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Development of Shrimp (*Penaeus monodon*) Shell Sauce

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Abstract

This study aimed to develop a concentrated liquid sauce from shrimp (Penaeus monodon) shell waste and evaluate its sensory properties, microbial safety, and shelf life. Three sauce formulations were prepared: Control (5 g ginger), Ginger (50 g ginger), and Chili (30 g Capsicum frutescens). Fifteen expert panelists evaluated sensory qualities (appearance, aroma, consistency, taste) over three replications using a 9-point hedonic scale. One hundred consumers (teachers, cooks, restaurant owners, students, housewives) assessed general acceptability. Microbial analysis for Salmonella and Escherichia coli was conducted on the best treatment, and shelf life was determined at room (25±2°C) and chilled (4±1°C) temperatures. Results showed that experts rated Control highest overall (mean 7.71, "Liked Very Much"), while consumers preferred Chili (mean 7.25, "Liked Very Much"). Analysis of variance revealed no significant differences among treatments for most sensory attributes ($p>0.01$), except for consistency in expert evaluations. Microbial analysis detected no Salmonella in 25 g sample and E. coli count was <0.018 MPN/g, well below the acceptable limit (11 MPN/g). Shelf life was 7 days at room temperature and 35 days under chilled storage. The study concludes that shrimp shell waste can be successfully valorized into an acceptable, safe, and marketable sauce, offering a sustainable solution to reduce environmental pollution from shrimp processing waste.

Keywords: Penaeus Monodon; Shrimp Shell Waste; Sauce Development; Sensory Evaluation; Microbial Safety; Shelf Life; Waste Valorization

1. Introduction

In many coastal areas, the processing of shrimp generates substantial organic waste, presenting both environmental and public health challenges. This issue is particularly evident in the Municipality of Pontevedra, Province of Capiz, Philippines, especially in the coastal barangay of Binetian, where shrimp shells are routinely discarded. The primary livelihoods in this region aquaculture and capture fisheries produce significant quantities of Penaeus monodon (black tiger shrimp), a species of considerable commercial value.

Globally, Penaeus monodon accounts for approximately 47% of total world shrimp production, underscoring its economic importance, particularly in Asian countries such as the Philippines. Driven by high demand in both Asian and international markets, black tiger shrimp farming and capture remain highly profitable activities that generate substantial employment (Waihi et al., 2025; Ali et al., 2022). Historically, this species was harvested from traditional trapping-growing ponds or as a by-product of extensive milkfish ponds. The brackish coastal waters of Capiz constitute one of the richest fishing grounds in Western Visayas, explaining the abundance of this species across the province. Consequently, black tiger shrimp is regarded as a signature product of Capiz, exported both within and beyond the province.

Despite its economic value, the processing of Penaeus monodon generates considerable waste. Based on the researcher's direct experience operating a buying station in Binetian, Pontevedra, Capiz which handles peeled,

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uncooked, frozen shrimp the shells are consistently treated as refuse. Local aquaculture operators and fishers typically discard these shells back into rivers or onto open land. During decomposition, the accumulated waste emits a strong, unpleasant odor, contributing to air pollution and environmental degradation. Motivated by this observation, the present study seeks to add value to shrimp shell waste by developing an acceptable and marketable concentrated liquid shrimp sauce derived from this by-product.

Objectives of the Study

The main purpose of this study was to formulate and develop a shrimp concentrates sauce utilizing the shrimp shell.

Specifically, this study sought to

- determine the sensory qualities the shrimp shell sauce in terms of appearance, aroma, consistency and taste as evaluated by experts in three replications;
- determine the general acceptability of the shrimp shell sauce in terms of appearance aroma, consistency and taste as evaluated by consumers;
- find out if there is a significant difference in the sensory qualities of shrimp shell sauce in terms of appearance, aroma, consistency and taste as evaluated by experts in three replications;
- find out if there is a significant difference in the general acceptability of the shrimp shell sauce in terms of appearance, aroma, consistency and taste as evaluated by the consumers;
- submit the best treatment for Microbial Analysis to determine the level of microorganisms present and
- determine the maximum shelf-life span of the shrimp shell sauce in room temperature and chilled temperature.

2. Materials and Methods

2.1. Materials and Instruments

The following materials and equipment were used for the preparation of shrimp shell sauce: working table, strainer, cutting board, knife, mortar and pestle, utility tray, sterilized glass jars (250 mL capacity), frying pan, stock pot (5 L capacity), ladle, spoon, fork, saucer, weighing scale (accuracy ±0.1 g), digital weighing scale (accuracy ±0.01 g), sieve (mesh size 0.5 mm), basin, and gas stove. Sterilization of jars was performed by boiling in water for 15 minutes.

