

PRODUCT FORMULATION, ANALYSIS, AND SHELF-LIFE OF CHESTNUT AND SQUASH MUFFINS WITH MALUNGGAY LEAVES

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Abstract: The aim of this study was to develop a muffin made from chestnut, squash, and malunggay leaves. Specifically, it aimed to (1) describe the sensory qualities of the product formulated in terms of appearance, aroma, taste, and texture; (2) determine the acceptability of muffin in terms of sensory qualities among five treatments; (3) find out if there is a significant difference in the sensory qualities of the product among five treatments in terms of appearance, aroma, taste, and texture; (4) find out if there is a significant difference in the acceptability of product among five treatments in terms of four sensory qualities; (5) determine the shelf-life of muffin considering room temperature; and (6) submit the best treatment of muffin for microbial and proximate analysis. The researcher used Completely Randomized Design (CRD) with five (5) treatments in three replications. The first, second, and third replications of treatments were evaluated by ten (10) semi-trained panelists who were Food Technology Teachers of Capiz State University. The final product was evaluated by seventy (70) consumers. The Nine Point Hedonic Scale was utilized to rate the products. The statistical tools used to analyze the results were the mean, Analysis of Variance (ANOVA), and the Post Hoc Test. The findings of the study revealed that the sensory qualities of the Chestnut and Squash muffin with Malunggay leaves were evaluated by the semi-trained panelists with five treatments in terms of appearance Treatment A got a very much appealing, very much pleasant, very much delicious, and very much soft and intact in terms of appearance, aroma taste, and texture. Treatment B was very much appealing, very much pleasant, very much delicious, and moderately soft and intact. Treatment C was very much appealing, very much pleasant, very much delicious, and very much soft and intact. Treatment D was very much appealing, very much pleasant, very much delicious, and moderately soft and intact. Treatment E was very much appealing, extremely pleasant, extremely delicious, and very soft and intact as evaluated by semi-trained panelists. The consumers' acceptability of the chestnut and squash muffin with Malunggay leaves considering the sensory qualities that all products of chestnut and squash were all extremely liked as evaluated by seventy (70) consumers. However, product E got the highest result in all quality attributes. There was no significant difference found in the sensory qualities and consumer's acceptability of chestnut and squash muffin with malunggay leaves among five treatments in terms of appearance, aroma, taste, and texture. Shelf-life of treatment E of chestnut and squash muffin with malunggay leaves when stored at room temperature, could last for three (3) days with no changes in the sensory attributes when sealed well. The chestnut and squash muffin with malunggay leaves was safe for human consumption based on the results of microbial analysis of the product and based on the BFAD standard for microorganism tests for products belonging to the baked goods category.

Keywords: Chestnut, Squash, Malunggay Leaves, and Muffin, Product-Formulation, Shelf-Life

I. INTRODUCTION

The chestnuts are a group of eight or nine species of deciduous trees and shrubs belonging to the genus *Castanea* in the Fagaceae family. They are indigenous to temperate regions of the Northern Hemisphere. The name also refers to the nuts produced by the tree. Chestnuts lower cholesterol and stabilize blood glucose levels. In addition, they reduce the risk of constipation and intestinal complications like diverticulitis. The majority of nuts appear to be generally healthy, though some may contain more nutrients that are heart-healthy than others. Even after cooking, chestnuts remain a good source of antioxidants. They are abundant in gallic acid and ellagic acid, two antioxidants whose concentration increases when cooked. Antioxidants and minerals such as magnesium and potassium reduce the risk of cardiovascular conditions like heart disease and stroke (Encyclopedia Britannica, 2022). Squash (*Cucurbita Maxima*), is rich in vitamin C and a good source of magnesium, iron, vitamin A, calcium, and vitamin B6 (Sachdev, 2022), whereas *Moringa oliefera* leaves, also known as Malunggay leaves, contain seven times as much vitamin C as oranges and fifteen times as much potassium as

bananas. In addition, it contains calcium, protein, iron, and amino acids, which aid in healing and muscle growth. In addition, it is loaded with antioxidants, substances that can protect cells from damage and boost your immune system (Ratini, 2021). Moreover, malunggay is one of the many prevalent vegetables that thrive in the Philippines. Malunggay (*Moringa Oleifera*) plant is a highly nutritious vegetable that can help prevent underlying conditions. It can help millions of people combat hunger, poverty, and chronic malnutrition. In order to combat malnutrition while still allowing people to enjoy consuming the aforementioned vegetable, researchers sought a more effective method to provide alternative ways to consume it (Lavilla, 2019). As a researcher, it is essential to comprehend the impact of diet and food components on normal growth and development. The essential role of nutrition in early life for growth and development, as well as for health and well-being, must be continuously evaluated.

