

Development and Acceptability of Sea Cucumber (Holothuria Edulis) Kropek

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ABSTRACT

This study aimed to develop and evaluate the acceptability of sea cucumber (*Holothuria edulis*) kropek using a developmental–descriptive research design. Product development and physicochemical analysis were conducted at the Surigao del Norte State University Food Laboratory, while sensory evaluation was carried out among 60 purposively selected respondents composed of food industry experts, Home Economics teachers, and consumers. Three kropek formulations (100 g, 75 g, and 50 g mixtures) were assessed using an adopted and modified 9-point Hedonic Scale to measure appearance, aroma, taste, texture, and overall acceptability. Data were analyzed using frequency counts, percentages, means, standard deviations, and analysis of variance at a 0.05 level of significance. Results showed that respondents were predominantly young adults, mostly single, with moderate income levels, providing a relevant consumer profile. Across all sensory attributes, the 75 g mixture consistently obtained the highest ratings, falling under the “like very much” category, and demonstrated statistically significant differences compared to the other formulations, particularly in taste and texture. No significant differences in sensory acceptability were observed when respondents were grouped according to age, sex, civil status, educational attainment, and income, indicating broad demographic appeal. Physico-chemical analysis of the most preferred formulation revealed acceptable ash (3.6%), sodium (1.1%), and moisture (6.9%) contents, supporting product stability and nutritional suitability. Overall, the findings identify the 75 g formulation as the most acceptable and commercially viable sea cucumber kropek, combining superior sensory qualities with favorable nutritional characteristics.

Keywords: Sea cucumber kropek, *Holothuria edulis*, Sensory acceptability, Product development, Hedonic scale evaluation

Introduction

Kropek it is a traditional dried crispy food product that is mostly consumed in South-East Asian nations, especially Indonesia and Malaysia (Caniedo, et al, 2023). It is one of the more versatile finger foods when one wants a quick nibble. It is a popular crunchy food snack that is most liked not only by children but also by adults because of its unique attributes (Pagatpatan, Morante, Lagramada & Lacaba, 2019).

There were many variations of Kropeks depending on the new ingredients that were being incorporated with the purpose of increasing the nutritional value of this product. Labinghisa (2024) developed a Kropek Jackfruit with Moringa Leaves which he found out that this variation of Kropek’s nutritional value significantly better than conventional kropek without Jackfruit and Moringa Leaves. Pagatpatan, et (2019)

developed Kropek with Spider Conch has better quality which is very much like by the consumers compared to the Squid Kropek and Fish Kropek.

Although there were many studies conducted about the development of Kropeks in order to make it more palatable and nutritious but there was no study conducted yet using Sea Cucumber (*Holothuria edulis*) as the main ingredient in order to enhance the protein content of the product. Especially that proteins are essential macronutrients allowing both growth and maintenance and are required for the structural and functional system of the human body (Park, Chung, Hwang, Shon & Kim, 2022). Thus, the food that the people should intake must not only be delicious but should also give them necessary nutrient like the protein so that the systems of the human body will be functioning well.

Aside from this, it is aligned to the Sustainable Development Goal (SDG) number 12 which is responsible consumption and production in several ways. First, it promotes sustainable use of marine resource since utilizing sea cucumbers for Kropek production encourages the sustainable harvesting of these marine species. Next, it reduces food waste by using parts of the sea cucumber that might be discarded in traditional harvesting practices. Also, it encourages sustainable production practices since it encourages local for sustainable aquaculture of sea cucumbers. Finally, it enhances economic opportunities and livelihood because it can empower coastal communities by providing them with a sustainable livelihood through the production and sale of value-added products.

These premises prompted the researcher to develop a Sea Cucumber Kropek product which aims to increase its protein content. With this, the consumers will enjoy a maximum benefit in consuming the Kropek product because it gives them pleasure and necessary nutrients specifically the protein for their body. Sea cucumbers are benthic marine invertebrates with a soft and elongated body, belonging to the class *Holothuroidea* of the phylum *Echinodermata* (Hickman et al., 2019). In fact, Liu et al., 2021 provides evidence that the viscera of the sea cucumber may contain significant amounts of proteins, amino acids, polysaccharides, fatty acids, saponins, and other components similar to those of the body wall, and thus could be used as a source of biomolecules and nutritional compounds. Pangestuti and Arifin, (2019) also found out that sea cucumbers are known to synthesize a wide range of biomolecules, such as polysaccharides, peptides, proteins, lipids, fucoidan, fucosylated chondroitin sulfate, sulfated fuan, phenols, and saponins, among others.

The result of this study will have a significant impact on the food industry and health of the consumers. In turn, the consumers will enjoy eating a delicious snack that is beneficial to their health. Also, it can be a source of income for a small-time entrepreneur, which will impact the economy.

Conceptual Framework

This study utilizes the IPO Model which stands for Input, Process, and Output. This framework is an analytical tool for this study. It is used to make conceptual distinctions and bring together different ideas. This also led to the actual relationship of the intended objectives.

The inputs for this research as shown in the first box are the development of Sea Cucumber which has the following formulations: Formulation 1: 100% Sea Cucumber Base, Seasonings); Formulation 2: 75% Sea Cucumber, 25% Starch, Seasoning); The center box represents the process that should be conducted by the researcher in the development of the product wherein the three formulations should undergo physicochemical analysis. It should also be evaluated based on its sensory attributes such as Appearance, Aroma, taste, Texture, and Overall Acceptability using a standardized survey questionnaire, the Hedonic Scale by Peryam and Pilgrim (1957).

