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RESEARCH ARTICLE

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DEVELOPMENT OF PLANT-BASED CHEESECAKE USING FORTIFYING VEGETABLE INGREDIENT

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ABSTRACT

Unhealthy dietary habits in the Philippines, including the consumption of junk food, gave rise to health risks such as obesity, diabetes, and cardiovascular diseases. In response, there was a growing interest in plant-based diets, which emphasize fruits, vegetables, whole grains, and legumes and have been effective in managing conditions like type 2 diabetes. To address these health concerns, researchers developed a plant-based cheesecake as a nutritious and dairy-free dessert. The study, conducted via batch data collection, mainly involved participants from the Gen Z age group (10-25 years old), with over half of them being female. Among various cheesecake formulas, S498, devoid of composite vegetable ingredients, was preferred for its neutral mouthfeel, great texture, and taste. Its ivory-white color closely resembled the controlled cheesecake, enhancing its overall appeal. For nutritional analysis, researchers selected formula S256 due to its composite vegetable ingredient, aligning with their goal of creating a healthy dessert. The study culminated in a dairy-free plant-based cheesecake that caters to the increasing number of females adopting plant-based diets. The sensory analysis of S256, which includes Momordica charantia (bitter melon), revealed significant mineral content (62.69% iron and 20.11% zinc) determined using atomic absorption spectrophotometry. Additionally, it contained 40.70% vitamin C, determined through high-performance liquid chromatography, enhancing the cheesecake's nutritional value. This research supported the global shift towards plant-based diets, contributing to culinary knowledge and benefiting individuals and communities.

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INTRODUCTION

The Philippines faces prevalent health risks, including obesity, diabetes, cardiovascular diseases, and cancer, attributed to poor dietary habits and insufficient physical activity. These health issues are exacerbated by the widespread consumption of nutritionally deficient junk foods. A solution proposed in the literature is the adoption of a plant-based diet, primarily consisting of fruits, vegetables, whole grains, and legumes, excluding animal-derived products. Studies suggest that such a diet is beneficial for managing type 2 diabetes and addressing obesity-related conditions. Contrary to the health benefits associated with plant-based diets, research by Astrup et al. (2016) implicates dairy products, specifically milk and cheese, in contributing to obesity, type 2 diabetes, and cardiovascular diseases. However, the connection between these findings and the health issues prevalent among Filipinos remains unclear. Recognizing the potential health risks posed by dairy products, the study aims to develop a plant-based cheesecake as a nutritious alternative, catering to individuals with specific dietary requirements, including lactose intolerance and diabetes. The research aligns with broader goals of promoting healthier lifestyles and reducing the negative health

impacts associated with the consumption of animal products. Additionally, the study emphasizes sustainability by utilizing locally available plant-based ingredients, thereby supporting the agricultural sector. In summary, the investigation aims to contribute to public health, dietary diversity, and sustainable practices through the development and promotion of a plant-based cheesecake alternative in the Philippines. The research recognized the favorable benefits of plant-based diets over animal-based diets, considering the potential to consume fewer natural resources and contribute to environmental well-being. The study acknowledged the increasing demand for animal-origin foods due to a rising global population and increased wealth. Ultimately, the researchers aimed to provide the culinarian and academic community with new theoretical knowledge about plant-based cheesecake and healthy variations. This information was intended to serve as an alternative dessert option, addressing concerns about blood sugar levels and dairy product consumption. The study aimed to benefit future researchers and studies in the fields of culinary development and plant-based food. By offering concrete information, recommendations, and conclusions, the study sought to contribute to community improvements.