II. STATEMENT OF THE PROBLEM & LITERATURE REVIEW

This study aimed to develop a muffin made from chestnut, squash and malunggay leaves and is supported by six (6) problem statements. These are (1) describing the sensory qualities of the product formulated in terms of appearance, aroma, taste, and texture; (2) determining the acceptability of muffin in terms of sensory qualities among five treatments; (3) finding out if there is a significant difference in the sensory qualities of the product among five treatments in terms of appearance, aroma, taste and texture; (4) finding out if there is a significant difference in the acceptability of product among five treatments in terms of four sensory qualities; (5) determining the shelf-life of muffin considering the room temperature; and (6) submitting the best treatment of muffin for microbial and proximate analysis.

Hence, this study contained two (2) hypotheses:

1. There is no significant difference in the sensory qualities of the product among five treatments in terms of appearance, aroma, taste, and texture; and
2. There is no significant difference in the acceptability of muffin among five treatments in terms of sensory qualities.

Good nutrition can reduce the likelihood of developing other health problems, including obesity, heart disease, diabetes, and some types of cancer. Overweight and obesity are often accompanied by other chronic health conditions such as diabetes, heart disease, hypertension, certain cancers, and arthritis. Rural populations with a higher risk of obesity including those who ages 10 and above. A healthy weight is largely dependent on healthy eating habits. Eating well helps reduce the risk of physical health problems like heart disease and diabetes. It also helps with sleeping patterns, energy levels, and your general health. Thus, the study was realized. Muffins are widely considered as healthy choice for breakfast, especially if they contain healthy ingredients such as squash, moringa, and chestnuts. Indeed, food shapes the way people live. A healthy diet is important to support the immune system, the chestnut and squash muffin with malunggay leaves is a healthy food that could be easily presented even to the children.

Chestnuts differ from other nuts by their low-fat content, making them ideally suited for high complex carbohydrate and low-fat diets. It is a unique nut crop with outstanding potential for diverse high-quality food products: as a vegetable, as bread and pastries, as a dessert, and as a snack. Semi-processed or finished products include dried chestnuts, flour, marrons glaces, creams, peeled and frozen nuts, flakes, and beer or liquor. Roasted chestnuts sold in the street are popular autumn and winter sight in cities all over the world. For optimum economic success, chestnut culture must be readjusted to market demand. According to Bounous (2003), improved cultivars and production methods need to be adopted, and pending problems must be solved.

III. MATERIAL SELECTION AND EXPERIMENTAL WORK

Experimental-Developmental method of research was used in this study. Cited by Worth (2016), the experimental method is a method involving control or manipulation of conditions to study the relative effect and various treatments applied to members of different samples. However, the experimental method focuses on the right proportions of chestnut, squash, and malunggay leaves in producing muffins. Developmental research is defined as a systematic study of designing, developing and evaluating instructional programs, processes, and products that must meet the criteria of internal consistency and effectiveness (Wayne 2001). Thus, developmental method was also used for the production of chestnut and squash muffin with malunggay leaves for potential product development and commercialization.

The Experimental Design

The Completely Randomized Design (CRD) is the experimental design used in this study in which a group of tests chestnut, squash, and malunggay leaves was studied with subsequent replications conducted to determine the cause of change. There was no control in this design; the subject underwent a randomization procedure (Calmorin, 1985).

Tools and Equipment Used

The tools and equipment used in the study were the following: two (2) pieces of chopping board, one (1) piece knife, three (3) pieces of a wooden spoon, one (1) set of measuring cup, one (1) set of measuring spoons, one (1) piece measuring glass, three (3) pieces medium mixing bowl, three (3) pieces rubber scraper, one (1) piece food tong, one (1) piece utility tray, one (1) unit digital weighing scales, and one (1) unit oven with gas range.

Ingredients and Experimental Treatments

The experiment was carried out in five (5) product formulations namely: Treatment A, B, C, D, and E using chestnut powder, cake flour, mashed squash, and malunggay leaves in three (3) replications. The proportions of the ingredients were found in Table 1 below.

Ingredients	Treatments				
	A	B	C	D	E
Chestnut powder	10g	20g	30g	40g	50g
Cake flour	90g	80g	70g	60g	50g
Squash (Mashed)	45g	45g	45g	45g	45g
Malunggay leaves (Freshly-Chopped)	3g	3g	3g	3g	3g
Brown Sugar	40g	40g	40g	40g	40g
Butter	20g	20g	20g	20g	20g
Egg	20g	20g	20g	20g	20g
Powder Milk	10g	10g	10g	10g	10g
Baking powder	5g	5g	5g	5g	5g
Water (Mineral)	30g	30g	30g	30g	30g

Table 1. Proportion of Ingredients in making Muffin.

