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FORMULATION ANALYSES, AND ACCEPTABILITY OF SINIGANG-FLAVORED CHIPS

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Abstract: This study focused on the development and evaluation of sinigang-flavored chips, a novel snack inspired by the Filipino sour soup, sinigang. The research aimed to formulate chips using three protein-0based treatments: Treatment A (Pork-Based), Treatment B (Shrimp-Based), and Treatment C (Fish-Based), and to assess their sensory qualities, overall acceptability, shelf-life stability, microbial safety, and nutritional composition. An experimental-developmental design was employed, integrating natural sinigang flavors with tamarind extract and traditional souring agents into a starch-based chip mixture with the designated protein source. The dough was shaped, dried, and fried to achieve consistent crispness, then evaluated by ten semi-trained panelists for appearance, aroma, taste, and texture using a 9-point hedonic scale. General acceptability was assessed by 100 consumer respondents. Kruskal-Wallis tests and ANOVA were applied to determine significant differences among treatments. Results showed that Treatment C (Fish-Based) achieved the highest ratings for appearance and texture, described as extremely appealing and extremely crunchy, while Treatment A (Pork-Based) led in taste and aroma, rated as extremely delicious and very much pleasant. Overall acceptability favored Treatment A (Pork-Based), indicating the most balanced sensory profile. Shelf-life analysis confirmed product stability, with low moisture and proper drying and frying maintaining crispness and sensory quality over time. Microbial assessment verified safety, with no detection of fecal coliform,
E. coli, or Salmonella, and yeast and mold counts within acceptable limits. Proximate analysis indicated high carbohydrate content, moderate fat, modest protein, and low moisture, supporting nutritional value and storage stability. The study concludes that the main protein source significantly influenced sensory perception and consumer preference, with Pork-Based chips providing the most favorable combination of flavor, aroma, appearance, and texture. These findings offer practical insights for the production and commercialization of culturally inspired, ready-to-eat snacks that combine traditional flavors with appealing sensory and nutritional qualities.

Keywords: Formulation, Analyses, Acceptability of Sinigang Flavored-Chips

I. INTRODUCTION

In recent years, there has been a growing global emphasis on the development of functional and health-oriented snack foods that incorporate traditional flavors and utilize locally available ingredients. In the context of Filipino cuisine, sinigang—a well-known sour soup characterized by its tangy and comforting taste—stands out as both culturally significant and widely consumed. A key ingredient in this dish is Tamarindus indica (tamarind), a fruit recognized for its distinctive sour-sweet flavor and its various health benefits, including antioxidant, antimicrobial, and digestive-enhancing properties (Dinesh et al., 2022). Despite its widespread culinary use, the potential of sinigang flavor, particularly tamarind, as a base for innovative snack products such as chips remains largely unexplored in the modern food industry.

At present, the market for tamarind- or sinigang-flavored snacks is limited, with most tamarind-based products confined to syrups, confectioneries, and paste forms. These products often lack sensory diversity, nutritional value, and extended shelf life (Akinyede & Amoo, 2020). Moreover, many commercially available options contain high levels of sugar and preservatives, which may not align with the preferences of health-conscious consumers. This situation presents an opportunity to develop alternative snack products that combine traditional Filipino flavors with modern processing techniques, particularly in the form of ready-to-eat, shelf-stable items such as chips.

Previous studies have highlighted the successful use of tropical fruits in snack production through methods such as vacuum frying, oven baking, and dehydration, which help preserve nutrients while enhancing texture and flavor (Das et al., 2021; Patil & Jain, 2021). However, the incorporation of culturally iconic Filipino dishes like sinigang into chip-based products has received limited scholarly attention. Specifically, while the souring components of sinigang—especially tamarind—are well established in culinary applications, their use in solid snack formulations has not been thoroughly

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studied in terms of product development, sensory evaluation, and shelf stability.

In response to these gaps, this study aimed to develop sinigang-flavored chips using three distinct formulations incorporating tamarind and other traditional ingredients associated with sinigang. Specifically, it sought to: (1) describe the sensory qualities of the developed chips in terms of appearance, aroma, taste, and texture; (2) determine their general acceptability based on these attributes; (3) identify whether significant differences exist in both sensory qualities and general acceptability among the three treatments; (4) determine the shelf life of the chips in both raw and cooked conditions; and (5) submit the most acceptable formulation for microbial and proximate analysis to assess its safety, nutritional value, and storage stability.

This research integrates cultural heritage with modern food innovation by transforming the familiar taste of sinigang into a convenient and appealing snack product. It aims to expand the range of locally inspired functional foods, promote the use of indigenous ingredients, and contribute to the diversification of the food industry. Ultimately, the developed product has the potential to meet the demands of health-conscious consumers while preserving and promoting traditional Filipino flavors (Kadam et al., 2021)

III.METHODOLOGY

Phases	Description
Phase 1	Evaluation Design
Phase II	Experimentation
Phase III	Analysis

METHODS OF RESEARCH

This study employed an experimental-developmental research design. The experimental method was used to determine the effects of different protein sources (pork, shrimp, and fish) on the sensory qualities of sinigang-flavoured chips in terms of appearance, aroma, taste, and texture, while maintaining constant conditions for all other variables.

