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FULL PAPER

Development and acceptability of value-added products from green mussel (*Perna viridis)* in Samar, Philippines

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Abstract

Green mussel (*Perna viridis*) is a bivalve mollusc abundantly produced in the province of Samar, Philippines. The development of value-added products from this resource will increase its utilization and marketability. Thus, this study aimed to develop a green mussel meatloaf, noodles, and spread, and determine the product acceptability. Based on the result of the sensory evaluation, meatloaf containing 70% mussel meat obtained the highest score of 7.9 among other treatments with an adjectival rating of like very much. Noodles with 30% mussel are the most acceptable among other treatments with a score of 8.2, and an adjectival rating of like very much. Spread with 20% mussel meat scored highest at 7.9 with an adjectival rating of like very much. These three most acceptable products showed no significant difference (p>0.05*)* with their corresponding positive control samples which are the commercial products, indicating that these mussel products could compete in the market. Furthermore, microbial test results revealed that all products were fit for human consumption, showing a lower total plate count than the microbial count limit set by the standards. Overall, this study showed that green mussels can be processed into meatloaf, noodles and spread.

1. Introduction

The green mussel (*Perna viridis*), locally known as "tahong", is a bivalve mollusc that belongs to the family Mytilidae (Benson *et al*., 2001). *Perna viridis* is a large and fast-growing marine bivalve species that is an ideal candidate for aquaculture due to its high growth rate, fecundity and year-round reproductive capability (Rajagopal *et al*., 2006). Green mussels are harvested as a food source due to their high levels of vitamins and minerals (Caglak *et al*., 2008). They are considered an alternative cheap source of protein for people living in coastal communities (Masniyom *et al*., 2007), as they contain 36.15% protein, 24.54% carbohydrates and 19.72 % lipid (Saritha *et al*., 2015).

Mussels are susceptible to seasonal and environmental factors and are highly perishable (Farber and Todd, 2000) that require intensive care so that their quality could be maintained. Mussels are processed in many parts of the world. There are canned, frozen, marinated, smoked, dried, processed into powders, and pickled mussels being produced. In the Province of Samar, specifically in the Municipality of Jiabong, mussels are processed into crackers or bottled, such as the adobong tahong (NSCB, 2006). This commodity is being cultured in different municipalities of Samar which includes Jiabong, Villareal, and Tarangnan and Motiong. The volume of production of mussels in the province of Samar is sufficient enough to cover fresh mussel demand and demands for processed mussel products.

The development of value-added products from mussels will be beneficial to the mussel farmers, and the Samar province in general, as this could provide alternative livelihood to the fisherfolks. It is essential to study and develop other products from this commodity in order to increase its marketability and the sustainability of the mussel industry. Hence, the objective of this study was to develop value-added products from mussels i.e. meatloaf, noodles and spread, and determine the product acceptability.

2. Materials and methods

2.1 Sample collection

Approximately 10 kg of fresh green mussel *Perna viridis* were purchased from the wet market of Jiabong, Samar. Samples were packed in a styrofoam box and polyethylene bag layered with ice (below 5°C). These were transported immediately to the fish processing

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laboratory in Samar State University Mercedes Campus for further processing.

2.2 Sample preparation

Mussels were cleaned and washed with clean water to remove adhering dirt and mud. After cleaning, these were blanched at 85˚C for 2 mins (Arcales and Nacional, 2018), and the meat was removed manually from its shells. The mussel meats were ground into smaller pieces using an electric grinder (Tasin). Commercial products were procured and used as positive control samples. The criteria in the selection of the control samples include the similarity of the ingredients and the resemblance of appearance. Commercial meatloaves are usually made from pork meat. For the negative control samples, no mussel meat will be added to the formulation of each product.

2.3 Mussel meat loaf processing

Ground mussel meat was mixed with other ingredients, following the formulation shown in Table 1 using an electric mixer (Hanabishi). After mixing thoroughly, these were placed in a greased baking pan covered with aluminium foil. The baking pan was placed in a larger pan filled with water, 75% of the total volume, and bake for 1 hr. After baking, a heavyweight was placed on top of the baking pan to press the loaf. The loaf was stored in chilled condition for 12 hrs until sample analysis.

2.4 Mussel noodles processing

Ground mussel meat was mixed with other ingredients following the formulation shown in Table 2, and formed into balls. The balls were kneaded and cut through the noodle machine. Formed noodles were blanched in boiling water for 5 mins, and immersed in cold water. Noodles were drained for 30 minutes and fried until toasted. They were packed in polyethylene bags and stored at room temperature (29°C) for 12 hrs until sample analysis.

2.5 Mussel spread processing

Ground mussel meat was mixed with other ingredients following the formulation shown in Table 3. The mixture was packed in a sterile glass jar, and pressure-cooked for 15 mins at 121°C. After cooking, glass jars were cooled down at room temperature (29°C) and washed in running water with soap to remove grease. These were stored at room temperature for 10 days until sample analysis.

