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Utilization of Sea Cucumber (*Holothuria scabra*) for Nutritious and Healthy Food Consumption in the Maluku Community

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ABSTRACT

Types of sea cucumbers consumed by communities in the Maluku region are primarily *Bohadschia bivittata*, *Holothuria scabra*, and *Pentamera calcigera*, which are found in sandy substrates, hence referred to as "sandy sea cucumbers." Proximate analysis results show the highest protein content at 6.19% in *Pentamera calcigera* and the lowest at 5.24% in *Holothuria scabra.* The highest fat content is 0.71% in *Bohadschia bivittata*, and the lowest is 0.55% in *Pentamera calcigera*. The highest ash content is 3.29% in *Bohadschia bivittata*, and the lowest is 3.10% in *Pentamera calcigera*. The highest moisture content is 90.65% in *Bohadschia bivittata*, while *Holothuria scabra* has nutritional values between the other two species. A significant relationship exists between knowledge and skills in managing nutritious meal preparation, as indicated by an R^2 value of 0.961. This suggests that 96.1% of the community's skill in preparing nutritious and healthy meals from sandy sea cucumbers is influenced by their knowledge, with only 3.99% attributed to other factors. The novelty of this study lies in its integrative approach combining nutritional (proximate) analysis of sandy sea cucumbers with a socio-behavioral assessment of community knowledge and culinary practices an aspect rarely explored in previous marine nutrition studies. In other words, the higher the community's knowledge about sea cucumbers as a nutritious and healthy food source, the better their skills in preparing nutritious meals.

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INTRODUCTION

The Maluku Province is administratively divided into nine regencies and two cities, characterized by its archipelagic nature, with a total area of 712,480 km², whereas 7.6% is land and 92.4% is sea. The total coastline stretches 10,662 km with a population of 1,848,892. This population resides along the coast, with a population growth rate of 1.83% (BPS Maluku Province Data, 2024). This population growth necessitates the support of food sources from coastal and marine waters. As the population increases, the food provision elevates. A solution to meet food demand is the exploration of new food sources through the expansion of areas and diversification of food from coastal and marine waters, which contain various types of marine biota that can be utilized by coastal communities in this region.

Coastal and marine waters serve as ecosystems for various types of marine biota, which are essential for the survival of the communities but have yet to be fully explored, particularly concerning their functions and roles as sources of nutritious food. According to Sri Puryono et al. (2019), coastal and marine waters hold great potential for human life, especially given that their ecosystems and marine biota still harbor many undiscovered secrets as sources of nutritious food. Hasan Tuaputty (2022) noted that the tidal zone, which includes intertidal and subtidal areas, hosts various marine life forms that are crucial for the livelihood of coastal communities. Among the marine biota that serve as a nutritious food source with economic value for coastal communities in Maluku Province are various species of sea cucumbers (Holothuria sp.). This point is further emphasized by Louhenapessy, D. G., and J. M. F. Sahetapy (2017), who stated that many coastal communities in Maluku harvest and collect marine biota, particularly various species of sea cucumbers (Holothuria sp.), found in sandy coastal and marine waters to be consumed with their families.

The varieties of sea cucumbers (Holothuria sp.) consumed by communities in this region are primarily those found living in fine sandy, gravelly, and even crushed stone substrates in various coastal waters of Maluku Province. The varieties consumed by coastal communities exhibit morphological differences, including body size, length, width, and color. According to Gratia D. Manuputty (2021), sea cucumbers (Holothuria sp.) are highly favored by coastal communities for consumption, particularly those with elongated, cucumber-like bodies, a smooth texture, spines, and colors ranging from brown, dark brown, to gray with black spots. Louhenapessy, D. G. et al. (2017) noted that the increasing consumption of sea cucumbers as a nutritious food source by coastal communities could lead to over-exploitation, necessitating knowledge, skills, and awareness among coastal communities. Marsoedi et al. (2020) stressed the need for oversight of excessive sea cucumber exploitation, although it has not yet occurred in Maluku. Efforts in cultivation and protection are necessary to ensure the availability and sustainability of sea cucumbers as a nutritious food source for the community.

The varieties of sea cucumbers as a nutritious food source are mainly utilized by coastal communities and have not yet become a staple for the general population. This is likely due to a lack of knowledge and skills in preparing dishes from sea cucumbers, despite their rich nutritional content. The consumption of sea cucumbers as nutritious food is primarily limited to coastal communities, making them less popular as a nutritious food source. According to Devi Wulansari et al. (2023), there is a need for public awareness of the nutritional value contained in sea cucumbers as a healthy and nutritious food, beneficial for human health. Gratia D. Manuputty (2022) highlighted that various nutrients in sea cucumbers (Holothuria sp.) are crucial for human health, although their preparation requires patience and precision.