In this study, the product developed was a muffin using chestnut, squash and malunggay leaves. The proportions of other ingredients are the same throughout the five (5) treatments. The experiment was carried out in five (5) treatments for product formulation namely: Treatment A (10g chestnut powder and 90g cake flour), Treatment B (20g chestnut powder and 80g cake flour), Treatment C (30g chestnut powder and 70g cake flour), Treatment D (40g chestnut powder and 60g cake flour), and Treatment E (50g chestnut powder and 50g cake flour). The quantity of the other ingredients was not varied except for the amount of the chestnut powder and cake flour. The purpose of the treatments was to find out the acceptability of chestnut and squash muffin with malunggay leaves. The measurements for the ingredients such as mashed squash, chopped malunggay leaves, brown sugar, butter, egg, powdered milk, baking powder, and water were all in the same amount in every treatment.

Table 1 above shows also the proportion of ingredients of chestnut and squash muffin with malunggay leaves used for the consumer’s acceptability during the establishment of the product formulation for the five treatments. The recipe for the muffin was taken from the standard recipe (theflavorbender, n.d.)

Experimental Procedure

Step 1. Preparation of Chestnut Powder

The chestnut was gathered and peeled individually. Then, the peeled chestnuts were dried under the heat of the sun until it becomes crisp. The dried chestnuts were grinded using an electric grinder until the fine texture was achieved. Set aside for later use.

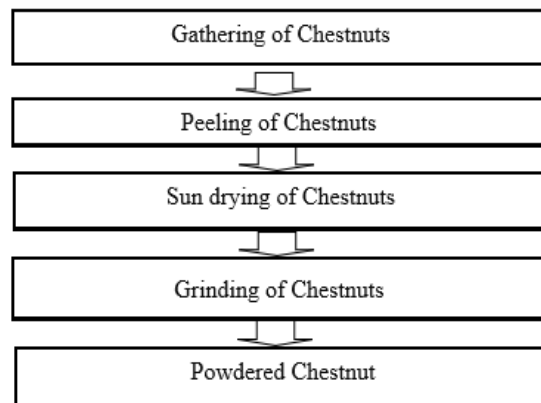


Figure 1. Flow chart showing the preparation of chestnut powder.

Step 2. Preparation of Squash and Malunggay Leaves

The young squash was selected and washed thoroughly using running water. Then, pared and cut into 1-inch size. Boiled the squash until it was cooked. Let it cool for a few minutes before putting in the blender and blend until the smooth texture was achieved. Set aside for later use.

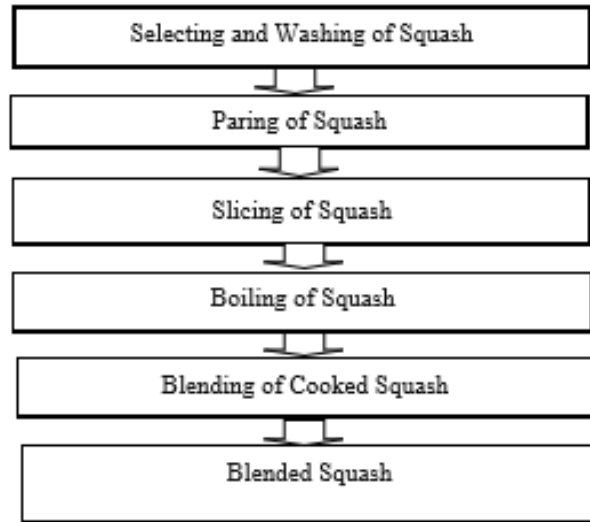


Figure 2. Flow chart showing the preparation of squash.

The young malunggay leaves were sorted-out and washed thoroughly using running water. Chopped the malunggay leaves into a fine texture. Set aside for later use.

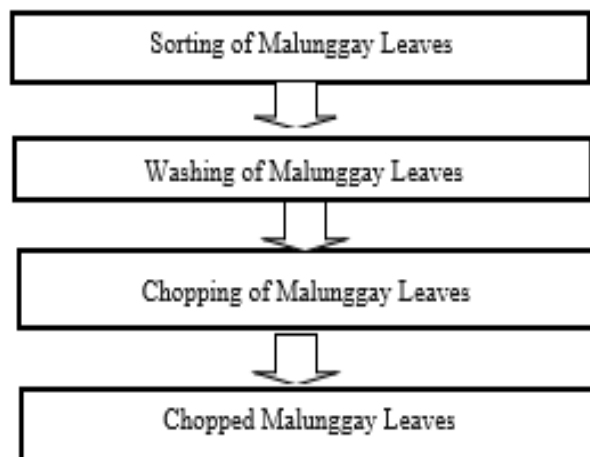


Figure 3. Flow chart showing the preparation of malunggay leaves.

