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NUTRITIONAL ANALYSIS OF KOMO TUNA FISH SAMOSA (*Euthynnus affinis*) FORTIFIED WITH SEAWEED *Gracilaria* sp.

Analisis Nutrisi Samosa Ikan Tongkol Komo *(Euthynnus affinis)* Berfortifikasi Rumput Laut *Gracilaria* sp.

Jawiana Saokani Sofyan*, Siti Atika Alwi, Harianti

Institute of Maritime Technology and Business Balik Diwa

Perintis Kemerdekaan Street Number 8, Makassar City, South Sulawesi Province

*Corresponding Author: jawianasaokani@itbm.ac.id

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ABSTRACT

Komo tuna is one of the pelagic fish from the scombridae family that is often found in the Makassar Strait. Samosa (sanbosag) is one of the triangular-shaped street snacks with a savory taste, distinctive spice aroma, crunchy texture, and a yellow-brown filling consisting of two main parts, namely the skin and the filling. The purpose of the study was to determine the nutritional content of komo tuna (*Euthynnus affinis*) samosas fortified with *Gracilaria* sp. seaweed and to determine the level of acceptance of komo tuna (*Euthynnus affinis*) samosas fortified with *Gracilaria* sp. seaweed. The research method used the experimental laboratories method. The tests carried out were nutritional testing, sensory testing with 3 treatments and 3 repetitions. Data analysis used the ANOVA test. The results of the nutritional test obtained the highest water content in the treatment of adding 20% *Gracilaria* sp. seaweed, the highest ash content in the treatment of adding 20% *Gracilaria* sp. seaweed, the highest protein content in the control treatment meaning there was no addition of 0% *Gracilaria* sp. seaweed, the highest fat content in the treatment of adding 20% *Gracilaria* sp. seaweed and the highest fiber content in the treatment of adding 20% *Gracilaria* sp. seaweed. The level of consumer acceptance of komo tuna samosa fortified with *Gracilaria* sp. seaweed was targeted at sample C, with the addition of 20% *Gracilaria* sp. seaweed the most preferred by panelists among the three treatments in all parameters

Key words: Fortified, Komo Tuna, Nutrition, Seaweed, Samosa

ABSTRAK

Ikan tongkol komo merupakan salah satu ikan pelagis dari famili scombridae yang banyak ditemui di Perairan Selat Makassar. Samosa (sanbosag) merupakan salah satu jajanan kaki lima yang berbentuk segitiga dengan rasa yang gurih aroma rempah yang khas, bertekstur renyah, serta isian yang berwarna kulit kuning kecoklatan yang terdiri dari dua bagian utama yaitu kulit dan isian. Tujuan penelitian mengetahui kandungan nutrisi samosa ikan tongkol komo (Euthynnus affinis) berfortifikasi rumput laut *Gracilaria* sp dan untuk mengetahui tingkat penerimaan samosa ikan tongkol komo (*Euthynnus affinis*) berfortifikasi rumput laut *Gracilaria* sp. Metode penelitian menggunakan metode experimental laboratories. Pengujian yang dilakukan ialah pengujian nutrisi, pengujian sensori dengan 3 perlakuan dan 3 kali pengulangan. Analisis data menggunakan uji ANOVA. Hasil pengujian nutrisi diperoleh kandungan air terbesar dimiliki pada perlakuan penambahan rumput laut *Gracilaria* sp. 20%, kadar abu kandungan tertinggi dimiliki pada penambahan rumput laut *Gracilaria* sp. 20%, kadar protein tertinggi

dimiliki pada perlakuan kontrol artinya tidak ada penambahan rumput laut *Gracilaria* sp. 0%, kadar lemak kandungan tertinggi dimiliki pada penambahan rumput laut *Gracilaria* sp. 20% dan kadar serat kandungan tertinggi dimiliki pada penambahan rumput laut *Gracilaria* sp. 20%. Tingkat peneriman konsumen terhadap samosa ikan tongkol komo berfortifikasi rumput laut *Gracilaria* sp dituju pada sampel C, dengan penambahan 20% rumput laut *Gracilaria* sp. paling disukai panelis diantara ketiga perlakuan pada semua parameter.
Kata Kunci: Berfortifikasi, Ikan Tongkol Komo, Nutrisi, Rumput Laut, Samosa

INTRODUCTION

Fish is one of the animal protein-based food commodities that has a high level of availability and is easily accessible at various types of distribution and trade centers. However, it is unfortunate that enthusiasts of consuming fish are very minimal in Indonesia in 2021, especially in the Yogyakarta area, with a figure of 34.82 kg/capita, (Adliya & Setiawan, 2022). The Maluku region is the region that ranks highest where the highest Fish Consumption Rate is 77.49 kg/capita/year. This figure shows that fish consumption is not evenly distributed throughout Indonesia, (Adliya & Setiawan, 2022). According to Pratiwi *et al.* (2025), that one of the fish species that has an important role in the Indonesian fisheries sector is tuna. Tuna is a type of pelagic fish from the scombridae family that is widely found in the Makassar Strait Waters, including the waters around Indonesia. This fish species has high economic significance and plays a role as one of the mainstay commodities in the domestic capture fisheries sector. Tuna is generally used as a basic ingredient in various processed food products such as sardines, shredded fish, and canned fish, and can be marketed fresh or frozen, (Gorintha & Pratiwi, 2023).

Anggadiredja *et al.* (2019), explained that the main area in Indonesia that is the habitat and main producer of tuna1 is the Indian Ocean, which stretches from southern Java to Nusa Tenggara with the southern boundary located in Batu Nampar Selatan Village. Tuna komo is a type of fish that is rich in protein and has a high omega-3 fatty acid content. According to the South Sulawesi Central Statistics Agency, marine fishery products obtained at the Fish Auction Place with the type of tuna komo, in 2019 to 2021, (BPS, 2022). In 2019, the production of tuna komo fish was 19,640.35 quintals. Meanwhile, in 2020, the production of komo tuna was 19,831.31 quintals. Then in 2021, the production of komo tuna decreased by 17,598.74 quintals, (BPS, 2022).

Tuna (*Euthynnus affinis*) has great potential because it contains complete nutrition, including up to 26% protein, omega-3 fat content, and various important minerals in high amounts, (Sitompul *et al.,* 2020). Tuna contains 22 grams of protein in every 100 grams of tuna. According to Cokrowati *et al.* (2020), nutritional components have an essential role in supporting physiological functions and human survival. The level of nutritional completeness in a food ingredient is often used as the main indicator in assessing the quality of consumption. In general, carbohydrate intake is still the nutritional element that dominates the consumption patterns of people in Indonesia. In addition, there are also other macro and micronutrients, such as lipids, proteins, vitamins, fiber, and minerals, which also contribute to meeting daily nutritional needs, (Fatmawati, 2018).