The ingredients for producing the shrimp shell broth and sauce included: fresh Penaeus monodon shells (obtained from a local buying station in Binetian, Pontevedra, Capiz), cooking oil (commercially refined vegetable oil), onion (Allium cepa), garlic (Allium sativum), fresh gingerroot (Zingiber officinale), chili (Capsicum frutescens L., locally known as sailing labor), black pepper (ground), salt (iodized), cornstarch, and potable water. All specialized chemicals (e.g., cornstarch, spices) were purchased from a local supermarket in Roxas City, Capiz, Philippines. No analytical-grade or proprietary chemicals were required.

2.2. Preparation of Shrimp Shell Broth

Fresh shrimp shells, collected from shrimp peeling operations, were washed thoroughly with warm water (≈50 °C) to remove adhering foreign materials, then drained and set aside. The shells were soaked in lemon solution (30 mL lemon juice per 1 L water) for 30 minutes to reduce odor, then drained again. After draining, the shells were weighed and pounded using a mortar and pestle until a course, fragmented consistency was achieved. Five kilograms (5 kg) of pounded shells were sautéed in 5 mL cooking oil with 5 g finely minced onion, 5 g finely minced garlic, and 5 g finely minced gingerroot for 3 minutes over medium heat. Subsequently, 2500 mL of water was added, and the mixture was brought to a boil over high heat until the liquid turned orange in color (approximately 15 minutes). The heat was then reduced to low, and the mixture was simmered for another 30 minutes. The resulting broth was filtered through a sieve to remove solid residues. Each preparation yielded approximately 3750 mL (3.75 L) of shrimp shell broth concentrate.

2.3. Formulation of Treatments

Three treatments were developed: Control (ginger-flavored, with 5 g ginger), Ginger (with 50 g ginger), and Chili (with 30 g chili). All other ingredients were kept constant across treatments. The final ingredient composition for each treatment is presented in Table 1.

Table 1 Final formulation of shrimp shell sauce treatments (per 500 mL batch)

Ingredients	**Treatment**		
	Control (A)	Ginger (B)	Chili (C)
Shrimp Shell Broth	500 ml	500 ml	500 ml
Cooking oil	5 ml	5 ml	5 ml
Onion (finely minced)	5 g	5 g	5 g
Garlic (finely minced)	5 g	5 g	5 g
Ginger (finely minced)	5 g	5 g	0 g
Chili (siling Lauby)	0 g	0 g	30 g
Black pepper	1 g	1 g	1 g
Salt	10 g	10 g	10 g
Cornstarch	20g	20g	20g
Water	50ml	50ml	50ml

2.4. The preparation procedure for each treatment was as follows

Control flavored shrimp shell sauce: Cooking oil (5 mL) was heated in a stock pot over medium heat. Finely minced garlic (5 g), onion (5 g), and ginger (5 g) were sautéed until fragrant (≈2 minutes). Shrimp shell broth (500 mL) was added, followed by a slurry of cornstarch (20 g) dissolved in water (50 mL). The mixture was simmered for 30 minutes, then seasoned with black pepper (1 g) and salt (10 g). The sauce was strained through a sieve to remove sautéed solids and lumps, allowed to cool to room temperature, and then poured into sterilized glass bottles. Bottles were sealed and stored at 4 °C until evaluation.

- **Ginger flavored shrimp shell sauce:** The same procedure was followed, except that 50 g of finely minced ginger was used instead of 5 g.
- **Chili flavored shrimp shell sauce:** The same procedure was followed, except that chili (30 g finely minced siling labor) was added together with the onion and garlic; ginger was omitted.

2.5. Experimental Design and Treatment Distribution

The study employed a completely randomized design (CRD) with three treatments and three replications per treatment. Each replication consisted of an independently prepared batch. The assignment of treatments to replication units was determined by draw lots.

Table 2 The composition of evaluated treatments by the panel of expert in three trials

Ingredients	**Trial 1 Treatment**			**Trial 2 Treatment**			**Trial 3 Treatment**		
Shrimp Shell Broth	500 ml	500 ml	500 ml	500 ml	500 ml	500 ml	500 ml	500 ml	500 ml
Cooking oil	5 ml	5 ml	5 ml	5 ml	5 ml	5 ml	5 ml	5 ml	5 ml
Onion (Finely minced)	5 g	5 g	5 g	5 g	5 g	5 g	5 g	5 g	5 g
Garlic (Finely minced)	5 g	5 g	5 g	5 g	5 g	5 g	5 g	5 g	5 g
Ginger (Finely minced)	0 g	30 g	0 g	5 g	40 g	0 g	0 g	50 g	0 g
Chili (Siling Lauby)	0 g	0 g	30 g	0 g	0 g	40 g	5 g	0 g	50 g
Black pepper	1 g	1 g	1 g	1 g	1 g	1 g	1 g	1 g	1 g
Salt	10 g	10 g	10 g	10 g	10 g	10 g	10 g	10 g	10 g
Cornstarch	20 g	20 g	20 g	20 g	20 g	20 g	20 g	20 g	20 g
Water	50 ml	50 ml	50 ml	50 ml	50 ml	50 ml	50 ml	50 ml	50 ml

2.6. Sensory Evaluation

2.6.1. Panel of Experts

Fifteen panelists with expertise in food sensory evaluation participated in the initial formulation trials and final product validation. The panel comprised: ten Home Economics teachers from Capiz State University (Roxas City), three Master Teachers in Agri-Fishery, and two Technical Vocational and Livelihood (TVL) teachers from Jose Diva Avelino Jr. National High School.

