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DEVELOPMENT, NUTRITIONAL PROFILING AND SENSORY EVALUATION OF DRIED SPAGHETTI PASTA ENRICHED WITH SEA HARE *(Dolabella auricularia)* EGG MASS "LUKOT"

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ABSTRACT

The main objective of this study was to create and evaluate a functional food product made from dried spaghetti pasta enriched with the egg masses (a.k.a. "lukot") of the sea hare (Dolabella auricularia). The goal of this research was to establish the product profile, nutritional composition, sensory properties, and level of consumer acceptability for three different preparations of sea hare egg mass: 1) blanched, 2) fresh, and 3) powdered. An experimental research design was conducted involving 50 purposively selected individuals comprising Senior High School students, food technology teachers, MATVE students, pasta manufacturers, and food vendors. Sensory evaluations of aroma, appearance, taste, and texture were conducted using a 5-point hedonic scale. Nutritional analysis was completed in the laboratory to analyse the proximate composition of the product. Data analysis revealed that Treatment 3 (powdered sea hare egg mass) had the highest mean scores for aroma (4.26), appearance (4.34), taste (4.36), and texture (4.22), and all treatments were considered to be highly acceptable. Treatments 1 (blanched) and 2 (fresh) were acceptable but had lower mean scores than Treatment 3. In addition, the results of statistical analysis showed that the mean scores for taste ($p = 0.012$) and texture ($p = 0.035$) differed significantly; however, the mean scores for aroma and appearance did not differ significantly. In addition, Treatment 3 had superior shelf-life stability and was nutritionally superior in protein, carbohydrate, and minerals (specifically iron and manganese) when compared with Treatments 1 and 2. Therefore, based on these results, powdered sea hare egg mass is the most appropriate form of egg mass to be used for enriching spaghetti pasta. This study concludes that egg mass from sea hares can be incorporated as a functional ingredient in the production of enriched spaghetti pasta to increase the nutritional value and consumer acceptability.

KEYWORDS: *Marine Source, Functional Food Creation, Taste Approval By Users, Food Production, Shelf-Stable.*

1. INTRODUCTION

Research around the world is providing Family Celebration Traditions on what is now commonly called Spaghetti. Also, it meets the nutritional needs of billions of people worldwide. Given these realities, there are new efforts to create functional foods that not only meet the basic nutritional needs but also provide additional health benefits. A promising avenue for innovation in functional foods has been the exploration of new food sources from the ocean, commonly referred to as Marine Sources. One promising marine food source that could be used as a functional food is the sea hare (Dolabella auricularia), also known as 'lukot' in Tagalog. The egg-producing sea hare is a potential functional food because it contains protein, amino acids, minerals, and numerous bioactive compounds that have exhibited antioxidant and antibacterial properties (Tayone et al., 2020; 2021). Additionally, there have been prior studies that examined the nutritional potential of adding functional (nutritional enhancement) ingredients, such as sea hare egg masses, to the base (staple) products of spaghetti, thus providing a substantial opportunity for improvement to dietary intake and a means to address nutrient deficiencies with minimal impact upon the quality of a product. The use of sea hare egg masses in processed foods has thus far received little attention from researchers, resulting in a significant lack of innovation utilising available local resources (marine) to develop new prepared foods. This research will provide new information on the inclusion of sea hare egg masses in the production of dried spaghetti-type pasta products, as well as determining consumer acceptability and nutrition of the new product. There are three ways to include sea hare egg mass in the spaghetti product: blanched, unblanched (fresh), and powdered forms. Further investigation of the new product will include: • Developing a Product Profile including: types and costs of ingredients, required utensils/tools, methods of product creation, expected shelf life, and nutritional value of product. • Evaluation of key sensory characteristics related to the new product, including aroma, appearance, flavour, and texture. • Determining the level of consumer acceptability of each new portion of the product based on the three different methods of incorporation of food. • Determining significant differences between the three methods. • Developing a technical manual to assist in using the newly developed product. The theoretical basis for this research draws on Innovation Theory, Functional Food Theory, and Experiential Learning Theory to support the creation of new food products through innovation and experimentation and the application of scientific principles.