The nutritional content of the varieties of sea cucumbers consumed by coastal communities in several areas of Maluku Province needs to be analyzed through proximate testing to determine protein, fat, moisture, and ash content. This will help communities gain accurate knowledge of the nutritional value of sea cucumbers (Holothuria sp.) as a nutritious food source beneficial for health. Additionally, it is essential to develop good skills in preparing dishes from sea cucumbers for consumption by coastal communities in this region. Eliska et al. (2021) emphasized the importance of knowledge and skills in processing food materials from coastal and marine waters, given the differences in food processing between coastal and urban communities. Knowledge among urban mothers differs from those in rural areas. Incorrect food processing can lead to a decrease in nutritional value, making the food less desirable. According to Hendy Noor Irawan (2022), to meet the need for nutritious food, one should

consume healthy foods, as eating is not just about satisfying hunger but also about meeting the body's nutritional needs. Therefore, this study aims to reveal the nutritional content of various types of sea cucumbers consumed by coastal communities based on proximate testing and assess the community's knowledge of sea cucumbers as a nutritious food source and their skills in preparing sea cucumber dishes as favored food, given the excellent nutritional value of sea cucumbers for human health.

MATERIALS AND METHOD

This research was conducted through a multi-experimental approach, which consisted of surveys carried out in various regions of Maluku Province and laboratory analyses performed at the Faculty of Fisheries and Marine Science, Pattimura University, Ambon. To ensure accurate data collection, several steps were undertaken. First, data collection sites were purposively selected from different regions within Maluku Province, namely Central Maluku Regency, West Seram Regency, Ambon City, East Seram Regency, and South Buru Regency. Surveys were then conducted among coastal communities known to consume sea cucumbers (*Holothuria* sp.) as a nutritious and healthy food source. The surveyed communities included Kailolo Village in Central Maluku Regency, Kairatu Village in West Seram Regency, Eri Village in Ambon City, Namrole Village in South Buru Regency, and Gorom Island in East Seram Regency.

A total of 75 respondents participated in the survey, representing four regencies and one city in Maluku Province, with 15 respondents selected from each region. Data collection was carried out through interviews and questionnaire distribution. In addition, sea cucumber species (*Holothuria* sp.) consumed by the communities were collected from various coastal waters in Maluku Province for nutritional analysis. The proximate analysis, covering protein, fat, ash, and moisture content, was conducted at the laboratory of the Faculty of Fisheries and Marine Science, Pattimura University, following the standardized guidelines of the Association of Official Analytical Chemists (AOAC, 2005).

The questionnaire consisted of ten questions, five of which focused on assessing respondents' knowledge of sea cucumbers as a nutritious and healthy food source, while the remaining five evaluated their skills in preparing dishes made from sea cucumbers. The details of these questions are presented in **Table 1**.

Table 1. Knowledge and Skill Questions in the Questionnaire Related to Sea Cucumbers as a Source of Nutrition and Health

	Knowledge Questions	Answers		Skill Questions	Answers	
1	Do you have knowledge about sea cucumbers (Holothuria scabra) as a source of nutrition and health passed down through your family?	yes	no	Can you prepare various dishes using sea cucumbers?	yes	no
2	Can you describe the morphological and physiological characteristics of sea cucumbers (Holothuria sp.)	yes	no	When preparing sea cucumber dishes, are there parts of the sea cucumber that need to be removed?	yes	no
3	Can you explain why the habitat of sea cucumbers (Holothuria sp.) is difficult to find due to sand or rock extraction in coastal areas?	yes	no	Are the seasonings used for cooking sea cucumbers (Holothuria scabra) the same as for other ingredients?	yes	no
4	Can you explain that sea cucumbers are nutritious for health due to the good nutrients and minerals found in their meat?	yes	no	Do you need special skills to determine the ingredients used in cooking sea cucumbers, considering their distinctive smell?	yes	no
5	Can you describe how consuming sea cucumbers can contribute to health, as they contain carbohydrates, fats, proteins, minerals, and water?	yes	no	Is it necessary to have skills in processing sea cucumbers (Holothuria scabra) as nutritious and healthy food so that it is palatable and retains its nutritional value?	yes	no

The responses to the questionnaire regarding the community's knowledge and skills in preparing nutritious and healthy dishes from various sea cucumber species were analyzed based on the achievement scores of each respondent. These scores were then subjected to inferential statistical testing.