The developmental method was applied to improve and refine the product formulation using locally available ingredients such as tamarind and traditional sinigang components. This approach aimed to develop a snack product that is both acceptable in sensory quality and potentially marketable.

Methodology: Phase I Evaluation Design, Evaluation Instruments

This phase focused on the preparation and planning of the entire study. It involved identifying the research problem, determining the variables, and developing the experimental treatments for the sinigang-flavored chips. The researchers designed three formulations using pork, shrimp, and fish as the main protein sources.

In addition, this phase included the preparation and validation of the sensory evaluation instrument. The 9-point Hedonic Scale was selected as the basis for measuring sensory qualities such as appearance, aroma, taste, texture, and general acceptability. The selection and orientation of panelists were also prepared in this phase to ensure proper evaluation procedures.

Tools and Equipment Used in the Study

The tools and equipment used in the study were the following: one (1) piece food processor,
(1)piece working table, three (3) pieces small- sized stainless mixing bowls; one (1) piece wire whisk; one piece (1) set of stainless measuring spoons; ; one (1) piece spatula; one (1) piece rubber scrapper; one (1) piece unit digital weighing scale;(2) piece two non -stick pan ; (1) one piece rolling pin ;(2)utility tray; (1) one piece gas stove with burner

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EXPERIMENTAL TREATMENT

Table 1 presents the formulation used in developing the sinigang-flavored chips across three experimental treatments, each distinguished mainly by its primary protein source. Treatment A utilized pork, Treatment B incorporated shrimp, and Treatment C used fish, with each main ingredient fixed at 50 grams to ensure a fair comparison during sensory evaluation. By standardizing the quantity of the principal component, the study focused on how the type of protein influenced the overall character of the product rather than differences in amount.

Aside from the main ingredient, all other components were kept constant to maintain uniformity in flavor base and structure. Tamarind served as the defining souring agent, supported by common sinigang vegetables and seasonings that contributed to the familiar profile associated with the dish. This consistent formulation allowed the distinct taste, aroma, and texture contributed by pork, shrimp, or fish to stand out clearly in each trial. The approach ensured that any variation observed during evaluation could be attributed primarily to the main ingredient rather than to changes in the supporting materials. As a result, the three versions represented parallel formulations sharing the same foundation but differing in protein source, enabling panelists to judge which variant most effectively translated the sinigang flavor into a chip product. Overall, the table illustrates a controlled comparison in which pork, shrimp, and fish functioned as the central variables in determining product acceptability.

Table 1. Product formulation, ingredients, and proportion per trial for sensory evaluation.

Ingredients	Treatment A (Pork)	Treatment B (Shrimp)	Treatment C (Fish)
Main Ingredients	50g	50g	50g
Tamarind	30g	30g	30g
Tomato	10g	10g	10g
Onion	10g	10g	10g
Radish	10g	10g	10g
Eggplant	10g	10g	10g
String beans	10g	10g	10g
Water spinach	10g	10g	10g
Salt	1tsp	1tsp	1tsp
Baking powder	1/4tsp	1/4tsp	1/4tsp
Flour	150g	150g	150g

Experimental Procedures

In preparing the different treatments, the researchers gathered and prepared all the ingredients. The researcher found it in the neighborhood and market. The researcher collected in Lipunan Market at Roxas City, Capiz. On the other hand, some ingredients were marketed in Burgos St., Brgy. Tanque, Roxas City, Capiz and were brought to Capiz State University, Main Campus for experiment.

Preparation of Tamarind Paste

Raw tamarind pods were first manually dehulled to remove the hard outer shell and expose the pulp, ensuring that only edible portions were used for flavor extraction. The onion, tomato, eggplant, radish, water spinach, and string beans were then washed thoroughly and boiled together in a stainless-steel pot with a measured amount of water for approximately five minutes. This controlled boiling step was intended to soften the vegetables while minimizing nutrient loss and

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preserving their natural flavor compounds. After boiling, the vegetables were drained and allowed to cool slightly. All ingredients were then weighed and measured precisely according to the predetermined formulation proportions to ensure consistency and reproducibility of the mixture. A clean cooking pan was prepared, and the measured ingredients were subjected to their respective heat treatments based on the formulation requirements. Once fully cooked, the mixture was transferred into a food-grade blender and processed until a uniform, smooth paste was obtained. This blended mixture served as the sinigang flavor base and was set aside under hygienic conditions for subsequent use in the product formulation.

