

Sensory Acceptability of Squash (*Cucurbita maxima*) and Water Spinach (*Ipomoea aquatica*) Pancake

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ABSTRACT

The growing demand for healthier and nutrient-enriched food products has encouraged the incorporation of vegetables into commonly consumed foods. This study aimed to develop and evaluate the sensory acceptability of pancakes enriched with squash (*Cucurbita maxima*) and water spinach (*Ipomoea aquatica*). Specifically, the study assessed the acceptability of three pancake formulations in terms of appearance, aroma, taste, texture, and overall acceptability and determined whether significant differences existed among the formulations. A quasi-experimental research design was employed, involving three formulations with varying proportions of squash and water spinach. Sensory evaluation was conducted using a 9-point Hedonic Rating Scale administered to 100

purposively selected respondents. Data were analyzed using mean, standard deviation, and one-way analysis of variance (ANOVA) at a 0.05 level of significance. Results revealed that all formulations were highly acceptable, with mean ratings ranging from 8.55 to 8.80, corresponding to the verbal interpretation "Like Extremely." Among the formulations, Treatment 3 obtained the highest overall acceptability rating ($M = 8.80$, $SD = 0.42$), indicating superior consumer preference. However, ANOVA results showed no significant differences among the three formulations in terms of appearance ($p = 0.38082$), aroma ($p = 0.22244$), taste ($p = 0.09555$), texture ($p = 0.21577$), and overall acceptability ($p = 0.06512$). The findings suggest that squash and water spinach can be successfully incorporated into pancake formulations without compromising sensory quality. The study highlights the potential of these locally available vegetables as functional food ingredients for the development of nutritious, acceptable, and innovative food products.

Keywords: *Cucurbita maxima*, *Ipomoea aquatica*, sensory evaluation, hedonic testing, functional foods, pancake formulation

INTRODUCTION

The increasing prevalence of nutrition-related health concerns and changing consumer preferences have stimulated interest in the development of functional foods that provide health benefits beyond basic nutrition. Functional foods are recognized as food products containing biologically active compounds that contribute to health promotion and disease prevention (Granato et al., 2020). Consequently, researchers and food developers have increasingly explored the incorporation of nutrient-dense plant materials into commonly consumed food products to improve their nutritional value while maintaining consumer acceptability.

Pancakes are among the most popular breakfast and snack foods worldwide due to their convenience, affordability, and versatility. Traditionally prepared from wheat flour, eggs, milk, and

leavening agents, pancakes can serve as effective carriers of nutrient-rich ingredients, making them suitable vehicles for food fortification and functional food development. Recent studies have demonstrated that incorporating vegetables into bakery products can significantly improve their nutritional composition while maintaining desirable sensory characteristics (Aydar et al., 2023). As consumers become more health-conscious, the development of vegetable-enriched pancakes presents an innovative approach to increasing vegetable consumption through familiar and widely accepted food products.

Among the vegetables with considerable potential for food fortification is squash (*Cucurbita maxima*). Squash is a nutrient-dense vegetable rich in dietary fiber, β -carotene, vitamin C, potassium, and various antioxidant compounds that contribute to overall health and well-being (Azeem et al., 2021; Batool et al., 2022). The natural sweetness, attractive yellow-orange color, and favorable flavor profile of squash make it an ideal ingredient for bakery and snack products. Previous studies have shown that squash incorporation enhances both the nutritional quality and sensory attributes of food products. For instance, Mallillin et al. (2025) reported high consumer acceptability of squash-enriched donuts, while Aguiar et al. (2020) found that pumpkin-based baked goods achieved favorable ratings in appearance, taste, texture, and overall acceptability.