Data Analysis

The collected data were analyzed according to the research problems and hypothesis testing to find answers related to sea cucumber (*Holothuria scabra*) as a nutritious and healthy food for coastal communities in Maluku Province. This involved both proximate analysis and questionnaire analysis using descriptive and inferential statistics, utilizing *SPSS 20.0*.

RESULTS AND DISCUSSION

The observation of sea cucumber (*Holothuria* sp.) varieties consumed by coastal communities in Maluku Province reveals that the brown sea cucumber is the species *Bohadschia bivittata*, the gray sea cucumber is *Holothuria scabra*, and the white sea cucumber is *Pentamera calcigera*.

Bohadschia bivittata *Holothuria scabra* *Pentamera calcigera*

Figure 1. Documentation of Sandfish Sea Cucumber (Holothuria scabra) Consumed by Communities in Maluku Province.

The images and documentation indicate that these sea cucumber varieties inhabit intertidal coastal waters with sandy or fine gravel substrates. These species can also be found in subtidal zones with various substrates, including sand and gravel, often surrounded by macroalgae like *Sargassum crassifolium* and *Padina gymnosspora*. Coastal communities consume these sea cucumbers, stating that all types living in sandy areas can be eaten, except for those that are black in color.

The nutritional analysis (proximate analysis) was conducted on samples of brown, gray, and white sea cucumbers. The proximate analysis was performed at the Faculty of Fisheries Laboratory, University of Pattimura, with three repetitions, and the average values are shown in **Table 2**.

Table 2. Proximate Analysis Results of Various Sea Cucumber Varieties Found on Sandy Substrates and Consumed by Coastal Communities in Maluku Province

Sea Cucumber Variety	Nutritional Content (%)			
	Protein	*Fat*	*Ash*	*Moisture*
Brown sea cucumber (Bohadschia bivittata)	*5.88%*	*0.71%*	*3.29%*	*90.35%*
Gray sea cucumber (*Holothuria scabra)*	*5.24%*	*0.65%*	*3.23%*	*90.68%*

White sea cucumber (*Pentamera calcigera)*	*6,19%*	*0,55%*	*3.10%*	*88.20%*

Based on the data in **Table 2**, there are significant differences in the nutritional content among the sea cucumber varieties consumed by coastal communities. The white sea cucumber (*Pentamera calcigera*) has the highest average protein content at 6.19%, followed by the brown sea cucumber (*Bohadschia bivittata*) at 5.88%, with the gray sea cucumber (*Holothuria scabra*) having the lowest protein content at 5.24%. The brown sea cucumber has the highest fat content at 0.71%, while the white sea cucumber has the lowest at 0.55%. The brown sea cucumber also has the highest ash content at 3.29%, with the white sea cucumber having the lowest at 3.10%. In terms of moisture, the gray sea cucumber has the highest content at 90.68%, followed by the brown sea cucumber at 90.35%, with the white sea cucumber having the lowest at 88.20%.

A regression and Anova analysis conducted based on responses from 75 respondents regarding their knowledge of sea cucumber varieties as nutritious and healthy food and their skills in preparing sea cucumber dishes favored by the community. The results are shown in **Table 3.**

Table 3. Regression and Anova Analysis between Knowledge of Various Sea Cucumber Varieties (*Holothuria* sp.) and Community Skills in Preparing Sea Cucumber Dishes as a Source of Nutrition and Health

Model Summary

R	R Square	Adjusted R Square	Std. Error of the Estimate
.961	.924	.923	.038

The independent variable is Skills.
Predictors (constant is knowledge.

ANOVA

	Sum of Squares	df	Mean Square	F	Sig.
Regression	1.227	1	1.227	870.159	.000
Residual	.102	72	.001		
Total	1.329	73			

The independent variable is Skills.
Predictors (constant is Knowledge

This is evidenced by the correlation analysis results, which show an R^2 value of 0.961. This indicates a significant correlation between the community's knowledge of sand sea cucumbers (*Holothuria* sp*.)* as a food and health source, and their skills in preparing various dishes from these sea cucumbers as nutritious and healthy food. The significant correlation, with an R^2 value of 0.961, suggests that 96.1% of the community's skills in creating nutritious and healthy dishes from sand sea cucumbers are influenced by their knowledge, while only 3.99% is attributed to other factors.

