

Development of Meatloaf, Sausage and Dried Green Mussel (*Perna viridis*) Products

Leonora Doncillo* & Nilda Combras

College of Fisheries and Marine Sciences, Samar State University, Philippines

*leonoradoncillo@yahoo.com

Abstract: The paper presents the quality attributes of three green bay mussel (*Perna viridis*) namely; tahongganisa (sausage), embutido (meatloaf) and dried mussel. The original formulation was enhanced by adding white fish meat to the meatloaf and sausage mixture which has improved taste and color of the final product. Dried mussel received the highest acceptability but is relatively more pricy than the first two products. Each serving size of the sausage contains 4% vitamin A and 10% iron; meatloaf contains 4% Vitamin A, 2% calcium and 20% iron and dried mussel has 4% Vitamin A, 8% calcium and 50% iron. The shelf life of dried mussel at normal temperature is about five months while the meatloaf and sausage stored at -14°C will last 16 and 18 months respectively.

Keywords: value added, tahong, marine products, post processing, food

1. Introduction

The green bay mussel is one of the major products of Eastern Visayas Region in the Philippines with major producer located at the municipality of Jiabong Samar, Philippines (NSCB, 2006). Production of green mussel peaked in the Philippines sometime in 2012 with around 26,000 metric tons to about 16,000 in 2015 (BAS, 2016). Even with the decline in production, there is still huge supply forcing many mussel producers to sell their harvest at a much lower price to avoid wastage or spoilage. Value-added products from green bay mussel will, therefore, benefit the farmers.

Mussels are highly perishable products that require intensive care if the quality is to be maintained after harvesting whether they are supplied fresh or in processed form. Post-harvest handling should aim at

reducing contamination or growth spoilage organisms.

Green mussel and other mollusk are susceptible to seasonal an environmental factors and are highly perishable (Farber & Todd, 2000; CMFRI, 1980). The occurrence of harmful algal bloom may pose problems on the gathering of the resource as mussels are filter feeder and consume algae (Riisgard et al., 2011). However, this can be resolved by the government programs thru strict monitoring of the harvest ground and apply depuration techniques (Lee et al., 2008; CMFRI, 1980). Another approach is to adopt new culture technology such the hanging raft method (Zuraek, 2016) or bamboo tray module (Cebu, 2016; Gomba & Cebu, 2016) which can reduce the impact of Harmful Algal Bloom (HAB) and improved volume of production. During lean season, people are deprived of a good source of nutrition and considerable source of income.

Green mussel (*Perna viridis*) contain 36.15% protein, 24.54% carbohydrates and 19.72 % lipid (Saritha et al., 2015). Essential Amino acids were found to be higher than the non-essential amino acids; it has seven vitamins in vitamins A and C are the highest. There are also six macro minerals and two trace minerals. These properties made green mussel a valuable food source for human consumption especially because of its high-quality protein and well-balanced nutritional composition (ibid).

There are many forms of post-processing of mussel as practiced in many parts of the world. Canned, frozen, marinated, smoked, dried, processed into powder, and pickled (CMFRI, 1980). In the Philippines, the mussel is processed into crackers or bottled like the adobong tahong (NSCB, 2006).

2. Objectives

The paper aimed at improving the quality attributes of green bay mussel (*Perna virides*) sausage, meatloaf, and dried meat, specifically;

- 2.1 Standardize the formulation of the value-added products,
- 2.2 Determine consumer product acceptability
- 2.3 Establish storage stability

3. Methodology

The products were formulated and initially tested at the SSU-COFMAS, and better samples were introduced to consumers in Eastern Visayas and Quezon City, Philippines.

3.1 Preparation of the Raw Materials

Raw materials specifically the green mussel meat were all sourced from Jiabong and Catbalogan City, Samar. Fresh mussel was thoroughly cleaned and cooked it by steaming (no water added) for about 20 minutes or until the shell is fully opened. The steamed meat was removed from its shell, and then the byssal threads are removed using scissors or knife. After which the meat was immediately processed into the three products or refrigerated to prevent spoilage.