Another promising vegetable for functional food development is water spinach (*Ipomoea aquatica*), commonly known as kangkong. Water spinach is widely consumed in tropical countries and is recognized as a rich source of vitamins A and C, iron, calcium, dietary fiber, and antioxidant phytochemicals (Abdullah et al., 2024; Alam et al., 2023). Beyond its nutritional value, water spinach contains polyphenols and flavonoids that exhibit antioxidant and anti-inflammatory properties, making it a valuable functional ingredient. Despite these benefits, water spinach remains largely underutilized in processed food products and is commonly consumed only as a cooked vegetable. Previous studies have demonstrated its potential in food innovation, including kangkong polvoron (Delmoro et al., 2023), kangkong-enriched pandesal (Bartolome et al., 2023), and food wrappers developed from water spinach leaves (Telan et al., 2025), all of which achieved favorable consumer acceptance.

Sensory acceptability plays a critical role in determining the success of newly developed food products. Regardless of nutritional value, consumers are unlikely to adopt products that fail to satisfy sensory expectations. According to Rodrigues et al. (2024), sensory evaluation remains one of the most reliable methods for assessing food quality and consumer preference. Similarly, Huey et al. (2024) emphasized that appearance, aroma, taste, texture, and overall acceptability are among the primary determinants of consumer acceptance of functional and nutrient-enriched foods. Consequently, sensory evaluation serves as an essential component in food product development, particularly when incorporating unconventional ingredients that may alter traditional product characteristics.

Numerous studies have investigated the utilization of vegetable-based ingredients in bakery and snack products. Research involving pumpkin, sweet potato, and other vegetable-enriched baked goods consistently reported improvements in nutritional quality while maintaining acceptable sensory properties (Gebremariam et al., 2022; Hernández et al., 2025; Aydar et al., 2023). Likewise, local studies have demonstrated the successful incorporation of squash and water spinach individually into various food products without negatively affecting consumer acceptance (Mallillin et al., 2025; Delmoro et al., 2023; Bartolome et al., 2023).

However, despite the growing body of literature on vegetable-fortified food products, a significant research gap remains. Existing studies have predominantly focused on the individual utilization of squash or water spinach in bakery and snack products. While previous investigations have established the nutritional benefits and acceptability of squash-based products and water spinach-based products separately, limited empirical evidence exists regarding their combined application in a single food formulation. Furthermore, no published local or international study has comprehensively evaluated the sensory acceptability of pancakes enriched with both squash (*Cucurbita maxima*) and water spinach (*Ipomoea aquatica*) using multiple sensory parameters such as appearance, aroma, taste, texture, and overall

acceptability. The interaction of these two vegetables in a pancake formulation remains largely unexplored, particularly regarding their combined influence on consumer perception and product acceptance.

Addressing this gap is important because combining squash and water spinach may offer complementary nutritional benefits while creating a functional food product capable of increasing vegetable intake among consumers. Moreover, understanding the sensory implications of integrating these vegetables into a familiar food product may provide valuable insights for food innovation, product development, and the utilization of locally available agricultural resources.

Therefore, this study aimed to develop pancakes enriched with squash (*Cucurbita maxima*) and water spinach (*Ipomoea aquatica*) and evaluate their sensory acceptability in terms of appearance, aroma, taste, texture, and overall acceptability. Specifically, the study sought to determine the most acceptable formulation and assess whether significant differences existed among the developed formulations. The findings are expected to contribute to the growing literature on functional food development and provide a scientific basis for the utilization of squash and water spinach as ingredients in nutritious and consumer-acceptable food products.

METHODS

Research Design

This study employed a quasi-experimental research design to develop and evaluate the sensory acceptability of pancakes enriched with squash (*Cucurbita maxima*) and water spinach (*Ipomoea aquatica*). The design was appropriate because it involved the manipulation of ingredient proportions across different formulations to determine their influence on sensory acceptability without random assignment of participants to treatment groups. Three pancake formulations containing varying proportions of squash and water spinach were developed and subjected to sensory evaluation. The sensory attributes assessed included appearance, aroma, taste, texture, and overall acceptability.