Step 3. Procedure in making chestnut and squash muffin with malunggay leaves

All the needed ingredients were gathered and prepared. Five (5) treatments were administered. The oven was preheated up to 400 degrees Celsius. The chestnut powder, baking powder, all-purpose flour was combined and sifted. Set aside. The butter was creamed until smooth and add the brown sugar gradually and add the beaten egg and mixed the mixture completely and add little by little the sifted dry ingredients. The dry and wet ingredients were combined thoroughly and the mashed squash, malunggay leaves and powder milk were added. The muffin pan was lined with paper cups. Then, the muffin mixture was poured up to $\frac{3}{4}$ full in the muffin pan. The muffin was baked for 15-20 minutes or until done. To test the muffin a toothpick inserted at the center of a muffin comes out clean then it's done.

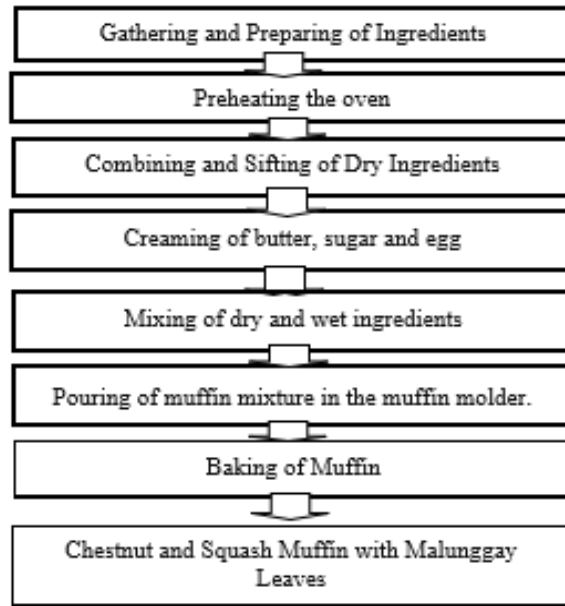


Figure 4. Flow chart showing the preparation of Chestnut and Squash Muffin with Malunggay Leaves

For sensory evaluation, the instrument used was a score card. It looked into the quality attributes of the product such as appearance, aroma, taste, and texture. These four sensory qualities were included in determining the general acceptability of Chestnut and Squash Muffin with Malunggay Leaves.

The evaluators were invited and given instructions on how to evaluate the product. The evaluation sheet was given to the 10 semi-trained panelists from Capiz State University, Main Campus with their honest opinions were solicited. The evaluators were instructed to evaluate the product using a Nine (9) - Point Hedonic Scale as to appearance, aroma, taste, and texture. The sensory qualities of the product formulation of chestnut and squash muffins with malunggay leaves prepared in five treatments in three replications were evaluated by ten (10) Food Technology Teachers as semi-trained panelists and the product acceptability were evaluated by ten (10) Technology and Livelihood Education (TLE) teachers and thirty (30) students in different year levels and thirty (30) potential consumers composed of LGU employees, vendors, housewives of Balasan, Iloilo.

After the evaluation of the product, the evaluation sheets were gathered, tallied, summarized and ready for computation. The mean was used to determine the sensory qualities of Chestnut and Squash Muffin with Malunggay Leaves in terms of appearance, aroma, taste, and texture and general acceptability as a whole.

Scoring of Variables

In scoring the variables, the researcher used the Nine Point Hedonic Rating Scale to rate the product.

The categorizations of each variation are as follows:

1. Appearance of the product

Score	Mean Score	Adjectival Description
9	8.12 – 9.00	Extremely Appealing
8	7.23 – 8.11	Very Much Appealing
7	6.34 – 7.22	Moderately Appealing
6	5.45 – 6.33	Slightly Appealing
5	4.56 – 5.44	Neither appealing nor unappealing
4	3.67 – 4.55	Slightly Unappealing
3	2.78 – 3.66	Moderately Unappealing
2	1.89 – 2.77	Very Much Unappealing
1	1.00 – 1.88	Extremely Unappealing

2. Aroma of the product

Score	Mean Score	Adjectival Description
9	8.12 – 9.00	Extremely Pleasant
8	7.23 – 8.11	Very Much Pleasant
7	6.34 – 7.22	Moderately Pleasant
6	5.45 – 6.33	Slightly Pleasant
5	4.56 – 5.44	Neither Pleasant nor Unpleasant
4	3.67 – 4.55	Slightly Unpleasant
3	2.78 – 3.66	Moderately Unpleasant
2	1.89 – 2.77	Very Much Unpleasant
1	1.00 – 1.88	Extremely Unpleasant