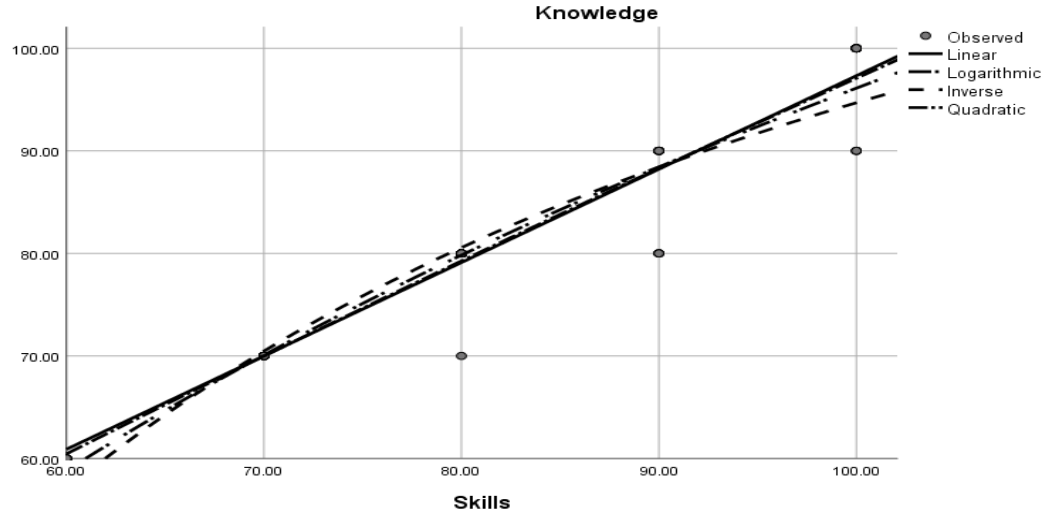
The analysis data also reveal an influence of knowledge about the types of sand sea cucumbers (*Holothuria* sp*.)* on the community's skills in preparing nutritious and healthy dishes in Maluku Province. This is evident from the analysis showing a significant influence with a degree of freedom (df) = 73-72= 1 and an F-value of 870.159 at a significance level of 0.000, which is less than $p < 0.05$. This indicates a significant impact of the community's knowledge about the varieties of sand sea cucumbers (*Holothuria* sp*.)* on their skills in making healthy and nutritious dishes, which also positively affects children's health and intelligence when consuming various varieties of sand sea cucumbers (*Holothuria* sp.).

Based on the results of the regression analysis, a highly significant regression coefficient was obtained, indicating a strong relationship between the community's knowledge of various types of sand sea cucumbers (*Holothuria* sp.) as a food and health source, and their skills in preparing nutritious and healthy dishes from these sea cucumbers. This is illustrated in Table **4 below**.

Table 4. Regression Coefficients between Knowledge of Sea Cucumber Varieties and Skills in Preparing Nutritious and Healthy Dishes as a Source of Nutrition and Health for Communities in Maluku Province

Coefficients					
	Unstandardized Coefficients		Standardized Coefficients		
	B	Std. Error	Beta	t	Sig.
The independent variable is Skills	1.011	.000	2.614	2581.144	.000
(Constant) Knowledge	31.421	1.008		31.174	.000

Table 4 shows significant regression coefficients indicating a linear correlation based on the equation y = a + bx = 1.011 + 31.421. This signifies that the higher the community's knowledge about sea cucumber varieties, the higher their skills in preparing nutritious and healthy dishes, as evidenced by the linear correlation in Graph 1 below.



Graph 1. Linear Correlation between Community Knowledge of Sea Cucumber Varieties and Skills in Preparing Nutritious and Healthy Dishes

Graph 1 illustrates a significant correlation between community knowledge of various sea cucumber varieties (*Holothuria sp*) as a source of nutrition and health, and their skills in preparing nutritious and healthy dishes in several districts and cities in Maluku Province. The linear correlation is shown by the observation points and the inverse, logarithmic, and quadratic lines closely following the linear correlation line.