METHODOLOGY

This research employs an experimental design to evaluate the potential advantages of plant-based cheesecake, utilizing multiple product formulations. The study involves a nutritional analysis of these formulations and sensory evaluations using a 9-point Hedonic Scale. Factors like participants' age and sex are considered to understand how sensory assessments of plant-based cheesecake may influence the health and demographics of the target population. The study acknowledges the importance of selecting an appropriate experimental design from pre-experiment, quasi-experiment, and true-experiment categories to meet specific research objectives. Ingredients were locally sourced, and a 750 ml microwavable plastic container was used to provide samples for laboratory testing at the Lipa Quality Control Laboratory in Lipa City, Batangas. The plant-based cheesecakes were prepared with varying amounts of composite ingredients, including Moringa Oleifera leaf powder or Malunggay powder and Minced Bitter Gourd/Ampalaya, to enhance nutritional value, benefits, and flavor. Four distinct formulations were created, differing in the composition of composite ingredients. This study involved 120 untrained panelists, predominantly from Generation Z (81.7%), with a gender distribution of 62.5% female and 37.5% male. The research utilized a 9-point Hedonic Scale to evaluate taste, texture, mouthfeel, appearance, color, and general acceptability of various plant-based cheesecake formulations. The sample size determination considered parameters such as an alpha error of 0.05, effect size of 0.30, and power of 0.90. The baking process involved preparing a cheesecake crust with a cookie dough base, made from a mixture of margarine, sugars, oil, flour, and baking soda. The crust was baked and crushed to form the base. The cheesecake filling included toasted cashews, coconut cream, maple syrup, coconut oil, vanilla extract, and nutritional yeast. Non-dairy whipping cream was whipped and folded into the cashew mixture, with the addition of either malunggay powder or minced bitter gourd. The survey questionnaire, conducted using the Hedonic Scale, took place in batches, including on-site sessions at Lyceum of the Philippines University – Laguna and in Marville Subdivision, Calamba City. Ethical considerations were addressed through informed consent, ensuring confidentiality and compliance with data privacy regulations. Data analysis involved frequency/percentage distribution, weighted mean, Scheffé and Duncan post hoc tests, and ANOVA (F-test) for the Test of Differences. Nutritional analysis was outsourced to a third-party laboratory testing center in Lipa Quality Control Center, Lipa City, Batangas, Philippines, with a significance level set at 0.05 for variables ranging between 6 and 10.

Table 1. Sensory Evaluation of Plant Based Cheesecake using composite vegetable ingredient formulation S131

Dimension	Weighted Mean	Verbal Interpretation
Mouthfeel	6.82	Like Moderately
Texture	6.83	Like Moderately
Taste	6.69	Like Moderately
Appearance and Color	6.94	Like Moderately
General Acceptability	7.12	Like Moderately
Composite Mean	6.88	Like Moderately

Table 1 presents sensory evaluation results for formulation S131 of the plant-based cheesecake with Moringa Oleifera Powder, with a composite mean of 6.88 indicating moderate liking. General acceptability scored the highest at 7.12, highlighting the role of sensory characteristics in food acceptability. Appearance and Color (6.94) ranked second due to the appetizing green color resembling trendy matcha. Texture (6.83) ranked third, reflecting a smooth and creamy consistency. Table 2 presents the sensory evaluation of formulation S256, a plant-based cheesecake incorporating Momordica Charantia (bitter gourd/ampalaya) as a composite ingredient, with a total composite mean of 7.33, signifying moderate likability. The highest-rated parameter for S256 is General Acceptability of Food (7.43), reflecting favorable ratings across sensory aspects. Sensory

characteristics are pivotal in determining food acceptability and influencing consumer preferences. This prioritization of sensory aspects by manufacturers is evidenced by studies (Wanjiru Maina & Juliana Wanjiru Maina Murang, 2018; Appleton et al., 2021).

Table 2. Sensory Evaluation of Plant Based Cheesecake using composite vegetable ingredient formulation S256

Dimension	Weighted Mean	Verbal Interpretation
Mouthfeel	7.33	Like Moderately
Texture	7.38	Like Moderately
Taste	7.17	Like Moderately
Appearance and Color	7.35	Like Moderately
General Acceptability	7.43	Like Moderately
Composite Mean	7.33	Like Moderately

Table 3. Sensory Evaluation of Plant Based Cheesecake using composite vegetable ingredient formulation S357

Dimension	Weighted Mean	Verbal Interpretation
Mouthfeel	6.84	Like Moderately
Texture	7.38	Like Moderately
Taste	6.98	Like Moderately
Appearance and Color	6.96	Like Moderately
General Acceptability	7.04	Like Moderately
Composite Mean	7.04	Like Moderately