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2. MATERIAL AND METHODS

2.1 Research Design

An experimental research design was used to develop and evaluate dried spaghetti pasta enriched with sea hare (Dolabella auricularia) egg mass ("lukot"). The researcher compared three forms of sea hare egg mass (blanched, fresh, and powdered) in reference to sensory attributes and overall acceptability. This design allowed systematic comparisons among the different types and created a basis for attributing any inconsistencies in results to the sea hare egg mass used in the product formulation.

2.2 Locale of the Study

This study was conducted in Panglao, Bohol, where sea hare egg masses are abundant in their natural state. The preparation and processing of the pasta were controlled to ensure consistency, hygiene, and reliable results throughout.

2.3 Respondents of the Study

A total of 50 respondents were purposively selected to participate in the product evaluation. This group was composed of 20 senior high school cookery students, five food technology teachers, 10 food technology students in the MATVE program, 10 pares vendors, and five pasta makers, all of whom were knowledgeable and experienced in food preparation as well as sensory evaluation, making them qualified evaluators of the developed product.

Materials (Ingredients)

Ingredients (Materials) To prepare a batch of dried spaghetti, the following will be needed: 200 grams of all-purpose flour; 100 grams of lizard egg mass (*Dolabella auricularia);* 1 egg; 2 teaspoons of oil and water (used only in the powder treatment). All of the above will be sourced locally for ease of access and representation during product development. Instruments/Tools The instruments/tools used during the preparation of dried spaghetti are listed below: dry measuring cups, measuring spoons, mixing bowls, a spoon, a rolling pin, a manual pasta maker, baking trays and clean kitchen towels. Equipment utilized during the preparation of dried spaghetti is shown below: oven, gas stove, refrigerator, dough mixer, weighing scale, & blende. All instruments/tools were thoroughly cleaned and sanitized before use to assure food safety and maintain product integrity.

Three Treatments

A total of three different treatments were created for this study. The first treatment (T1) was made with a total of 100 g of blanched sea hare eggs. For the second treatment (T2), 100 g of fresh sea hare eggs were used. The third treatment (T3) was prepared by taking 100 g of unprocessed sea hare eggs, processing them down to about 15 g of powder, and then mixing the products to form the treatment. Other than the type of sea hare egg product used, there were no other differences in components or procedures between the three types of treatments.

Preparation Procedure

Preparation steps for pasta were performed in the same manner throughout the study/analysis process:

1. Used items (tools/equipment) have been prepped by cleaning/sanitizing before use.
2. All sea hare egg masses were rinsed thoroughly.
3. Each mass (2.5 lb) of sea hare eggs was treated as follows:
o Blanching (Treatment 1)
o Fresh Blending (Treatment 2)
o Drying & Grinding (Treatment 3)
4. Ingredients (flour, egg, oil, sea hare egg) were combined.
5. Dough was kneaded for 10 minutes and rested for 30 minutes.
6. After resting, the dough was rolled out and cut into spaghetti shape.
7. Processed pasta was either air-dried or oven-dried.
8. All pasta samples that were cooked were also prepared/reviewed for sensory evaluation purposes.

By following these methodological approaches for the preparation of each treatment from sea hare eggs into pasta, there was a high degree of consistency among all three treatments through the entire study process, therefore allowing this research to establish parameters or variables (influencing factors) that impact sensory characteristics of sea hare eggs (by treating) within the context of sensory research studies.