The proximate analysis of the brown sea cucumber (*Bohadschia bivittata*) revealed an average protein content of 5.88%. In comparison, the gray sea cucumber (*Holothuria scabra*) exhibited an average protein content of 5.24%, while the white sea cucumber (*Pentamera calcigera*) showed the highest protein content, averaging 6.19%. According to Lena Jeane Damongilala (2021), sea cucumbers exhibit a variety of species with protein content ranging from 1.4% to 7.8%. Nona Shalgie et al. (2021) explained that the proximate analysis of various sea cucumber species revealed protein levels ranging from 0.87% to 5.92%. The protein content in sea cucumbers can be utilized not only as a nutritious food but also for medicinal purposes, given that the protein composition in sea cucumbers can reach up to 11.3% (Marcelien D. R. Oedjoe, 2021). Protein levels in sea cucumbers are higher compared to fat, as protein functions in muscle formation and hormone production, with high water content generally being present compared to fat, and minerals neutralizing various metabolic processes within the sea cucumber's body.

Nutritious and healthy food source, sea cucumbers also contain fat, with the brown sea cucumber (*Bohadschia bivittata*) showing a fat content of 0.71%, the gray sea cucumber (*Holothuria scabra*) at

0.65%, and the white sea cucumber (*Pentamera calcigera*) at 0.55%. Upon converting the fat content in various sea cucumber species from proximate analysis, it was found that the fat content does not exceed 1%. This aligns with the explanation by Thi N.A. Nguyen et al. (2022), who stated that the proximate analysis of various sea cucumber species revealed very low-fat content ranging from 0.3% to 1.9%, compared to the higher protein content. Agelica J.F. Renyaa (2024) reported that proximate tests on sea cucumbers with multiple repetitions resulted in fat content ranging from 0.1802% to 0.1806%. Thus, the fat content in various sea cucumber species is very suitable for consumption as a healthy and nutritious food, with low-fat content of less than 1%, as fat is mostly found in muscle tissues and ossicles and is distributed throughout the body. This is further supported by the explanation by Sabilu et al. (2020), who stated that differences in fat and protein content among various sea cucumber species can be attributed to differences in their habitat substrates. The ash content in various sea cucumber species revealed that the brown sea cucumber (*Bohadschia bivittata*) had an ash content of 3.29%, the gray sea cucumber (*Holothuria scabra*) had an ash content of 3.23%, and the white sea cucumber (*Pentamera calcigera*) had an ash content of 3.10%. The slight differences in ash content among these three sea cucumber species are likely due to differences in species. Additionally, the slight differences in ash content could be due to the soaking process of the sea cucumbers in water with varying salinity, as well as the increase in water temperature during soaking before analysis was conducted. This is in line with the explanation by Nurul Afifah Elfath et al. (2019), who stated that ash content can serve as an indicator of the mineral content in food materials, with ash content in sea cucumbers ranging from 0.82% to 5.19%. The ash content of sea cucumbers is related to the mineral content within the sea cucumber material. The variations in ash content are influenced by the different species of organisms and the aquatic environment in which they live. Differences in ash content among various sea cucumber species consumed by coastal communities are attributed to their different habitats and the different food sources available in those habitats.

The moisture content in the proximate analysis showed that the gray sea cucumber (*Holothuria scabra*) had an average moisture of 90.68%, while the brown sea cucumber (*Bohadschia bivittata*) had an average moisture content of 90.39%, and the white sea cucumber (*Pentamera calcigera*) had an average moisture content of 88.20%. Differences in moisture content are likely due to the collection of sea cucumbers during the rainy season and the varying species of sea cucumbers. Abdullah Rasyid et al. (2020) reported that the high moisture content in fresh sea cucumbers of various species ranges from 81.24% to 85.56%. These differences are likely attributed to varying coastal water conditions and environmental factors, as well as differences in sea cucumber species. Based on data from the analysis of community knowledge on *Holothuria* sp. as a nutritious and health-promoting food source, there was a significant influence of knowledge on the skills of communities in managing sea cucumber-based dishes, as shown by the influence test results with a df = 73-72 = 1 and an F-value of 870.159, with a significance level of 000, < p 0.05. This indicates a significant influence of community knowledge on sea cucumbers (*Holothuria sp.*) as a food and health source on their skills in preparing nutritious and healthy sea cucumber-based dishes.