Tuna is a type of sea fish that is rich in antioxidants that fight free radicals and has various health benefits. In general, the population tends to utilize this ingredient in various forms of culinary processing, including crackers, shredded meat, various snacks, and pempek. Given its high nutritional value and abundant availability in the Indonesian archipelago, tuna has significant prospects to be optimized as a basic ingredient in the diversification of innovative food products (Gorintha & Pratiwi, 2023). To improve the nutritional content profile, tuna-based processed products should be enriched through a fortification process with other local food ingredients that have great potential, especially those rich in protein, iron (Fe), and other essential nutritional elements, such as seaweed. As a food source that is rich in important nutrients, seaweed plays a crucial role, especially for pregnant women, in efforts to prevent the risk of stunting in children by optimally meeting nutritional needs. Scientifically, seaweed is a chlorophyll-containing thallus plant that is macroscopic in size and is known as algae (Ayuni & Rishel, 2021).

Seaweed is included in the benthic macroalgae group, which ecologically lives by attaching itself to the bottom substrate of waters, (Mulyani & Indrawati, 2019). In addition, seaweed is recognized as one of the strategic commodities with high competitiveness with great prospects as a functional food

ingredient, thanks to its abundant fiber, vitamin in, and mineral content. In addition, seaweed acts as a source of natural antioxidants that can be easily accessed, making it an essential component in the development of health-based food (Ridhowati, 2016). *Gracilaria* sp. as one type of seaweed with significant development potential, where demand from suppliers in Indonesia increases every year. Along with this trend, the development of *Gracilaria* sp. cultivation businesses is expected to open up substantial profit opportunities, (Mulyani & Indrawati, 2019).

According to Masrikhiyah and Wahyani (2020), the total production of *Gracilaria* sp. seaweed reached 558.2 thousand tons. Gracilaria sp is known to have a very optimal composition and nutritional content. *Gracilaria* sp. in 100g dry in seaweed composition is calorie (kcal) 321; protein 1.3 (g); fat 1.3 (g); carbohydrate 83.5 (g); fiber (g); and ash (g) 4, (Sipahutar *et al.,* 2020). Limitations in food intake or imbalance in the nutritional content of food consumed can cause delays in the development of organs, tissues, and brain development. One of the main reliable solutions, namely the need for animal protein, is fish. In addition, fish have a fairly low price, in contrast to other proteins, such as beef and chicken, which are quite high. The results of Handayani *et al.* (2014), study on the iron content of pelagic fish can show that tuna is one of the pelagic fish with the highest iron content when compared to other pelagic fish. Tuna weighing 240 g and 28.5 cm long has a significant iron content. Meanwhile, the research conducted by the author focuses on the analysis of the nutritional content in samosas made from komo tuna. Furthermore, the results of the study by Puspitasari & Komariah (2023) regarding the manufacture of samosas from tuna to overcome the problem of malnutrition in the Gen Z generation in Indonesia show that the use of fish meat can be used as an innovation in samosa filling, in addition to beef and chicken. Fish samosa products can be recommended as nutritious snacks for people with malnutrition to reduce stunting rates in Indonesia, especially among Generation Z. Fish as a source of animal protein with high protein and low fat, provides great benefits for health.

This study focuses on the analysis of nutritional content in samosas made from komo tuna (*Euthynnus affinis*) enriched with *Gracilaria* sp. seaweed. Optimization of the utilization of tuna and *Gracilaria* sp. seaweed can be achieved through the fortification process in various processed products, which is an effective strategy to increase the function and economic value of these food ingredients. One approach to this fortification is to process it into processed products with added value. One of these processed foods is a snack of komo tuna (*Euthynnus affinis*) samosas fortified with *Gracilaria* sp. seaweed that can be consumed by all levels of society and has a selling value. In addition, in this study, *Gracilaria* sp. seaweed can be used as a substitute for rice vermicelli.

RESEARCH METHODS

This research was conducted in August 2024 with nutritional content testing carried out at the Biochemistry Laboratory of the Pangkep State Agricultural Polytechnic (POLITANI) and hedonic sensory analysis carried out at the ITBM Balik Diwa Makassar campus. The Samosa making tools used in this study were digital scales, measuring spoons, cutting boards, spatulas, spoons, and rolling pins. While the Samosa testing tools were ovens, blenders, Erlenmeyer flasks, porcelain ash cups, filter paper, desiccators, glass funnels, analytical scales, ashing furnaces, Kjeldahl flasks, Soxhlet, and clamps. This study used Samosa making materials, namely Komo tuna, *Gracilaria* sp. sea r., spring onions, garlic, shallots, red chilies, turmeric powder, coriander, pepper, salt, sugar, oil, wheat flour, water and Samosa testing materials, namely H_2SO_4, HCI, H_2O_2, NaOH, aquades, catalyst tablets.

This study uses a quantitative method with an experimental approach, (Hasdar *et al.,* 2021). The experiment conducted was a completely randomized design (CRD) which included three treatments and three replications so that nine experimental units were obtained and using the experimental laboratories method or trial method, (Rahmawati & Erina, 2020). The making of this komo tuna samosa with the inclusion of *Gracilaria* sp. seaweed. This study was used to find the impact of certain treatments. The variables in this study consist of independent variables and dependent variables. The independent variables in this study are tuna obtained from the Poetere Makassar Fisheries Auction and *Gracilaria* sp. seaweed obtained from CV. LARS, while the dependent variables are the nutritional and hedonic values of the komo tuna samosa product fortified with *Gracilaria* sp. seaweed.

The stages of making modified komo tuna samosa by Nur (2017) by adding *Gracilaria* sp. seaweed are: 1) preparation of raw materials; 2) implementation stage consisting of handling *Gracilaria*

sp. seaweed, the process of making Samosa skin, the process of making komo tuna samosa filling fortified with *Gracilaria* sp. seaweed; and 3) testing stage, namely chemical testing consisting of fiber content test, protein content test, fat content test, water content test, ash content test conducted at the Nutrition and Cultivation Chemistry Laboratory of the Pangkajene Islands State Agricultural Polytechnic, and hedonic scale sensory test conducted at ITBM Balik Diwa Makassar. Meanwhile, the data analysis technique used is the One Way Anova method in the SPSS (Statistical Product and Service Solution) application by knowing the average value between each sample between the control in each treatment and then calculated using the Tukey HSD Test.

