

Sensory Acceptability of Sweet Potato (*Ipomoea batatas*) and Carrot (*Daucus carota*) Fries Enriched with *Moringa oleifera*

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Abstract

This study aimed to determine the acceptability of sweet potato (*Ipomoea batatas*) and carrot (*Daucus carota*) fries enriched with *Moringa oleifera* as a functional snack alternative. Anchored on the theory of sensory evaluation, the study employed a quasi-experimental research design involving three formulations evaluated using a researcher-made questionnaire with a 9-point hedonic scale. The respondents consisted of sixty-five third-year Bachelor of Science in Hospitality Management students selected through purposive sampling. Data were analyzed using mean, standard deviation, and Analysis of Variance (ANOVA) to assess differences in appearance, aroma, taste, texture, and general acceptability. The results showed that all formulations were generally well accepted, with Formulation 2 consistently obtaining the highest ratings across all sensory attributes. No significant differences were found in appearance, taste, texture, and general acceptability, while a significant difference was observed only in aroma. These findings indicate that the incorporation of *Moringa oleifera* did not compromise sensory quality and that Formulation 2 achieved the most balanced sensory profile. The study concludes that moringa-enriched sweet potato and carrot fries are acceptable and suitable for product development and potential commercialization. This study aligns with Sustainable Development Goal 3 (Good Health and Well-Being) and Sustainable Development Goal 12 (Responsible Consumption and Production) by promoting healthier snack alternatives and encouraging the use of locally available ingredients. It contributes to sustainability by supporting improved dietary practices and enhancing the utilization of local agricultural resources for food innovation.

Keywords: Acceptability, Carrot, Moringa, Sensory Evaluation, Sweet Potato, Texture

1. Introduction

This study examines the acceptability of sweet potato (*Ipomoea batatas*) and carrot (*Daucus carota*) fries enriched with *Moringa oleifera* as a functional snack alternative. It integrates nutritional enhancement and sensory evaluation to determine whether healthier snack formulations can meet consumer preferences. Grounded in sensory evaluation theory, the study synthesizes existing literature on functional food development, highlights gaps in fried vegetable-based snacks, and establishes its relevance within local and global contexts, including sustainability and nutrition-related development goals.

1.1 Background of the Study

The increasing awareness of the relationship between diet and health has driven demand for healthier snack alternatives. Traditional fried snacks, although widely consumed, are often high in calories and low in essential nutrients, contributing to poor dietary patterns and increased risk of non-communicable diseases (Chen et al., 2022). This trend has encouraged the development of functional snack products that enhance nutritional value without compromising sensory appeal. Sweet potato (*Ipomoea batatas*) and carrot (*Daucus carota*) are nutrient-rich root crops recognized for their dietary fiber and beta-carotene content, which supports vision, immunity, and antioxidant activity (Sharma et al., 2021). Their natural sweetness and color make them suitable for vegetable-based snack innovations. *Moringa oleifera* is widely acknowledged for its high protein, vitamin, mineral, and antioxidant content (Leone et al., 2021). Studies have shown that incorporating moringa into food products enhances nutritional value while maintaining acceptable sensory qualities when used at appropriate levels (Nugraheni et al., 2023; Cervera-Chiner et al., 2024). However, its application in fried vegetable-based snacks remains limited, prompting the need to evaluate its use in fries as a healthier alternative.

1.2 Themes and Insights from Related Literature on Moringa-Enriched Snack Acceptability

Existing literature consistently highlights *Moringa oleifera* as a functional ingredient that improves the nutritional profile of food products. Its incorporation has been shown to enhance protein, mineral, and antioxidant content, contributing to

healthier dietary options (Trigo et al., 2022; Ferreira et al., 2023). However, studies also emphasize the challenge of maintaining sensory acceptability. Higher levels of moringa incorporation can negatively affect taste, aroma, and appearance due to its strong green color and distinct flavor (Trigo et al., 2022; Cervera-Chiner et al., 2024). Similar findings indicate that moderate inclusion levels maintain acceptable sensory qualities, while excessive amounts reduce consumer preference (Ismawati et al., 2019; Valdez et al., 2025). Local studies further demonstrate that moringa-enriched products, such as cookies and chips, can achieve acceptable sensory ratings, although formulation significantly influences outcomes (Terana et al., 2022). These findings underscore the importance of balancing nutritional enhancement with sensory quality in functional food development.