3.2 Production of Sausage, Meatloaf, and Dried Green Bay Mussel

3.2.1. Sausage and Meatloaf Production

The production process is presented and illustrated in a registered utility model at the Intellectual Property Office of the Philippines (IPOPPL). The utility model registration number of green mussel sausage and meatloaf are PH/2/2014/661 and PH/2/2014/663 (Doncillo et al., 2014). The procedure for sausage production includes cleaning of green mussel, precooking, shucking, grinding, mixing of ingredients, chilling, stuffing, packaging, and storage. On the other hand, meatloaf process includes cleaning, steaming, shucking, weighing, mixing of ingredients, chilling, foil packing, steaming again, cooling, and storage.

3.2.3 Drying Procedure

The drying is best achieved if a cabinet dryer is used. Relying on the sun may result in spoilage especially during rainy or cloudy days. Exposure to air and insects also affects shelf life. The following are the process of drying of mussel.

Raw material. Freshly harvested mussel was bought from mussel farmers.

Cleaning and washing and sorting. Cleaning was performed to remove adhering dirt such as mud, sand or pieces of shells on the mussel. This was done through brushing or scraping until thoroughly clean. It will be washed four times with fresh water. Small size mussel (1-2 in) were separated from the big ones (3-4). Smaller sizes will be dried whole while bigger sizes will be prepared by splitting before drying.

Pre-cooking. This will be done through steaming. Small and big sized mussel must be cooked separately.

Shucking. Mussel meat is removed from its shell. Byssal threads are also removed.

Marinating. The smaller size mussel meat is soaked in the formulated marinade for one hour, while the split mussel meat is soaked in 25% brine solution only.

Draining. After marinating and brining, the mussel meats are drained in a colander to remove excess moisture.

Drying. This process employed both artificial and natural sun drying. The cabinet drier for fish products can also be used in drying mussel. In this project, drying of mussel meat utilizes a fabricated solar dryer to avoid contamination due to dust and insects primarily fly. Drying time depends on the weather condition and drier used.

3.3 Product Development and Tasting

The product concepts were based on similar existing products using other meat. The mussel-based products were subjected to descriptive sensory evaluation by ten laboratory-trained panelists for various quality attributes. Score cards were developed, and ideal qualities were set. Scores were assigned to some quality

attributes and for general acceptability according to hedonic (1-9) scale.

Trial formulations were performed repeatedly until the product meets the pre-set qualities. Fish meat and other ingredients were added to the existing product formulation to enhance its flavor and color. Depending on the white meat used, nutrients may also be further enhanced.

3.4 Maintenance of Raw Materials

Mussels are a perishable commodity and require careful handling and processing. Maintenance of low temperature is necessary to control quality changes of the product. It is necessary to store unprocessed raw material as well as the processed product inside freezers or chillers during and after production.

3.5 Packaging Materials and Methods

Different packaging materials were considered for the three (3) products. In Tahong Longganisa, a synthetic casing was used as the primary packaging material. The product is packed in six or 12 using the PE bags. For Tahong Embutido, the primary product packaging is an aluminum foil and placed individually in a secondary packaging like a PE bag. Dried Tahong packaging uses PE bags and vacuum packed. Quantity varies per pack.

The said packaging was submitted to DOST-ITDI for evaluation. Suggested packaging materials, as well as label design, was the one selected.

3.5 Assessment of the Products

The products were subjected to the proximate analysis: moisture and ash (AOAC, 1975), crude protein (modified Kjeldahl method), crude fat (Soxhlet

Method), an estimate of carbohydrate (by difference) and Chloride as NaCl by Volhard method (Christian, 1978). For dried products, water activity was determined using Luft a_w -meter) to estimate packaging and storage requirements.

Assessment for safety and storage properties of products will be conducted using microbiological methods: Coliforms (MPN) for raw materials, Total Plate Count (TPC) and Molds and Yeast Count (MYC), and Sensory Evaluation Scorecard for Storage Study.

3.6 Shelf-Life Testing

Packed samples were monitored at regular interval of seven days for three months or until rejection. The samples with better shelf life observed were submitted to Department of Science & Technology (DOST) for more in-depth analysis of the products shelf-life.