RESULT

The results of the nutritional research on komo tuna samosa fortified with *Gracilaria* sp. seaweed, were analyzed to determine the nutritional content of komo tuna samosa fortified with *Gracilaria* sp. seaweed and to determine the level of consumer acceptance of komo tuna samosa which can be described as follows:

Chemical Test Analysis

Chemical test analysis is a test that plays an important role in testing nutritional content, this test is intended to determine the basic chemical composition contained in the material. In this study, the test includes a series according to the procedures of the Biochemistry Laboratory of the Pangkep State Agricultural Polytechnic (POLITANI). The results of the study are presented below:

Table 1. Results of the nutritional test of komo tuna samosa fortified with *Gracilaria* sp. seaweed

Parameter	Sample A	Sample B	Sample C
Water content	44.59	48.33	51.76
Ash Content	2.29	2.44	3.11
Protein Content	16.15	15.46	14.78
Fat Content	1.38	1.41	1.45
Fiber Content	3.43	13.59	18.86

Source: test results, 2024

Water Content

Water content refers to the amount of water that can trigger a reaction that causes a decrease in the quality of food ingredients, thus requiring a certain reduction in the water content of the product. Therefore, water content is one of the crucial quality parameters in assessing food products, where the lower the water content, the better the quality. The results of the water content test are presented in the table below:

Table 2. Tukey HSD Water Content Test Results

Treatment	*Sig*	Testing	Decision
Control vs 10%	0,000	*Sig* < 0.05	Significant
Control vs 20%	0.002	*Sig* < 0.05	Significant
10% vs 20%	0.003	*Sig* < 0.05	Significant

Source: test results, 2024

Table 1 shows that the significant value (Sig) in each treatment is less than 0.05, which indicates that there is a significant difference in the average of each treatment. This leads to the conclusion that there is a significant difference in the nutritional water content of komo tuna samosa fortified with *Gracilaria* sp. seaweed in each treatment tested. The nutritional water content value of komo tuna samosa fortified with *Gracilaria* sp. seaweed can be seen in the Figure below:

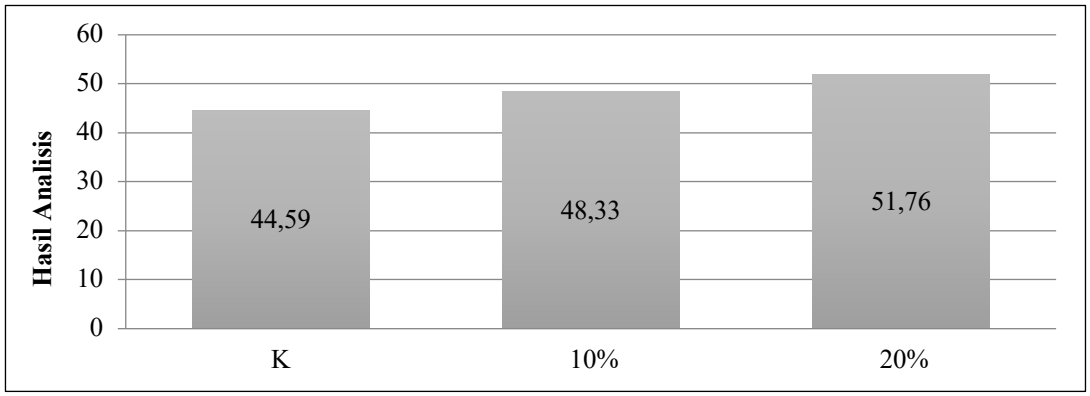

Figure 1. Nutritional water content of Komo tuna samosa fortified with *Gracilaria* sp. seaweed.

The highest average nutritional water content in komo tuna samosa fortified with Gracilaria sp seaweed was recorded in the 20% treatment, with a water content value of 51.76%. In contrast, the lowest average value was found in the control treatment, which showed a water content of 44.59%.

Ash Content

Ash content is one of the parameters in proximate analysis used to evaluate the nutritional content of a food ingredient, and indicates the total amount of minerals contained in the ingredient, including those with toxic properties. The results of the Tukey HSD ash content test are presented in the table below:

Table 3. Results of the Tukey HSD ash content test

Treatment	*Sig*	Testing	Decision
Control vs 10%	0.723	*Sig* > 0.05	Not Significant
Control vs 20%	0.014	*Sig* < 0.05	Significant
10% vs 20%	0.035	*Sig* < 0.05	Significant

Source: test results, 2024

Table 2 shows that the comparison between the control treatment and the 10% treatment showed similar results, where the difference in the average descriptive value between the two was not significant. This indicates that there is no difference in the nutritional ash content of the komo tuna samosa fortified with *Gracilaria* sp. seaweed between the control and 10% treatments. However, in other treatments, the significance value obtained was less than 0.05, which means that there is a significant average difference between the treatments. Thus, it can be concluded that there is a difference in the nutritional ash content of the komo tuna samosa fortified with *Gracilaria* sp. Seaweed in these treatments. The nutritional ash content of the komo tuna samosa fortified with *Gracilaria* sp. seaweed can be seen in the Figure below:

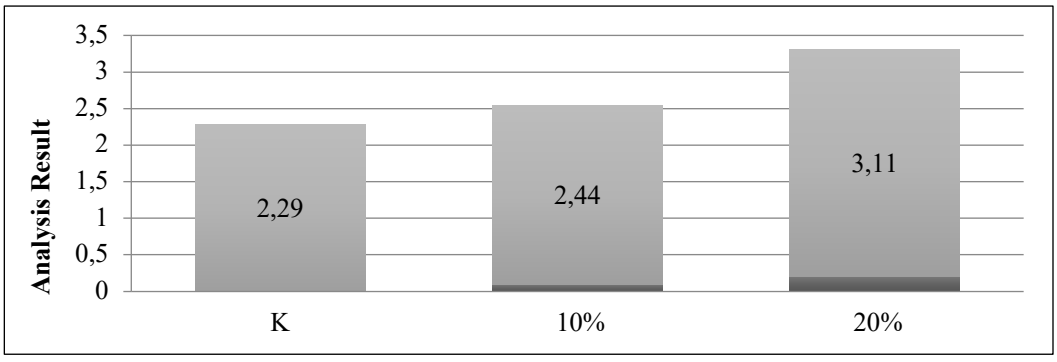

Figure 2. Ash content of Komo tuna samosas fortified with *Gracilaria* sp. seaweed.