2.4 Sample and Sampling Procedures

For this study, 50 individuals were selected because they had knowledge, skills, or experience in evaluating food products developed specifically for this project. The subgroups of these individuals were:

- 20 Senior HS students enrolled in Cookery
- 5 Food Technology Teachers
- 10 MATVE courses for Food Technology students
- 10 vendors of Aiubamasa (Pares)
- 5 distributors of Noodles contributed by masseurs

As these individuals have experience preparing or serving food, they were able to properly identify certain sensory characteristics (aroma, appearance, flavour and texture) of the developmental sea-hare egg mass-enriched dried spaghetti.

Sampling Procedure

In this research, purposive sampling was used. Purposive sampling is a sampling methodology that selects samples based on criteria related to the topic under study. For this study, the researcher selected individuals with some level of experience and/or familiarity with food (including sensory analysis or pasta) to ensure they had access to participants who could provide valuable and valid feedback on the food product.

Each of the individuals selected to participate were drawn from target populations (students, instructors/teachers, and food professionals) that had relevant expertise; researcher obtained approval from each of the institutional authorities for each of the potential study participants; researcher provided each of the selected individuals who participated with an opportunity to participate; researcher provided/modified instructions to identify how to evaluate each food product; and researcher provided an opportunity between each of the food products for the participant

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to cleanse their palate with water to help ensure that their ratings were not biased by the order of foods tested.

Because this sampling provided insights from knowledgeable individuals and a greater reliability and validity to the data, purposive sampling was appropriate for this study.

2.5 Research Tool

The researcher employed a modified 5-point hedonic scale questionnaire to measure the sensory attributes of the product (sea hare egg mass) for the following: Aroma, Appearance, Taste and Texture.

Each sensory attribute has a scale of 1 to 5 (1 = Not Acceptable and 5 = Highly Acceptable), allowing participants to express varying levels of satisfaction with a product attribute.

2.6 Procedure for Data Collection

The researcher was meticulous in the procedures for collecting data (e.g. establishing accuracy and consistency of the data). The researcher secured the following permissions to conduct the study: the Dean of the School of Advanced Studies, the Director of Bohol Island State University's Campus, the University President, and the Principal of San Agustin Academy (Panglao). Once that was accomplished, the researcher developed a final instrument and prepared everything else needed for the experiment (e.g. all tools and equipment were cleaned and sanitized before use).

The researcher also collected the sea hare (Dolabella auricularia) egg mass from Panglao, Bohol, and obtained all the other ingredients for the study from the local market.

The researcher prepared dried spaghetti pasta from three treatments (blanched, fresh, and powdered) of sea hare egg mass using a standardized method: mixing, kneading, rolling, cutting, and drying to ensure all pasta was the same across samples.

Once all samples were prepared, they were distributed to the respondents selected by the researcher for the sensory evaluation. During this process, all respondents were given precise instructions on how to use the 5-point hedonic scale to evaluate the product's sensory attributes (aroma, appearance, taste, texture). Furthermore, all respondents were given a glass of water and instructed to rest for 5 minutes between tastings of each sample to reduce potential bias.

After the sensory evaluation was completed, all questionnaires were consolidated and checked for completeness and accuracy by the researcher in preparation for subsequent data analyses. The data collected were then tallied, compiled, and recorded to determine the acceptability rate for each sample within its respective treatment group. Samples from each treatment of the product were taken to the FAST Laboratory for proximate and nutritional analysis of moisture content, protein, fat, carbohydrate, and mineral composition.

Lastly, a shelf-life study for each treatment was conducted by storing product samples (dried spaghetti) at room temperature for the duration of the study while assessing the sensory reaction of each sample continuously. All data collected were analysed using statistical techniques to conclude this study

2.7 Data Analysis Techniques

Statistical methods, including descriptive and inferential methods, were employed to evaluate the results of the sensory evaluation and the data generated through this process were analyzed.

The weighted mean was used to measure the level of acceptance associated with four attributes of Dried Spaghetti Pasta fortification with Sea Hares *(Dolabella Auricularia),* which include Aroma, Visual Quality, Flavor, and Texture; using the five point hedonic scale the researcher was able to summarize each attribute into a Weighted Mean and provide the six treatments that were being evaluated based on their average value (Overall Lynne Preference) as it relates to the overall "Overall Lynne Preference" and the seven treatments that were being evaluated based on their average value.