The last box shows the intended output of the study which is the developed Sea Cucumber products. The figure 1 below shows the schematic diagram and interplay of the variables in the study

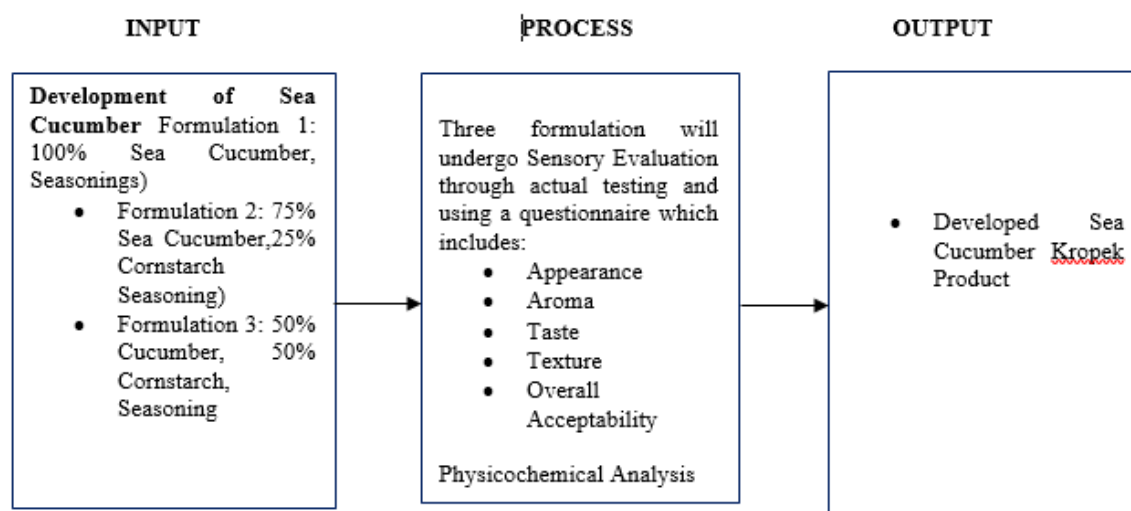


Figure 1
The Schematic Diagram

Statement of the Problem

This study generally aims to develop a Protein-enriched Kropek incorporating Sea Cucumber. Further, this study evaluates the sensory attributes of the product by the target respondents of the study.

Specifically, it seeks to answers to the following questions:

1. What is the formulation and process of making a Sea cucumber Kropek product?
2. What is the level of sensory attributes of the developed Kropek product as perceived by the respondents of the study in terms of:
 - 2.1.Aroma;
 - 2.2.Appearance;
 - 2.3.Taste;
 - 2.4.Texture; and
 - 2.5.Overall acceptability?
3. What is the physicochemical analysis of the Sea Cucumber Kropek product?

METHODS

Research Design

This study will utilize the Developmental-Descriptive research design. The researcher finds these designs appropriate because the study is characterized by having a treatment in order to develop a Protein-enriched Kropek food product. It is developmental because the researcher will develop a Protein-enriched Kropek food product. Further, it is also descriptive in nature because the researcher will conduct a survey in order to determine the sensory attributes of the product which includes appearance, aroma, taste, texture, and overall acceptability.

Research Environment

This study particularly the development of the product will be conducted at Surigao del Norte State University Food Laboratory, Surigao City, Surigao del Norte. Surigao del Norte State University (SNSU),

located in Surigao City, Surigao del Norte, Philippines, has a rich history of transformation and growth in higher education.

Research Respondents

The respondents of this study will be the chosen experts in food industry, Home Economics teachers, and Consumers. They will be selected through purposive sampling, to ensure that all perceptions are being represented. A purposive sampling is a sample selected in a deliberative and non-random way to achieve research objectives.

Research Instrument

This study will utilize an adopted and modified standardized survey instrument (Appendix B) which is the 9-point Hedonic Scale developed by **Peryam and Pilgrim** (1957) at the Quartermaster Food and Container Institute of the U.S. Armed forces. It was developed to measure the food preference of U.S. soldiers and has since been adopted by the food industry to determine the acceptability of foods and beverages (Johnson, 2021; Preko, et al., 2023). It is to date the most popular and commonly used hedonic scale used to measure consumer acceptance of both food and non-food products (Lim, 2011; Preko, et al., 2023). It will measure the sensory attributes of the product such as appearance, aroma, taste, texture, and overall acceptability which the respondents will answer and rate accordingly. The instrument had already undergone validity and reliability testing since it is a standardized instrument.

Data Analysis

The data gathered will be organized, tallied, and analyzed using Microsoft Excel and IBM SPSS Statistics Version 22. Specifically, the following statistical tools will be utilized for the analysis of data in 0.05 level of significance:

Frequency Count and Percent. These tools will be used to determine the distribution of the respondents.

Mean and Standard Deviation. These tools will be utilized to determine the level of sensory attributes such as Appearance, Aroma, taste, Texture, and Overall Acceptability of the Protein-enriched Kropek product. Furthermore, it will also be used to determine the physicochemical analysis result of the Kropek product.