3. Taste of the product

Score	Mean Score	Adjectival Description
9	8.12 – 9.00	Extremely Delicious
8	7.23 – 8.11	Very Much Delicious
7	6.34 – 7.22	Moderately Delicious
6	5.45 – 6.33	Slightly Delicious
5	4.56 – 5.44	Neither Delicious nor Not Delicious
4	3.67 – 4.55	Slightly Not Delicious
3	2.78 – 3.66	Moderately Not Delicious
2	1.89 – 2.77	Very Much Not Delicious
1	1.00 – 1.88	Extremely Not Delicious

4. Texture of the product

Score	Mean Score	Adjectival Description
9	8.12 – 9.00	Extremely Soft and Intact
8	7.23 – 8.11	Very Much Soft and Intact
7	6.34 – 7.22	Moderately Soft and Intact
6	5.45 – 6.33	Slightly Soft and Intact
5	4.56 – 5.44	Neither Soft and Intact
4	3.67 – 4.55	Slightly Not Soft and Intact
3	2.78 – 3.66	Moderately Not Soft and Intact
2	1.89 – 2.77	Very Much Not Soft and Intact
1	1.00 – 1.88	Extremely Not Soft and Intact

5. Acceptability of the Product

Score	Mean Score	Qualitative Description
9	8.12 – 9.00	Liked Extremely
8	7.23 – 8.11	Liked Very Much
7	6.34 – 7.22	Liked Moderately
6	5.45 – 6.33	Liked Slightly
5	4.56 – 5.44	Neither Liked nor Disliked
4	3.67 – 4.55	Disliked Slightly
3	2.78 – 3.66	Disliked Moderately
2	1.89 – 2.77	Disliked Very Much
1	1.00 – 1.88	Disliked Extremely

Statistical Tools and Analysis

The data were tabulated and statistically analyzed by SPSS software using the Arithmetic Mean and the Analysis of Variance (ANOVA).

The Arithmetic Mean was used to determine the sensory qualities and acceptability of the product among five treatments. While, Analysis of Variance (ANOVA) was used to determine the significant difference in the sensory qualities of the product in terms of appearance, aroma, taste, and texture as well as the differences among the three treatments (Larson, 2008) level of significance was set at a 0.01 alpha and Post Hoc Test was used to determine where the significant difference lies among five treatments considering the sensory qualities.

Cost Analysis

Table 2 shows the product cost analysis of the ingredients used in making the chestnut and squash muffins with malunggay leaves using the treatment E proportions.

Ingredient	Quantity	Total
Chestnut powder	50grams	7.00
Cake flour	50grams	5.00
Squash (fresh)	45 grams	2.00
Malunggay leaves(fresh)	3 grams	1.00
Brown Sugar	40 grams	10.00
Butter	20 grams	5.00
Egg	20 grams	3.00
Baking powder	5 grams	5.00
	10 grams	2.00
Powder Milk	30 grams	3.00
Mineral Water	13 pieces	7.00
Paper Cups Molder	Total	Php 50.00

Table 2. Product Cost and Analysis of Treatment E.

A. Labor

Labor is equal to 40% of the cost of materials

$$\begin{aligned} \text{Labor} &= \text{Php } 50.00 \text{ (cost of materials)} \\ &= .40 \times \text{Php } 50.00 \\ &= 20.00 \end{aligned}$$

If the labor consists of 40% of the cost of materials, the total product cost of Treatment E therefore was:

$$\begin{aligned} \text{Labor} &= \text{Php } 20.00 \\ \text{Cost of Materials} &= 50.00 \\ \text{Product Cost} &= 70.00 \end{aligned}$$

B. Summary of Expenses of Treatment E.

The above data shows the cost of all the materials used in making Treatment E. Hence, if the 40% is labor and it is added to the cost of materials for treatment, and the project cost of the product therefore was:

$$\begin{aligned} \text{Labor} &= 20.00 \\ \text{Cost of Materials} &= 50.00 \\ \text{Product Cost} &= 70/ 18 \text{ pieces} \\ \text{Cost per piece} &= 3.88 \text{ per piece} \end{aligned}$$

IV. DISCUSSION OF THE RESULTS

Product Formulation of Chestnut and Squash Muffins with Malunggay Leaves through Sensory Evaluation

Table 3 shows the product formulation of chestnut and squash muffins with malunggay leaves in terms of appearance, aroma, taste and texture. The sensory qualities of Chestnut and squash with malunggay leaves as evaluated by the semi-trained panelists with product A 10 grams chestnut, for Product B 20 grams chestnut for product C 30 grams chestnut, for product D 40 grams chestnut and product D 50 grams chestnut in terms of appearance, aroma, taste, and texture.

The Chestnut and Squash Muffin with Malunggay Leaves.in terms of appearance showed that treatment A got the highest mean score of 8.10 which was described “Very Appealing”, followed by treatment E with a mean score of 7.90, treatment B with a mean score of 7.80, treatment |D with a mean score of 7.60 and treatment C mean score of 7.50, which all described as “Very Much Appealing”. This implies that all treatments of muffin were very much appealing regardless the variation of the amount of chestnut per treatments.