The highest average ash content in the nutrition of komo tuna samosa fortified with *Gracilaria* sp. seaweed was found in the 20% treatment, which resulted in an ash content value of 3.11%. In contrast, the control treatment showed the lowest ash content value of 2.29%.

Protein Content

Protein, as one of the essential macronutrients, plays a crucial role in various cellular processes and overall body metabolism. Protein also functions to support the growth and regeneration of body tissues. The results of the Tukey HSD test for protein content are presented in the table below:

Table 4. Results of the Tukey HSD test for protein content

Treatment	*Sig*	Testing	Decision
Control vs 10%	0.159	*Sig* > 0.05	Not Significant
Control vs 20%	0.013	*Sig* < 0.05	Significant
10% vs 20%	0.172	*Sig* > 0.05	Not Significant

Source: test results, 2024

Table 4 shows that the comparison between the control treatment and the 10% treatment, as well as between the 10% and 20% treatments, showed significant similarities. Descriptively, the average difference between the two treatments did not show a striking difference. This indicates that there is no significant variation in the protein content of the nutrition of komo tuna samosa fortified with *Gracilaria* sp. seaweed between the control and 10% treatments, and between the 10% and 20% treatments. In contrast, the comparison between the control and 20% treatments produced a value smaller than 0.05, indicating a significant average difference. Therefore, it can be concluded that there is a very significant difference in the protein content of the nutrition of komo tuna samosa fortified with *Gracilaria* sp. seaweed between the control and 20% treatments. The protein content of the nutrition of komo tuna samosa fortified with *Gracilaria* sp. seaweed can be seen in the picture below:

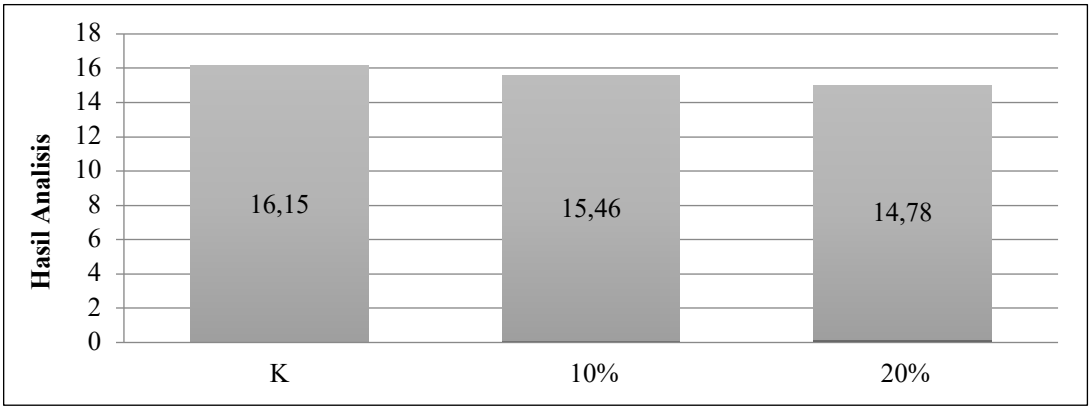

Figure 3. Nutritional protein content of Komo tuna samosas fortified with *Gracilaria* sp. seaweed.

The highest average result of nutritional protein content of komo tuna samosa fortified with *Gracilaria* sp. seaweed in the control treatment with a protein content value of 16.15%. While the lowest average value was obtained in the 20% treatment with a protein content value of 14.78%.

Fat Content

Fat content is a compound that is generally soluble in organic solvents such as ether, chloroform, or other solvents, but only a few can dissolve in water. The results of the Tukey HSD test for fat content are presented in the table below:

Table 5. Tukey HSD test results for fat content

Treatment	*Sig*	Testing	Decision
Control vs 10%	0.562	*Sig* > 0.05	Not Significant
Control vs 20%	0.095	*Sig* > 0.05	Not Significant
10% vs 20%	0.364	*Sig* > 0.05	Not Significant

Source: test results, 2024

Table 5 shows that the Significant value (Sig) in each treatment is greater than 0.05. Thus, it can be concluded that all treatments show similarities, and the average difference between the treatments does not show descriptive significance. This indicates that there is no significant difference in the fat content of the nutrition of komo tuna samosa fortified with *Gracilaria* sp. seaweed in all treatments tested. The nutritional fat content of komo tuna samosa fortified with *Gracilaria* sp. seaweed can be seen in the picture below:

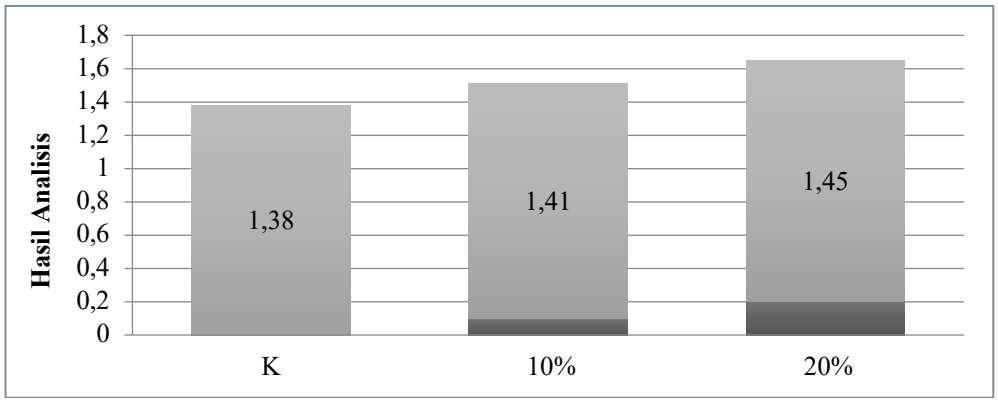

Figure 4. Nutritional fat content of Komo tuna samosas fortified with *Gracilaria* sp. seaweed.

The highest average result of nutritional fat content of komo tuna samosa fortified with *Gracilaria* sp. seaweed in the 20% treatment with a fat content value of 1.45%. While the lowest average value was obtained in the control treatment with a protein content value of 1.38%.