Table 3 displays sensory evaluation results for formulation S357, a plant-based cheesecake with 50% Moringa Oleifera powder and 50% Momordica Charantia (bitter gourd/ampalaya). The total composite mean is 7.04, indicating moderate likability. Texture (7.38) ranks highest, attributed to the diverse textures experienced when consuming the cheesecake, with a creamy and smooth cheesecake base reminiscent of traditional dairy cheesecake. General Acceptability of food (7.04) secures the second position, reflecting the harmonious combination of sensory elements making the food product acceptable. Appearance and Color (6.96) takes the third spot, with the light green color of the cheesecake base potentially influencing some participants' impressions. Taste (6.98) ranks fourth, characterized by a slightly acidic and tangy flavor due to the use of lemon instead of cream cheese. Mouthfeel (6.84) is the lowest-rated parameter for formulation S357, with mixed responses potentially shaped by the preferences of younger demographics who consume fewer vegetables. The slight bitterness of bitter gourd may also affect consumption perceptions.

Table 4. Sensory Evaluation of Plant Based Cheesecake using composite vegetable ingredient formulation S498

Dimension	Weighted Mean	Verbal Interpretation
Mouthfeel	7.41	Like Moderately
Texture	7.43	Like Moderately
Taste	7.34	Like Moderately
Appearance and Color	7.40	Like Moderately
General Acceptability	7.53	Like Very Much
Composite Mean	7.42	Like Moderately

Table 4 shows sensory evaluation results for Plant-based cheesecake formulation S498, which excludes any composite vegetable ingredients and relies solely on the plant-based cheesecake base. S498 achieved a composite mean of 7.42, the highest among the four formulations. General acceptability of food (7.53) is the top-rated parameter, signifying "Like Very Much." This high rating is due to S498's close resemblance to traditional desserts, with its pearly white appearance and exceptionally smooth and creamy texture. This emphasizes the importance of sensory analysis in understanding consumer preferences and market trends (Maria Sirangelo, 2019). The researcher conducted a statistical analysis to determine if there were significant differences among the four formulations in terms of sensory attributes like appearance, mouthfeel, texture, taste, and overall acceptability. The table above displays the significant differences observed.

Table 5. Significant Differences between the four sample formulations in terms of its Sensory Evaluation

Variable	S131		S256		S357		S498	
	Weighted Mean	SD	Mean	SD	Mean	SD	Mean	SD
Mouthfeel	6.82	1.47	7.33	1.37	6.84	1.50	7.41	1.43
Texture	6.83	1.45	7.38	1.57	7.38	1.57	7.43	1.32
Taste	6.69	1.38	7.17	1.28	6.98	1.50	7.34	1.38
App Color	6.94	1.52	7.35	1.33	6.96	1.59	7.40	1.39
Acceptability	7.12	1.49	7.43	1.30	7.04	1.65	7.53	1.28

Table 6. Post Hoc Test for Significant Differences between the four sample formulations in terms of its Sensory Evaluation

Variable	F	Sig.	Decision
Mouthfeel	5.633	0.001	Significant
Texture	4.537	0.004	Significant
Taste	4.833	0.003	Significant
App and Color	3.399	0.018	Significant
Acceptability	3.236	0.022	Significant

Table 7. Laboratory Results of Plant Based cheesecake formulation S256 for Nutritional Analysis

Test Parameters	Results	Replicates	Test Method	RDA
Iron (Fe), mg/kg	62.69	60.24; 62.46; 65.38	Atomic Absorption Spectrophotometric Method (AAS)	18 mg Women 8mg Men
Zinc (Zn), mg/kg	20.11	20.41; 20.13; 19.80		8 mg Women 11 mg Men
Vitamin C (Ascorbic Acid), mg/kg	40.70	41.93; 41.19; 38.94	High Performance Liquid Chromatography Method (HPLC)	75 mg Women 90 mg Men

Table 8. Comparison of Nutritional Value for both Commercial Dairy Cheesecake and Plant-Based Cheesecake