3.7 Consumer and Market Testing of the Products

Using the optimized formulation, the bulk of samples was processed for consumer testing. Approximately more than one hundred consumers were tapped, identifying different sectors (i.e., gender, social status and age level). Sensory evaluations for consumer acceptability were conducted using the Sensory Score Card developed for each product.

4. Results and Discussion

The project aims to improve the quality attributes of sausage, meatloaf and the dried green bay mussel (*Perna virides*) Major focus was the standardization of formulation, processing with good manufacturing practices, develop an

appropriate label and packaging materials, establish shelf life and perform financial analysis.

4.1 Production Standardization

The original formulation developed in 2006 was evaluated together with two new formulations developed based on recommendations from the previous study (Doncillo: 2006). The formulations were subjected to the sensory evaluation performed by ten trained tasters as the panelist. Table 1 and 2 shows the summary of the sensory evaluation conducted.

Dried Mussel. Based on the results, D3 garnered the highest acceptability rating of 8.3 or "liked very much." The color of the cooked dried mussel did not appeal much to the panelist as it is dark in color. It only garnered an average score of 6.8 with a qualitative rating of "like moderately." Formulation D3 is pure dehydrated meat while D1 and D2 have salt and pepper.

Sausage. Sample S2 garnered the best formulation for the sausage with general acceptability rating of 8.08 or "liked very much." The color of the cooked sausage did not appeal much to the panelist as it is dark in color. It only garnered a qualitative rating of "dislike slightly." There was also comment from some of the panelists that the texture was a bit soft and suggested a more granular texture. Formulation S2 is a bit spicy as the amount of pepper was increased and a bit sweet.

Meatloaf. Sample M2 garnered the highest sensory rating of 7.67 or "liked very much." The color of cooked meatloaf did not appeal much to the panelist as it is dark in color. It only garners an average an average score of 5.42 with a qualitative rating of "neither like nor dislike."

All three products have low acceptability in terms of color especially when it is cooked through frying. The color could not be enhanced by just addition of food coloring, subjecting the mussel meat to bleaching process was avoided to maintain its natural nutrients. It was also found-out that the kind of cooking affects the color. The color of cooked sausage and meatloaf is darker when fried than when it is steamed.

the products quality. The selection of evaluators is stratified purposive sampling taking into consideration age gender and economic classes. The activity was conducted in four different occasion/venue (2011 Alumni Homecoming of the Samar State University, 2011 Catbalogan Fiesta, 2011 SSU Charter Day, and Brgy Mercedes Catbalogan) and Table 2 summarizes the overall product acceptability evaluation using a nine-point scale.

4.2 Product Enhancement and Market Acceptability Test

4.2.1 Initial Market Acceptability Test

The best formulation identified in the laboratory-scale sensory evaluation was market tested. The product was presented to more than 100 tasters across economic status and age level to determine acceptability and to gather additional suggestions to improve

As shown in table 2, dried mussel has higher acceptability followed by sausage and meatloaf. Complain of most respondents is the dark color of cooked sausage and meatloaf. The dried mussel is more acceptable to ages 26-45 and was identified as best for “pulutan” or a healthy substitute for crackers, while sausage is more for regular meals while meatloaf is potential food for parties occasions like fiestas.

Table 1: Taste Test of Mussel Products

Attributes	Dried Mussel			Sausage			Meatloaf		
	D1	D2	D3	S1	S2	S3	M1	M2	M3
Color	6.40	6.50	6.80	3.92	4.25	4.42	5.50	5.42	5.50
Flavor	8.00	8.00	8.40	5.42	8.25	5.92	5.42	7.50	5.67
Texture	7.20	7.20	7.70	5.75	8.00	6.08	5.75	7.25	5.33
General Acceptability	7.40	7.40	8.30	6.42	8.08	6.75	7.17	7.67	6.33

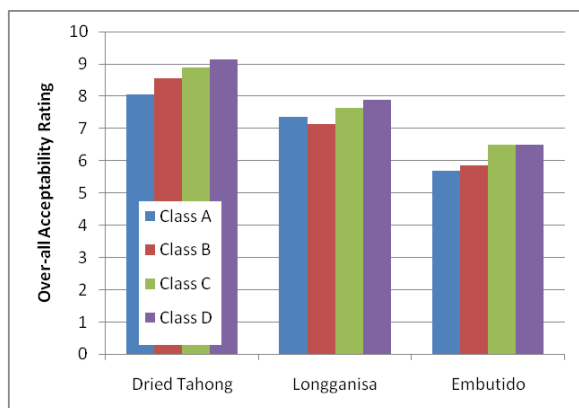
Table 2: Overall Acceptability of Mussel Products