RESULTS AND DISCUSSIONS

PROFILE OF THE PARTICIPANTS IN TERMS OF AGE, SEX, CIVIL STATUS, HIGHEST EDUCATIONAL ATTAINMENT, AND FAMILY MONTHLY INCOME

Table 4. Profile of the Respondents

Profile		Count (n)	Percentage(%)	Mode
Age	20 years old and below	0	0.00	21 – 30 years old
	21 – 30 years old	33	55.00	
	31 – 40 years old	19	31.67	
	41 – 50 years old	6	10.00	
	51 years old and above	2	3.33	
Sex	Male	27	45.00	Female
	Female	33	55.00	
Civil Status	Single	34	56.67	Single

	Married	19	31.67	
	Single Parent	7	11.67	
Highest	Student	33	55.00	
Educational	Baccalaureate	16	26.67	Student
Attainment	Masters	10	16.67	
	Doctorate	1	1.67	
	10000 and below	5	8.33	
Monthly	10001-20000	11	18.33	20001-30000
Income	20001-30000	26	43.33	
	30001- and above	18	30.00	
Total		60	100	

The demographic profile of the 60 respondents reveals several interesting patterns that provide valuable context for understanding the study's participant base. The age distribution shows a clear concentration in the younger adult population, with over half (55%) falling within the 21-30 age range, followed by nearly one-third (31.67%) in the 31-40 bracket. This creates a predominantly millennial and early Gen X sample, with minimal representation from older demographics - only 13.33% of respondents are over 40 years old, and no participants under 21. This age skew suggests the findings may be most applicable to working-age adults in their prime career years.

The gender distribution is relatively balanced but leans slightly female, with women comprising 55% of the sample compared to 45% men. This near-even split enhances the generalizability of findings across gender lines. The civil status data reveals that single individuals dominate the sample at 56.67%, while married respondents account for 31.67% and single parents represent 11.67%. The high proportion of single respondents aligns with the younger age profile, as many participants are likely in early career stages before settling into long-term partnerships.

Perhaps most notably, the educational profile shows an exceptionally high level of academic engagement, with 55% of respondents currently being students. This finding is particularly significant as it suggests the sample may represent individuals in transition or skill-building phases rather than established professionals. Among completed education levels, baccalaureate holders comprise 26.67%, master's degree holders 16.67%, and doctorate holders just 1.67%. The income distribution reflects this educational pattern, with the largest group (43.33%) earning between 20,001-30,000 monthly, followed by 30% earning above 30,001. Only 8.33% earn 10,000 or below, while 18.33% fall in the 10,001-20,000 range. This income profile suggests a sample that is largely economically stable but not affluent, consistent with the high student population and early-career professionals represented in the age demographics.

LEVEL OF ACCEPTABILITY OF THE SENSORY ATTRIBUTES OF THE THREE FORMULATIONS OF DEVELOPED SEA CUCUMBER KROPEK IN TERMS OF APPEARANCE, AROMA, TASTE, TEXTURE, COMPOSITE APPEAL

Table 5. Perceptions of the respondents on the sensory acceptability as to Appearance.

Appearance	100grams Mixture		75 grams Mixture		50 grams Mixture	
	mean	Qualitative Description	mean	Qualitative Description	mean	Qualitative Description

1. The color of the product looks appealing.	5.23	Neither Like nor Dislike	8.03	like very much	5.98	like slightly
2. The color is vibrant and fresh.	6.08	like slightly	7.95	like very much	5.87	like slightly
3. The product's color is consistent and uniform.	6.17	like slightly	8.03	like very much	5.43	Neither Like nor Dislike
4. The color of the product is suitable for its type.	5.78	like slightly	8.22	like very much	5.50	Neither Like nor Dislike
5. The product's color matches my expectations for this type of product.	6.00	like slightly	7.98	like very much	5.53	like slightly
Average mean	5.85	like slightly	8.04	like very much	5.85	like slightly

Preferred Mixture

For scoring, we utilized the nine-point hedonic scale (1 to 9), where 1 = dislike extremely; 2 = dislike very much; 3 = dislike moderately; 4 = dislike slightly; 5 = neither like nor dislike; 6 = like slightly; 7 = like moderately; 8 = like very much; 9 = like extremely (Pimentel et al., 2016)

The sensory evaluation data for appearance reveals a striking and consistent pattern across all measured attributes, with the 75-gram mixture emerging as the clear preference among respondents. This formulation achieved remarkably high scores across all five appearance criteria, with individual means ranging from 7.95 to 8.22, all falling within the "like very much" category. The overall average mean of 8.04 for the 75-gram mixture significantly outperforms both alternatives, suggesting this concentration represents an optimal balance for visual appeal. This preference may be related to the specific ingredients used in the mixture and their interaction, as well as the processing methods applied (Ghadarloo et al., 2023).

The performance gap between formulations is particularly noteworthy. While both the 100-gram and 50-gram mixtures achieved identical overall averages of 5.85, categorized as "like slightly," their individual attribute scores reveal different strengths and weaknesses. The 100-gram mixture showed its best performance in product color consistency and uniformity (6.17) and color vibrancy and freshness (6.08), but struggled with basic appeal, scoring only 5.23 for whether the color looks appealing. Conversely, the 50-gram mixture demonstrated more variable performance, with its highest score for color appeal (5.98) but lower ratings for consistency (5.43) and suitability (5.50), both falling into the neutral "neither like nor dislike" category.