The weighted mean, as it relates to the level of acceptance for each attribute, has been assigned a numerical value to assist in determining overall results. The following numerical values based on the weighted mean will be assigned according to the following scale.

- 4.21 -5.00: Highly Acceptable
- 3.41 - 4.20: Acceptable
- 2.61 - 3.40: Moderately Acceptable
- 1.81 - 2.60: Slightly Unacceptable
- 1.00 - 1.80: Not Acceptable

To determine whether there were statistically significant differences in acceptability among the three treatment groups, a Friedman Test was performed. Because this is a non-parametric test, it can be used to compare three or more related samples. Therefore, using the Friedman Test allowed for identification of differences between the three treatment groups with respect to aroma, appearance, flavour and texture.

To further describe the differences between the treatments, pairwise comparisons were conducted, providing additional detail on how the treatment groups differed.

All data were systematically organized, analyzed and interpreted to support the conclusions and recommendations of this study. As such, the results were used as the basis for this research.

2.8 Ethics of Study Design and Implementation

Ethics of Study Design and Implementation
Research is conducted with high ethical standards to protect study participants' rights, safety, and welfare.

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The researcher obtained the necessary permissions from both the relevant institutional authorities (the school administrator) and respondents before conducting data collection.

The study's objective was also explained to all respondents, and participation was completely voluntary. Additionally, respondents had the option to decline or withdraw from the research at any time without penalty.

The identities of the respondents were kept confidential, and all data collected was for academic purposes only. Data was securely stored, and personal identifiers were not recorded; respondents could not be identified.

Food safety and hygiene practices were followed in the preparation of the dried spaghetti pasta with *(Dolabella Auricularia)* egg mass. Equipment/tools were thoroughly cleaned/sanitized and ingredients were handled with care to ensure that food samples were safe for consumption.

The researcher also ensured that the sensory evaluation process would not harm the respondents. All respondents were given proper instructions on tasting food samples and were supplied with water for palate cleansing between treatments.

Furthermore, data integrity and honesty were maintained throughout the research by presenting results as accurately as possible and by not modifying/fabricating results. All sources utilized or referenced are appropriately acknowledged.

The researcher adhered strictly to the ethical principles of voluntary participation, confidentiality, safety, and integrity when conducting and reporting on this research study.

3. RESULTS AND DISCUSSION

3.1 Sensory Quality of Cooked Spaghetti Pasta Made With Dried Sea Hare Egg Mass

This section of this paper will describe how the sensory evaluation results for dried spaghetti made with sea hare (Dolabella auricularia) egg mass were determined by testing aroma, look, taste, and texture of cooked spaghetti from three methods of adding the sea hare egg mass to the dough: blanched dried spaghetti (T1), fresh (T2), and powdered (T3) dried spaghetti.

The results from the respondents indicated that all three methods of preparing dried spaghetti were generally acceptable; however, T3 (powder) received the highest mean scores across all sensory attributes assessed, with mean taste at 4.36, mean appearance at 4.34, mean aroma at 4.26, and mean texture at 4.2. All scores indicate high overall acceptability.

The results for appearance indicate that T3 has a more uniform colour and smoother appearance than either T1 or T2. This is likely because the powdered sea hare egg mass was much smaller than the whole eggs, thus allowing better incorporation into the dough. Previous research has indicated that a smaller particle-size egg mass results in improved visual uniformity and product.

In examining the aroma data, it is clear that T3 received the highest mean score, suggesting that the drying process may have helped concentrate the natural flavour characteristics of the egg masses. Conversely, some aroma characteristics were likely reduced in the egg mass due to heat exposure during blanching in T1.