2.6.2. Consumer Panel

One hundred consumers were recruited for the final acceptability test, consisting of 20 teachers, 20 restaurant/canteen owners, 20 cooks, 20 secondary and tertiary students, and 20 housewives.

2.7. Evaluation Procedure

Sensory evaluation was conducted over three consecutive days (December 5–7, 2018). Each sample (≈30 mL per treatment) was served in a standardized container at room temperature (25 ± 2 °C) with a clean stirrer. A 9-point hedonic scale was used to rate appearance (1 = extremely unattractive to 9 = extremely attractive), aroma (1 = extremely unauthentic to 9 = extremely authentic), consistency (1 = extremely not nappe to 9 = extremely nappe), taste (1 = extremely not delicious to 9 = extremely delicious), and overall acceptability (1 = disliked extremely to 9 = liked extremely). Between samples, panelists were provided with potable water to cleanse their palates. Score sheets were collected immediately after each session.

2.8. Microbial Analysis and Shelf Life

The best-performing treatment (Ginger flavor, based on sensory scores) was subjected to microbiological analysis at the Department of Science and Technology (DOST) regional laboratory. Analyses were performed to detect the presence of Escherichia coli and Salmonella spp. using standard culture methods (AOAC International procedures).

Shelf life was determined by storing samples of the best treatment under two conditions: room temperature (25 ± 2 °C) and chilling temperature (4 ± 1 °C). Three bottles per condition were observed daily for visible changes (mold growth, off-odor, phase separation, or gas formation). The maximum number of days before any detectable change was recorded.

2.9. Cost Analysis

Production cost per batch (3500 mL) was calculated based on ingredient and material expenses (purchased at local market prices in 2018) and labor. The cost of shrimp shell broth was considered zero (recycled waste material). Total cost per 50 mL serving was determined.

2.10. Statistical Analysis

All sensory evaluation data were tabulated and analyzed using one-way analysis of variance (ANOVA) to determine significant differences among the three treatments for each sensory attribute (appearance, aroma, consistency, taste, and overall acceptability). A significance level of $\alpha = 0.05$ was applied. Mean scores were interpreted using the adjectival scales defined in the scoring system (e.g., 8.12–9.00 = liked extremely). Statistical computations were performed using SPSS version 20.0 (IBM Corp., Armonk, NY, USA) or equivalent software.

2.11. Ethical Approval and Informed Consent

This study involved human participants (sensory panelists) for the evaluation of a food product derived from shrimp shell waste. No live animals were used. The research protocol, including the recruitment of panelists, sensory evaluation procedures, and data handling, was reviewed and approved by the Research Ethics Committee of Capiz State University (Approval Code: CapSU-REC-2018-011, dated November 20, 2018). All procedures were conducted in accordance with the ethical standards of the institutional research committee and with the 1964 Helsinki declaration and its later amendments.

Written informed consent was obtained from each participant prior to their involvement. The consent form explained the purpose of the study, the voluntary nature of participation, the absence of known risks (the product was prepared from food-grade ingredients and tested for microbial safety), and the confidentiality of individual responses. Participants were informed that they could withdraw from the evaluation at any time without penalty. For the panel of

experts, additional consent was obtained regarding their role in iterative product refinement. All evaluation sheets were anonymized prior to statistical analysis.

No ethical approval was required for the use of shrimp shells, as these were collected as post-consumer/post-processing waste from a commercial operation and did not involve live animals or animal procedures.

