



SWEET POTATO CUPCAKES FORTIFIED WITH MORINGA (*Moringa oleifera*) and BITTER GOURD (*Momordica charantia*) LEAVES

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Abstract: With the increasing demand for healthier and functional food products, the development of nutritious bakery items using locally available ingredients has become significant. This study aimed to develop sweet potato cupcakes fortified with moringa (*Moringa oleifera*) and bitter gourd (*Momordica charantia*) leaves as a healthier alternative to conventional cupcakes made from commonly used flour. Specifically, the study sought to formulate and determine the most preferred cupcake formulation through purposive sampling and laboratory testing in terms of microbial analysis, proximate analysis, and nutritional content; evaluate the product's acceptability in terms of aroma, appearance, taste, and texture; and develop a promotional flyer for the product. The study utilized a developmental-descriptive research design. The 9-point Hedonic Scale developed by Peryam et al. (1957) and the 5-point Food Tasting Scorecard by Ackbarali et al. (2013) were employed to assess both expert evaluation and consumer acceptability. The 5-point Food Tasting Scorecard was used to determine the most preferred formulation, while the 9-point Hedonic Scale measured consumer acceptability. Mean and standard deviation were used to analyze and interpret the gathered data. Findings revealed that the formulation containing 10% moringa and 5% bitter gourd leaves obtained the highest preference rating from experts and was interpreted as highly preferred. Consumer evaluation further showed that both younger and older respondents rated the sweet potato cupcakes as very much acceptable in terms of aroma, appearance, taste, and texture. Based on the findings, the study concluded that sweet potato cupcakes fortified with moringa and bitter gourd leaves have strong potential for commercialization and may serve as a viable source of livelihood and economic opportunity for educational institutions and local communities through extension services and technology transfer initiatives.

Keywords: bitter gourd leaves, moringa leaves, food innovation, developmental and descriptive design.

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Introduction

Food product innovation requires extensive planning, research, and continuous development to create products that meet consumer demands and market trends. Food manufacturing companies introduce new products annually to attract more customers, expand their markets, increase profitability, and generate greater consumer interest. The growing demand for healthier and more nutritious delicacies has encouraged the development of food products that are not only appealing in taste but also beneficial to health. According to Aramouni et al. (2015), the development of food products may take from six months to five years, depending on the technology, innovation, and food processing methods involved. In this context, sweet potato cupcakes fortified with moringa and bitter gourd leaves were conceptualized as a unique and nutritious food product for development and study. According to Cervoni (2024), sweet potatoes are root vegetables rich in beta-carotene, vitamin A, fiber, potassium, and vitamin C. They are low in fat and sodium while providing essential nutrients beneficial to the body. Cervoni (2024) further emphasized that the glycemic index of sweet potatoes varies depending on the preparation method and variety. In addition to vitamin A, sweet potatoes also contain calcium, iron, magnesium, and folate. Moringa leaves, on the other hand, are recognized as nutrient-dense leafy vegetables rich in phytochemicals, antioxidants, vitamins, and minerals. They are an excellent source of vitamin A, vitamin C, folates, and B-complex vitamins, which contribute to immunity enhancement, antioxidant protection, and proper metabolic functioning. Furthermore, Rudrappa (2021) stated that moringa leaves are abundant in essential minerals such as calcium, magnesium, phosphorus, iron, potassium, manganese, selenium, and zinc. Bitter gourd leaves are also rich in antioxidants, flavonoids, and polyphenols that may help reduce inflammation and lower health risks. According to Doe (2024), bitter gourd leaves contain bioactive compounds such as saponins and terpenoids, which may help regulate blood sugar levels and support glucose metabolism. These leaves are likewise good sources of essential vitamins, minerals, and antioxidants that strengthen immunity and protect against oxidative stress. The incorporation of moringa and bitter gourd leaves into sweet potato cupcakes enhances the nutritional value of the product, making it a healthier alternative to conventional cupcakes.