For taste, the highest overall preference was recorded for T3 due to the distribution of the powdered sea hare egg mass, which was compared with that of whole, fresh or blanched sea hare egg mass. Therefore, a more uniform and equal distribution of flavour compared with T1 and T2 provided for a more complete and richer taste profile.

With respect to texture, T3 exhibited the most desirable characteristics and was described as being firm with a slight chewiness. The improved dough structure and gluten network likely caused this difference between T1 and T3. Conversely, T2 may have affected firmness, as the dough likely had a significantly higher moisture content than did T3.

In conclusion, the above results confirm that the incorporation of powder sea hare egg mass significantly improved the sensory quality of cooked dried spaghetti produced with sea hare egg mass.

3.2 Overall Acceptability Of Each Treatment

This section describes how well the respondents evaluated the three treatments of dried spaghetti pasta types in terms of overall acceptability.

Overall acceptability ratings showed that all three treatment styles (powder, blanched, and fresh) were acceptable to very highly acceptable. Treatment 3 (powder form) received greater overall acceptability than both Treatment 1 (blanched form) and Treatment 2 (fresh form), even though they both received acceptable ratings.

The high overall acceptability rating (300%) for Treatment 3 may be due to having superior performance on all sensory characteristics. The fact that the treatment was made from a powdered product improved the treatment mix, gave it a superior mouthfeel, and provided a higher concentration of flavour than the other two treatments, resulting in consumers preferring to consume the product made from Treatment 3 over the other two.

It has been shown that both functional food development and product improvement through processing depend on ingredient processing, thereby improving overall food quality. This study supported other studies that have documented that drying and grinding foods have improved texture, flavour and overall consumer acceptability of food products.

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These data support the potential use of a sea hare egg mass-based pasta (pasta with seafood content by consumers, indicating there is a good chance that more products developed with these specific types of ingredients may have potential in the food product marketplace.

Acceptability Level of Dried Spaghetti Pasta enriched with sea hare (*Dolabella auricularia*) egg mass "lukot" among the Three Different Treatments in Terms of Aroma, Appearance, Taste and Texture

Sensory Attributes	Mean	Standard Deviation	Description	Rank
APPEARANCE				
Treatment 1	4.12	0.872	Acceptable	3
Treatment 2	4.28	0.858	Highly Acceptable	2
Treatment 3	4.34	0.872	Highly Acceptable	1
AROMA				
Treatment 1	4.12	0.799	Acceptable	2.5
Treatment 2	4.12	0.872	Acceptable	2.5
Treatment 3	4.26	0.922	Highly Acceptable	1
TASTE				
Treatment 1	4.04	0.832	Acceptable	2
Treatment 2	4.00	0.881	Acceptable	3
Treatment 3	4.36	0.749	Highly Acceptable	1
TEXTURE				
Treatment 1	3.92	0.877	Acceptable	3
Treatment 2	4.12	0.718	Acceptable	2
Treatment 3	4.22	0.764	Highly Acceptable	1

3.3 Results of Statistical Analyses Showing the Differences in Trait Results by Treatments

The data presented herein summarize the statistical analyses performed to evaluate whether sensory attribute differences exist between the three treatments applied to sea hare egg mass material.

Statistical indicators show significant differences in taste (P = 0.012) and texture (P = 0.035) among the three treatments, indicating that the way sea hare egg masses are treated significantly affects these two sensory attributes. Specifically, Treatment 3 yielded significantly different results compared to Treatments 1 or 2 and would therefore be considered superior.

The aroma and appearance results showed no significant differences among the three treatments; therefore, all three treatments were equivalent in this regard. Therefore, it can be concluded that while the processing method affects flavour and texture, visual and aroma attributes are less affected by treatment than this texture.

The data partially support the null hypothesis: statistically significant differences were observed for some sensory attributes, whereas none were found for other evaluated attributes.