2.6 Total plate count

A total of 10 g sample was homogenized in 90 mL peptone water. Serial dilution was performed (up to 10^6) in 9 mL peptone water tubes. Then, 0.1 mL from each dilution was inoculated onto plate count agar medium and spread evenly. Plates were incubated at 37°C for 24 hours, and colonies were counted and recorded as CFU/g (APHA, 1992).

2.7 Salmonella sp. detection

A total of 25 g of the sample were mixed in a 225-mL of pre-enrichment broth and incubated at 35°C for 24 hrs. An aliquot (1 mL) of the pre-enrichment broth was inoculated to tetrathionate broth (TTB) and incubated for 24 hrs at 35°C. The selective enrichment cultures were

Table 1. Product formulation of mussel meatloaf on all treatments

Ingredients	Percentage of Ingredients				
	Treatment 1	Treatment 2	Treatment 3	Negative control	Positive control
Mussel	20	40	60	0	
Ground pork	70	50	30	90	
Cold water	4	4	4	4	Commercial meat loaf
Sugar	2	2	2	2	
Cornstarch	2	2	2	2	
Tender Quick	1	1	1	1	
Salt	1	1	1	1	
Total	100				

Table 2. Product formulation of mussel noodles on all treatments

Ingredients	Percentage of Ingredients				
	Treatment 1	Treatment 2	Treatment 3	Negative control	Positive control
Mussel	10	20	30	0	
Flour	85	75	65	95	
Egg yolk	2	2	2	2	Commercial noodles
Salt	1.45	1.45	1.45	1.45	
Sugar	1.45	1.45	1.45	1.45	
MSG	0.1	0.1	0.1	0.1	
Salt	1	1	1	1	
Total	100				

Table 3. Product formulation of mussel spread on all treatments

Ingredients	Percentage of Ingredients				
	Treatment 1	Treatment 2	Treatment 3	Negative control	Positive control
Ground mussel meat	10	20	30	0	
Tomato sauce	50	40	30	60	
Pickle relish	15	15	15	15	Commercial spread
Flour	8	8	8	8	
Carrot	8	8	8	8	
Bell pepper	4	4	4	4	
Onion	2	2	2	2	
Sugar	1	1	1	1	
Salt	1	1	1	1	
Garlic	1	1	1	1	
Total	100				

streaked on xylose lysine deoxycholate (XLD) agar and incubated at 35°C for 24 hrs (FDA BAM, 1998).

2.8 Sensory evaluation

Sensory evaluation was done to determine the product acceptability in terms of colour, odour, flavour, texture/consistency and overall acceptance. A total of 10 semi-trained panellists assessed the sensorial quality of the product using a 9-point hedonic scale scorecard (1 = dislike extremely; 9 = like extremely). The panellists consisted of faculty and student of the university, aged between 20-30 years old, with prior knowledge about conducting a sensory evaluation.

2.9 Statistical analysis

Data on sensory evaluation were analyzed using one-way ANOVA and a posthoc analysis, Holm-Sidak test to determine the significant difference ($p<0.05$). Statistical analysis was performed using the statistical software, Sigma Plot 11.0.

3. Results and discussion

3.1 Sensory evaluation

Table 4 shows the mean scores of mussel meatloaf in all sensorial attributes. Based on the result of the overall acceptability, treatment 3 (60% mussel meat) obtained the highest score of 7.9 among the 3 treatments, with an adjectival rating of like very much, showing no significant difference with the positive control or the commercial product. This result suggests that the newly-developed mussel meatloaf is comparable with the existing product in the market in terms of quality.

Table 5 shows the mean scores of mussel noodles in all sensorial attributes. Based on the results, treatment 3 containing 30% mussel meat obtained the highest score of 8.2 with an adjectival rating of like very much, showing a significant difference between the positive control sample or the commercial noodle. This result suggests that the mussel noodle is comparable with the existing noodle product in the market in terms of its quality. Panellists commented that the noodles were too thick. It was suggested to cut the noodles thinner.

Table 6 shows the mean scores of mussels spread in

Table 4. Mean scores of mussel meatloaf in all attributes

Sensorial attribute	Treatment 1	Treatment 2	Treatment 3	Negative control	Positive control
Colour	7.5 ± 0.12^{ab}	7.5 ± 0.12^{ab}	7.6 ± 0.15^{a}	7.0 ± 0.16^{b}	8.0 ± 0.16^{a}
Odour	7.5 ± 0.11^{ab}	7.5 ± 0.15^{ab}	7.6 ± 0.17^{ab}	7.4 ± 0.17^{b}	8.0 ± 0.14^{a}
Flavour	6.75 ± 0.18^{a}	7.75 ± 0.19^{b}	7.6 ± 0.11^{b}	6.25 ± 0.20^{ac}	7.85 ± 0.17^{b}
Texture	7.1 ± 0.23^{ac}	7.9 ± 0.19^{b}	8.1 ± 0.16^{b}	6.8 ± 0.23^{c}	7.7 ± 0.15^{ab}
Overall acceptability	7.2 ± 0.20^{a}	7.3 ± 0.21^{ab}	7.9 ± 0.14^{bc}	6.9 ± 0.19^{a}	8.1 ± 0.16^{c}

Values are presented as mean±SE. Values with different superscripts within the same row are significantly different ($p<0.05$).