Product Formulation

Three formulations of squash and water spinach pancakes were prepared using varying proportions of squash and water spinach while maintaining standardized quantities of the other ingredients, including all-purpose flour, milk, egg, butter or vegetable oil, baking powder, baking soda, salt, and cinnamon powder. Treatment 1 contained 7/8 cup of squash and water spinach mixture, Treatment 2 contained 3/4 cup, and Treatment 3 contained 2/3 cup. The formulations were prepared under controlled conditions to ensure consistency in ingredient measurement, batter preparation, cooking procedure, and sample presentation.

Fresh squash was washed, peeled, cooked until tender, and mashed to obtain a smooth consistency. Water spinach leaves were thoroughly washed, drained, and finely chopped prior to incorporation into the batter. The ingredients were mixed until a homogeneous batter was obtained. The batter was then cooked on a preheated non-stick pan until both sides were evenly browned. The cooked pancakes were allowed to cool slightly before being prepared for sensory evaluation.

Participants

The study involved 100 consumers selected through purposive sampling. Participants were chosen based on their suitability as potential consumers of the developed product and their ability to provide reliable sensory evaluations. To be included in the study, respondents had to be at least 18 years of age, willing to participate voluntarily, capable of consuming pancake products, and free from known allergies or health conditions associated with squash, water spinach, or any ingredients used in the formulations.

Sensory Evaluation Instrument

Sensory acceptability was assessed using a researcher-developed questionnaire based on a 9-point Hedonic Rating Scale, a widely used instrument for measuring consumer preferences and food acceptability (Lim, 2023). The questionnaire consisted of two sections. The first section provided information regarding the purpose of the study and instructions for evaluation, while the second section contained the sensory evaluation form.

Participants evaluated each pancake formulation according to five sensory attributes: appearance, aroma, taste, texture, and overall acceptability. Ratings ranged from 1 (“Dislike Extremely”) to 9 (“Like Extremely”), with higher scores indicating greater acceptability.

Validity and Reliability of the Instrument

Content validity of the sensory evaluation questionnaire was established through expert review by three specialists in food technology and research. Their recommendations were incorporated to improve the clarity, relevance, and appropriateness of the instrument.

To determine reliability, a pilot test was conducted among respondents with characteristics similar to those of the target population. The instrument obtained a Cronbach’s alpha coefficient of 0.87, indicating good internal consistency and reliability for measuring sensory acceptability.

Data Collection Procedure

Prior to data collection, the developed pancake formulations were prepared and coded to minimize evaluator bias. Sensory evaluation was conducted in a clean and controlled environment conducive to food assessment. Participants were briefed regarding the objectives of the study and were asked to provide informed consent before participation.

Each respondent received coded samples of the three pancake formulations and was instructed to evaluate them independently using the sensory evaluation questionnaire. Drinking water was provided between sample evaluations to minimize sensory fatigue and carryover effects (Stone et al., 2020). Upon completion of the evaluation, all questionnaires were collected, checked for completeness, and prepared for statistical analysis.

Statistical Analysis

The collected data were encoded and analyzed using the Statistical Package for the Social Sciences (SPSS). Descriptive statistics, including mean and standard deviation, were used to determine the level of sensory acceptability of each formulation in terms of appearance, aroma, taste, texture, and overall acceptability.

To determine whether significant differences existed among the three formulations, one-way analysis of variance (ANOVA) was employed. The test compared the mean sensory ratings across treatments for each evaluated attribute. Statistical significance was established at the 0.05 level.

Ethical Considerations

The study adhered to fundamental ethical principles in research involving human participants. Participation was entirely voluntary, and informed consent was obtained from all respondents before the sensory evaluation. Participants were informed of the purpose of the study, assured that their responses would remain confidential, and informed that they could withdraw from participation at any time without penalty. No identifying information was collected, and all data were used solely for academic and research purposes.

RESULTS AND DISCUSSION

Sensory Acceptability of Squash (*Cucurbita maxima*) and Water Spinach (*Ipomoea aquatica*) Pancake Formulations

The sensory acceptability of the developed squash (*Cucurbita maxima*) and water spinach (*Ipomoea aquatica*) pancakes was evaluated based on appearance, aroma, taste, texture, and overall acceptability. Table 1 presents the mean scores and standard deviations obtained from the evaluations of the 100 respondents.