3. Results and Discussion

3.1. Sensory Qualities as Evaluated by Experts in Three Replications

Table 3 Sensory qualities of shrimp shell sauce among three treatments in first replication

Sensory Quality	Control (TA)	Ginger (TB)	Chili (TC)
Appearance	8.00 (VMA)	7.53 (VMA)	8.00 (VMA)
Aroma	8.13 (EA)	8.20 (EA)	8.00 (VMAU)
Consistency	7.73 (VMN)	8.20 (EN)	7.73 (VMN)
Taste	7.27 (VD)	7.67 (VD)	6.60 (MD)

Legend:

VMA	Very Much Attractive	VMD	Very Delicious
VMAU	Very Much Authentic	MD	Moderately Delicious
EA	Extremely Authentic	TA	Treatment A
EN	Extremely Nappe	TB	Treatment B
VMN	Very Much Nappe	TC	Treatment C

The data on the evaluation of the sensory qualities of Shrimp Shell Sauce by the panel of fifteen experts in the first replication is shown in Table 5.1. In terms of appearance, the data revealed that all of the treatments were “Very Much Attractive”. However, the Treatment A (TA) which is the control flavor and Treatment C (TC) which is the Chili Flavor both have the highest mean of 8.00 and followed by the Treatment B (TB) which is the ginger flavor with the mean of 7.53 In terms of Aroma, it was shown that Treatments A and were “Extremely Authentic” yet Treatment B (Ginger) had th highest mean of 8.20. It is followed by Treatment A (Control with 8.13. Treatment C (Chili) was interpreted as “Very Muc Authentic” with the mean of 8.0. In terms of Consistency, the third sensory qualities the Treatment B (Ginger) which refers to the Ginger Flavored Shrimp Shell Sauce were described to be “Extremely Nappe” with the mean of 8.20. Both the Treatments A’s and C’s consistency were “Very Much Authentic” with the mean of 7.73.

In terms of Taste, The Treatment B (Ginger) had the highest mean of 7.67 followed by the Treatment A (Control)with 7.27 however both were “Very Delicious”. The Treatment C (Chili) is “Moderately Delicious” with the mean 6.60. The data on the evaluation of the sensory qualities of Shrimp Shell Sauce by the panel of fifteen experts in the second replication is shown in Table 4. In terms of Appearance, the Treatment C (Chili) which refers to the Chili Flavored Shrimp Shell Sauce was described to be “Extremely Attractive” with the mean of 8.47. Both the Treatments A’s and B’s appearance were “Very Much Attractive” with the mean of 7.87 and 7.27 respectively.

Table 4 Sensory qualities of shrimp shell sauce among three treatments in second replication

Sensory Quality	Control (TA)	Ginger (TB)	Chili (TC)
Appearance	7.87 (VMA)	7.27 (VMA)	8.47 (EA)
Aroma	7.93 (VMAU)	8.13 (EAU)	8.13 (EAU)
Consistency	7.73 (VMN)	7.60 (VMN)	8.00 (VMN)
Taste	7.07 (MD)	6.73 (MD)	6.87 (MD)

Legend:

VMA	Very Much Attractive	VMD	Very Delicious
VMAU	Very Much Authentic	MD	Moderately Delicious
EA	Extremely Authentic	TA	Treatment A
EN	Extremely Nappe	TB	Treatment B
VMN	Very Much Nappe	TC	Treatment C

In terms of Aroma, The Treatment B (Ginger) and Treatment C (Chili) had the highest mean of 8.13 and describe as "Extremely Authentic" and lastly is the Treatment A (Control)was "Very Authentic" with the mean of 7.93. In terms of Consistency of three treatments in second replication, all the three treatments were "Very Much Nappe". Moreover, the Treatment C (Chili) had the highest mean of 8.00, followed by Treatment A (Control)with the mean of 7.73 and the mean of Treatment B (Ginger) was 7.60. In terms of Taste, Treatment A, B and C were "Moderately Delicious" yet the mean of Treatment A (Control)was 7.07, Treatment C's mean was 6.87 and the Treatment B (Ginger) had the mean of 6.73. The data on the evaluation of the sensory qualities of Shrimp Shell Sauce by the panel of fifteen experts in the third replication is shown in Table 5.3. In terms of Appearance, the Treatment A, B and C were all "Very Much Attractive" with the mean of 7.80, 7.47 and 7.67 respectively. The Table 3.3 shows that Aroma of three treatments was all "Very Much Authentic". However, the means of these treatments varied. The Treatment B (Ginger) had the highest mean of 8.0 followed by Treatment C (Chili) with 7.73 and Treatment A (Control)with 7.53. With the Consistency of the three treatments, the mean of Treatment B (Ginger) was 7.67, Treatment A (Control)had 7.60 and Treatment C (Chili) with the mean of 7.33. Thus, all of these treatments were "Very Much Nappe". The last Sensory Quality was Taste and the table below showed that Treatment A (Control)was "Very Much Delicious" with the mean of 7.87. Second to Treatment A (Control)was Treatment B (Ginger) with the mean of 7.13 and the taste of Treatment C (Chili) was "Slightly Delicious" with the mean of 6.33

Table 5 Sensory qualities of shrimp shell sauce among three treatments in third replication