The analysis also showed a significant relationship between knowledge and community skills, as demonstrated by the analysis results showing an R^2 value of 0.961, indicating that knowledge influences 96.1% of the skills in managing sea cucumber-based dishes, with only 3.9% influenced by other factors. The analysis further demonstrated in Graph 1 that the higher the community's knowledge, the higher their ability to manage nutritious meals. The knowledge of the nutritional content of various sea cucumber species used as food and health sources can provide solutions to enhance food security for coastal communities. According to Gratia D. Manuputty et al. (2022), to achieve high-quality sea cucumber dishes with nutritional value, knowledge of proper processing techniques and culinary skills is required. Proper processing must consider the sea cucumber species being prepared as nutritious and healthful dishes. According to Ramesha Thimmappa et al. (2023), sea cucumbers contain essential chemical compounds necessary for the body, making it important to maintain quality during processing. As sea cucumbers are a highly perishable food, processing them requires specific skills. Fresh sea cucumbers with physical damage should be avoided, as this can lead to a decrease in the quality of nutritional content.

The *Holothuria sp.* sea cucumber species are found in all coastal waters of Maluku Province, and this species is consumed by all coastal communities in the region. Based on observations and a family-centered approach, it was found that the sand sea cucumber (*Holothuria scabra*) is found in various coastal waters with sandy substrates and is commonly consumed for daily needs as well as sold as a food source. Sri Turni Hartati et al. (2020) stated that sand sea cucumbers dominate coastal waters more than other sea cucumber

species consumed by the community. Alefane Ndun et al. (2021) explained that coastal communities typically utilize marine products, such as sand sea cucumbers (*Holothuria scabra*), for daily needs and for sale. Sea cucumbers are used by coastal communities as a food source and have economic value as they can be used in the food, pharmaceutical, and cosmetics industries. Based on the results of the nutritional content analysis of the three sea cucumber species (brown, gray, and white), it was found that the highest protein content was in the *Pentamera calcigera* species. This species has a smaller body size (9-10 cm) and a firmer and denser body compared to the other two species, *Bohadschia bivittata* and *Holothuria scabra*. The community highly prefers this sea cucumber for consumption due to its high protein content. Rahman Karnila et al. (2021) stated that healthy food sources for health must have high protein content, making them suitable as raw materials for various industries in different countries. Research shows that sea cucumber protein content in various species can be used as a raw material for the pharmaceutical industry. Thus, the variety of sea cucumbers found in the coastal waters of Maluku Province, as a nutritious and healthy food source for the community, is a blessing from the Creator to the people in this area. It is necessary to increase the utilization of coastal and marine resources for the well-being of the community in this region. Soenan Hadi Poernomo et al. (2021) stated that empowering communities by utilizing local marine resources as high-quality regional products can improve community nutrition and compete in the market. The local government must encourage the economic independence of coastal communities through the development of superior marine products, particularly the sand sea cucumber variety, by creatively and innovatively processing local marine resources, presenting superior products in terms of taste and nutrition, ensuring they are halal, and maintaining the quality of sea cucumber products as a nutritious and healthy food source for the community in this region.

The novelty of this study lies in its integrative approach combining nutritional (proximate) analysis of sandy sea cucumbers with a socio-behavioral assessment of community knowledge and culinary practices—an aspect rarely explored in previous marine nutrition studies. By linking biochemical composition with local knowledge and food utilization patterns, this research provides a new perspective on the role of traditional marine resources in improving community nutrition and food security in the Maluku region. The findings serve as a valuable reference for promoting sustainable sea cucumber utilization and community-based marine food innovation.

CONCLUSION

1. The types of sea cucumbers consumed by the community in this region as a nutritious and healthy food source are species Bohadschia bivittata, Holothuria scabra, and Pentamera calcigera. These three species of sea cucumbers have different morphologies, body sizes, and colors.
2. Pentamera calcigera has the highest protein content at 6.19%, while Bohadschia bivittate contains the highest fat content at 0.71%, the highest ash content at 3.29%, and the highest moisture content at 90.65%. Holothuria scabra has nutritional values that fall between the other two species consumed by the community as a nutritious and healthy food source.
3. The community's knowledge about Holothuria sp. as a nutritional and health food source significantly influences their skills in preparing dishes from sea cucumbers. This is evident from the analysis, with a degree of freedom (df) of 1 (73-72), and an F-value of 870.159 at a significance level of 0.000, which is less than $p < 0.05$. The analysis also shows a significant relationship between knowledge and skills, as indicated by an R^2 value of 0.961, meaning that 96.1% of the variance in skills is explained by knowledge, with only 3.9% attributed to other factors.

AUTHORS CONTRIBUTION

Tuaputty, H.., Leiwakabessy, F., Wael, S. designed and conducted the research, analysed and interpretation the data.

CONFLICT OF INTEREST

The authors declare that there are no competing interests.

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