The findings of this study may provide valuable insights for the food industry, particularly in the development of healthier baked products that address health concerns associated with commonly used flour. The study may also contribute to future innovations in food product development by emphasizing the importance of ingredient selection in producing functional baked goods with desirable sensory qualities and nutritional value. Thus, this study was conducted to develop sweet potato cupcakes fortified with moringa (*Moringa oleifera*) and bitter gourd (*Momordica charantia*) leaves. Specifically, it aimed to determine the most preferred formulation among the following ratios: 10% moringa and 10% bitter gourd leaves, 5% moringa and 5% bitter gourd leaves, and 10% moringa and 5% bitter gourd leaves. Furthermore, the study sought to conduct laboratory testing of the

most preferred formulation in terms of microbial analysis, proximate analysis, and nutritional facts; evaluate its acceptability in terms of aroma, appearance, taste, texture, and overall acceptability; and develop a promotional flyer for the product.

Methodology

The study used the developmental, and descriptive methods. A standard questionnaire of a 5-point food tasting score card developed by Dimple Singh-Ackbarali and Rohanie Maharaj (2013) was used to determine the most flavored formulation by expert respondents with three (3) varying percentages of fortification to choose from, as reflected in the introduction of the study. The experts were the respondents using purposive sampling. Regarding the evaluation of the acceptability of the most flavored sweet potato cupcakes fortified with moringa and bitter gourd leaves in terms of aroma, appearance, taste, and texture, the standard 9-point Hedonic Scale of likes and dislikes, developed by Peryam (1957), was used. The respondents were from both young and old consumer groups. Mean and standard deviation using SPSS was the statistical tool used for both most flavored and acceptability evaluation, and laboratory testing was used for microbial, proximate, and nutritional content analysis conducted by Negros PRAWN Producers Cooperative Analytical and Diagnostic Laboratory.

Processes involved in the Development of Sweet Potato Cupcakes Fortified with Moringa (*Moringa oleifera*) and Bitter Gourd (*Momordica charantia*) Leaves are reflected below.

- A. Preparing Process: Materials and Ingredients Used and Preheat the oven to 400°F (200°C).
- B. Measuring of Ingredients
- C. Creaming Process
- D. Mixing Process (Dry and Liquid Ingredients to form a Batter Mixture)
- E. Beating Process
- F. Mixing Process (Batter Mixture and Beaten Egg 2White)
- G. Filling and Baking Process
- H. Cool the finished cupcake
- I. Storing/Packaging Process
- J. Testing Process using purposive sampling
- K. Laboratory Testing
- L. Laboratory testing of the microbial and nutritional value of the most flavored
- M. formulation.
- N. Evaluation process of acceptability by consumers
- O. Development of Flyers

Table 1*Equipment Used in Development of the Research Study*

Equipment Used	Model & Manufacturer	Country of Origin
Oven	50 4-Burner Gas Oven PFG540 10B – La Germania	Italy
Mixer	Artisan Series 5-Quart Tilt-Head Hobart Manufacturing Company	USA

As shown in Table 1, the list of equipment used in the research study includes a 50 4-burner gas oven (model PFG540 10B – La Germania) from Italy and an Artisan Series 5-quart tilt-head mixer from the Hobart Manufacturing Company in the USA. The stove is known for reliable and even heating, which helps ensure the development of the products are done consistently. The sturdy mixer mixes ingredients well, ensuring everything is blended evenly. Using trusted tools worldwide shows the researchers' focus on quality and accuracy, helping the study deliver dependable results.

Ethical Protocol

Safety was the first consideration in the research study to ensure fairness and equality in food product development. The respondents obtained informed consent to conduct the laboratory testing. The packaging was carefully labeled with sweet potato cupcakes fortified with moringa and bitter gourd. It uses biodegradable packaging, ensuring a sustainable product development process that considers the environment. The study's respondents, both experts and consumer participants, were asked to

understand the essence of evaluating the most flavored cupcakes and acceptability by explaining how to formulate the food product. Since the formulated food products have paper wrappers, the researcher ensured that the wrappers have a reservoir for waste management, bringing along a collection bag as part of the social, environmental, and food production responsibilities of the researcher herself. Since the school is establishing a Research Ethics Committee after a series of training sessions and evaluations of the chosen panel members, the school cannot provide current certification; only informed consent.