Sensory Quality	Control (TA)	Ginger (TB)	Chili (TC)
Appearance	7.80 (VMA)	7.47 (VMA)	7.67 (VMA)
Aroma	7.53 (VMAU)	8.00 (VMAU)	7.73 (VMAU)
Consistency	7.60 (VMN)	7.67 (VMN)	7.33 (VMN)
Taste	7.87 (VMD)	7.13 (MD)	6.33 (SD)

Legend:

VMA	Very Much Attractive	VMD	Very Delicious
VMAU	Very Much Authentic	MD	Moderately Delicious
EA	Extremely Authentic	TA	Treatment A
EN	Extremely Nappe	TB	Treatment B
VMN	Very Much Nappe	TC	Treatment C

Table 6 revealed the gathered data from the evaluation of the panel of fifteen experts towards the overall sensory qualities of the Shrimp Shell Sauce among the three treatments. In terms of Appearance, it was indicated in table 5.4 that all three treatments were "Very Much Attractive". The mean of Treatment C (Chili) was 8.05, the Treatment A's mean was 7.89 and the mean of Treatment B (Ginger) was 7.42. Based on Aroma, Treatment B (Ginger) had the highest mean of 8.11 which was describe as "Very Much Authentic".

Table 6 Overall sensory qualities of shrimp shell sauce among three treatments

Sensory Quality	Control (TA)	Ginger (TB)	Chili (TC)
Appearance	7.89 (VMA)	7.42 (VMA)	8.05 (VMA)
Aroma	7.86 (VMAU)	8.11 (VMAU)	7.95 (VMAU)
Consistency	7.69 (VMN)	7.82 (VMN)	7.69 (VMN)
Taste	7.40 (VMD)	7.18 (MD)	6.60 (MD)

Legend:

VMA	Very Much Attractive	VMD	Very Delicious
VMAU	Very Much Authentic	MD	Moderately Delicious
EA	Extremely Authentic	TA	Treatment A
EN	Extremely Nappe	TB	Treatment B
VMN	Very Much Nappe	TC	Treatment C

Next to it was Treatment C (Chili) with 7.95 which were also interpreted as "Very Much Authentic". Last is the Treatment A (Control) with 7.86 considered as well to be "Very Much Authentic". Based on the Consistency of the treatments, all treatments were "Very Much Nappe". The mean of Treatment B (Ginger) was 7.82 and both Treatment A (Control) and

C had 7.69. In terms of Taste, the overall evaluation according to the panel of experts of Treatment A (Control) was 7.40 or "Very Much Delicious". For Treatment B (Ginger) was 7.18 and Treatment C (Chili) was 6.60 thus, both treatments were "Moderately Delicious". In overall sensory qualities, the treatment with the highest level of sensory qualities was Treatment A (Control) with 7.71 followed by Treatment B (Ginger) with 7.63 and Treatment C (Chili). Thus, all three treatments were "Very Much Liked"

3.2. General Acceptability of Shrimp Shell Sauce as Evaluated by Consumers in Three Replications

Table 7 Sensory qualities of shrimp shell sauce among three treatments in first replication as evaluated by consumers

	Replication 1		
Sensory Quality	Control (TA)	Ginger (TB)	Chili (TC)
Appearance	7.96 (VMA)	7.35 (VMA)	7.42 (VMA)
Aroma	7.27 (VMAU)	7.35 (VMAU)	7.01 (MAU)
Consistency	7.11 (MN)	7.03 (MN)	6.98 (MN)
Taste	7.02 (MD)	6.48 (MD)	6.33 (SD)

Legend:

VMA	Very Much Attractive	VMD	Very Delicious
VMAU	Very Much Authentic	MD	Moderately Delicious
EA	Extremely Authentic	TA	Treatment A
EN	Extremely Nappe	TB	Treatment B
VMN	Very Much Nappe	TC	Treatment C

The data on the evaluation of the sensory qualities of Shrimp Shell Sauce by the one hundred consumers composed of twenty cooks, twenty restaurants/canteen Owners, twenty teachers, twenty students and twenty housewives in the first replication is shown in Table 6.1. In terms of appearance, the data revealed that all of the treatments were "Very Much Attractive". However, the Treatment A (Control)which is the Natural Flavored Shrimp Shell Sauce had a mean of 7.96 and Treatment C (Chili) refers to the Chili Flavored Shrimp Shell Sauce with 7.42 mean and Treatment B (Ginger) or the Ginger Flavored Shrimp Shell Sauce with the mean of 7.35. In terms of Aroma, it was shown that Treatments A and B were "Very Much Authentic" with the mean of 7.27 and 7.35 respectively. Treatment C (Chili) was "Moderately Authentic" in terms of aroma with the mean of 7.01. In terms of Consistency, the third sensory qualities, all treatments were "Moderately Nappe". However, the treatment with highest acceptability in terms of consistency was the Treatment A with 7.11, followed by Treatment B (Ginger) with 7.03 and last is Treatment C (Chili) with 6.98 In terms of Taste, both the Treatment A (Control)with the mean of 7.02 and Treatment B (Ginger) with 6.48 were "Moderately Delicious" and the Treatment C (Chili) had the mean of 6.33 and "Slightly Delicious" in terms of taste.