Fiber Content

Fiber content is a component in food that cannot be broken down by digestive enzymes in the body's digestive tract, but can undergo a fermentation process by microorganisms, especially bacteria, found in the large intestine. The results of the Tukey HSD test for fiber content are presented in the table below:

Table 6. Results of the Tukey HSD test for fiber content

Treatment	*Sig*	Testing	Decision
Control vs 10%	0,000	*Sig* < 0.05	Significant
Control vs 20%	0,000	*Sig* < 0.05	Significant
10% vs 20%	0,000	*Sig* < 0.05	Significant

Source: test results, 2024

Table 6 shows that all Sig values in each treatment are smaller than 0.05, so it can be concluded that there is an average difference or more significantly different in each treatment. This shows that there is a difference in the nutritional fiber content of komo tuna samosa fortified with *Gracilaria* sp.

seaweed in each treatment. Meanwhile, the nutritional fiber content of komo tuna samosa fortified with *Gracilaria* sp. seaweed can be seen in the picture below:

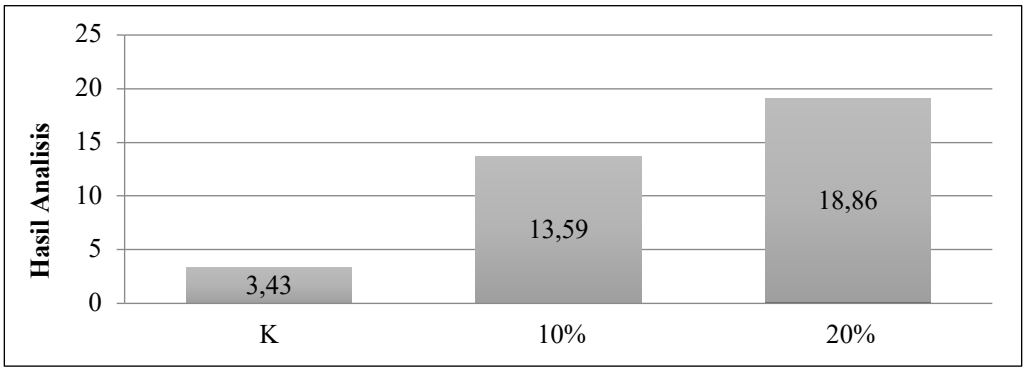

Figure 5. Nutritional fiber content of Komo tuna samosas fortified with *Gracilaria* sp. seaweed.

The highest average result of nutritional fiber content of komo tuna samosa fortified with *Gracilaria* sp. seaweed in the 20% treatment with a fiber content value of 18.86%. While the lowest average value was obtained in the control treatment with a fiber content value of 3.43%.

Sensory Testing

Sensory testing is a test of the acceptability of komo tuna samosa fortified with Gracilaria sp seaweed carried out by 30 untrained panelists to determine consumer acceptability using a score scale of 1 to 5. Samples are presented differently to determine the panelists' acceptability of sensory testing (hedonic scale) with specifications including appearance, texture, taste, and aroma.

Table 7. Hedonic test results of komo tuna samosa fortified with *Gracilaria* sp. seaweed

Specification	Sample A	Sample B	Sample C
Appearance	3,933	4,200	4,233
Texture	3,733	3,766	3,866
Flavor	4,466	4,333	4,366
Aroma	3,923	3,833	3,933

Source: test results, 2024

The details of the average value and the results of the ANOVA test are described as follows:

Appearance

Appearance is the initial impression captured and evaluated by the panelists, which is the first organoleptic parameter in a presentation, because it involves the sense of sight. Attractive visual aesthetics can increase the interest and taste of panelists or consumers in enjoying the product.

Table 8 Average value and results of the ANOVA test on appearance

Treatment	*Mean*	Sig	Decision
Control	3,933		
10%	4,200	0.236	Not Significant
20%	4,233		

Source: test results, 2024

The results of the panelist assessment, the highest score was obtained in the 20% *Gracilaria* sp. seaweed treatment with a mean value of 4.233 (like), while the lowest score was obtained in the control treatment (without the addition of *Gracilaria* sp. seaweed) with a mean value of 3.933 (less like). The

results of the analysis of variance (ANOVA) of the interaction of Gracilaria sp seaweed did not significantly affect the nutritional appearance of Komo tuna samosa, with a Sig value greater than 0.05.

Aroma

Aroma is part of the parameters that function to assess sensory properties (organoleptic) through the sense of smell. Aroma is considered acceptable if the resulting material emits a distinctive odor. In addition, aroma is also a subjective sensation produced by the smelling process through the sense of smell.

Table 9. Average values and results of the ANOVA test on aroma

Treatment	*Mean*	Sig	Decision
Control	3,933		
10%	3,833	0.813	Not Significant
20%	3,933		

Source: test results, 2024

The results of the panelist assessment, the highest score was obtained in the control treatment (without the addition of *Gracilaria* sp. seaweed with a mean value of 3.933) and the 20% *Gracilaria* sp. seaweed treatment with a mean value of 3.933 (less like), while the lowest score was obtained in the 10% treatment with a mean value of 3.833 (less like). The results of the analysis of variance (ANOVA) of the interaction of *Gracilaria* sp. seaweed did not have a significant effect on the nutritional aroma of Komo tuna samosa, with a Sig value greater than 0.05.

Texture

Texture refers to perceptions related to touch or feel. Often, texture is considered to have an equal level of importance to color, taste, and aroma, because it can affect the taste experience of the product. In this case, the most significant texture in food is softness and elasticity. However, properties such as hardness, compactness, and water content often receive less attention.

Table 10. Average values and results of the ANOVA test on texture

Treatment	*Mean*	Sig	Decision
Control	3,866		
10%	3,733	0.762	Not Significant
20%	3,866		

Source: test results, 2024

The results of the panelist assessment, the highest score was obtained in the control treatment (without the addition of Gracilaria sp seaweed with a mean value of 3.866) and the 20% *Gracilaria* sp. seaweed treatment with a mean value of 3.866 (like), while the lowest score was obtained in the 10% treatment with a mean value of 3.733 (less like). The results of the analysis of variance (ANOVA) of the interaction of *Gracilaria* sp. seaweed did not significantly affect the texture of the komo tuna samosa, with a Sig value greater than 0.05.

Taste

Taste is one of the determining elements whether a processed product is accepted or rejected by consumers. This taste is a sensation felt by the sense of taste, which in human senses consists of four basic tastes, namely sweet, sour, bitter, and salty, which can be strengthened by additional responses when stimulated.

Table 11 Average value and results of the ANOVA test on taste

Treatment	*Mean*	Sig	Decision
Control	4,466		
10%	4,333	0.766	Not Significant
20%	4,366		

Source: test results, 2024

The results of the panelist assessment, the highest score was obtained in the control treatment (without the addition of *Gracilaria* sp. seaweed) with a mean value of 4.466 (like), while the lowest score was obtained in the treatment of 10% *Gracilaria* sp. seaweed content with a mean value of 4.333 (like). The results of the analysis of variance (ANOVA) of the interaction of *Gracilaria* sp. seaweed did not significantly affect the texture of komo tuna samosa, with a Sig value greater than 0.05.