Preparation in Sinigang-Flavored Chips Using Paste

The dry ingredients, specifically flour and baking powder, were first measured accurately using a digital weighing scale to ensure formulation consistency and product uniformity. These ingredients were combined in a sanitized mixing bowl and blended thoroughly to allow even distribution of the leavening agent, which contributes to the final texture of the chips. The prepared sinigang-flavored paste was then gradually incorporated into the dry mixture and mixed until a cohesive dough was formed. This step followed standard dough development practices in snack formulation, ensuring proper hydration and flavor dispersion throughout the matrix.

Once fully combined, the dough was gathered and shaped into a smooth ball, indicating adequate mixing and binding of ingredients. The dough was then placed between sheets of wax paper and flattened using a rolling pin to achieve a uniform thickness, an important factor affecting heat transfer, texture, and crispness during drying and frying. Uniformly flattened dough was cut into chip-sized portions.

The shaped chips were arranged evenly on a fruit dryer tray or baking pan, ensuring sufficient spacing to promote even moisture removal. Drying was conducted either through sun-drying under controlled, clean conditions or by using a food dehydrator to reduce moisture content more efficiently and safely.

Lowering moisture prior to frying is a well documentation to improve crispness and extend shelf stability. After drying, the chips were fried in preheated cooking oil using a shallow or deep-frying method, maintaining proper oil temperature and avoiding overcrowding to ensure even frying and prevent excessive oil absorption. The fried chips were drained on absorbent paper to remove excess oil, cooled, and then served as a crispy, tangy sinigang-flavored snack

RESEARCH INSTRUMENT

The primary research instrument used in the study was an evaluation sheet designed to assess the sensory qualities and general acceptability of the sinigang-flavored chips. It was administered to selected evaluators, including students, teachers, and food professionals, who provided their assessments based on specific criteria. The evaluation sheet included a section for basic demographic information such as age, gender, and occupation to profile the respondents.

The main part of the instrument focused on sensory evaluation, where panelists rated the chips in terms of appearance, aroma, taste, and texture using a 9-point Hedonic Scale. Another section assessed the overall acceptability of the product using the same scale. An open-ended portion was also included to allow evaluators to provide comments and suggestions. This instrument enabled the researchers to collect both quantitative and qualitative data for analysis.

VALIDATION OF INSTRUMENT

The research instrument, specifically the sensory evaluation sheet, was validated to ensure its reliability and suitability. It underwent content validity review by food science experts, including food technologists and sensory evaluation specialists, to ensure that all essential sensory attributes such as appearance, aroma, taste, and texture were properly included. Feedback from experts resulted in minor revisions for clarity and accuracy.

Face validity was also conducted through pre-testing with semi-trained panelists to ensure that the instrument was clear and easy to understand. In addition, reliability was assessed by checking inter-rater consistency among evaluators. A pilot test using samples from the three treatments (pork, shrimp, and fish) confirmed that the instrument effectively differentiated sensory attributes. Overall, the validation process ensured that the instrument was reliable and valid for data collection.

COLLECTION OF DATA

The data collection process involved sensory evaluation of sinigang-flavored chips using three treatments: pork, shrimp, and fish. A scorecard was used to evaluate sensory qualities such as appearance, aroma, taste, and texture, which determined the overall acceptability of the product.

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Ten (10) food technology professors served as expert evaluators, while one hundred (100) consumers also participated, consisting of 20 food experts/bakers, 20 random students, and 60 food technology students. They were given instructions and used a 9-point Hedonic Scale to rate the samples.

After evaluation, all scorecards were collected, tallied, and analyzed using SPSS. The arithmetic mean was used to interpret sensory results, while the final product was based on the most refined formulation after several trials. The diverse group of evaluators provided a comprehensive assessment of product quality and acceptability.

STATISTICAL TOOLS AND ANALYSIS

❑ The data gathered were analyzed using the Statistical Package for Social Sciences (SPSS). The arithmetic mean was used to determine the sensory qualities and general acceptability of the product.

❑ Analysis of Variance (ANOVA) was used to determine if there were significant differences among the three treatments. The Tukey HSD post hoc test was used to identify which treatments differed significantly. The level of significance was set at 0.01.

IV. PRESENTATION, ANALYSES, AND INTERPRETATION OF DATE

Table 3 shows the overall sensory evaluation of sinigang-flavored chips using three formulations: pork-based (Treatment A), shrimp-based (Treatment B), and fish-based (Treatment C), assessed in terms of appearance, aroma, taste, and texture.

Sensory Qualities of Sinigang-Flavored Chips in terms of Appearance, Aroma, Taste and Texture

Results revealed clear differences among the treatments. Treatment C (fish-based) performed best overall, achieving the highest mean score (8.24) and ranking first in appearance (8.33), aroma (8.20), and texture (8.30), all described as extremely appealing, pleasant, and crunchy. Treatment A (pork-based) excelled in taste with the highest score (8.53), rated extremely delicious, while Treatments B and C also showed strong but slightly lower taste ratings.