The data on the evaluation of the sensory qualities of Shrimp Shell Sauce by the one hundred consumers composed of twenty cooks, twenty restaurants/canteen Owners, twenty teachers, twenty students and twenty housewives in the second replication is shown in Table 6.2. In terms of Appearance, Treatment C (Chili) was "Extremely Attractive" with the mean of 8.26 and Treatment A (Control) with the mean of 7.34 and Treatment B (Ginger) with 7.34 both were "Very Much Attractive". In terms of Aroma, Treatment C (Chili) and Treatment B (Ginger) was "Very Much Authentic" with the mean of 7.74 and 7.45 respectively. The Treatment A (Control) was "Moderately Authentic" with 7.08 mean. In with the Shrimp Shell Sauce's Consistency, the Treatment C (Chili) was "Very Much Nappe" with the mean of 7.57. The other two treatments, Treatment B (Ginger) and Treatment A (Control) were "Moderately Nappe" with mean of 7.18 for Treatment B (Ginger) and 7.06 for Treatment A (Control). For the taste, the Treatment C (Chili) was "Very Delicious" based on its 7.38 mean. Treatment B (Ginger) with 6.75 mean and Treatment A(Control) with 6.62 mean were both "Moderately Delicious".

Table 8 Sensory qualities of shrimp shell sauce among three treatments in second replication as evaluated by consumers

	Replication 2		
Sensory Quality	Control (TA)	Ginger (TB)	Chili (TC)
Appearance	7.34 (VMA)	7.57 (VMA)	8.26 (EA)
Aroma	7.08 (MAU)	7.45 (VMAU)	7.74 (VMAU)
Consistency	7.06 (MN)	7.18 (MN)	7.57 (VMN)
Taste	6.62 (MD)	6.75 (MD)	7.38 (VD)

Legend:

VMA	Very Much Attractive	VMD	Very Delicious
VMAU	Very Much Authentic	MD	Moderately Delicious
EA	Extremely Authentic	TA	Treatment A
EN	Extremely Nappe	TB	Treatment B
VMN	Very Much Nappe	TC	Treatment C

The data on the evaluation of the sensory qualities of Shrimp Shell Sauce by the one hundred consumers composed of twenty cooks, twenty restaurants/canteen Owners, twenty teachers, twenty students and twenty housewives in the Third replication is shown in Table 6.3. In terms of Appearance in third replication, the Treatment A (Control) with the mean of 7.69 and Treatment C (Chili) with 7.51 mean were "Very Much Attractive" and the Treatment B (Ginger) was "Moderately Attractive" with 7.10 mean. In terms of Aroma, all three treatments were "Moderately Authentic". The Treatment A (Control) had a 7.21 mean, Treatment C (Chili) with 7.07 mean and Treatment B (Ginger) with 7.02 mean. In terms of Consistency, all three treatments were "Moderately Nappe". Treatment A (Control) had the highest mean of 7.18, followed by Treatment C (Chili) with 7.11 and last was Treatment B (Ginger) with 6.99 mean. In terms of Taste, the Treatment A (Control) with the mean of 7.26 was "Moderately Delicious" and Treatment C (Chili) with 6.56 mean and Treatment B (Ginger) with 6.45 mean were both "Moderately Delicious".

Table 9 Sensory qualities of shrimp shell sauce among three treatments in third replication as evaluated by consumers

	Replication 3		
Sensory Quality	Control (TA)	Ginger (TB)	Chili (TC)
Appearance	7.69 (VMA)	7.1 (MA)	7.51 (VMA)
Aroma	7.21 (MAU)	7.02 (MAU)	7.07 (MAU)
Consistency	7.18 (MN)	6.99 (MN)	7.11 (MN)
Taste	7.26 (VMD)	6.45 (MD)	6.56 (MD)

Legend:

VMA	Very Much Attractive	VMD	Very Delicious
VMAU	Very Much Authentic	MD	Moderately Delicious
EA	Extremely Authentic	TA	Treatment A
EN	Extremely Nappe	TB	Treatment B
VMN	Very Much Nappe	TC	Treatment C

Table 6.4 revealed the gathered data from the evaluation of the one hundred consumers toward the overall sensory qualities of the Shrimp Shell Sauce among the three treatments. In terms of Overall Evaluation of Appearance, all three treatments were "Very Much Attractive". However, Treatment C (Chili) had the highest overall evaluation mean of 7.73, followed by Treatment A (Control) with 7.66 mean and Treatment B (Ginger) with the mean of 7.34.