Age	Gender	Dried Mussel		Sausage		Meatloaf	
		M	F	M	F	M	F
15-25		7.9	7.5	7.3	7.7	6.1	6.6
26-35		8.4	7.5	7.6	7.7	6.3	6.2
36-45		8.2	8.1	7.7	8.7	6.1	5.8
46-55		7.5	8.1	7.3	6.9	6.2	6.3
56-65		7.4	7.4	7.2	7.3	5.7	6.0
Across All Ages		7.9	7.7	7.4	7.6	6.1	6.2
Both Gender		7.8		7.5		6.1	

Legend: 1 – dislike extremely 4 – dislike slightly 7 – like moderately
 2 – dislike very much 5 – neither like nor dislike 8 – like very much
 3 – dislike moderately 6 – like slightly 9 – like extremely

Meatloaf is more acceptable to people ages 36-65 that are more up-to taste than appearance. They also commented that if the color of the product is lighter and texture more granular, the said product would also appeal to the youth.

As shown in figure 1, the sausage has almost similar acceptability on all economic classes while dried meatloaf appeal more to lower classes. Majority of respondents has rated the three products above five which mean that they like the products with dried mussel as the most acceptable. Interview of respondents also reveals that dried mussel is easier to handle and can also be considered as a take-home “pasalubong” item, the product does not require refrigeration thus can be sent easily anywhere in or outside the country.



Legend: 1 – dislike extremely 6 – like slightly
 2 – dislike very much 7 – like moderately
 3 – dislike moderately 8 – like very much
 4 – dislike slightly 9 – like extremely
 5 – neither like nor dislike

Figure 1: Overall Acceptability of Mussel Products According to Economic Classes

4.2.2 Improved Formulation

Several efforts to improve color and texture of the finished meatloaf and sausage were performed. These efforts involve using various food color, the addition of more

binders and extenders such as flour, and adding of white meat from chickens or fish. Addition of white fish meat has a lighter color and better taste. The first three formulations subjected to laboratory-scale taste-test and the final formulation developed based on the suggestion from the 100 evaluators.

4.2.3 Nutrient Analysis of Enhanced Formulation

The solution adopted to improve sausage and meatloaf color was to add white fish meat to the mixture. The addition of new ingredients would mean alteration of products nutrient content. Samples of sausage and meatloaf with and without fish meat including samples of dried mussel were sent to a DOST accredited laboratory for nutrient analysis.

Nutrient Facts of Dried Mussel. Each pack contains about ½ cup weighing around 50g of uncooked dried mussel. The notable nutrient present is iron which is about 50% of the daily value. It also contains 4% and 8% of vitamin A and calcium respectively. The product does not contain trans-fat and no sugar. High intake of trans-fatty acid is associated with increased risk of heart attack. The product, however, has 1 g dietary fiber, these fibers are the indigestible portion of the product.

Nutrient Content of Sausage with and without Fish. Each pack contains about five pcs of uncooked sausage, each weighing around 25g. The nutrient content is based on per serving size. Nutrient content between the pure mussel meat and those with fish meat were also examined. Most of the nutrient contents were reduced when white-fish meat was added except on the total carbohydrates which have increased by 1g per serving. Total fat was reduced from 4

Table 3: Large Market Sensory Evaluation (overall acceptability)

Respondents	Mean Scores		
	Dried Mussel	Sausage	Meatloaf
Housewife	8.5	8.0	7.5
Executive/Managerial	8.2	8.8	8.1
White Collar Workers	8.7	8.2	8.3
Blue Collar Workers	8.3	7.7	8.2
Students (College & HS)	8.1	8.2	7.9
Others	8.5	8.3	8.1
Mean Score	8.4	8.2	8.0
<i>Legend:</i>	<i>1 – dislike extremely</i>	<i>4 – dislike slightly</i>	<i>7 – like moderately</i>
	<i>2 – dislike very much</i>	<i>5 – neither like nor dislike</i>	<i>8 – like very much</i>
	<i>3 – dislike moderately</i>	<i>6 – like slightly</i>	<i>9 – like extremely</i>

to 3.5g, sodium from 95 to 90mg, protein by 7 to 6 g while cholesterol and vitamin A remain 10mg and 4% respectively. The most significant changes, however, was the reduction by half of the iron content from 20% to 10%.