DISCUSSION

Chemical Test Analysis

Water Content

The results showed that the lowest water content value was found in the control treatment, namely without the addition of *Gracilaria* sp. The water content of *Gracilaria* sp. seaweed in wet conditions is higher than that in dry conditions, this is due to the drying process which causes water evaporation from the sample due to heating (sunlight). Water content according to Diachanty & Nurjanah (2017) that food ingredients that undergo drying will experience a more significant decrease in water content, including minerals. Another study by Bahi *et al.* (2020), stated that the addition of seaweed tends to increase water content, considering that seaweed itself contains a fairly high amount of water, which is around 27.8%. The nature of the thickening agent in seaweed which has a high capacity to absorb water increases the contribution of the added water content. As for the results of the ANOVA test, it can be concluded that there is a significant difference in the average water content in each treatment. This shows a significant difference in water content in the nutrition of komo tuna samosa fortified with *Gracilaria* sp. seaweed in each treatment. Thus, the addition of *Gracilaria* sp seaweed to the nutrition of komo tuna samosa has a significant effect on the water content of the samosa.

Ash Content

Researcher data shows that the lowest ash content value is in the control treatment, namely without the addition of Gracilaria sp seaweed. Ash content functions as a parameter to measure the amount of inorganic material (minerals) contained in a material or product. The higher the ash content, the more inorganic material there is in the product. The components of inorganic materials in a material vary greatly, both in terms of type and quantity, such as calcium, potassium, phosphorus, iron, magnesium, and others. Ash content is the result of burning organic material residues containing inorganic elements, (Togatorop et al., 2020). The high ash content in seaweed is related to its mineral content; the higher the mineral content, the higher the ash content, (Nosa et al., 2020). Furthermore, the ANOVA test showed that there was no significant difference between the control and 10% treatments, where the average difference descriptively between the two treatments did not show significant variation. This indicates that the ash content in the nutrition of Komo tuna samosa fortified with Gracilaria sp seaweed in the control and 10% treatments did not show any significant difference.

Protein Content

Protein is a vital nutritional component for the body because it plays a role as a building material and regulator of body functions, (Adriani, 2016; Rahma *et al*., 2024; Suprayitno & Sulistiyati, 2017). Protein also functions as a source of amino acids, both essential and non-essential, (Suprayitno & Sulistiyati, 2017). The protein content contained in a food ingredient is the main indicator for determining the quality of the food ingredient. The main purpose of analyzing protein content in food products is to measure the amount of protein contained in the ingredient, evaluate its quality from a

nutritional value perspective, and assess the role of protein as one of the chemical compounds integrated into the composition of the food ingredient, (Sudarmadji *et al.,* 2017).

Seaweed is considered a valuable source of vegetable protein, especially for individuals on a vegetarian or vegan diet, because it provides essential amino acids needed for human health. Incorporating seaweed into the diet can contribute to meeting daily protein needs while also offering other health benefits associated with its nutritional content, (Espinosa *et al.,* 2023). The results of the ANOVA test can be concluded that the comparison of the control and 10% treatments, 10% vs 20% treatments are the same and the difference in the average value descriptively between the two treatments is not significant. This shows that there is no difference in the nutritional protein content of komo tuna samosas fortified with *Gracilaria* sp. seaweed in the control and 10% treatments and 10% vs 20% treatments. While the control and 20% treatments are smaller than 0.05, so it can be concluded that there is an average difference or more significantly different in these treatments. This shows that there is a difference in the nutritional protein content of komo tuna samosas fortified with Gracilaria sp seaweed in the control and 20% treatments.

Fat Content

Based on the test results, it is known that the highest fat content value is in the 20% treatment or the addition of 20% *Gracilaria* sp. seaweed, meaning that the addition of *Gracilaria* sp. seaweed can increase the nutritional fat content of Komo tuna samosa. Several literatures report that some seaweeds contain essential fatty acids (Lopes *et al.,* 2020). Seaweed is an important source of fatty acids, including healthy polyunsaturated fatty acids (PUFA). In general, seaweed is characterized by a fatty acid composition that is quite beneficial for human health, with the amount of unsaturated fatty acids (UFA) usually higher than the amount of saturated fatty acids (SFA) (Kumari *et al.,* 2010). Furthermore, the results of the ANOVA test can be concluded that the Sig value in each treatment is greater than 0.05, so it can be concluded that all treatments are the same and the difference in the average value descriptively between the two treatments is not significant. This shows that there is no significant difference in the nutritional fat content of komo tuna samosa fortified with *Gracilaria* sp. seaweed in all treatments.

Fiber Content

The results of the study showed that the highest value of the nutritional fiber content of komo tuna samosa fortified with *Gracilaria* sp. seaweed was in the 20% treatment with a fiber content value of 18.86%. While the lowest average value was obtained in the control treatment with a fiber content value of 3.43%. The higher the *Gracilaria* sp. seaweed treatment given, the higher the fiber content produced by the nutrition of *Gracilaria* sp. seaweed fortified tuna samosa. As a comparison, a study conducted by Rohmah *et al.* (2021), the crude fiber content of *Gracilaria* sp. seaweed was obtained at 1.13%. So it can be concluded that *Gracilaria* sp. seaweed fiber has a very rich nutritional content. According to (Hermina et al., 2016). fiber can be obtained from various foods, including vegetables and fruits. *Gracilaria* sp. seaweed is known to have a fairly high dietary fiber content, around 40.6 g/100 g dry weight (Neto *et al.,* 2018). Dietary fiber has many health benefits, including helping to control blood cholesterol levels, preventing constipation, avoiding obesity, and various other benefits (Agung *et al.,* 2019). Based on the results of the ANOVA test, it is known that there is an average difference or more significantly different in each treatment. This shows that there is a significant difference in the nutritional fiber content of komo tuna samosa fortified with *Gracilaria* sp. seaweed in each treatment.