The Chestnut and Squash Muffin with Malunggay Leaves.in terms of aroma showed that treatment E got the highest mean score of 8.60 which was described “Extremely pleasant”, followed by treatment D with a mean score of 7.80, treatment B and C with a mean score of 7.70, and treatment |A with a mean score of 7.40, which all described as “Very Much Pleasant”. This implies that treatment E of muffin was extremely pleasant due to the same proportion of chestnut and flour. The aroma compounds such as benzaldehyde, pyrazine, 2, 5-dimethyl- were identified in roasted Italian chestnuts, whereas decanal, hexanedioic acid, and dimethyl ester have been found in roasted and boiled Chinese chestnuts (Krist et al. 2004).

TREATMENTS										
Sensory Qualities	A (10 grams)		B (20 grams)		C (30 grams)		D (40 grams)		E (50 grams)	
	Mean	AD	Mean	AD	Mean	AD	Mean	AD	Mean	AD
	Appearance	8.10	VMA	7.80	VMA	7.50	VMA	7.60	VMA	7.90
Aroma	7.40	VMP	7.70	VMP	7.70	VMP	7.80	VMP	8.60	EP
Taste	8.00	VMD	7.60	VMD	7.50	VMD	7.60	VMD	8.20	ED
Texture	8.00	VMSI	7.20	MSI	7.60	VMSF	7.20	MSI	7.90	VMS

Table 3. Product Formulation of Chestnut and Squash Muffins with Malunggay Leaves through Sensory Evaluation.

Legend: AD – Adjectival Description

EA- Extremely Appealing

ED- Extremely Delicious

MSI- Moderately Soft and Intact

VMA - Very Much Appealing

VMD-Very Much Delicious

VMP - Very Much Pleasant

EP- Extremely Pleasant

VMSI-Very Much Soft and Intact

The Chestnut and Squash Muffin with Malunggay Leaves in terms of taste showed that treatment E got the highest mean score of 8.20 which was described “Extremely delicious”, followed by treatment A with a mean score of 8.00, treatment B and D with a mean score of 7.60, and treatment |C with a mean score of 7.50, which all described as “Very Much Delicious”. This implies that treatment E of muffin was extremely delicious due to the increasing amount of chestnut. The Chestnut and Squash Muffin with Malunggay Leaves.in terms of texture showed that treatment A got the highest mean score of 8.00 which was described “Very much soft and intact”, followed by treatment E with a mean score of 7.90, treatment C with a mean score of 7.60, and treatment |B and D with a mean score of 7.20, which all described as “Very Much Soft and Intact”. This implies that all treatments have a very much soft and intact texture regardless of the amount of chestnut per treatments.

The result of the study parallel to the findings of the study entitled Image Analysis of Gluten-free Breads Prepared with Chestnut and Rice Flour and Baked in Different Ovens by Ilkem Demirkesen, Gulum Sumnu & Serpil Sahin, 2008. The fiber content and larger starch granules of chestnut flour contributed towards the stabilization of gas bubbles resulting in better crumb structure or texture of the bread same with the present study that the more chestnut powder the better the texture of the muffin. In general, the aroma of Chestnut and Squash Muffin with Malunggay Leaves ranked first followed by taste, then appearance and lastly texture as evaluated by 10 semi-trained panelists.

General Acceptability Chestnut and Squash Muffin with Malunggay Leaves as evaluated by Consumers

Table 4 revealed the results in the general acceptability of Chestnut and Squash Muffin with Malunggay Leaves. Consumers’ choice towards Chestnut and Squash Muffin with Malunggay Leaves considering the five (5) treatments from the seventy (70) participants, assessment of appearance, aroma, taste and texture showed that was “Liked Very Much” even in different proportion of the amount of chestnut in making muffin such as Treatment E (mean = 7.86), Treatment D (mean = 7.68), Treatment C (mean = 7.51), Treatment A (mean = 7.44), Treatment B (mean = 7.39). This implies that the five (5) treatments in making chestnut and squash muffin with malunggay leaves found to be similar as whole regardless of the variation in the amount of chestnut and flour. This result conforms to the qualities of chestnuts that when boiled, they absorb water which is strongly bound by starch, giving a glassy appearance to the texture which breaks at the first bite and after chewing becomes floury.