1.3 Local, National, and Global Context of Functional Snack Development

Globally, there is a growing trend toward plant-based and functional food products that address nutritional deficiencies and promote healthier lifestyles. The use of nutrient-dense ingredients such as moringa, sweet potato, and carrot aligns with this movement, supporting food innovation and dietary improvement. At the local and national levels, the utilization of readily available crops such as sweet potato and moringa presents opportunities for sustainable food production and community-based entrepreneurship. Carrots and sweet potatoes are widely cultivated and valued for their health benefits, including antioxidant properties and immune support (Sharma et al., 2021). The integration of these ingredients into snack products supports both nutritional improvement and local agricultural sustainability, reinforcing the importance of developing innovative, accessible, and health-oriented food options.

1.4 Theoretical or Conceptual Basis: Sensory Evaluation of Moringa-Enriched Vegetable Fries

This study is anchored in the theory of sensory evaluation, defined as a scientific discipline that applies experimental design and statistical analysis to measure human responses to food through sensory perception (Lawless and Heymann, 2010). Sensory attributes such as appearance, aroma, taste, texture, and overall acceptability are critical determinants of consumer preference and product success. Sensory evaluation provides a systematic approach to assessing food characteristics and guiding product development (British Nutrition Foundation, 2021). In this study, it serves as the primary framework for evaluating the acceptability of sweet potato and carrot fries enriched with Moringa oleifera, ensuring that nutritional improvements do not compromise consumer satisfaction.

1.5 Research Gaps and Rationale for Moringa-Enriched Sweet Potato and Carrot Fries

Despite extensive research on moringa-enriched food products, most studies focus on baked goods such as cookies, biscuits, and crackers, as well as chips. Limited research has explored its application in fried vegetable-based snacks, particularly fries made from sweet potato and carrot. Additionally, while existing studies confirm the nutritional benefits of moringa, they also highlight the need for formulation optimization to maintain sensory acceptability. There remains a need to evaluate how moringa incorporation affects the sensory qualities of fried snack products across different formulations. This gap justifies the present study, which aims to assess the acceptability of sweet potato and carrot fries enriched with Moringa oleifera using sensory evaluation, identifying formulations that achieve a balance between nutritional enhancement and consumer preference.

1.6 Alignment with Relevant Sustainable Development Goals (SDGs)

This study aligns with SDG 3 – Good Health and Well-Being by promoting healthier snack alternatives that may reduce the risk of diet-related non-communicable diseases. It also supports SDG 2 – Zero Hunger through the utilization of nutrient-dense and locally available food sources that contribute to improved nutrition. Furthermore, the study relates to SDG 12 – Responsible Consumption and Production by encouraging the development of sustainable food products using locally sourced ingredients such as sweet potato, carrot, and moringa. These alignments highlight the role of food innovation in promoting health and sustainability.

1.7 Importance of the Study to Multidisciplinary Sustainability

This study contributes to public health sustainability by supporting the development of nutritious snack alternatives that encourage healthier dietary habits. It also promotes economic and community sustainability by providing opportunities for local entrepreneurs and farmers to utilize accessible agricultural resources. In terms of educational sustainability, the findings serve as a reference for food science and culinary instruction, supporting innovation in product development. Additionally, the study contributes to agricultural sustainability by increasing the value and demand for locally grown crops such as sweet potato and moringa. Overall, the research integrates nutrition, food science, agriculture, and community development, demonstrating its relevance across multiple sustainability domains while addressing both health and economic needs.

2. Material and methods

2.1 Research Design

The study utilized a quasi-experimental research design to determine the acceptability of sweet potato and carrot fries enriched with *Moringa oleifera* in terms of appearance, aroma, taste, texture, and general acceptability. This design allowed for the comparison of different product formulations under controlled conditions without random assignment of respondents. As explained by Capili and Anastasi (2024), quasi-experimental research lies between true experimental and observational designs and enables meaningful comparisons through statistical analysis. In this study, the different formulations served as treatment groups for evaluating variations in sensory acceptability.

2.2 Locale of the Study

The study was conducted at the University of Antique – Tario-Lim Memorial Campus located in Tibiao, Antique, Philippines, where the preparation, product testing, and sensory evaluation were carried out.