Sensory Testing

Appearance

The results of the study showed that overall, there was no significant difference in the appearance of the komo tuna samosa between the three treatments related to color and shape, which remained attractive and in accordance with the characteristics of samosas in general. Consumer acceptance of product appearance is not only influenced by color, but also by shape factors and uniformity of size. Based on the research findings, samosas in the control, 10%, and 20% treatments had a brownish color which indicated a good level of acceptance. This color is due to the similarity of the properties of the

ingredients used, such as komo tuna, Gracilaria sp, garlic, shallots, spring onions, carrots, pepper, turmeric, and salt, which were uniform during the frying process. The komo tuna samosa studied had a brownish color, but not too bright. According to Wadli (2023), the brownish color of the product can be caused by the protein content in fish and other ingredients that are mixed, which react when heated above the melting point. This process changes the color to darker to brownish. In addition, the addition of seaweed also contributes to browning due to the starch content contained in *Gracilaria* sp. seaweed, which changes color during frying.

Aroma Results

The results of the panelist assessment, the highest score was obtained in the treatment of 20% *Gracilaria* sp. seaweed content with a mean value of 3.933 (less like), while the lowest score was obtained in the treatment of 10% with a mean value of 3.833 (less like). This shows that the addition of *Gracilaria* sp. seaweed to the komo tuna samosa is preferred by consumers or panelists, because it will strengthen the aroma of the komo tuna samosa. The results of the analysis of variance (ANOVA) related to the interaction of *Gracilaria* sp. seaweed showed that there was no significant effect on the aroma of nutrients in the komo tuna samosa, with a significance value greater than 0.05. This indicates that the addition of *Gracilaria* sp. seaweed does not significantly affect the aroma of the komo tuna samosa (sig> 0.05). The strong and fishy natural aroma is still there, which is thought to come from the seaweed itself, especially after the addition of sugar which emphasizes the distinctive smell of the seaweed. In addition, white sugar contains alline, an active compound that plays a role in the formation of distinctive flavors and aromas (Buckle, 1987). Aroma usually appears in processed ingredients, caused by volatile compounds that are released during the processing or certain treatments (Suparmi *et al.,* 2021). The addition of seaweed did not show a significant effect (p> 0.05) on the aroma of komo tuna samosa. Research by Sinurat, (2006) also found that the addition of wheat flour and seaweed did not have a significant impact on the aroma of the seaweed stick snacks produced.

Texture Results

The results of the panelist assessment, the highest score was obtained in the control treatment (without the addition of *Gracilaria* sp. seaweed with a mean value of 3.866) and in the treatment of 20% *Gracilaria* sp. seaweed content with a mean value of 3.866 (like), while the lowest score was obtained in the 10% treatment (with the addition of *Gracilaria* sp. seaweed) with a mean value of 3.733 (less like). This shows that the addition of *Gracilaria* sp. seaweed levels and no addition of *Gracilaria* sp. seaweed at all in the komo tuna samosa is preferred by consumers or panelists, because it will improve the texture of the komo tuna samosa.

The results of the analysis of variance (ANOVA) on the interaction of *Gracilaria* sp. seaweed showed that there was no significant effect on the texture of the tuna samosa, with a significance value greater than 0.05. This may be due to the carrageenan content in seaweed, which has the ability to bind water. The increase in elasticity that occurs can be caused by variations in the percentage of ingredients used in making komo tuna samosas, which in turn affects the texture of the product. In addition, the difference in texture in komo tuna samosas may also be caused by the dominance of seaweed as a stabilizer and emulsifier, which plays a more significant role than other ingredients. In komo tuna samosas, the softer the texture produced, the less energy is needed to chew it. Based on the results of the analysis, the addition of Gracilaria sp seaweed did not have a significant effect on the organoleptic assessment of the texture of tuna samosas. This finding is in line with research by Nupu *et al.* (2023), which showed that the addition of seaweed did not significantly affect (p> 0.05) the texture of dry salted mackerel sambal. Similar results were also found in research by Handayani *et al.* (2014), which used the Friedman statistical test in the hedonic test of texture. The results show a P value (value) > 0.05, namely 0.686, which indicates that there is no significant effect on the texture of the cake using seaweed substitution.

Taste Results

The results of the panelist assessment, the highest score was obtained in the control treatment (without the addition of *Gracilaria* sp. seaweed) with a mean value of 4.466 (like), while the lowest

score was obtained in the treatment of 10% *Gracilaria* sp. seaweed content with a mean value of 4.333 (like). This shows that the addition of *Gracilaria* sp. seaweed content to the komo tuna samosa is preferred by consumers or panelists, because it will add to the taste of the komo tuna samosa. Based on the results of the study, the three treatments (Control, 10% and 20%) were in the "like" category. The results of the analysis of variance (ANOVA) on the interaction of *Gracilaria* sp. seaweed showed that there was no significant effect on the texture of the komo tuna samosa, with a significance value greater than 0.05. Taste is one of the important factors that influences food acceptance. Panelist acceptance of taste is influenced by various factors, including chemical compounds, temperature, concentration, and interactions between other taste components (Winarno, 1997). In this study, the addition of *Gracilaria* sp. seaweed did not affect the taste of komo tuna samosa. The taste of the samosa was obtained from a mixture of komo tuna, garlic, shallots, spring onions, and other ingredients that act as control variables in the process of making komo tuna samosa. In addition, the taste of Gracilaria sp seaweed tends to be less preferred because it still retains a fairly significant fishy taste. This finding is in line with research by Wardhani (2016), which stated that seaweed puree did not affect the taste of siomay. Research conducted by Sajidah *et al.* (2022), also showed that based on the Kruskal-Wallis test, the concentration of seaweed did not have a significant impact ($p > 0.05$) on the taste of analog rice.

CONCLUSION

Based on the results of the research conducted by the researcher, it can be concluded that the content of komo tuna samosa fortified with *Gracilaria* sp. seaweed includes, the largest water content is in the treatment of adding 20% *Gracilaria* sp. seaweed, for the highest ash content is in the addition of 20% *Gracilaria* sp. seaweed, for the highest protein content is in the control treatment meaning there is no addition of 0% *Gracilaria* sp. seaweed, for the highest fat content is in the addition of 20% *Gracilaria* sp. seaweed and for the highest fiber content is in the addition of 20% *Gracilaria* sp. seaweed from the average results of each test as many as 3 times. Furthermore, the level of consumer acceptance of komo tuna samosa fortified with *Gracilaria* sp. seaweed. The highest value is aimed at sample C, with the addition of 20% *Gracilaria* sp. seaweed the most preferred by panelists among the three treatments in all parameters. Where in the three treatments of the results of the analysis of variance (ANOVA), the interaction of Gracilaria sp seaweed did not significantly affect the appearance, aroma, texture and taste of Komo tuna samosa.