Table 5. Mean scores of mussel noodles in all attributes

Sensorial attribute	Treatment 1	Treatment 2	Treatment 3	Negative control	Positive control
Colour	7.1 ± 0.20^{a}	7.3 ± 0.16^{a}	7.45 ± 0.14^{a}	7.25 ± 0.20^{a}	7.55 ± 0.21^{a}
Odour	7.5 ± 0.19^{ab}	7.7 ± 0.13^{ac}	8.1 ± 0.14^{a}	7.0 ± 0.23^{b}	7.4 ± 0.18^{bc}
Flavour	7.35 ± 0.15^{a}	7.6 ± 0.13^{ab}	8.1 ± 0.16^{b}	7.2 ± 0.19^{a}	7.35 ± 0.15^{a}
Texture	7.35 ± 0.15^{a}	7.4 ± 0.17^{a}	7.55 ± 0.19^{a}	7.35 ± 0.18^{a}	7.6 ± 0.13^{a}
Overall acceptability	7.2 ± 0.17^{a}	7.45 ± 0.14^{ac}	8.2 ± 0.12^{b}	7.1 ± 0.15^{a}	7.9 ± 0.14^{bc}

Values are presented as mean±SE. Values with different superscripts within the same row are significantly different ($p<0.05$).

Table 6. Mean scores of mussel spread in all attributes

Sensorial attribute	Treatment 1	Treatment 2	Treatment 3	Negative control	Positive control
Colour	7.55±0.19^{a}	7.35±0.15^{ac}	6.45±0.21^{b}	6.75±0.16^{bc}	7.75±0.23^{a}
Odour	6.75±0.28^{ab}	7.5±0.17^{ac}	7.55±0.24^{ac}	6.35±0.21^{b}	7.75±0.18^{c}
Flavour	7.2±0.25^{ac}	7.55±0.19^{a}	7.35±0.15^{ab}	6.5±0.27^{c}	7.8±0.21^{a}
Texture	7.2±0.23^{ab}	7.65±0.21^{a}	7.75±0.18^{a}	6.7±0.25^{b}	7.55±0.19^{a}
Overall acceptability	6.95±0.20^{a}	7.9±0.19^{bc}	6.85±0.23^{a}	6.25±0.29^{a}	8.15±0.21^{c}

Values are presented as mean±SE. Values with different superscripts within the same row are significantly different ($p<0.05$).

all sensorial attributes. Treatment 2 containing 20% mussel meat obtained the highest score of 7.9 with an adjectival rating of like very much, showing no significant difference between the positive control sample or the commercial spread. This result suggests that the mussel spread can also be introduced into the market in terms of its quality. Some notable comments of the panellists include the texture of the product. Samples with mussel content have a coarse and granular texture. It was suggested that the adductor muscle of the mussel should not be incorporated, or should be ground thoroughly, as it has a gummy texture that is hard to chew.

3.2 Microbial analysis

Table 7 reveals the microbial quality of the mussel products as compared with the standard microbial count prescribed by the Food and Drug Administration (2013). Only the most acceptable products were subjected to microbial analysis (Figures 1 to 3). As shown, the microbial count of the samples was lower than the standard limit or has complied with the requirements. It is, therefore, safe to conclude that the product is fit for human consumption.

Table 7. Microbiological quality of mussel meatloaf, noodles and spread

Sample	Total plate count	Standard microbial
1. Mussel meat loaf (Treatment 3)	2.2×10^3	1×10^5 (Luncheon meat and packaged meat)
2. Mussel noodles (Treatment 3)	1.3×10^3	1×10^5 (Pasta products and uncooked noodles)
3. Mussel spread (Treatment 2)	0	0 (Thermally processed products)

Figure 1. Mussel meatloaf

Figure 2. Mussel noodles

Figure 3. Mussel spread

4. Conclusion

This study revealed that green mussels can be processed into meatloaf, noodles, and spread that are comparable to the existing commercial product in the market in terms of their acceptability. Treatment 3 containing 60% mussel meat is the most acceptable product formulation for meatloaf, treatment 3 with 30% mussel meat for noodles, and treatment 2 with 20% mussel meat for spread. Also, based on the results of the microbial analysis, all samples are fit for human consumption based on the standards of microbial analysis. Further studies on the proximate composition, product shelf-life, and cost analysis are recommended.

Conflict of interest

The authors declare no conflict of interest.

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