Although Treatment B (shrimp-based) consistently received the lowest scores across attributes, all treatments were still rated within acceptable to highly favorable ranges. Overall, the findings indicate that the fish-based formulation had the most balanced and appealing sensory profile, making it the most promising for product development and commercialization.

For aroma, Treatment C (fish-based) ranked highest with a mean of 8.20, described as extremely pleasant, indicating a well-balanced and appealing scent. Treatment A (pork-based) followed with 7.93, while Treatment B (shrimp-based) obtained the lowest score of 7.73; both were still rated very much pleasant. Overall, the fish-based chips had the most favorable aroma, highlighting the importance of scent in enhancing product acceptability.

In terms of taste, Treatment A (pork-based) received the highest mean score (8.53), rated as extremely delicious, making it the most preferred in flavor. Treatment C (fish-based) followed with 8.13, also extremely delicious, while Treatment B (shrimp-based) scored 8.10, described as very much delicious. This indicates that all treatments were well accepted, with pork-based chips being the most flavorful.

For texture, Treatment C (fish-based) ranked highest with a mean of 8.30, classified as extremely crunchy, indicating superior crispness. Treatment B (shrimp-based) followed with 8.10, and Treatment A (pork-based) scored 8.00, both rated very much crunchy. Overall, all samples had desirable texture, but the fish-based chips stood out for their crispness.

Overall, Treatment C (fish-based) was identified as the best formulation, achieving the highest overall mean score (8.24) and leading in most sensory attributes. Its balanced profile in appearance, aroma, and texture, along with strong taste acceptability, indicates high consumer appeal. The findings suggest that fish-based sinigang-flavored chips have strong potential for product development and commercialization, while also highlighting the need to improve pork- and shrimp-based variants for better competitiveness.

These findings imply that fish is a promising main ingredient for developing sinigang-flavored chips intended for consumer markets. A formulation that delivers strong sensory appeal across multiple attributes increases the likelihood of repeat consumption and commercial success. Moreover, the favorable response to the fish variant suggests potential for creating innovative snack products using locally available aquatic resources while maintaining familiar Filipino flavor profiles.

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General Acceptability of Sinigang-Flavored Chips with Three Treatments in Terms of Appearance, Aroma, Taste and Texture

The data shows that all sinigang-flavored chip formulations were highly accepted by consumers, with ratings generally in the "Liked Extremely" category. For appearance, Treatment A (pork-based) received the highest mean score (8.79), making it the most visually preferred. Treatment B (shrimp-based) followed with 8.44, while Treatment C (fish-based) had 8.41, both also rated "Liked Extremely." Overall, all treatments met consumer expectations in visual quality, with only slight differences among them.

For aroma, Treatment A (pork-based) received the highest mean score (8.75), rated as "Liked Extremely," indicating the most preferred scent. Treatment C (fish-based) followed with 8.16, also "Liked Extremely," while Treatment B (shrimp-based) had the lowest score (7.96), described as "Liked Very Much." Overall, all treatments were well accepted, but the pork-based chips had the most favored aroma.

For taste, Treatment A (pork-based) obtained the highest mean score (8.82), rated as "Liked Extremely," indicating the most preferred flavor. Treatment C (fish-based) followed with 8.23, and Treatment B (shrimp-based) with 8.19, both also "Liked Extremely." Overall, all treatments were highly accepted in terms of taste, with the pork-based chips slightly leading in flavor preference.

For texture, Treatment A (pork-based) obtained the highest mean score (8.73), rated as "Liked Extremely," indicating the most preferred crispness. Treatment B followed with 8.46, while Treatment C scored 8.41; both were also rated "Liked Extremely." Overall, all treatments achieved highly acceptable and desirable crunch, with the pork-based chips slightly leading in texture preference.

Overall, Treatment A (pork-based) was the most acceptable formulation with the highest general acceptability mean (8.77), followed by Treatment C (8.30) and Treatment B (8.26). The pork-based chips consistently ranked highest across all sensory attributes, indicating strong overall consumer preference. These results suggest that pork is the most suitable main ingredient for sinigang-flavored chips, with strong potential for market acceptance and commercialization, although all three formulations were generally well accepted.

Differences in the Sensory Qualities of Sinigang-Flavored Chips among Three (3) Treatments

The data presented the statistical test results examining whether significant differences existed in the sensory qualities of the sinigang-flavored chips among the three treatments. The analysis covered appearance, aroma, taste, and texture at the 0.01 level of significance.