The most reasonable explanation for the observed differences is the processing method used by each of the treatments evaluated. That is, drying and grinding the sea hare egg masses removed moisture from the product and provided a more even particle distribution, thereby improving texture and flavour. Conversely, both fresh and blanched treatments retain more moisture, which would likely negatively affect the product.

The results are consistent with the principles of food processing theory, which state that moisture management and distribution play a significant role in determining both the texture and the sensory characteristics of the food product.

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Difference in the Acceptability Level of Dried Spaghetti Pasta enriched with sea hare (*Dolabella auricularia*) egg mass "lukot" among the Three Different Treatments in Terms of Aroma, Appearance, Taste and Texture

N = 50

Variables	Test Statistic	df	p-value	Decision	Interpretation
Aroma	1.18	2	0.553	Do not reject null hypothesis	Not Significant
Appearance	2.04	2	0.361	Do not reject null hypothesis	Insignificant
Taste	8.85	2	0.012	Reject null hypothesis	Significant
Texture	6.72	2	0.035	Reject null hypothesis	Significant

Pairwise Comparisons of Treatment Acceptability Evaluation in Terms of Taste

Treatments	Test Statistic	p-value	Decision	Interpretation
T1 vs T2	0.07	0.943	Do not reject null hypothesis	Insignificant
T1 vs T3	2.64	0.010	Reject null hypothesis	Significant
T2 vs T3	2.71	0.008	Reject null hypothesis	Significant

Pairwise Comparisons of Treatment Acceptability Evaluation in Terms of Texture

Treatments	Test Statistic	p-value	Decision	Interpretation
T1 vs T2	1.52	0.131	Do not reject null hypothesis	Insignificant
T1 vs T3	2.65	0.009	Reject null hypothesis	Significant
T2 vs T3	1.12	0.263	Do not reject null hypothesis	Insignificant

4. CONCLUSION & RECOMMENDATIONS

Conclusion

The overall findings of the research project were that sea hare (Dolabella auricularia) fish roe could be used to enhance the quality of dried spaghetti noodles. In addition to finding that there was a significant difference in noodle quality when the type of sea hare roe was compared, researchers determined that the powdered form provided the highest amount of protein, carbohydrate, and essential minerals (e.g., iron and manganese). Thus, powdered sea hare fish roe is an acceptable option for providing sensory quality and enhancing the nutritional quality of dried spaghetti noodles. All three preparation methods (blanched, fresh and powder) received acceptable sensory ratings. The powdered sea hare roe received the highest scores (blended) for aroma, appearance, flavour, and texture; and significant differences in the taste and texture of the noodles were noted.

Recommendations

Based on the findings, Treatment 3 (powdered sea hare eggs) is the final product for commercial production because it has high acceptability and a longer shelf-life than the other treatments. In addition, future researchers are encouraged to investigate ways to improve drying and grinding techniques to optimize the quality and efficacy of the end product. Long-term shelf-life evaluation studies and the development of new packaging methods to ensure continued product stability and safety should also be conducted. Example: income generation projects need to be established by teaching and incorporating sea hare egg mass into new food products through community education. Coastal communities can benefit significantly from the introduction of an income-generating sea hare-based project, which also presents an opportunity for innovation in food technology.

Compliance with ethical standards

A researcher from the University ensured compliance with ethical research practices with human participants. Before initiating the study, the researcher received approval and informed consent from all respondents. This made it possible for respondents to participate voluntarily in the study and withdraw without penalty at any time.

Throughout the entire data collection process, respondents were assured confidentiality and anonymity. That is, at no time would respondents' identities be provided or used for any purpose other than the research project. No personal identifiers were obtained or maintained.

The researcher ensured that all food samples used for sensory evaluation were prepared under proper sanitation, hygiene and food safety standards to avoid any risk to participants. All data were collected, analyzed, and reported with integrity, and only the accurate findings from the study were published; no data were fabricated or manipulated.

The researcher has no conflicts of interest associated with this study and has properly acknowledged all sources of information in accordance with academic standards.

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