Results and Discussion

The first objective of the study was to formulate and determine the most flavored formulation of Sweet Potato Cupcake Fortified with Moringa and Bitter Gourd Leaves using the following variants: 10% Moringa leaves and 10% Bitter gourd leaves; 5% Moringa leaves and 5% Bitter gourd leaves; and 10% Moringa leaves and 5% Bitter gourd leaves. The formulated recipes are reflected in Tables 5 and 6 on the next page.

Table 2*Formulated Recipe of Sweet Potato Cupcake Fortified with Moringa and Bitter Gourd Leaves with the three (3) varying percentage of Fortification*

Ingredients	10% Moringa and 5% Bitter Gourd Leaves Puree	10% Moringa and 5% Bitter Gourd Leaves Puree	10% Moringa and 5% Bitter Gourd Leaves Puree
Sweet Potato Flour	1000 grams	1000 grams	1000 grams
Baking Powder	80 grams	80 grams	80 grams
Iodized salt	12 grams	12 grams	12 grams
Refined Sugar	800 grams	800 grams	800 grams
Butter	600 grams	600 grams	600 grams
Egg yolk	300 grams	300 grams	300 grams
Egg white	300 grams	300 grams	300 grams
Evaporated Milk	800 grams	800 grams	800 grams
Water	400 grams	400 grams	400 grams
Vanilla	20 grams	20 grams	20 grams
Moringa Leaves (Puree)	100 grams	50grams	100 grams
Bitter Gourd Leaves (Puree)	100 grams	50 grams	50 grams

Table 2 shows the three (3) formulations of sweet potato cupcakes. These become the basis of determining the most flavored formulation by the experts as respondents.

Table 3: Mean Score Evaluation of the most flavored formulation of the three sample variants as determined by Experts

Respondents	10% Moringa 10% Bitter Gourd Leaves Puree			5% Moringa 5% Bitter itGourd Leaves Puree			10% Moringa 5% Bitter it Gourd Leaves Puree			As a whole		
	Mean	SD	Interpretation	Mean	SD	Interpretation	Mean	SD	Interpretation	Mean	SD	Interpretation
Foods Trade Instructor	4	1.00	Like a little	3.80	1.64	Like a little	4.20	0.84	Like a little	4.00	1.13	Like a little
HM Instructor	4	1.41	Like a little	3.80	0.45	Like a little	4.40	0.55	Like a lot	4.07	0.88	Like a little
Chemist and Pastry Chef	3.20	0.45	Neither like	4.20	0.45	Like a little	5.00	0.00	Like a lot	4.13	0.83	Like a little nor Dislike
Total Average Mean Score	3.73	1.03	Like a little	3.93	0.95	Like a little	4.53	0.64	Like a lot	4.07	0.94	Like a little

As shown in Table 3, the experts' average mean score of the most flavored formulation was interpreted as "a little". Based on the individual results of the study by experts, 10% Moringa and 5% bitter gourd leaves puree have the highest average mean score of 4.53, interpreted as a lot, which implies that this is the most flavored formulation among the three variants since it garnered the highest mean score.

The 2nd objective of the study was to determine the laboratory test of the most flavored formulation of sweet potato cupcakes fortified with moringa and bitter gourd leaves in terms of microbial analysis, proximate analysis, and nutrition facts, as reflected in Tables 4, 5, and 6, respectively on the next page.

Table 4

Microbial Analysis of the Most Flavored Sweet Potato Cupcake Fortified with Moringa and Bitter Gourd Leaves

Microbial Analysis	Results	Standard Reference Limit	Method
Aerobic Plate Count (CFU/g)	4.7 x 10 ³	4.7 x 10 ⁴	Pour Plate Method
Total Coliforms ((CFU/g)	Negative at 10 ¹	Negative	3M Petrifilm
E. coli (CFU/g)	Negative at 10 ¹	Negative	3M Petrifilm
Salmonella	Absent in 25 grams	Not detected or Absence	Compact Dry Media
Yeasts Count (CFU/g)	17	< 100 CFU/g	3M Petrifilm
Molds Count (CFU/g)	21	< 100 CFU/g	3M Petrifilm
Staphylococcus aureus (CFU/g)	Negative at 10 ¹	< 100 CFU/g (ideally negative)	3M Petrifilm

Source: Negros Prawn Producers Cooperative Analytical and Diagnostic Laboratory (2025).