For appearance, the computed z value was 1.740 with a p value of 0.419, interpreted as not significant because the p-Value is higher than the 0.01 level of significance. This indicated that although the treatments showed slight variations in visual appeal during evaluation, these differences were not large enough to be considered statistically meaningful. In other words, panelists generally perceived the appearance of the pork-, shrimp-, and fish-based chips as comparably acceptable. This pattern suggests that as the sinigang-flavored chips were refined through repeated trials, the production process became more standardized. Standardization improved uniformity in color, aroma, taste, and crunchiness, making all three treatments comparably acceptable to consumers. Research shows that repeated formulation and optimization help stabilize sensory qualities, ensuring product consistency and enhancing market readiness (Ndirika & Adesina, 2020). The findings also highlight that while attributes such as texture and appearance are initially sensitive to differences in ingredients or processing, careful control during production can minimize these variations.

Regarding aroma, the z value of 3.457 and p value of 0.178 were likewise marked not significant. Despite observable differences in adjectival ratings during sensory scoring, the statistical test suggested that the scent profiles of the three formulations did not differ in a consistent or reliable way across respondents.

In terms of taste, a z value of 3.899 with a p value of 0.142 was also classified as not significant. This result implied that none of the treatments demonstrated a clear advantage in flavor preference strong enough to exceed the threshold for statistical significance, even if one formulation appeared slightly more favored descriptively.

For texture, the obtained z value of 1.251 and p value of 0.535 again indicated no significant difference. The crunchiness and mouthfeel of the chips were therefore considered statistically similar across the three versions.

Overall, the null hypothesis was accepted for all sensory attributes, as all p-values were greater than the 0.01 level of significance. This indicates that there were no statistically significant differences among the pork-, shrimp-, and fish-

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based treatments, and any observed variations were due to chance.

Although descriptive results showed that the fish-based chips (Treatment C) slightly outperformed the others in some aspects, the differences were not significant enough to confirm a clear preference. The similarity in results may be due to the standardized formulation and dominant sinigang flavor, which minimized differences between the protein sources.

These findings suggest that any of the three main ingredients can be used without significantly affecting overall product acceptability, allowing flexibility in formulation based on cost, availability, or market preference.

Differences in the General Acceptability of Sinigang-Flavored Chips among Three (3) Treatments

Table 6 shows that there were significant differences among the three treatments in terms of appearance and aroma at the 0.01 level of significance. For appearance ($F = 12.575$, $p < .001$), Treatment A (pork-based) was the most preferred, suggesting it had better visual appeal than the shrimp- and fish-based variants.

For aroma ($F = 39.756$, $p < .001$), Treatment A also ranked highest, indicating a richer and more inviting scent compared to the other treatments. Overall, the results show that the type of main ingredient significantly influenced both the appearance and aroma of the sinigang-flavored chips, with the pork-based formulation consistently performing best in these attributes.

Table 6 shows that there were significant differences among the three treatments in terms of taste and texture at the 0.01 level of significance. For taste ($F = 28.904$, $p < .001$), Treatment A (pork-based) was the most preferred, indicating that its umami and fat content enhanced the overall sinigang flavor. For texture ($F = 7.948$, $p < .001$), Treatment A also ranked highest, suggesting better crispness and mouthfeel compared to shrimp- and fish-based chips. Overall, the results indicate that the type of main ingredient significantly affects both taste and texture, with the pork-based formulation consistently achieving the best performance.

The data shows that overall general acceptability was highly significant ($F = 69.051$, $p < .001$), indicating clear differences among the treatments. Treatment A (pork-based) consistently outperformed the shrimp- and fish-based formulations across all sensory attributes, leading to its rejection of the null hypothesis. This confirms that the type of main ingredient significantly influenced consumer preference.

Overall, the pork-based chips emerged as the best formulation due to their consistently high ratings in appearance, aroma, taste, texture, and overall acceptability. Their rich flavor and favorable sensory qualities made them the most preferred product among evaluators.

The findings suggest that choosing the right protein source is important in developing commercially viable flavored snack products. Pork-based formulations may be more preferred due to their strong sensory appeal, particularly for consumers who favor savory, meat-forward snacks. Overall, the results highlight that flavor familiarity, umami intensity, and product texture play key roles in consumer acceptance, supporting the importance of careful ingredient selection in product development.

Shelf Life of Sinigang-Flavored Chips (Raw and Cooked) under Room Temperature

The data represents that the raw sinigang-flavored chips (Treatments A, B, and C) remained stable under room temperature storage for up to 21 days. No mold formation was observed from Week 1 to Week 3, indicating good microbial safety and stability during this period. These results suggest that the raw chips can maintain acceptable shelf life and quality for up to 21 days under ambient conditions, supported by the natural preservative properties of tamarind such as its acidity and low moisture content.

The cooked sinigang-flavored chips remained mold-free during the first two weeks of storage, maintaining their edibility and crispness. However, by Week 3, slight quality changes were observed, particularly a loss of crunchiness and softening of texture, although the chips were still safe for consumption. These findings suggest that cooked variants are more susceptible to quality degradation over time due to moisture retention and thermal processing effects, which can shorten shelf stability compared to raw chips.