Nutrient Content of Meatloaf with and without Fish. Each pack contains one pc. of uncooked meatloaf weighing around 300g. Each serving size is 1/6 of the whole pack or about 50g. Caloric content reduced from 80 to 70 and total carbohydrates from 3 to 2g for meatloaf without and with white fish meat respectively. Total fat, cholesterol has stayed the same for both formulations with values of about 2 and 3% respectively. Protein and sodium content has increased from 6 to 9 g and 3 to 2mg respectively. Vitamin content has not changed, it registers around 4%, 2% and 20% for vitamin A, calcium and iron respectively. All products have no transfat making it good food for people who are on a diet.

Exposure of meat to higher temperature reduces the amount of amino acid and fatty acids. However, the mineral composition of processed mussel was significantly higher than the raw samples (Biji, 2015). Processed mussel have improved protein content by 23.14%, Potassium from 0.147 to 0.903 while

Calcium from 0.051 to 0.2029 g in percent dry weight (ibid).

4.2.4 Large Market Acceptability Survey

Final formulation was introduced inside a mall in Tacloban City. This was conducted during the 11th year anniversary of the Eastern Visayas Consortium for Industry and Energy Research and Development (EVCIERD). There were about 40 packs of dried mussel, 25 packs of meatloaf, and 30 packs of sausage for sale. These products were sold out in 3 hours. To determine products acceptability, samples for free tasting were also available, and a checklist was provided to the respondents for rating. There were about 127 respondents who were grouped in five categories such as housewives, executive/managerial, white collar, blue-collar workers, and students. Table 3 summarizes the over-all acceptability ratings for the three products using a 9 point scale.

The sausage and meatloaf have improved acceptability compared to the previous formulation without fish meat. The improvement is attributed to the change in taste and more importantly the change in color. The current formulation has lighter color especially when the meatloaf and sausage are steamed rather than fried.

Concealing the true color by having a lighter coating (like red coating on hotdogs) may improve acceptance.

4.3 Material Balance

For every 30kg (shell-on) of boiled green mussel around 7.5kg or about ¼ of the total weight is meat. The weight is reduced to 25% after drying. That means to produce 1 kg of dried mussel around 16kg of fresh mussel (shell on) is needed. The waste

produced is the mussel shell which can be further utilized to develop various products, most of which are for decorative purposes. The stock (waste water produced in steaming fresh mussel) can further be processed to produce glycogen (Moya and Diocton, 2014).

For every 30kg of fresh mussel, around 38 packs of 50g/pack dried mussel is produced. The same amount of fresh mussel combined with 6.5 kg of fish meat and about