The consistency of the 75-gram mixture's superior performance across all attributes suggests this formulation achieves an ideal concentration that enhances visual characteristics without overwhelming them. The fact that it scored above 8.0 in four out of five categories, with the lowest score being 7.95, indicates strong consumer acceptance and suggests this mixture creates the most commercially viable visual presentation. This data strongly supports the 75-gram mixture as the preferred formulation from

an appearance standpoint, with its combination of appealing color, vibrancy, consistency, and expectation alignment making it the clear choice for further development or market introduction. Conjoint Analysis can identify the relative contributions of attributes to the actions of decision-makers (Aguiar et al., 2024). The attributes are reduced to a limited set of factors such as Brand name, Price, and guarantee (Isravel et al., 2022).

Table 6. Perceptions of the respondents on the sensory acceptability as to Aroma.

Aroma	100grams Mixture		75 grams Mixture		50 grams Mixture	
	mean	Qualitative Description	Mean	Qualitative Description	mean	Qualitative Description
1. The product has an appealing odor.	5.10	Neither Like nor Dislike	7.90	like very much	6.36	like slightly
2. The product's odor is pleasant and not overpowering.	5.92	like slightly	8.00	like very much	5.60	like slightly
3. The product has a natural odor.	5.64	like slightly	8.12	like very much	5.62	like slightly
4. The odor of the product is pleasant enough to encourage consumption.	5.52	like slightly	8.25	like very much	5.67	like slightly
5. The product's odor is consistent with its intended flavor.	5.63	like slightly	8.08	like very much	5.52	like slightly
Average mean	5.56	like slightly	8.07	like very much	5.75	like slightly
Preferred Mixture						

For scoring, we utilized the nine-point hedonic scale (1 to 9), where 1 = dislike extremely; 2 = dislike very much; 3 = dislike moderately; 4 = dislike slightly; 5 = neither like nor dislike; 6 = like slightly; 7 = like moderately; 8 = like very much; 9 = like extremely (Pimentel et al., 2016)

The aroma evaluation data reinforces the superiority of the 75-gram mixture established in the appearance assessment, with even more pronounced differences between formulations. The 75-gram mixture achieved exceptional performance across all aroma attributes, with individual scores ranging from 7.90 to 8.25, and an outstanding overall average of 8.07 in the "like very much" category. This consistent excellence suggests the 75-gram concentration creates an optimal aromatic profile that strongly resonates with consumer preferences.

The performance hierarchy shows interesting distinctions between the alternative formulations. The 50-gram mixture slightly outperformed the 100-gram mixture with an average of 5.75 compared to 5.56, both categorized as "like slightly." However, the 50-gram mixture demonstrated more consistent performance across attributes, with scores ranging from 5.52 to 6.36, while the 100-gram mixture showed greater variability, particularly struggling with basic appeal (5.10) which fell into the neutral "neither like

nor dislike" category. The 50-gram mixture's highest score was for appealing odor (6.36), suggesting that while it doesn't achieve the intensity of the 75-gram mixture, it maintains better overall balance than the 100-gram formulation. This detailed analysis of consumer evaluations facilitates a data-driven strategy for optimizing product development (Teixeira-Lemos et al., 2021).

The 75-gram mixture's dominance is particularly evident in its ability to encourage consumption, scoring 8.25 for the attribute measuring whether the odor is pleasant enough to encourage consumption. This finding has significant commercial implications, as aroma plays a crucial role in initial product attraction and purchase decisions. The consistent scoring above 8.0 across all five aroma attributes indicates that this formulation not only meets but exceeds consumer expectations for aromatic appeal, naturalness, and appropriateness. Combined with its superior appearance ratings, the 75-gram mixture emerges as the clear winner for creating a product that engages multiple senses effectively and encourages consumer acceptance. The olfactory experience profoundly influences consumer acceptance and willingness to try a product, making aroma optimization a critical step in product development (García-Pizarro et al., 2025).

Table 7. Perceptions of the respondents on the sensory acceptability as to Taste.

Taste	100grams Mixture			75 grams Mixture			50 grams Mixture		
	mean	Qualitative Description		mean	Qualitative Description		Mean	Qualitative Description	
1. The taste of the product is enjoyable.	5.38	Like	nor Dislike	8.03	Like Very Much		5.68	Like	Slightly
2. The product has a balanced taste.	4.95	Like	nor Dislike	7.98	Like Very Much		5.68	Like	Slightly
3. The taste of the product is unique and refreshing.	5.62	Like Slightly		8.05	Like Very Much		5.17	Neither Like nor Dislike	
4. The product has the right level of sweetness or saltiness.	5.25	Like	nor Dislike	7.95	Like Very Much		5.45	Neither Like nor Dislike	
5. The aftertaste of the product is pleasant.	5.37	Like	nor Dislike	8.30	Like Very Much		5.73	Like Slightly	
Average mean	5.31	Neither Like nor Dislike		8.06	Like Very Much		5.54	Like Slightly	

Preferred Mixture

For scoring, we utilized the nine-point hedonic scale (1 to 9), where 1 = dislike extremely; 2 = dislike very much; 3 = dislike moderately; 4 = dislike slightly; 5 = neither like nor dislike; 6 = like slightly; 7 = like moderately; 8 = like very much; 9 = like extremely (Pimentel et al., 2016)