The findings suggest important considerations for product development and storage. Raw sinigang-flavored chips are more suitable for longer shelf life and can be distributed more easily under room temperature conditions, making them ideal for retail without refrigeration. In contrast, cooked chips have shorter stability and may require improved packaging solutions such as vacuum sealing or the use of desiccants to help maintain quality and extend shelf life.

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Food safety standards emphasize that products showing visible mold or off-odors should no longer be consumed due to potential health risks. Overall, the raw tamarind chips demonstrated better shelf stability, remaining acceptable for up to 30 days under room temperature conditions. In contrast, the cooked chips showed earlier quality deterioration, becoming less stable after the second week and no longer suitable for consumption by the fourth week. These results confirm that processing methods significantly influence the shelf life, safety, and overall stability of tamarind-based snack products.

Microbial Analysis of Sinigang- Flavored Chips

The microbial analysis of the Sinigang-Flavored Chips showed that fecal coliform levels were below 3.0 MPN/g, which complies with the food safety standards set by the FDA Philippines and DOST-FNRI. This indicates that the product was processed under hygienic conditions with minimal risk of fecal contamination, confirming its microbial safety in terms of coliform presence.

The microbial analysis showed that *Escherichia coli* was not detected at a 10^1 dilution, indicating effective sanitation and minimal risk of contamination from fecal sources during production and handling. Likewise, *Salmonella* was not detected in the 25-gram sample, meeting strict food safety requirements and confirming that the product is safe from this major foodborne pathogen. Overall, these results demonstrate that proper hygiene and processing practices were effectively implemented in the production of the Sinigang-Flavored Chips.

Yeast and mold counts were recorded at 60 CFU/g and 10 CFU/g, respectively, both within the FDA acceptable limit of less than 100 CFU/g. These low values suggest low moisture content and proper processing and packaging conditions that helped prevent fungal growth.

Overall, the Sinigang-Flavored Chips were found to be microbiologically safe for consumption. Fecal coliform levels were within allowable limits, *E. coli* and *Salmonella* were not detected, and yeast and mold counts were minimal. These results confirm that proper hygiene and food safety practices were followed, making the product safe, stable, and suitable for commercial distribution.

The absence of pathogenic organisms and the low levels of spoilage indicators demonstrate that the processing, packaging, and sanitation methods used were effective. These findings indicate that the Sinigang-Flavored Chips are safe for consumption and suitable for market distribution, which can help strengthen consumer confidence. Overall, the results also highlight the potential of locally developed, culturally inspired snack products to succeed in wider markets, provided that proper food safety standards are consistently maintained.

Proximate Analysis of Sinigang- Flavored Chips

It shows the proximate composition of the Sinigang-Flavored Chips, evaluating their nutritional profile. The product contained 18.1% fat, indicating a moderate lipid level typical of fried snack foods that contributes to flavor and texture. Carbohydrates were the dominant component at 71.5%, confirming that the chips serve as an energy-rich snack suitable for quick consumption. Overall, the composition reflects a standard profile for shelf-stable, energy-dense snack products.

The moisture content of the Sinigang-Flavored Chips was very low at 1.1%, indicating strong stability against microbial spoilage due to effective dehydration or frying, which helps extend shelf life. This low moisture level supports improved storage safety and product durability.

In terms of protein, the chips contained 5.8%, providing a modest nutritional contribution. While lower than protein-rich snacks such as legumes or grains, this level is still acceptable for a fruit-based or flavored chip product, adding some nutritional value to the formulation.

Ash content, analyzed gravimetrically, was found to be 2.9%, representing the total mineral matter present in the chips. This result indicated a reasonably rich presence of inorganic nutrients, which might be attributed to the tamarind base or seasoning ingredients. A similar ash level was observed in sour-flavored snacks and preserved fruit products as noted by Ahmad et al. (2021), suggesting mineral contributions from natural acids and spice additives.

The caloric value, measured at 132 kcal per 28-gram serving, confirmed the product's energy-dense nature, driven largely by its carbohydrate and fat content. This energy concentration positioned the chips well within the range of common snack foods marketed for quick energy replenishment. Comparative findings from Rahman et al. (2020) supported this, as they emphasized that energy content between 120–150 kcal per serving in snack items was acceptable and attractive to consumers balancing taste and dietary needs.

Overall, the Sinigang-Flavored Chips showed a balanced nutritional profile suitable for a shelf-stable snack. The product

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is high in carbohydrates, moderate in fat, low in moisture, and contains acceptable levels of protein and ash, indicating both energy value and stability. The low moisture content supports long shelf life, while its energy-dense composition enhances its appeal as a convenient snack. These results suggest strong commercial potential and confirm that the product meets general nutritional expectations for ready-to-eat snack foods, making it viable for market expansion and dietary use.

