moisture content. In general, the resulting products met most of the fish nugget quality requirements based on SNI 7758:2013 for the parameters of protein, ash, and fat. The hedonic test results showed that treatment B (20% carrot addition) was the most preferred treatment by panelists based on appearance, odor, taste, and texture. The addition of 20% carrot produced a more attractive color, a more preferred aroma, a more balanced taste, and a softer yet compact texture.

5. REFERENCES

1. Almayda, A. R., B. Ma'rifah, and A. Muhlishoh. (2024). Formulation of Snakehead Fish Nuggets with Red Bean Composite Flour and Carrot Flour Substitution as Functional Food. ARGIPA (Arsip Gizi Dan Pangan), 9(1), 64-85.
2. Aripudin, A., P. S. T. Panjaitan, L. Soeprijadi, and E. A. Sebayang. (2021). Study of Household-Scale Processing of Mackerel Fish Nuggets (Scombridae commerson). Pelagicus, 2(3), 167-175.
3. Association of Official Analytical Chemyst. 2007. Official Method of Analysis of The Association of Offial Analytical of Chemist. Arlington: The Association of Official Analytical Chemyst, Inc.
4. Azzahra, A. (2024). Impact Analysis of High-Temperature Serving Methods on the Quality of Ready-to-Eat Chicken Nuggets. Jurnal Ilmiah Sains dan Teknologi (SANTEK), 1(1).
5. Badan Standardisasi Nasional. 2006. SNI 01-2346-2006: Guidelines for Organoleptic and/or Sensory Testing. Jakarta: Badan Standardisasi Nasional.
6. Badan Standardisasi Nasional. 2006. SNI 01-2354.4-2006: Chemical Test Method - Part 2: Determination of Protein Content. Jakarta: Badan Standardisasi Nasional.
7. Ciptawati, E., I. B. Rachman, H. O. Rusdi, and M. Alvionita. (2021). Comparative Analysis of Catfish Processing Methods on Their Nutritional Content. Indonesian Journal of Chemical Analysis (IJCA), 4(1), 40-46.
8. Costa, W. Y., and F. M. Manihuruk. (2021). Chemical and Organoleptic Characteristics of Meat Crackers with Tapioca Flour Addition and Different Steaming Times. Jurnal AgroSainTa: Widyaiswara Mandiri Membangun Bangsa, 5(1), 9-14.
9. Feniola, L., F. D. Pratiwi, and M. R. Muftiadi. (2024). Diversity and Conservation Status of Fish Caught Using Fixed Gillnet Fishing Gear at PPN Sungailiat. Akuatik: Jurnal Sumberdaya Perairan, 18(1), 35-46.
10. Ferantika, C. N., S. Haryati, and D. Larasati. (2020). Physicochemical and Organoleptic Characteristics of Mackerel Fish Balls (Rastrelliger kanagurta) with Carrot (Daucus carota) Substitution. Jurnal Teknologi dan Hasil Penelitian, 15(1).
11. Inayah, A. N., R. Rukmelia, E. P. Safri, S. Sulfika, I. Haryono, A. Padapi, and M. Arsyad. (2024). Organoleptic Testing of Mackerel Scad (Decapterus spp.) Riceball Products on the Effect of Adding Carrots and Moringa Leaves: Organoleptic Testing of Mackerel Scad (Decapterus spp.) Riceball Products on the Effect of Adding Carrots and Moringa Leaves. Perbal: Jurnal Pertanian Berkelanjutan, 12(3), 411-420.

12. Lastri, D. R., and Y. P. Putra. (2020). Characterization of Physical Quality and Macronutrients of Starry Triggerfish (Abalistes stellaris) Fillets. Manfish Journal, 1(1), 15-20.
13. Maharantata, F. D., I. N. K. Putra, and G. A. K. D. Puspawati. (2025). Effect of Carrot Powder (Daucus carota L.) Concentration on the Physical, Chemical, and Sensory Properties of Mochi. Itepa: Jurnal Ilmu dan Teknologi Pangan, 14(4), 848-871.
14. Muchtar, F. (2025). Analysis of the Acceptance Level of Tuna Nuggets as a Source of Animal Protein in Malalanda Village. JUSTER: Jurnal Sains dan Terapan, 4(2), 55-66.
15. Nurdiansah, H., W. R. Dipakusuma, and D. Susanti. (2021). Effect of Hydrothermal Temperature Variation on the Structure and Capacitive Properties of Carbon Nanotube (CNT) with Ferrocene Precursor for Supercapacitor Applications. Jurnal Teknik ITS, 9(2), B140-B145.
16. Palandeng, F. C., L. C. Mandey, and F. Lumoindong. (2016). Physicochemical and Sensory Characteristics of Culled Laying-Hen Chicken Sausage Fortified with Carrot (Daucus carota L.) Paste. Jurnal Ilmu dan Teknologi Pangan, 4(2), 19-28.
17. Sulistyani, M., and N. Huda. (2017). Optimization of Protein Sample Vibrational Spectrum Measurement Using Fourier Transform Infrared (FT-IR) Spectrophotometry. Indones. J. Chem. Sci, 6, 173-180.
18. Susanti, R. (2017). The Effect of Carrot Addition on the Organoleptic Quality and β-Carotene Content of Nile Tilapia (Oreochomis niloticus) Nuggets. Kaya Tulis Ilmiah. Jurusan Gizi. Politeknik Kesehatan Kemenkes Padang.
19. Syadiah, E. A., R. Riska, and F. Adelina. (2022). Effect of Carrot Flour Addition on the Acceptability and Nutritional Content of Barramundi (Lates calcarifer) Fish Nuggets. Media Teknologi Hasil Perikanan, 10(1), 49.
20. Wahyu, E., H. Nasution, and H. Harahap. (2025). Synthesis and Characterization of Edible Film Based on Coffee Peel Waste with the Addition of Glycerol and Sorbitol as Plasticizers. Jurnal Teknik Kimia USU, 14(1), 27-35.
21. Wulandari, D. E., and A. Ulilalbab. (2023). Effect of Carrot Addition on Vitamin A Content and Acceptability of Snakehead Fish (Channa striata) Nuggets. INSOLOGI: Jurnal Sains dan Teknologi, 2(2), 298-306.