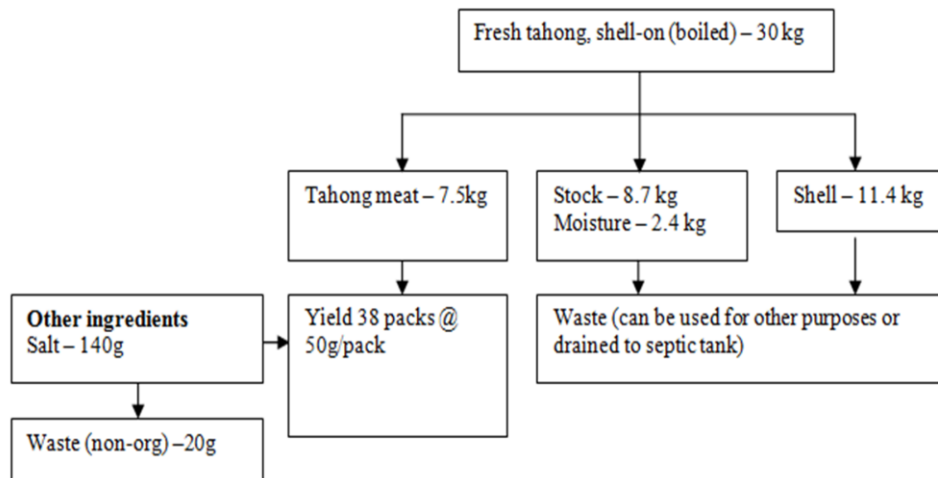


Figure 2. Material Balance for the Production of Dried Mussel

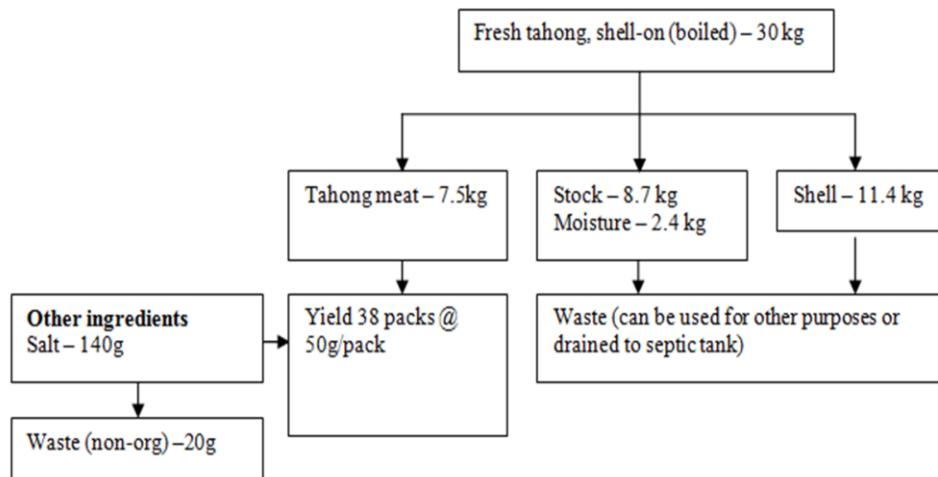


Figure 3. Material Balance for the Production of Sausage

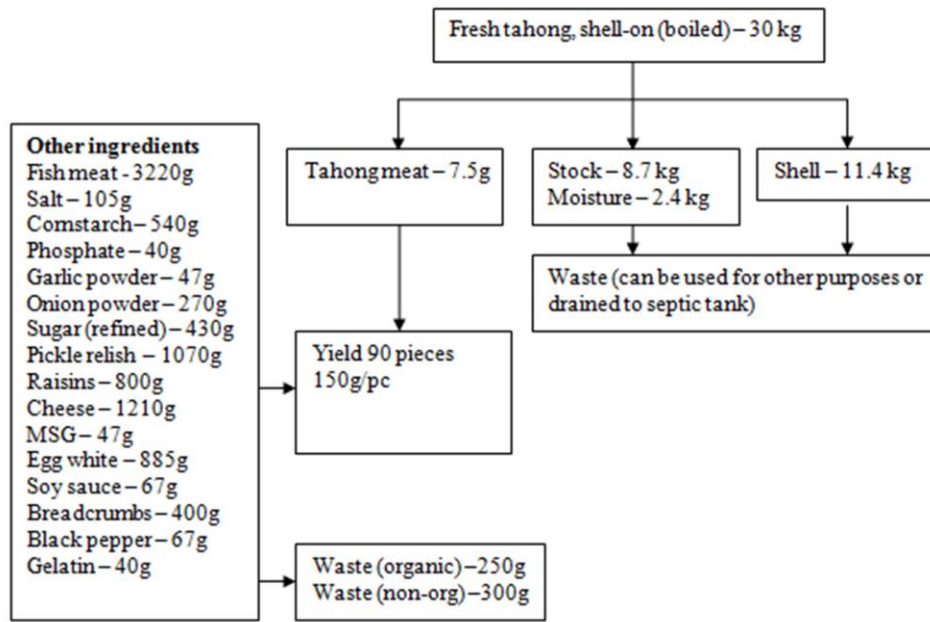


Figure 4. Material Balance for the Production of Meatloaf



a) Sausage (Tahongganisa)



b) Dried Mussel

c) Meatloaf (Tahong Embutido) →



Figure 5. Labeling Design for the Mussel Products

6.9 kg ingredients will yield 841 pcs, at 20g per sausage or around 168 packs each containing five pcs. The same amount of fresh mussel combined with 3.22 kg of fish meat and about 7.6 kg ingredients will yield 90 pcs, 150g each meatloaf or around 45 pcs of 300g/pc meatloaf. Studies to make use of stock from boiling or steaming mussel into energy supplement are being conducted.