Table 4 shows that microbial analysis of sweet potato cupcakes fortified with moringa and bitter gourd leaves demonstrates that preparing the formulated recipe falls within the

acceptable limits of standard food safety guidelines. Therefore, it implies that the products were safe, hygienically prepared, and stable for consumption.

Table 5: Proximate Analysis of the Most Flavored Formulation of Sweet Potato Cupcake Fortified with Moringa and Bitter Gourd Leaves

Proximate Analysis	Results	Method Used
Fiber	1.2%	Lepper Modification Method
Fat	14. 4%	Soxhlet Extraction Method
Moisture	29.4%	Gravimetric Oven Frying at 105°C
Protein	4.8%	Kjeldahl Method
Sugar	1.5 Bx	Refractometer
Sodium	121.6 mg	Flame AES Method
Carbohydrates	50.1%	Phenol Sulfuric Acid Method
Calories	113	

Source: Negros Prawn Producers Cooperative Analytical and Diagnostic Laboratory (2025).

As shown in Table 5, Proximate Analysis of sweet potato cupcake fortified with moringa and bitter gourd leaves indicates how many nutrients each serving of cupcake contains. This analysis implies that the cupcakes are healthy based on their approximate analysis. Therefore, the sweet potato cupcake,

fortified with Moringa and Bitter gourd leaves, offers a balanced nutritional profile with modest protein, fiber, moderate fat, sodium, and low sugar and calories, making it a healthy snack option in line with FDA dietary guidelines (2013).

Table 6: Nutrition Facts of the Most Flavored Formulation of Sweet Potato Cupcake Fortified with Moringa and Bitter gourd Leaves

Nutrition Facts	Results	% RE/NI
Calories (kcal)	133 Calories from fat 49	5
Total Fat (g)	6	2
Sodium (mg)	121.6	24.3
Total Carbohydrates (g)	19	3
Dietary Fiber (g)	<2	
Sugar (g)	<2	
Total Protein (g)	2	<2

*Source: Negros Prawn Producers Cooperative Analytical and Diagnostic Laboratory (2025).

*Percent RE/NI are based on a 2,530 - calorie diet for 19 - 29 y/o Male (Based on PDRI 2015). Your RE/NI may be higher or lower depending on your calorie need.

Table 6 shows the Nutrition facts of sweet potato cupcakes fortified with moringa and bitter gourd leaves. Looking into the laboratory results of the nutrition facts, the research study showed that sweet potato cupcakes fortified with moringa and bitter gourd leaves, in terms of calories and sodium, exceeded the requirements. Some nutrition facts, such as fat, carbohydrates, dietary fiber, sugar, and total protein, fall below the standard requirements. This

result implies that the cupcake appeals to health-conscious consumers, particularly those with high sugar and fat intake.

The third objective of the study was to evaluate the acceptability by consumers using sensory attributes in terms of aroma, appearance, taste, and texture. The result is reflected in Tables 7, 8, & 9 below.

Table 7: Mean Score on Sensory Evaluation of Sweet Potato Cupcake Fortified with Moringa and Bitter Gourd Leaves by Younger Respondents (Ages 17 and below)

Parameters	Mean	SD	Verbal Interpretation
Aroma	8.26	1.12	Very much Acceptable
Appearance	7.92	1.26	Very much Acceptable
Taste	8.38	1.14	Very much Acceptable
Texture	8.14	1.07	Very much Acceptable
Overall Acceptability	8.62	0.95	Extremely Acceptable
Total Average Mean Score	8.26	0.90	Very much Acceptable

Table 7 shows that the sensory evaluation of sweet potato cupcake fortified with moringa and bitter gourd leaves by younger respondents ages 17 and below, in terms of aroma,

appearance, taste, and texture, garnered 8.26, which was judged to be very much acceptable. This result only signifies that the cupcakes developed from sweet potato are acceptable.