The taste evaluation data provides the most compelling evidence yet for the superiority of the 75-gram mixture, with results that are both consistent and decisive across all taste attributes. The 75-gram

formulation achieved remarkable scores ranging from 7.95 to 8.30, with an exceptional overall average of 8.06 in the "like very much" category. Most notably, it scored highest (8.30) for pleasant aftertaste, a critical factor in consumer satisfaction and repeat purchase behavior, suggesting this formulation creates a lasting positive impression that extends beyond the initial consumption experience. It is important to consider the degree to which consumers' opinions and behaviors are shaped by the type of food and information provided on labeling, as these factors can significantly alter product opinion, purchase intention, and willingness to pay (Lefebvre et al., 2019).

The performance gap between formulations is most pronounced in the taste category, revealing significant differences in palatability. The 100-gram mixture struggled considerably, achieving an overall average of only 5.31, which falls into the "neither like nor dislike" category. This formulation performed particularly poorly in balanced taste (4.95), suggesting the higher concentration may create an overwhelming or unpleasant flavor profile. Four out of five taste attributes fell into the neutral category, with only the uniqueness and refreshing quality (5.62) reaching "like slightly." The 50-gram mixture performed marginally better with an average of 5.54 in the "like slightly" category, but showed inconsistent results across attributes, with two measures falling into the neutral zone.

The taste evaluation results carry particular weight in product development decisions, as taste ultimately determines consumer satisfaction and market success regardless of superior appearance and aroma. The 75-gram mixture's consistent excellence across all taste dimensions—enjoyability, balance, uniqueness, appropriate sweetness/saltiness levels, and pleasant aftertaste—indicates this formulation achieves the optimal flavor profile. The fact that it scored above 8.0 in four out of five taste attributes, with the lowest being 7.95, demonstrates exceptional consumer acceptance and suggests strong commercial viability. This data strongly reinforces the 75-gram mixture as the preferred formulation, creating a product that not only attracts consumers visually and aromatically but delivers a satisfying taste experience that encourages continued consumption. Product positioning statements, which should be included for all products, are especially important for new novel product categories and should effectively and straightforwardly present the product composition and characteristics (Chiplunkar et al., 2023).

Table 8. Perceptions of the respondents on the sensory acceptability as to Texture.

Texture	100grams Mixture			75 grams Mixture			50 grams Mixture		
	mean	Qualitative Description		mean	Qualitative Description		mean	Qualitative Description	
1. The texture of the product is smooth and pleasant.	5.27	Neither Like nor Dislike		8.13	like very much		5.92	like slightly	
2. The product has the right amount of crunch or softness.	5.52	like slightly		8.27	like very much		5.68	like slightly	
3. The texture is consistent throughout the product.	4.90	Neither Like nor Dislike		8.12	like very much		5.33	Neither Like nor Dislike	
4. The texture makes the product enjoyable to eat.	5.32	Neither Like nor Dislike		8.08	like very much		5.85	like slightly	

5. The texture is	Neither	like	very	Neither
suitable for the type of	Like	nor	much	Like
product.	Dislike			Dislike
Average mean	Neither	like	very	
	Like	nor	much	like slightly
	Dislike			

Preferred Mixture

For scoring, we utilized the nine-point hedonic scale (1 to 9), where 1 = dislike extremely; 2 = dislike very much; 3 = dislike moderately; 4 = dislike slightly; 5 = neither like nor dislike; 6 = like slightly; 7 = like moderately; 8 = like very much; 9 = like extremely (Pimentel et al., 2016)

The texture evaluation data completes the comprehensive sensory profile assessment and further solidifies the 75-gram mixture's dominance across all evaluated dimensions. The 75-gram formulation achieved consistently outstanding performance with scores ranging from 8.02 to 8.27, culminating in an impressive overall average of 8.12 in the "like very much" category. Particularly noteworthy is its highest score of 8.27 for having the right amount of crunch or softness, indicating this formulation achieves the ideal textural balance that consumers seek in this type of product.

The texture results reveal the most significant performance gaps between formulations observed across all sensory categories. The 100-gram mixture performed poorly with an overall average of 5.28, falling into the "neither like nor dislike" category, and notably struggled with textural consistency throughout the product (4.90), which barely reached the neutral threshold. This suggests the higher concentration may create textural irregularities or an unpleasant mouthfeel that detracts from the eating experience. The 50-gram mixture showed moderate performance with an average of 5.59 in the "like slightly" category, but demonstrated inconsistent results with three out of five attributes falling into the neutral zone, particularly for textural consistency (5.33) and product suitability (5.15). This suggests the lower concentration may create textural deficiencies that impact the overall sensory experience, which are insufficient to achieve optimal sensory performance. Further research is warranted to elucidate the complex interplay between formulation, oral processing, and consumer perception, potentially employing techniques like dynamic sensory analysis to capture the temporal evolution of texture during mastication, as well as exploring the relationship between texture and expectations of satiety and satiation (Nguyen et al., 2017).