Table 10 Overall general acceptability of sensory qualities Of Shrimp Shell Sauce among three treatments by Consumers

	Overall		
Sensory Quality	Control (TA)	Ginger (TB)	Chili (TC)
Appearance	7.66 (VMA)	7.1 (MA)	7.51 (VMA)
Aroma	7.19 (MAU)	7.02 (MAU)	7.07 (MAU)
Consistency	7.12 (MN)	6.99 (MN)	7.11 (MN)
Taste	6.97 (VMD)	6.45 (MD)	6.56 (MD)
Overall Acceptability	7.24 (VML)	7.06 (ML)	7.25 (VML)

Legend:

VMA	Very Much Attractive	VMD	Very Delicious
VMAU	Very Much Authentic	MD	Moderately Delicious
EA	Extremely Authentic	TA	Treatment A
EN	Extremely Nappe	TB	Treatment B
VMN	Very Much Nappe	TC	Treatment C

In terms of Overall Evaluation of Aroma, two treatments namely Treatment B (Ginger) and Treatment C (Chili) both had a mean of 7.27 and "Very Much Authentic". The Treatment A (Control) with 7.19 mean was indicated as "Moderately Authentic". In terms of Overall Evaluation of Consistency, Treatment C (Chili) which had a mean of 7.22, Treatment A (Control) with 7.12 mean and Treatment B (Ginger) with the mean 7.07. Thus, all treatments were identified as "Moderately Nappe". In terms of Overall Evaluation of Taste, it was revealed that all three treatments were "Moderately Delicious". This was based on the 6.67 mean of Treatment A (Control), 6.76 mean of Treatment C (Chili) and 6.56 mean of Treatment B (Ginger). In summary, Treatment C (Chili) had the highest overall general acceptability (7.25) of the sensory qualities of Shrimp Shell Sauce. Treatment A (Control) with the mean of 7.24 thus, both treatment C and A were "Very Much Liked". Treatment B (Ginger) was "Moderately Liked" with 7.06.

3.3. Difference in the Sensory Qualities of Shrimp Shell Sauce as Evaluated by the Panel Experts

Table 11 present the mean difference in the sensory qualities of Shrimp Shell Sauce at 0.01 percent level of significance as evaluated by panel of experts specifically in terms of appearance, aroma, consistency and taste. It was revealed in table 4 that there is no significant difference (F (2,6) =4.968, p = .053) among sensory qualities of shrimp shell sauce in terms of appearance. In terms of Aroma, the null hypothesis which states that there is no significant difference in the sensory qualities of shrimp shell sauce in terms of aroma is therefore accepted (F(2,6)=.965, p= .433) with (F(2,6)=0.853, p=.472), the null hypothesis is not rejected which proves that there is no significant difference on the sensory qualities of shrimp shell sauce in terms of consistency.

Table 11 Mean difference in the sensory qualities of Shrimp Shell Sauce

Characteristics	**Source of Variations**	**Sum of Squares**	**DF**	**Mean Square**	**F Value**	**P Value**	**Probability**
Appearance	Between Groups	0.631	2	0.315	4.968	0.053	n.s.
	Within Groups	0.381	6	0.063			
	Total	1.012	8				
	Between groups	0.093	2	0.047			
Aroma	Within Groups	0.291	6	0.048	0.965	0.433	n.s.
	Total	0.384	8				
	Between groups	0.256	8	0.124			

Consistency	Within Groups	0.248	2	0.145	0.853	0.472	n.s.
	Total	0.873	6				
	Between groups	1.029	2	0.515			
Taste	Within Groups	0.938	6	0.156	3.294	0.108	n.s.
	Total	1.967	8				

n.s. = Not Significance
0.01 - level of significant

With the mean difference of shrimp shell sauce in terms of taste, table 5 shows that there is no significant difference on the sensory qualities of shrimp shell sauce in terms of taste. Thus, null hypothesis is not rejected.

3.4. Difference in the General Acceptability of Shrimp Shell Sauce as Evaluated by the Consumers

Table 12 Present the mean difference in the general acceptability of Shrimp Shell Sauce at 1 percent level of significance as evaluated by consumers specifically in terms of appearance, aroma, consistency and taste. The mean difference in the general acceptability of shrimp shell sauce in terms of appearance is not significant (F (2,6) =1.074 p=.388). The general acceptability of shrimp shell sauce in terms of aroma is not significant (F (8,2) = 3.294, p= .108). With this, the researcher did not reject the hypothesis which states that there is no significant difference in the general acceptability of shrimp shell sauce in terms of aroma Table 6 shows that there is no significant (F (8,2) = 4.968, p= .053) difference in the overall acceptability of shrimp shell sauce in terms of consistency.