Vitamins and Minerals	Commercial Dairy Cheesecake per 80 g	Commercial Dairy Cheesecake per 750 g	Plant Based cheesecake per 80 g	Plant-based cheesecake per 750 g
Vitamin C (mg)	0.32	3	4.34	40.70
Zinc (mg)	0.41	3.84	2.14	20.11
Iron (mg)	0.5	4.69	6.69	62.69

Nutritional Value of Commercial Cheesecake is collated from the University of Rochester Medical Center Nutritional Facts for Cheesecake commercially prepared, 1 piece (1/6 of 17 oz cake)

Among the formulations, S498 showed significantly higher evaluations compared to S131, S256, and S357. This difference is notable in the aspects of appearance, mouthfeel, texture, taste, and overall acceptability of the cheesecake. S498 shares the same base formula as the other formulations, consisting of cashew, coconut cream, nutritional yeast, maple syrup, lemon, coconut oil, and non-dairy whipping cream. However, S498 is considered the reference formula in this context, as it excludes the composite ingredients, such as moringa oleifera powder and minced bitter gourd. This section highlights significant differences in sensory evaluations among various formulations in terms of mouthfeel, texture, taste, appearance & color, and overall acceptability, all statistically significant at the 0.05 level.

Mouthfeel: Formulas 498 and 256 excelled due to their pleasant mouthfeel, with formula 498 offering a creamy cheesecake base and a slightly crunchy crust. Despite containing minced bitter gourd, formula 256 also provided a good mouthfeel. Formula 357 and 131, with moringa oleifera, fell behind due to a grainy texture.

Texture: Formulas 498, 357, and 256 had significantly better textures than formula 131. Creamy and smooth cheesecake bases in the former formulations, along with the addition of bitter gourd in 357 and 256, contributed to pleasing textures. In contrast, formula 131's moringa oleifera disrupted the texture.

Color: Moringa oleifera in formula 357 and 131 led to less appealing green colors that deviated from the standard cheesecake appearance. Formulas 498 and 256, without composite ingredients, maintained visually appealing colors. Food color's impact on consumer preferences is highlighted (Spence, 2015).

Taste: Formulas 498 and 256, lacking composite ingredients, were preferred due to their simple and balanced sweetness.

Formula 131, with moringa oleifera and minced bitter gourd, was less favored. The study aligns with research emphasizing the sensory attributes of vegetables, including taste, influencing preferences (Albani et al., 2017).

Acceptability

Formulas 498 and 256 were significantly more acceptable than 131 and 357. Factors influencing acceptability included taste, color, appearance, mouthfeel, and texture. Visual appeal and the "feel-good" factor were significant in determining acceptability, underscoring the role of consumer characteristics. Formulation 2, chosen via hedonic scale testing, is rich in Iron (Fe) at 62.69% and Zinc (Zn) at 20.11%, primarily sourced from cashew nuts using Atomic Absorption Spectrophotometric (AAS) analysis (Rico et al., 2016). The Iron and Zinc content in Formulation 2 aligns with recommended daily dietary intake: 8 mg for men and 18 mg for women for Iron, and 11 mg for men and 8 mg for women for Zinc (Marcin, 2018). Formulation 2 is a safe and nutritious choice. Furthermore, Formulation 2 contains a substantial amount of Vitamin C (ascorbic acid) at 40.70%, primarily attributed to the inclusion of bitter gourd and analyzed using High-Performance Liquid Chromatography (HPLC). Bitter gourd, known for its nutrient density and health-promoting compounds, is suitable for individuals with diabetes and other health concerns (Lal, 2016). The table above displays the nutritional values of commercial dairy cheesecake and plant-based cheesecake per 80 g serving and a 750 g sample size. Plant-based cheesecake contains significantly higher levels of Vitamin C, Zinc, and Iron compared to commercial dairy cheesecake. This makes plant-based cheesecake an excellent choice for creating an innovative, healthy, and guilt-free dessert, as it is rich in essential vitamins and minerals, as confirmed by laboratory tests at the Lipa Quality Control Center.

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