The texture evaluation is particularly critical because it directly impacts the overall eating experience and consumer satisfaction during consumption. The 75-gram mixture's exceptional performance across all textural attributes—smoothness, appropriate crunch/softness balance, consistency, enjoyability, and suitability—demonstrates that this formulation creates an optimal mouthfeel that enhances the consumption experience. The consistent scoring above 8.0 across all five texture attributes indicates superior consumer acceptance and suggests this formulation achieves the ideal physical properties for market success. Combined with its superior performance in appearance, aroma, and taste, the texture data provides final confirmation that the 75-gram mixture represents the optimal formulation across all sensory dimensions, creating a product that delivers a complete and satisfying sensory experience from first sight to final swallow. Incorporating ingredients like soya, alfalfa, and wheat flour into vegan meat alternatives presents a promising avenue for developing nutritious and palatable products (Sharma et al., 2021).

Table 9. Perceptions of the respondents on the sensory acceptability as to Composite Appeal.

Characteristics	100grams Mixture		75 grams Mixture		50 grams Mixture	
	mean	Rank	mean	Rank	mean	Rank
Appearance	5.85	1	8.04	4	5.66	2
Aroma	5.56	2	8.07	2	5.75	1
Taste	5.31	3	8.06	3	5.54	4
Texture	5.28	4	8.12	1	5.59	3
Grand mean	5.50	Neither Like nor Dislike	8.07	Like Very Much	5.6	Like slightly

Scale	Parameter	Verbal Interpretation
1	1.00-1.50	Dislike
2	1.51-2.50	Extremely Dislike
3	2.51-3.50	Dislike Very Much
4	3.51-4.50	Dislike Moderately
5	4.51-5.50	Dislike Slightly
6	5.51-6.50	Neither Like nor Dislike
7	6.51-7.50	Like Slightly
8	7.51-8.50	Like Moderately
9	8.51-9.00	Like Very Much
		Like Extremely

The composite appeal analysis provides a comprehensive view of the sensory evaluation results and reveals the definitive superiority of the 75-gram mixture across all evaluated dimensions. The grand mean scores tell a clear story: the 75-gram mixture achieved an exceptional overall rating of 8.07 in the "like very much" category, dramatically outperforming both alternatives. This represents a significant performance gap, with the 75-gram mixture scoring nearly 50% higher than the 100-gram mixture (5.50) and 44% higher than the 50-gram mixture (5.60).

The ranking data within each formulation reveals interesting patterns about their relative strengths and weaknesses. For the winning 75-gram mixture, texture emerged as the highest-ranked attribute (8.12), followed closely by aroma (8.07), taste (8.06), and appearance (8.04). This remarkably tight clustering of scores between 8.04 and 8.12 demonstrates exceptional consistency across all sensory dimensions, indicating a well-balanced product that excels uniformly rather than compensating for weaknesses in some areas with strengths in others. The 50-gram mixture showed aroma as its strongest attribute (5.75), while the 100-gram mixture performed best in appearance (5.85), suggesting these formulations may have concentrated their positive qualities in specific sensory areas. Analyzing these subtle differences in

attribute rankings provides direction for strategic product development efforts, potentially guiding targeted refinements to enhance specific sensory qualities within each formulation and optimize their appeal to particular consumer segments. To ensure the integrity and reliability of sensory evaluation outcomes, meticulous examination of individual assessor data is paramount in detecting and mitigating the impact of potential outliers, who might introduce bias and distort the collective perception of the samples under investigation (Teixeira-Lemos et al., 2021).

The composite results have significant implications for product development and market positioning. The 75-gram mixture's ability to achieve "like very much" ratings across all sensory categories indicates strong consumer acceptance and commercial viability. The substantial performance gaps suggest that concentration level is a critical factor in product success, with the 75-gram formulation representing an optimal balance that maximizes sensory appeal without overwhelming consumers. The consistency of its superior performance across appearance, aroma, taste, and texture creates a synergistic effect where each positive sensory experience reinforces the others, likely leading to higher consumer satisfaction, repeat purchases, and positive word-of-mouth recommendations. This data strongly supports the 75-gram mixture as the preferred formulation for market introduction, with its comprehensive sensory excellence positioning it for commercial success. Product positioning statements are vital for detailing product composition and characteristics, especially for novel products, where effective and straightforward presentation is key (Chiplunkar et al., 2023).

SIGNIFICANT DIFFERENCE ON THE LEVEL OF ACCEPTABILITY OF THE SENSORY ATTRIBUTES OF THE THREE FORMULATIONS OF DEVELOPED AND ACCEPTABILITY OF SEA CUCUMBER (HOLOTHURIA EDULIS) KROPEK BASED ON THE PROFILE OF THE PARTICIPANTS

Table 10. Significant difference on the level of acceptability of the sensory attributes of the three formulations of developed and acceptability of Sea cucumber (*Holothuria edulis*) Kropek based on the profile of the participants.