2.3 Respondents of the Study

The respondents consisted of sixty-five (65) third-year Bachelor of Science in Hospitality Management students enrolled at the College of Business and Management of the University of Antique – Tario-Lim Memorial Campus. These respondents were selected to evaluate the sensory attributes and overall acceptability of the developed product.

2.4 Sample and Sampling Procedure

Purposive sampling was employed in selecting the respondents, ensuring that participants possessed relevant knowledge and experience in food evaluation. The selected group participated in the sensory testing of the different formulations of sweet potato and carrot fries enriched with *Moringa oleifera*, allowing for consistent and informed assessment of the product.

2.5 Research Instrument

Data were collected using a researcher-made questionnaire designed to measure the acceptability of the product across five sensory attributes: appearance, taste, texture, aroma, and general acceptability. The instrument utilized a 9-point hedonic scale, where responses ranged from “like extremely” to “dislike extremely” for sensory attributes, and from “extremely acceptable” to “extremely unacceptable” for overall acceptability. The questionnaire was divided into sections corresponding to each sensory attribute, ensuring systematic evaluation. To establish validity, the instrument underwent content and face validation by a panel of five experts, and revisions were made based on their recommendations. The Good and Scates’ Criteria of Validation were applied to ensure clarity, relevance, and completeness of the items. Reliability was established through a pilot test involving 30 respondents who were not part of the final sample. The instrument demonstrated high internal consistency, with a Cronbach’s Alpha of 0.952, indicating that it was reliable for measuring sensory acceptability.

2.6 Data Gathering Procedure

Permission to conduct the study was obtained from the Office of the Associate Dean of the College of Business and Management prior to data collection. The researcher personally administered the questionnaire during the product evaluation session and ensured that all responses were complete and accurate. Respondents were provided with clear instructions on how to evaluate the samples using the 9-point hedonic scale. To minimize sensory bias, water was provided for mouth rinsing between sample evaluations. The products were assessed based on appearance, taste, texture, aroma, and general acceptability. The procedure consisted of three phases: ingredient preparation, product development, and sensory evaluation. The preparation phase involved gathering and preparing ingredients such as sweet potato, carrot, moringa, flour, oil, and seasonings, using standard kitchen tools in a controlled setting. The product development phase followed a systematic sequence beginning with cleaning and washing the raw materials, followed by boiling and mashing the sweet potatoes and blending the carrots. The ingredients were then combined with moringa leaves, flour, and seasonings to form a uniform mixture, which was shaped into strips and fried until golden and slightly crisp. The final step involved draining the cooked fries and preparing them for evaluation. Three formulations were prepared using similar procedures with variations in ingredient proportions. Each formulation underwent the same standardized process of washing, boiling, mashing, mixing, shaping, frying, and serving to ensure consistency and comparability during sensory evaluation.

2.7 Data Analysis Techniques

The collected data were analyzed using appropriate statistical tools to determine the level of acceptability and differences among formulations. Mean was used to determine the average sensory ratings for each attribute, while standard deviation measured the variability of responses. Analysis of Variance (ANOVA) was employed to determine whether significant differences existed among the different formulations. The level of significance for inferential analysis was set at 0.05. All computations were processed using the Statistical Package for Social Sciences (SPSS). The interpretation of sensory ratings

was based on a defined scale ranging from highly acceptable to highly unacceptable, corresponding to numerical ranges derived from the 9-point hedonic scale. These interpretations guided the evaluation of overall product acceptability.

2.8 Ethical Considerations

The study adhered to ethical principles to protect the rights and welfare of all participants. These included informed consent, voluntary participation, confidentiality, anonymity, and the right to withdraw without penalty. Participants were given sufficient information about the study and were allowed to decide freely whether to participate. The researchers ensured compliance with institutional guidelines and maintained respect for participants throughout the research process, safeguarding their privacy and well-being during data collection.