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REFERENCES

Adliya, N., & Setiawan, Y. (2022). Analisis Penerapan Program 5m Pada Pelaksanaan Ptm Terbatas di Masa Pandemi Covid-19 SDN 2 Nglangitan. *Jurnal Ilmiah Wahana Pendidikan*, *8*(13), 347–361.

Anggadiredja, T. J., Zatnika, A., Purwoto, H., & Istini, S. (2019). Rumput laut: pembudidayaan. *Pengolahan Dan Pemasaran Komoditas Perikanan Potensial, Depok Penebar Swadaya.*

Ayuni, D. Q., & Rishel, R. A. (2021). Pemberian Konsumsi Rumput Laut (Eucheuma Spinosum) Terhadap Peningkatan Kadar Hemoglobin Pada Ibu Hamil Diwilayah Kerja Puskesmas Naras Kota Pariaman. *Jurnal Ilmu Keperawatan Dan Kebidanan*, *12*(1), 149–156.

Bahi, W., Sabtu, B., & Armadianto, H. (2020). Pengaruh penambahan rumput laut (Eucheuma) terhadap kualitas fisikokimia dan organoleptik bakso daging ayam broiler. *Jurnal Peternakan Lahan Kering*, *2*(1), 762–769.

BPS. (2022). Produksi Perikanan Laut yang dijual di Tempat Pelelangan Ikan (TPI) menurut Jenis Ikan (Kuintal), 2020-2021. *Badan Pusat Statistik Sulawesi Sealatan*.

Cokrowati, N., Nurâ, D., & Mukhlis, A. (2020). Edukasi nilai gizi ikan melalui pelatihan pembuatan makanan olahan berbahan baku ikan Tongkol. *Jurnal Abdi Insani*, *7*(1), 49–54.

Diachanty, S., & Nurjanah, A. A. (2017). Aktivitas antioksidan berbagai jenis rumput laut cokelat dari perairan Kepulauan Seribu. *Jurnal Pengolahan Hasil Perikanan Indonesia*, *20*(2), 305–318.

Fatmawati, A. (2018). *Regulasi diri pada penyakit kronis—systemic lupus erythematosus: kajian literatur*.

Gorintha, M., & Pratiwi, K. T. A. (2023). Pembuatan Nugget Berbahan Dasar Ikan Tongkol. *Jurnal Ilmiah Pariwisata Dan Bisnis*, *2*(10), 2335–2339.

Handayani, R., Aminah, S., & Suyanto, A. (2014). Variasi substitusi rumput laut terhadap kadar serat dan mutu organoleptik cake rumput laut (Eucheuma cottonii). *Jurnal Pangan Dan Gizi*, *2*(1).

Hasdar, M., Wadli, W., & Meilani, D. (2021). Rancangan Acak Lengkap dan Rancangan Acak Kelompok pada pH Gelatin Kulit Domba Dengan Pretreatment Larutan NaOH. *Journal of Technology and Food Processing (JTFP)*, *1*(01), 17–23.

Masrikhiyah, R., & Wahyani, A. D. (2020). Karakteristik Kimia dan Fisik Bubuk Rumput laut Gracilaria sp dengan agen Pemucat NaOCl. *Jurnal Teknologi Perikanan Dan Kelautan*, *11*(1), 93–98.

Merryana Adriani, S. K. M. (2016). *Pengantar gizi masyarakat*. Prenada Media.

Mulyani, S., & Indrawati, E. (2019). *Analisis Kelayakan Lahan Budidaya Rumput Laut Gracilaria sp di Tambak Kecamatan Sinjai Utara Kabupaten Sinjai*.

Nosa, S. P., Karnila, R., & Diharmi, A. (2020). Potensi kappa karaginan rumput laut (Eucheuma cottonii) sebagai antioksidan dan inhibitor enzim α-glukosidase. *Berkala Perikanan Terubuk*, *48*(2), 434–449.

Nur, U. (2017). Pengaruh Penggunaan Jenis Ikan (Tuna, Dori, Barakuda) Pada Isian Samosa Terhadap Daya Terima Konsumen. *Repository.Unj.Ac.Id*.

Pratiwi, A., Almira, C. S., Firdus, F., Nasir, M., & Muchlisin, Z. A. (2025). Literature Review: Komposisi Lambung Famili Scombridae di Perairan Indonesia. *Zoologi: Jurnal Ilmu Peternakan, Ilmu Perikanan, Ilmu Kedokteran Hewan*, *3*(1), 19–28.

Puspitasari, L. L., & Komariah, K. (2023). PEMBUATAN PRODUK SAMOSA IKAN TUNA DALAM USAHA MENGATASI MASALAH MALNUTRISI GEN Z DI INDONESIA. *Prosiding Pendidikan Teknik Boga Busana*, *18*(1).

Rahma, A. A., Nurlaela, R. S., Meilani, A., Saryono, Z. P., & Pajrin, A. D. (2024). Ikan Sebagai Sumber Protein dan Gizi Berkualitas Tinggi Bagi Kesehatan Tubuh Manusia. *Karimah Tauhid*, *3*(3), 3132–3142.

Rahmawati, A. S., & Erina, R. (2020). Rancangan acak lengkap (RAL) dengan uji anova dua jalur. *OPTIKA: Jurnal Pendidikan Fisika*, *4*(1), 54–62.

Sipahutar, Y. H., Taufiq, T., Kristiani, M. G. E., Prabowo, D. H. G., Ramadheka, R. R., Suryanto, M. R., & Pratama, R. B. (2020). The effect of Gracilaria powder on the characteristics of nemipterid fish sausage. *IOP Conference Series: Earth and Environmental Science*, *404*(1), 012033.

Sitompul, Y. M. L., Sugitha, I. M., & Duniaji, A. S. (2020). Pengaruh lama perendaman dalam ari perasan buah belimbing wuluh (Averrhoa blimbi Linn) dan lama penyimpanan terhadap karakteristik ikan tongkol (Euthynnus affinis) pada suhu ruang. *Jurnal Ilmu Dan Teknologi Pangan*, *9*(1), 71–80.

Sudarmadji, S., Suhardi, & Haryono, B. (2017). *Analisa bahan makanan dan pertanian*. Liberty Yogyakarta bekerja sama dengan Pusat Antar Universitas Pangan dan ….

Suprayitno, E., & Sulistiyati, T. D. (2017). *Metabolisme protein*. Universitas Brawijaya Press.

Togatorop, S., Hermansyah, H., & Norhayani, N. (2020). Kajian Mutu Dawet Rumput Laut (Eucheuma Cottonii). *Journal of Tropical Fisheries*, *15*(1), 8–19.