Profile	Sensory Attributes	Df	f-value	p-value	decision
AGE	Appearance	3/56	1.559	0.209	Fail to reject
	Aroma	3/56	0.240	0.787	Fail to reject
	Taste	3/56	0.292	0.748	Fail to reject
	Texture	3/56	0.831	0.366	Fail to reject
SEX	Appearance	1/58	0.013	0.910	Fail to reject
	Aroma	1/58	2.524	0.118	Fail to reject
	Taste	1/58	0.803	0.374	Fail to reject
	Texture	1/58	0.040	0.842	Fail to reject
CIVIL STATUS	Appearance	2/57	1.480	0.229	Fail to reject
	Aroma	2/57	0.503	0.481	Fail to reject
	Taste	2/57	1.669	0.201	Fail to reject
	Texture	2/57	0.089	0.766	Fail to reject
	Appearance	5/54	0.556	0.577	Fail to reject
	Aroma	5/54	2.708	0.075	Fail to reject

HIGHEST	Taste	5/54	0.663	0.578	Fail to reject
EDUCATIONAL	Texture	5/54	0.004	0.953	Fail to reject
ATTAINMENT					
MONTHLY	Appearance	4/55	0.653	0.664	Fail to reject
INCOME	Aroma	4/55	0.610	0.633	Fail to reject
	Taste	4/55	0.606	0.612	Fail to reject
	Texture	4/55	0.622	0.651	Fail to reject

*Significant at $\alpha < 0.05$.

The statistical analysis of demographic influences on sensory acceptability reveals a remarkably consistent pattern across all tested variables, with no significant differences found between any demographic groups for any of the four sensory attributes. This finding has profound implications for the generalizability and market potential of the sea cucumber kropek formulations, particularly the preferred 75-gram mixture. All p-values exceeded the 0.05 significance threshold, with most being substantially higher, indicating that demographic characteristics do not meaningfully influence how participants perceived the appearance, aroma, taste, or texture of the different formulations. The application of rigorous statistical methodologies is paramount when evaluating sensory data obtained from varied experimental designs, ensuring the generation of reliable and valid conclusions regarding product attributes and consumer preferences (Singh-Ackbarali & Maharaj, 2014).

The age analysis showed the most variability in f-values, ranging from 0.240 for aroma to 1.559 for appearance, yet even the highest f-value for appearance ($p=0.209$) remained well above the significance threshold. This suggests that sensory preferences for sea cucumber kropek are consistent across age groups, from younger adults in their twenties to older participants, indicating broad generational appeal. Similarly, gender differences were minimal across all attributes, with f-values ranging from 0.013 to 2.524, and all p-values well above 0.05, suggesting the product formulations appeal equally to both male and female consumers. The influence of cultural elements can indeed introduce variability in sensory studies, necessitating careful consideration of factors such as familiarity with the tested food or beverage, exposure to information regarding health benefits, scrutiny of food labels, linguistic nuances, and the surrounding food environment (Jeong & Lee, 2021).

The lack of significant differences across civil status, educational attainment, and monthly income categories further reinforces the universal appeal of the product formulations. Educational attainment showed the most variation, with aroma approaching but not reaching significance ($p=0.075$), while other attributes showed minimal variation. The absence of income-based differences is particularly noteworthy for commercial viability, as it suggests the product could appeal to diverse economic segments without requiring different formulations for different market tiers. This demographic independence strengthens the case for the 75-gram mixture's market potential, indicating that its superior sensory performance transcends demographic boundaries and could achieve broad market acceptance across diverse consumer segments. The consistent "fail to reject" decisions across all 20 statistical tests provide strong evidence that the sensory preferences identified in the study are robust and generalizable across the target population. Comprehensive sensory evaluations, encompassing descriptive analysis, consumer preference tests, and advanced statistical modeling, are indispensable for the effective optimization of food product formulations, ensuring precise alignment with consumer expectations and facilitating successful market entry and sustained market presence (Dilrukshi et al., 2020).

SIGNIFICANT DIFFERENCE ON THE SENSORY ATTRIBUTES OF THE DEVELOPED SEA CUCUMBER BASED ON THE THREE FORMULATIONS

Table 11. Significant difference on the sensory attributes of the developed sea cucumber based on the three formulations.

Profile	Sensory Attributes	Df	f-value	p-value	decision
Formulation A(100g mixture)	Appearance	3/56	1.062	0.352	Fail to reject
	Aroma	3/56	2.390	0.101	Fail to reject
	Taste	3/56	1.674	0.197	Fail to reject
	Texture	3/56	1.648	0.204	Fail to reject
Formulation B(75g mixture)	Appearance	3/56	3.341	0.026	Rejected
	Aroma	3/56	4.515	0.015	Rejected
	Taste	3/56	6.331	0.000	Rejected
	Texture	3/56	8.003	0.000	Rejected
Formulation C(50g Mixture)	Appearance	3/56	0.013	0.911	Fail to reject
	Aroma	3/56	0.014	0.910	Fail to reject
	Taste	3/56	0.027	0.870	Fail to reject
	Texture	3/56	0.822	0.368	Fail to reject

*Significant at $\alpha < 0.05$.

The statistical analysis of formulation differences reveals a striking and definitive pattern that strongly validates the superiority of the 75-gram mixture (Formulation B) across all sensory dimensions. This formulation is the only one to show statistically significant differences across all four sensory attributes, with all p-values well below the 0.05 significance threshold. The results are particularly compelling for taste ($p=0.000$) and texture ($p=0.000$), indicating extremely strong statistical evidence that the 75-gram mixture performs significantly differently from the other formulations in these critical sensory areas.