3. Results and Discussion

3.1 Sensory Acceptability of Moringa-Enriched Sweet Potato and Carrot Fries

3.1.1 Acceptability of Formulation 1, Formulation 2, and Formulation 3 Across Sensory Attributes

The results showed that all three formulations were generally rated positively across the five sensory attributes. Formulation 1 obtained its highest mean score in taste (8.17), interpreted as Highly Acceptable, while aroma (7.92) received the lowest rating but was still Very Acceptable. Formulation 2 recorded consistently high ratings across all attributes, with aroma (8.40) as the highest and appearance (8.33) as the lowest, both interpreted as Highly Acceptable. Formulation 3 also showed strong acceptability, with taste (8.33) as the highest and texture (8.08) as the lowest, both within the Highly Acceptable to Very Acceptable range. In terms of general acceptability, Formulation 2 obtained the highest mean score (8.37), followed by Formulation 3 (8.35) and Formulation 1 (8.07), indicating that all formulations were acceptable, with Formulation 2 being the most preferred. These findings indicate that the incorporation of Moringa oleifera into sweet potato and carrot fries did not negatively affect overall sensory quality. The consistently high ratings across all attributes suggest that the formulations were well-balanced in terms of taste, aroma, texture, and appearance. The slightly lower scores in some attributes, such as aroma in Formulation 1 and texture in Formulation 3, may reflect minor variations in ingredient proportion or preparation, but these did not substantially reduce acceptability. The higher general acceptability of Formulation 2 suggests that its formulation achieved an optimal balance between flavor, texture, and aroma, making it more favorable to respondents.

3.2 Differences in Sensory Acceptability Among Formulations

3.2.1 Comparative Differences Across Appearance, Aroma, Taste, Texture, and General Acceptability

The results of the one-way Analysis of Variance (ANOVA) revealed that there were no significant differences among the three formulations in terms of appearance ($F = 0.7794$, $p = 0.4602$), taste ($F = 2.5825$, $p = 0.0784$), texture ($F = 0.7495$, $p = 0.4741$), and general acceptability ($F = 3.0396$, $p = 0.05036$), as all p -values were greater than 0.05. However, a significant difference was observed in aroma ($F = 6.0100$, $p = 0.00298$), indicating that at least one formulation differed in terms of smell. Among the three, Formulation 2 obtained the highest mean score in aroma, suggesting that it was the most preferred in this attribute. These findings suggest that the three formulations were generally comparable in most sensory attributes, indicating consistency in product quality across variations. The absence of significant differences in appearance, taste, texture, and general acceptability implies that modifications in formulation did not substantially alter these attributes. However, the significant difference observed in aroma highlights the sensitivity of this attribute to formulation changes, possibly due to variations in ingredient proportions or the influence of Moringa oleifera on scent. Despite this, the overall acceptability remained statistically similar, reinforcing that all formulations were suitable for consumption, with Formulation 2 showing a slight advantage in sensory preference.

4. Conclusion and Recommendations

The study revealed that sweet potato (*Ipomoea batatas*) and carrot (*Daucus carota*) fries enriched with Moringa oleifera were generally well accepted across all formulations, with Formula B consistently obtaining the highest ratings in appearance, aroma, taste, texture, and general acceptability. Formula C also demonstrated high acceptability, while Formula A remained acceptable, indicating that all formulations met consumer preferences. The findings confirm that the incorporation of moringa did not compromise sensory quality and contributed to the overall appeal of the product, with Formula B emerging as the most balanced and preferred formulation.

Based on the findings, Formula B is recommended for product development and potential commercialization due to its consistently high acceptability. Further testing in a larger market setting is suggested to validate consumer response, along with improvements in packaging to maintain product quality. Future research should focus on nutritional analysis, shelf-life evaluation, formulation refinement, and assessment of consumer preferences across different groups. The product may also be promoted through educational initiatives and community programs to encourage healthier snack choices, while the use of locally sourced ingredients should be supported to enhance sustainability and local agricultural development.

The study was limited to three formulations evaluated through sensory assessment using a specific group of respondents, which may restrict the generalizability of the findings. The evaluation relied on subjective perceptions of appearance, aroma, taste, texture, and general acceptability, which may vary among individuals. Additionally, the study did not include extended product testing such as shelf-life analysis, broader consumer sampling, or nutritional quantification, limiting the scope of conclusions to sensory acceptability within the given conditions.

Compliance with ethical standards

The authors declare no conflict of interest and confirm that this study received no external funding. The study was conducted at the University of Antique – Tario-Lim Memorial Campus with the participation of Bachelor of Science in Hospitality Management students, whose involvement was voluntary and based on informed consent. Data were collected using non-invasive sensory evaluation procedures, and all responses were treated with strict confidentiality, with no identifying information disclosed.

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