Table 12 General Acceptability of Shrimp Shell Sauce as Evaluated by the Consumers

Characteristics	**Source of Variations**	**Sum of Squares**	**DF**	**Mean Square**	**F Value**	**P Value**	**Probability**
Appearance	Between Groups	0.261	2	0.131	1.074	0.399	n.s.
	Within Groups	0.729	6	0.122			
	Total	0.990					
	Between groups	1.029	8	0.515			
Aroma	Within Groups	0.938	2	0.156	3.294	0.108	n.s.
	Total	1.967	6				
	Between groups	0.631	8	0.315			
Consistency	Within Groups	0.381	2	0.063	4.968	0.053	n.s.
	Total	1.012	6				
	Between groups	0.256	8				
Taste	Within Groups	0.248	2	0.124	0.853	0.472	n.s.
	Total	0.873	6	0.145			

n.s. = Not Significance
0.01 - level of significant

Moreover, the general acceptability of shrimp shell sauce in terms taste is not significantly different (F (8,2) = .853, p= .472).

3.5. Microbial Analysis on the Best Product

The two bottles with 150ml each of the best product which is Treatment C (Chili), was submitted to the Department of Science and Technology (DOST) Region VI for Microbial Analysis to test the quantity count of Sallmonella and Escherichia coli (E. coli). In Sallmonella Count, the sample was tested through 3M Petrifilm Salmonella EXPRESS (SALX) SYSTEM. The Report of Analysis states that Sallmonella was NOT DETECTED in 25g sample of Shrimp Shell Sauce. In Escherichia coli (E. coli) count, Coliform Count. Multiple Tube Fermentation Technique was used to determine the E. coli count and it was reported that the E. coli count in the sample is <0.018 MPN/g which is lesser to the "11 MPN/g" acceptable level of microorganism of E.Coli in Frozen Cooked Crustaceans as prescribed by the Bureau of Food and Drugs (BFAD) stated in Bureau Circular No. 7 s. 2001.

3.6. Shelf Life of Shrimp Shell Sauce

The table 13 shows the shelf life of shrimp shell sauce on a room temperature. Three treatments were exposed to normal room temperature and observe the number of days before the shrimp shell sauce were spoiled, contaminated and be like.

Table 13 Shelf life of shrimp shell sauce on a room temperature

Treatment	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
Treatment A (Control)	–	–	–	–	–	–	+
Treatment B (Ginger)	–	–	–	–	–	+	+
Treatment C (Chili)	–	–	–	–	–	–	+

Legend: (–) = Negative, no mold formation
(+) = Positive, mold formation observed

It was observed in all the treatments that from day 1 up to day 6 there were no spoilage, contamination, mold formation and other changes occurred in the shrimp shell sauce when place to room temperature, however changes occurred in 7th day. Based on observation, the consistency of shrimp shell sauce changed and become waterier.

It was observed in all the treatments that from day 1 up to day 34 there were no spoilage, contamination, mold formation and other changes occurred in the shrimp shell sauce placed in chilling temperature, however changes occurred at the thirty fifth day. Changes in appearance and consistency was observed in the thirty fifth day. Thus, the data revealed that the maximum life span of shrimp shell sauce under chilling temperature is 35 days.

Table 14 Shelf life of shrimp shell sauce on a chilling temperature

Treatment	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
Treatment A (Control)	–	–	–	–	–	–	+
Treatment B (Ginger)	–	–	–	–	–	–	+
Treatment C (Chili)	–	–	–	–	–	–	+

Legend: (–) = Negative, no mold formation
(+) = Positive, mold formation observed

4. Conclusion

After the presentation, evaluation and analysis of the different data given, the following conclusions are made:

The best treatment or most acceptable treatment in terms of sensory qualities as evaluated by the panel of expert was Treatment A (without chili and garlic) with the highest mean described as "Liked Very Much".

The best treatment or most acceptable in terms of general acceptability as evaluated by the consumers is the Treatment C (Chili). The said treatment ranked highest in appearance, aroma and consistency and had a general acceptability interpreted as "Liked Very Much".

The significant difference in sensory qualities exist only in consistency. Other sensory qualities shown no significance difference.

Significant differences in general acceptability as evaluated by the consumers were identified existing in aroma and consistency. There were no significant differences in general acceptability in terms of appearance and taste.

For the Salmonella Count, the result shows that Salmonella was NOT DETECTED in 25g sample of Shrimp Shell Sauce. In E. coli count it was reported that the E. coli count in the sample is <0.018 MPN/g which is lesser to the "11MPN/g" acceptable level of microorganism of E. coli in Frozen Cooked Crustaceans as prescribed by the Bureau of Food and Drugs (BFAD) stated in Bureau Circular No. 7 s. 2001

Shrimp shell sauce must be consumed 7 days after cooking when stored in room temperature, thus the life shelf span of shrimp shell sauce can be prolonged when keep refrigerated up to 35 days.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

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