TREATMENTS										
Sensory Qualities	A (10 grams)		B (20 grams)		C (30 grams)		D (40 grams)		E (50 grams)	
	Mean	QD	Mean	QD	Mean	QD	Mean	QD	Mean	QD
	Appearance	7.74	LVM	7.53	LVM	7.33	LVM	7.53	LVM	7.60
Aroma	7.36	LVM	7.41	LVM	7.80	LVM	8.03	LVM	8.17	LE
Taste	6.96	LM	7.06	LM	7.39	LVM	7.67	LVM	8.07	LVM
Texture	7.71	LVM	7.59	LVM	7.54	LVM	7.47	LVM	7.61	LVM
General Acceptability	7.44	LVM	7.39	LVM	7.51	LVM	7.68	LVM	7.86	LVM

Table 4. General Acceptability of Chestnut and Squash Muffin with Malunggay Leaves as evaluated by Consumers.

Legend:	Scale of Means	Qualitative Description
8.12 – 9.0		Liked Extremely
7.23 – 8.11		Liked Very Much
6.34 – 7.22		Liked Moderately

Difference in the Sensory Evaluation of Chestnut and Squash Muffin with Malunggay Leaves

Table 5 revealed that there was no significant difference in the sensory qualities of the chestnut and squash muffin with malunggay leaves among five (5) treatments in terms of appearance, aroma, taste and texture as evaluated by the semi-trained panelists.

Sensory Qualities	Sum of Squares	df	Mean Square	F	Sig.	Remarks
APPEARANCE	2.280	4	.570	.847	.503	ns.
	30.300	45	.673			
	32.580	49				
AROMA	8.120	4	2.030	3.713	.011	ns.
	24.600	45	.547			
	32.720	49				
TASTE	3.680	4	.920	1.663	.175	ns.
	24.900	45	.553			
	28.580	49				
TEXTURE	5.680	4	1.420	1.436	.238	ns.
	44.500	45	.989			
	50.180	49				

Table 5. Difference in the Sensory Qualities of Chestnut and Squash Muffin with Malunggay Leaves.

Legend: p-value > .01, not significant at p-value < 0.01, significant at .01 alpha

Results showed that in the appearance, there was no significant difference (f-value = .847, p value = .503). This implies that the appearance did not differs in all treatments regardless of the increasing or decreasing amount of the main ingredients such as the chestnut and the flour.

Findings also revealed with no significant difference in aroma among the five (5) treatments (f-value = 3.713, p value = 0.11). This indicates that different proportion per treatments used in preparing chestnut and squash muffin with malunggay leaves the aromatic quality appeared to be the same due to its own unique characteristics of chestnut.

The outcomes on the test of difference among the products in terms of taste showed with no significant difference (f-value = 1.663, p-value = 0.175). The result signifies that there is no distinguishing taste when different proportion of chestnut and flour is used in making muffin.

Similarly, the results also revealed with no significant difference in texture among the five (5) treatments, (f-value = 1.436, p-value = 0.238). The soft and intact texture of the muffin was achieved by five (5) treatments. Generally, the null hypothesis forwarded before the experimentation was accepted since the sensory qualities showed no significant difference among the five (5) treatments.

Significant Difference in the Consumers’ Acceptability of Chestnut and Squash Muffin with Malunggay Leaves

The data on the differences in the general acceptability of the chestnut and squash muffin with malunggay leaves is shown in Table 6. As shown, the f-vale of 3.000 with p-value of 0.19 was greater than the 0.01 alpha level. This implies that there was no significant difference in the acceptability of chestnut and squash muffin with malunggay leaves among the five (5) treatments as a whole.

However, in terms of appearance, results showed that there was no significant difference in the treatments of chestnut and squash muffin with malunggay leaves (f-value = 0.993, p value = 0.411). The data showed that the null hypothesis forwarded was accepted. This implies that the appearance of chestnut and squash muffin with malunggay leaves with different treatments remained the same.

Sensory Qualities	Sum of Squares	df	Mean Square	F	Sig.	Remarks
APPEARANCE	6.269	4	1.567	.993	.411	.ns
	544.500	345	1.578			
	550.769	349				
AROMA	36.726	4	9.181	10.213	.000	s.
	310.143	345	.899			
	346.869	349				
TASTE	58.400	4	14.600	9.516	.000	s.
	529.314	345	1.534			
	587.714	349				
TEXTURE	2.257	4	.564	.417	.796	ns.
	466.671	345	1.353			
	468.929	349				
GENERAL ACCEPTABILITY	10.407	4	2.602	3.000	.019	ns.
	299.182	345	.867			
	309.589	349				

Table 6. Difference in the Acceptability of Chestnut and Squash Muffin with Malunggay Leaves.

Legend: p-value > .01, not significant at p-value < 0.01, significant at .01 alpha

In terms of aroma, findings revealed that there was a significant difference among the five (5) treatments of chestnut and squash muffin with malunggay leaves, (f-value = 10.213, p-value = 0.000). The results imply that the null hypothesis was rejected. Findings also suggests that the aroma of the product vary when the amount of chestnut was increasing.