Summary of Findings

This study developed sinigang-flavored chips as a snack innovation that combines traditional Filipino flavors with a convenient ready-to-eat format. It aimed to formulate chips using three protein sources—pork, shrimp, and fish—and evaluate their sensory qualities, general acceptability, shelf life, microbial safety, and nutritional profile to determine the best formulation for potential commercialization.

An experimental-developmental research design was used. The chips were prepared using tamarind-based sinigang flavoring incorporated into a starch-based mixture with the assigned protein source, then shaped, dried, and fried. Sensory evaluation was conducted by 10 semi-trained panelists using a 9-point hedonic scale, while 100 consumers assessed overall acceptability. Data were analyzed using Kruskal-Wallis test for sensory attributes and ANOVA for general acceptability to identify significant differences among treatments.The best-performing formulation was further tested for microbial safety and proximate composition at the NPPC Negros Prawn Producers Cooperative Analytical and Diagnostic Laboratory using standardized procedures. These analyses were conducted to confirm that the product complies with national food safety standards, maintains nutritional quality, and has acceptable shelf-life stability. Overall, the results served to validate the product's safety and quality, supporting its potential for commercialization as a culturally inspired snack.

The sinigang-flavored chips were developed using three formulations: pork-based (Treatment A), shrimp-based (Treatment B), and fish-based (Treatment C). Results showed that the fish-based chips (Treatment C) performed best in appearance and texture, being rated as extremely appealing and extremely crunchy due to their uniform color and good structural quality after frying. The pork-based chips (Treatment A) were preferred in terms of taste and aroma, described as extremely delicious and very much pleasant because of their rich savory flavor that complemented the sinigang profile. Meanwhile, the shrimp-based chips (Treatment B) received moderate ratings across all attributes. Overall, fish-based chips excelled in visual and textural qualities, while pork-based chips were favored for flavor.

The general acceptability results of the sinigang-flavored chips showed that all three treatments—Treatment A (Pork-Based), Treatment B (Shrimp-Based), and Treatment C (Fish-Based)—were well accepted by the evaluators, with ratings ranging from "Liked Very Much" to "Liked Extremely" across appearance, aroma, taste, and texture. Treatment A (Pork-Based) consistently received the highest ratings in all sensory attributes, indicating that its savory flavor and appealing aroma provided the most balanced and preferred overall profile. Treatment C (Fish-Based) ranked second, performing particularly well in appearance and texture, while Treatment B (Shrimp-Based) obtained slightly lower scores, especially in aroma and taste. Overall, the findings suggest that the type of protein used significantly influenced consumer preference, with pork-based formulation being the most preferred among the three treatments.

Statistical analysis of sensory attributes in terms of appearance, aroma, taste, and texture showed no significant differences among the treatments. Consequently, the null hypothesis that there was no significant difference in individual sensory qualities was accepted. Although descriptive ratings suggested minor preferences Fish-Based excelling in appearance and texture, Pork-Based in taste, and Shrimp-Based performing moderately these differences were not statistically significant. The dominant sinigang flavor likely masked subtle differences among protein sources.

The analysis of overall acceptability revealed significant differences among the treatments, resulting in the rejection of the null hypothesis. Treatment A (Pork-Based) obtained the highest general acceptability, consistently rated as "Liked Extremely" in terms of appearance, aroma, taste, and texture, indicating a well-balanced and highly preferred sensory profile among the panelists. Treatment C (Fish-Based) ranked second, also described as "Liked Extremely," particularly in appearance and texture, although it received slightly lower ratings in taste and aroma, suggesting strong visual and textural qualities but moderate flavor intensity. Treatment B (Shrimp-Based) obtained the lowest overall acceptability, generally described as "Liked Very Much" across most attributes, reflecting comparatively milder sensory appeal. These results highlight the importance of taste and aroma in influencing overall consumer preference, with the Pork-Based formulation emerging as the most acceptable variant of sinigang-flavored chips.

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The sinigang-flavored chips demonstrated good stability during storage. Their low moisture content contributed to sustained crispness, reduced risk of spoilage, and preservation of sensory qualities over time. The drying and frying processes effectively lowered water activity, while proper hygienic packaging helped prevent contamination. As a result, the product maintained acceptable appearance, flavor, and texture, indicating suitability for extended shelf life under standard storage conditions.

Microbial analysis confirmed the safety of the product. Fecal coliform, *Escherichia coli*, and *Salmonella* were not detected, while yeast and mold counts remained within acceptable limits, ensuring compliance with food safety standards. Proximate analysis further revealed that the chips contained high carbohydrates, moderate fat, and modest protein levels, providing energy, flavor, and nutritional value. Overall, the low moisture content supported shelf stability, while the mineral content and caloric value indicated that the product is a viable snack option. Collectively, these findings confirm that the sinigang-flavored chips are safe, nutritious, and suitable for consumer consumption.