The f-values for the 75-gram mixture demonstrate the magnitude of these differences, with texture showing the highest f-value (8.003), followed by taste (6.331), aroma (4.515), and appearance (3.341). These progressively higher f-values suggest that the 75-gram mixture's advantages become more pronounced in the more complex sensory attributes that directly impact consumption experience. The fact that taste and texture show the strongest statistical significance ($p=0.000$) is particularly important from a commercial perspective, as these attributes are most closely linked to consumer satisfaction and repeat purchase behavior. Further enhancing consumer satisfaction involves strategies to mitigate potential negative perceptions (Lefebvre et al., 2019).

In stark contrast, both the 100-gram and 50-gram mixtures failed to achieve statistical significance in any sensory attribute, with p-values ranging from 0.101 to 0.911. The 100-gram mixture showed some variability with higher f-values, particularly for aroma (2.390) and texture (1.648), but these differences were not statistically significant, suggesting inconsistent performance that doesn't translate to reliable consumer preference. The 50-gram mixture showed remarkably low f-values across all attributes, with most barely registering any variation, indicating this formulation fails to create distinctive sensory experiences that would differentiate it in the marketplace. This statistical evidence provides robust scientific support for the 75-gram mixture's superiority, demonstrating that its exceptional performance

in the descriptive sensory evaluation translates to statistically significant differences that would be reliably perceived by consumers, making it the clear choice for commercial development and market introduction. A holistic approach to food product development demands a thorough assessment of sensory properties, chemical makeup, and consumer anticipations to refine product designs and strategic market entries (Teixeira-Lemos et al., 2021)

NUTRITIONAL COMPONENTS OF THE MOST PREFERRED DEVELOPED SEA CUCUMBER KROPEK

Table 12. Physico-chemical analysis and nutritive value of the Sea cucumber kropek.

Parameters	Unit	Result	Method
Ash	%	3.6	Gravimetric
Sodium	%	1.1	Dry Ashing - ICP
Moisture	%	6.9	Gravimetric

Reference: Official Method of Analysis of AOAC International, 17th ed.



The physico-chemical analysis provides essential nutritional and quality information for the sea cucumber kropek, revealing characteristics that support both its commercial viability and nutritional value. The ash content of 3.6% falls within the typical range for processed seafood products and indicates a moderate mineral content, which is beneficial from a nutritional standpoint as ash represents the total mineral content remaining after organic matter is burned off. This level suggests the product retains important minerals from the sea cucumber source while not being excessively high, which could affect taste or texture negatively. The water activity registered which is consistent with levels that ensure microbial stability and prevent spoilage (Bassig et al., 2021).

The sodium content of 1.1% is particularly noteworthy from both health and regulatory perspectives. This level is relatively moderate for a processed snack food, especially considering that many commercial kropek and similar products often contain higher sodium levels due to added salt and flavor enhancers. The 1.1% sodium content suggests the product could appeal to health-conscious consumers while still providing sufficient flavor enhancement. This moderate sodium level also positions the product favorably in markets where sodium reduction is a priority, potentially allowing for health-conscious marketing claims while maintaining palatability.

The moisture content of 6.9% is crucial for product stability, shelf life, and texture quality. This relatively low moisture level indicates good preservation characteristics and suggests the product should have extended shelf stability when properly packaged. Low moisture content is essential for maintaining the

desired crispy texture that consumers expect from kropek products, while also preventing microbial growth that could compromise food safety. The combination of these three parameters - moderate ash content for nutritional value, controlled sodium for health considerations, and low moisture for stability and texture - creates a favorable profile for a processed seafood snack. The use of standardized AOAC methods ensures the reliability and international acceptance of these analytical results, supporting potential export opportunities and regulatory compliance across different markets. Marine organisms, including various fish species, are globally transformed into a diverse array of culinary products through methods such as salting, drying, canning, and grilling, each technique altering the nutritional and sensory properties of the final product (Kim et al., 2020)

RECOMMENDATIONS

For Teachers: Teachers should integrate this sea cucumber kropek study into food science curricula to demonstrate practical applications of sensory evaluation, statistical analysis, and sustainable seafood utilization through evidence-based product development methodology.

For Researchers: Future research should expand beyond basic composition analysis to investigate protein quality, bioactive compounds, shelf-life studies, processing optimization, and market acceptance patterns across different geographical regions for commercial viability.

For Policy Makers and Government Agencies: Government agencies should develop supportive policies that facilitate commercialization of innovative seafood products through streamlined approval processes, quality standards, sustainable processing incentives, and infrastructure development funding.

For Food Industry: The food industry should prioritize commercial development of the 75-gram sea cucumber kropek formulation by investing in pilot production facilities, packaging solutions, supply chain partnerships, and marketing strategies emphasizing health benefits and sustainability.

For Fisherfolk and Coastal Communities: Fisherfolk and coastal communities should explore sea cucumber harvesting and processing as a viable livelihood opportunity through cooperative structures, training programs, research partnerships, and community-based sustainable management systems.

For Health and Nutrition Advocates: Health and nutrition advocates should promote sea cucumber kropek as a nutritious snack alternative by emphasizing its moderate sodium content, mineral richness, and marine-derived nutrients while supporting research into its health benefits.

For Environmental Advocates: Environmental advocates should support sea cucumber kropek development as sustainable marine resource utilization that provides economic incentives for ocean conservation through responsible harvesting practices and certification programs.

For Consumers: Consumers should embrace sea cucumber kropek as a healthy, sustainable snacking option that supports marine conservation and coastal livelihoods while providing feedback to help grow the industry and making informed dietary choices

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