The results revealed that all three formulations received highly favorable ratings across all sensory attributes. Mean scores ranged from 8.55 to 8.80, corresponding to the verbal interpretation of “Like Extremely.” These findings indicate a high level of consumer acceptance of the developed vegetable-enriched pancakes regardless of formulation.

Among the three formulations, Treatment 3 consistently obtained the highest ratings across most sensory attributes. Specifically, Treatment 3 achieved mean scores of 8.68 for appearance, 8.69 for aroma, 8.74 for taste, 8.73 for texture, and 8.80 for overall acceptability. The highest rating for overall acceptability suggests that respondents perceived Treatment 3 as the most desirable formulation when all sensory characteristics were considered collectively.

The superior performance of Treatment 3 may be attributed to its balanced proportion of squash and water spinach, which likely enhanced the product’s sensory characteristics without introducing excessive vegetable flavor or undesirable textural changes. Squash contributes natural sweetness, moisture retention, and an appealing yellow-orange color due to its high carotenoid content, while water spinach provides nutritional enhancement and a mild vegetal flavor. The combination of these ingredients may have produced a product that maintained the familiar characteristics of traditional pancakes while offering improved nutritional value.

The relatively low standard deviation values observed across all treatments indicate consistency in respondents’ evaluations, suggesting a high degree of agreement regarding the sensory quality of the developed products. Such consistency strengthens the reliability of the findings and supports the acceptability of the formulations among potential consumers.

These results are consistent with previous studies reporting favorable consumer acceptance of vegetable-enriched bakery products. Aydar et al. (2023) noted that the incorporation of vegetables into bakery products can improve nutritional quality while maintaining desirable sensory characteristics. Similarly, Gebremariam et al. (2022) found that vegetable-based ingredients can be successfully incorporated into baked products without adversely affecting consumer preferences. Local studies involving squash-enriched donuts (Mallillin et al., 2025), kangkong-based products (Delmoro et al., 2023), and kangkong-enriched pandesal (Bartolome et al., 2023) likewise reported positive sensory evaluations, supporting the present findings.

The high acceptability ratings obtained in this study suggest that consumers are receptive to the incorporation of nutrient-rich vegetables into familiar food products. This finding supports the growing interest in functional food development and demonstrates the potential of squash and water spinach as ingredients in innovative food products.

Table 1. *Level of Sensory Acceptability of Squash (Cucurbita maxima) and Water Spinach (Ipomoea aquatica) Pancake Formulations*

Attributes	Formulation 1			Formulation 2			Formulation 3		
	Mean	SD	Interpretation	Mean	SD	Interpretation	Mean	SD	Interpretation
Appearance	8.57	0.74	Like Extremely	8.60	0.60	Like Extremely	8.68	0.55	Like Extremely
Aroma	8.60	0.76	Like Extremely	8.55	0.65	Like Extremely	8.69	0.56	Like Extremely
Taste	8.59	0.73	Like Extremely	8.60	0.59	Like Extremely	8.74	0.47	Like Extremely

Texture	8.61	0.65	Like Extremely	8.66	0.54	Like Extremely	8.73	0.51	Like Extremely
General Acceptability	8.66	0.64	Like Extremely	8.68	0.53	Like Extremely	8.80	0.42	Like Extremely

Differences in Sensory Acceptability Among the Pancake Formulations

To determine whether significant differences existed among the three pancake formulations, a one-way analysis of variance (ANOVA) was performed for each sensory attribute. The results are presented in Table 2.

The analysis revealed that all computed p-values were greater than the established significance level of 0.05. Specifically, appearance yielded a p-value of 0.38082, aroma 0.22244, taste 0.09555, texture 0.21577, and overall acceptability 0.06512. Consequently, the null hypothesis was accepted for all sensory attributes, indicating that no statistically significant differences existed among the three formulations.