4.4 Packaging and Label Design

Figure 5 shows the recommended label design for the three products. For dried green mussel, an OPP/CPP was used. Meatloaf is individually contained in an aluminum foil while the sausage meat mixture is stuffed in an edible sausage container before it is enclosed in a 200mm x 140mm x 100 microns transparent

Table 4. Commercial Acceptability of Mussel Products

Respondents	Percent of respondents								
	Dried Tahong			Tahong Longanisa			Tahong Embutido		
	DL	U	L	DL	U	L	DL	U	L
Housewife	5.1	20.5	74.4	6.4	28.2	65.4	11.5	29.5	59.0
Executive/ Managerial	8.8	20.6	70.6	5.9	14.7	79.4	11.8	17.6	70.6
Other White Collar Workers	5.7	16.4	77.9	9.8	18.0	72.1	9.0	18.0	73.0
Blue Collar Workers	11.7	13.6	74.8	14.6	19.4	66.0	9.7	18.4	71.8
Students (Col. & HS)	12.8	14.3	72.9	12.8	13.5	73.7	12.8	18.0	69.2
Others	8.1	16.2	75.7	8.1	18.9	73.0	8.1	24.3	67.6
Distribution	9.1	16.2	74.8	10.7	18.5	70.8	10.7	20.3	69.0

Legend: DL – dislike U – undecided L – Like

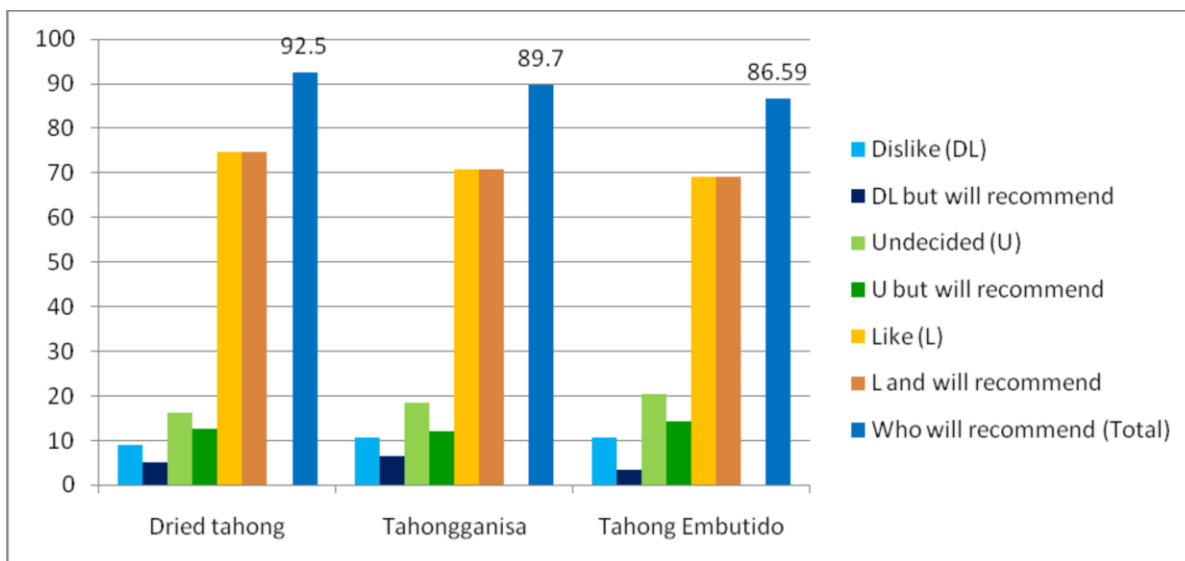


Figure 6. Percent of Respondents who will recommend the products to their family and friends

polyethylene (PE) bags.