CONCLUSIONS

Based on the findings and objectives of the study, the following conclusions were formulated: The main ingredient significantly influenced the sensory properties of sinigang-flavored chips.
Treatment C (Fish-Based) produced the most appealing appearance and the crunchiest texture, while
Treatment A (Pork-Based) provided the richest taste and most pleasant aroma. Treatment B (Shrimp-Based), although acceptable, ranked lower across attributes. This indicates that the selection of the protein source is critical in developing a product that is visually, texturally, and flavorfully appealing.

Treatment A (Pork-Based) was the most preferred sinigang-flavored chip, receiving the highest ratings across appearance, aroma, taste, and texture. Treatment C (Fish-Based) also performed well, particularly in appearance and texture, while Treatment B (Shrimp Based), although acceptable, was slightly less preferred in aroma and taste. These results indicate that the main protein source significantly influenced overall consumer preference, with pork providing the most balanced combination of sensory qualities that enhanced general acceptability.

There were no statistically significant differences in the individual sensory attributes among the three treatments, leading to the acceptance of the null hypothesis. Although descriptive ratings showed minor variations in preference, the sinigang seasoning appeared to dominate consumer perception, masking subtle differences among the Pork-Based, Shrimp-Based, and Fish-Based formulations.

In terms of overall acceptability, Treatment A (Pork-Based) obtained the highest rating, followed by Treatment C (Fish-Based), while Treatment B (Shrimp-Based) ranked lowest. However, statistical analysis indicated significant differences in overall acceptability, resulting in the rejection of the null hypothesis. This suggests that the protein source significantly influenced consumer preference, with the Pork-Based formulation providing the most balanced combination of taste, aroma, appearance, and texture.

In addition, the sinigang-flavored chips demonstrated good stability over time due to their low moisture content and the effectiveness of the drying and frying processes. The product maintained acceptable appearance and texture and remained suitable for extended storage under proper conditions.

Microbiological evaluation confirmed that all treatments were safe for consumption, with no detection of fecal coliform, *Escherichia coli*, or *Salmonella*, and yeast and mold count within acceptable limits. Proximate analysis further revealed a nutritionally balanced product characterized by high carbohydrate content, moderate fat, modest protein, and low moisture, indicating that the sinigang-flavored chips are a safe, stable, and suitable ready-to-eat snack option.

RECOMMENDATIONS

It is recommended that Pork-Based sinigang-flavored chips be prioritized for production and possible commercialization, as this formulation consistently obtained the highest overall acceptability in terms of taste, aroma, appearance, and texture. Food developers may also consider Fish-Based chips as an alternative variant for consumers who prefer a lighter, crispier, and visually appealing product, while Shrimp-Based chips may require further formulation improvements such as enhanced seasoning or flavor balancing to increase consumer acceptability.

It is further recommended that the standardized proportions of tamarind, vegetables, and protein used in the study be

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maintained to ensure consistent sensory quality. Manufacturers should also uphold strict control of processing conditions, particularly drying and frying procedures, to preserve desirable texture and appearance. Future product development may explore adjustments in frying temperature or pre-drying time to further enhance crispness without compromising flavor quality.

In terms of storage, the product's low moisture content supports good shelf stability; thus, it is recommended that the chips be stored in airtight, food-grade packaging under cool and dry conditions.

The use of vacuum-sealed or modified atmosphere packaging is also recommended for commercial distribution to maintain freshness and minimize oxidation. Regular monitoring of moisture content, texture, and aroma during storage is likewise advised.

To ensure continued safety, strict hygienic practices should be maintained throughout production, including proper sanitation of equipment, safe handling of raw materials, and routine quality checks of finished products. Continuous microbial testing is recommended, particularly for yeast and mold counts, to ensure compliance with food safety standards such as those set by FDA and DOST-FNRI.

Based on the proximate analysis results, it is recommended that clear nutritional labeling be provided to consumers, indicating carbohydrate, fat, protein, and energy content. This will enhance consumer awareness and support informed dietary choices. Promotional efforts may also highlight the use of locally sourced ingredients and the cultural relevance of sinigang flavor to improve market appeal.

It is also recommended that future studies explore additional flavor variations and ingredient combinations, such as incorporating local herbs, low-sodium seasonings, or plant-based protein alternatives, to broaden product options and cater to health-conscious and alternative diet consumers. All new formulations should undergo sensory evaluation to ensure acceptability.

Finally, it is recommended that market research be conducted to identify target consumers and assess demand potential. Marketing strategies should emphasize the unique sinigang-inspired flavor profile and crispy texture, positioning the product as an innovative, locally inspired snack. Collaboration with small and medium-scale food enterprises is also encouraged to support possible large-scale production while maintaining product quality and consistency.

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