Although Treatment 3 obtained the highest mean ratings, the differences were not sufficiently large to be considered statistically significant. This finding suggests that the varying proportions of squash and water spinach did not substantially influence respondents' perceptions of appearance, aroma, taste, texture, or overall acceptability.

The absence of significant differences may indicate that all formulations successfully maintained the desirable sensory qualities associated with traditional pancakes despite variations in vegetable content. This is particularly important in product development because it demonstrates formulation flexibility.

Food manufacturers and entrepreneurs may modify ingredient proportions according to nutritional goals, ingredient availability, or production costs without significantly affecting consumer acceptance.

These findings are supported by previous research emphasizing that moderate incorporation of vegetable ingredients generally does not negatively affect the sensory quality of bakery products. Zare et al. (2020) reported that consumers are more likely to accept functional bakery products when sensory attributes remain comparable to conventional products. Similarly, Sweeney et al. (2022) found that vegetable-based ingredients can be incorporated into baked goods while maintaining favorable consumer perceptions.

Furthermore, the results suggest that the nutritional enhancement provided by squash and water spinach can be achieved without compromising product quality. This observation aligns with the findings of Huey et al. (2024), who emphasized that sensory acceptability remains a critical determinant of consumer willingness to adopt nutrient-enriched food products.

The lack of significant differences among formulations highlights the feasibility of utilizing squash and water spinach in pancake production. The findings support the potential commercialization of the product and contribute to the growing body of literature on vegetable-enriched functional foods.

Table 2. *One-Way ANOVA Results for Sensory Acceptability of Squash Acceptability of Squash and Water Spinach Pancake Formulations*

Sensory Attribute	F-value	p-value	Decision
Appearance	0.96783	0.38082	Not Significant
Aroma	1.50892	0.22244	Not Significant
Taste	2.36226	0.09555	Not Significant
Texture	1.539558	0.21577	Not Significant
General Acceptability	2.75081	0.06512	Not Significant

Overall, the findings demonstrate that all three squash and water spinach pancake formulations were highly acceptable to consumers. Although Treatment 3 achieved the highest sensory ratings, statistical analysis revealed that all formulations were comparably acceptable. These results highlight the potential of squash and water spinach as functional ingredients capable of enhancing the nutritional profile of pancakes

while maintaining favorable sensory qualities, thereby supporting their application in food innovation and product development.

CONCLUSION

This study demonstrated the feasibility of developing a vegetable-enriched pancake using squash (*Cucurbita maxima*) and water spinach (*Ipomoea aquatica*) as functional ingredients. The sensory evaluation results revealed that all three formulations achieved high levels of consumer acceptance in terms of appearance, aroma, taste, texture, and overall acceptability, indicating that the incorporation of these vegetables did not adversely affect the sensory quality of the product.

Among the formulations evaluated, Treatment 3 obtained the highest mean ratings across most sensory attributes and exhibited the greatest overall acceptability. However, statistical analysis showed no significant differences among the three formulations, suggesting that variations in the proportions of squash and water spinach did not substantially influence consumer perceptions of the product. This finding indicates that the developed pancake formulations possess formulation flexibility while maintaining favorable sensory characteristics.

The results further highlight the potential of squash and water spinach as valuable ingredients in functional food development. Their incorporation into pancakes provides an innovative means of enhancing the nutritional profile of a commonly consumed food product without compromising consumer acceptability. The study also demonstrates the potential of utilizing locally available vegetables in the development of nutritious, affordable, and marketable food products that may contribute to improved dietary diversity and food innovation.

Overall, the findings suggest that squash and water spinach can be successfully utilized in pancake formulation and have promising applications in food product development, nutrition promotion, and value-added utilization of agricultural resources. Future studies may focus on nutritional composition analysis, shelf-life evaluation, consumer preference studies involving larger populations, and commercial-scale production to further establish the product's market potential and functional food value.

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