Table 8: Mean Score on Sensory Evaluation of Sweet Potato Cupcake Fortified with Moringa and Bitter Gourd Leaves by Older Respondents (Ages 18 and above)

Parameters	Mean	SD	Verbal Interpretation
Aroma	8.42	0.78	Very much Acceptable
Appearance	8.52	0.68	Extremely Acceptable
Taste	8.60	0.64	Extremely Acceptable
Texture	8.60	0.67	Extremely Acceptable
Overall Acceptability	8.66	0.52	Extremely Acceptable
Total Average Mean Score	8.56	0.49	Very much Acceptable

Table 8 shows that the sensory evaluation results of sweet potato cupcakes fortified with moringa and bitter gourd leaves, as evaluated by older respondents of the study ages 18 and above, indicate that the fortified cupcake appealed highly to the older consumer based on the results in terms of sensory attributes,

aroma, appearance, taste, and texture. The relatively low variability suggests that older respondents shared a more uniform perception of the product's sensory qualities, demonstrating strong agreement to accept the cupcakes.

Table 9: Summary of the Mean of the Mean Scores on the Evaluation of Acceptability when Consumer Respondents were grouped as a whole

Variable	Younger		Older		Whole		Verbal Interpretation
	Mean	SD	Mean	SD	Mean	SD	
Aroma	8.26	1.12	8.42	0.78	8.34	0.97	Very Much Acceptable
Appearance	7.92	1.26	8.52	0.68	8.22	1.05	Very Much Acceptable
Taste	8.38	1.14	8.60	0.64	8.49	0.93	Very Much Acceptable
Texture	8.14	1.07	8.60	0.67	8.37	0.92	Very Much Acceptable
Overall Acceptability	8.62	0.95	8.66	0.52	8.64	0.76	Extremely Acceptable
Total Average Mean Score	8.26	0.90	8.56	0.49	8.41	0.73	Very Much Acceptable

Table 9 shows that the sensory attributes for sweet potato cupcake fortified with moringa and bitter gourd leaves were very much acceptable when grouped as a whole. This result implies that younger and older consumers' respondents judged the sweet potato cupcakes as acceptable. The results indicate that the fortified

cupcake appeals to both younger and older ages, as shown in the table above, in terms of aroma, appearance, taste, and texture.

The fourth objective of the study was to develop a flyer of Sweet Potato cupcakes fortified with Moringa and Bitter Gourd Leaves.

Figure 1: Flyer Sweet Potato Cupcake Fortified with Moringa and Bitter Gourd Leaves



Conclusions and Recommendations

Based on the study's findings, the formulation can be standardized—producing a varied sample of the most flavored sweet potato cupcakes. Laboratory testing, such as microbial analysis, proximate analysis, and nutrition facts, can be used to claim that the baked products are safe and healthy. Regarding the sensory evaluation results, there's a possible commercialization of

cupcakes, and dissemination of the completed flyers to remote areas for maximum reach. Regarding the foregoing recommendations, further study is needed on its shelf life and toxicity as a prerequisite for commercialization with DFA Compliance before it can be reproduced for market consumption. There is a need for comprehensive laboratory testing and capacity building to train the local community to produce sweet potato cupcakes fortified with moringa and bitter gourd leaves as

livelihood development in promoting nutritious indigenous ingredients. It will encourage the community to produce small-scale food, promoting economic empowerment. It is also highly recommended that the Sweet Potato Cupcake Fortified flyer with Moringa and Bitter Gourd Leaves be widely disseminated using social media, digital, and print platforms to raise awareness about its nutritional benefits effectively. The distribution of flyers in schools, health centers, and local markets to promote healthy eating practices and encourage using nutrient-rich, local ingredients in home and commercial baking.

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