4.4 Shelf Life

The three products were submitted to DOST-ITDI for the storage stability analysis. Below were the results of the various tests conducted to determine the shelf life of the products.

Stale taste of dried mussel is developed after five months storage at 40C. It increased to 7.5 when the temperature was reduced to 30C. It is predicted that the shelf life will increase to 11 months if the temperature is reduced to 20°C. The shelf

life of the product can be improved if handling and drying method is improved. Reliance to the sun for drying will result in varied shelf life due to variable intensity of heat and humidity. Using a cabinet dryer is highly encouraged.

Vacuum packed samples of sausage and meatloaf with fish using 200mm x 140mm x 100 microns were stored at -14C and remained acceptable at the end of 18 and 16 months respectively.

4.5 Consumer Product Evaluation

The more than 500 respondents in the three market testing conducted were

Table 5. Shelf Life of Dried Mussel

Storage Temperature (°C)	Shelf Life (months)	Limiting Factors
40	5.0	<ul style="list-style-type: none"> • Development of stale taste
30	7.5	<ul style="list-style-type: none"> • Development of stale taste • Change of texture from crunchy to slightly hard
20**	11.0	<ul style="list-style-type: none"> • Development of stale taste • Change of texture from crunchy to slightly hard

Parameters: Water activity, pH, Microbial Analyses and Sensory Evaluation

**Packed in OPP/ CPP, Net weight per pack: 50 grams*

***Predicted shelf life using Q₁₀*

Table 6: Shelf Life of Sausage

Storage Temperature (°C)	Packaging Materials	Shelf Life (months)	Limiting Factors
-14	Nylon/LLDPE (vacuum packed) 200mm (L) x 140mm (W) x 100 microns (thickness)	18	<ul style="list-style-type: none"> • Development of off-odor/off taste

Parameters monitored: Water activity, pH, Microbial Analyses and Sensory Evaluation

Table 7: Shelf Life of Meatloaf

Storage Temperature (°C)	Packaging Materials	Shelf Life (months)	Limiting Factors
-14	Nylon/LLDPE (vacuum packed) 200mm (L) x 140mm (W) x 100 microns (thickness)	16	<ul style="list-style-type: none"> • Development of off-odor/off taste

Parameters monitored: Water activity, pH, Microbial Analyses and Sensory Evaluation

asked if they like and will buy the product and will recommend it to their friends/families. Shown in Table 4 and Figure 6 is the summary of those responses. Having the highest acceptance is the dried mussel with 74.8% of the population liking the product; this was followed by the sausage and meatloaf with 70.8% and 69.0% respectively.

Follow-up interviews with those who did not like the dried mussel reveal that it is due to relatively high-cost of product and neither on the taste nor color. There are more students and blue collar workers who do not like the product than other respondent categories. Unlike the dried mussel, majority of the respondents who do not like sausage and meatloaf attribute it to the color but approves of the taste.

As shown in figure 6, a number of those who were undecided and those who do not like the three mussel products will still recommend the mussel products to others. There were about 93.0%, 89.7%, and 86.6% of the respondents who will recommend dried mussel, sausage and meatloaf to their family and friends.

5. Conclusion and Recommendation

The three value-added products are widely accepted across economic status and ages. The study has shown that pure mussel meat processed into sausage or meatloaf are less acceptable compared to those with fish meat (white meat). A significant improvement in acceptability was noted when fish meat was added.

Of the three products, dried mussel received the highest acceptability. Production is simple and uses no additional ingredients unless flavoring is sought. Despite this, the dried product is the more

expensive. This is attributed to the shrinking of the tahong meat when dried to about 50%. Shelf life at normal temperature may range from 7.5 to 5 months. It has higher iron content per serving than the other two products.

The biggest challenge to the sausage and meatloaf is the color of the product. At 14°C storage, the sausage and meatloaf can last up to 18 and 16 months respectively. Vitamin A, iron and calcium are present in these products. All of the three products has no transfat making it good food for people who are on a diet. The nutrient content will vary depending on the added meat into the mixture.

The products are ready for commercialization, and the technology owner is open to going into production engagement to any producer.

6. Acknowledgement

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