Consequently, the outcomes on the test of difference among the products in terms of taste showed a significant difference (F-value = 9.516, p-value = 0.000). This implies that the five (5) treatments with varying amount of chestnut and flour used in making muffin has a comparable taste. This result prompted the rejection of null hypothesis.

On the contrary, the results revealed that there was no significant difference in the texture of chestnut and squash muffin with malunggay leaves with varying amounts of chestnut and flour used as treatments, (f-value = .417, p-value = 0.796). Texture of chestnut and squash muffin with malunggay leaves did not differs considering the five (5) treatments. The result implies that the null hypothesis was accepted.

Shelf-life of Chestnut and Squash Muffin with Malunggay Leaves at Room and Chilling Temperature

Table 7 presented the observed shelf-life of Chestnut and squash muffins sealed when stored at room and chilling temperature away from water and sunlight. The observation of the shelf-life was done every day to examine if the product was of good quality or if there are any changes taking place in the chestnut and squash muffin with malunggay leaves. The muffin stayed only for three (3) days and showed no changes in the products’ qualities. However, on four-five days, the product was noticed to have undergone changes like mold formation and staleness. Muffin mold growth rate depends on several factors, the temperature being the most important one. This result conforms to the characteristics in terms of water content % that the fresh fruit got 90-95%, while dry fruit got 5-15%, and the Chestnut got 50-60%. The observations of the mold formation for the shelf-life were due to the water content of the Chestnut even it was dried.

Variant	One- Two days Mold Formation	Two- Three days Mold Formation	Four- five days Mold Formation
Treatment E (chestnut muffin)	0	0	+
	0	0	+
	0	0	+

Table 7. Observed the Shelf-life of Chestnut and Squash Muffin with Malunggay Leaves at Room Temperature.

Legend: Negative (-) no molds formation
Positive (+) molds formation observed

Microbial Analysis of Chestnut and Squash Muffin with Malunggay Leaves

Table 8 showed the microbial report analysis of Chestnut and Squash Muffin with Malunggay Leaves samples conducted by the DOST Regional Standard and Testing Laboratory, Iloilo City. Test Service Request No. R6-092021-MIC-0510-0813 was submitted dated August 30, 2022 and was analyzed from August 30, 2022 to September 07, 2022 as attached in Appendix M.

The Chestnut and Squash Muffin with Malunggay Leaves with three (3) packs at 200grams per pack were subjected to Aerobic Plate Count using Pour plate method, 35°C, 48 hrs., PCA, USFDA BAM Online (2001), Coliform Count using Multiple Tube Fermentation Technique, USFDA BAM Online (2001), and Mold and Yeast Count using Pour plate method, 25°C, 5-7 days., PCA, USFDA BAM Online (2001).

Sample Description	Parameter	DOST	FDA Standards	
			m	M
Chestnut and Squash Muffin, 200g (3 packs @ 20g/pk; MFD:10/09/2022 EXP: 10/14/2022)	Aerobic Plate Count	58000 cfu/g sample	10 ⁴	10 ⁶
	Molds and Yeast Count	<100 cfu/g sample (estimated)	10 ²	10 ⁴
	Total Coliform	2.0 MPN/g sample	50	10 ³

Table 8. Microbial Analysis of Chestnut and Squash Muffins with Malunggay Leaves.

Legend: **m** –acceptable level of microorganism determined by a specified method: values are generally based on levels that are achievable under GMP

M – level which when exceeded in one or more samples would cause the lot to be rejected as this indicates potential health hazard or imminent spoilage.

As shown in the result above, the Chestnut and Squash Muffin with Malunggay Leaves has the Aerobic Plate Count of 58000 cfu/g sample based on the BFAD reference criteria for aerobic plate count which M in level of rejection and m for an acceptable level. For molds and yeast count it had the result of 100 cfu/g sample with the BFAD criteria which was both acceptable in m and M. The Total Coliform of 2.0 MPN/g sample. The result given in this report was during the time of examination and referred only to the particular sample submitted.

Proximate Analysis of Chestnut and Squash Muffin with Malunggay Leaves

Table 9 shows the report of proximate analysis of Chestnut and Squash Muffin with Malunggay Leaves samples conducted by the Department of Science and Technology (DOST) Regional Standard and Testing Laboratory, Iloilo City. Test Service Request No. R6-122022-CHE-0222-0409 was January 09, 2023 and was analyzed from January 19, 2023 to March 02, 2023 as attached in Appendix O.

The Chestnut and Squash Muffin with Malunggay Leaves with 250-gram sample in a plastic container were subjected to moisture, ash, crude protein, total fat content, carbohydrate and energy. Moisture by Oven Method. Official Methods of Analysis of AOAC International (2019) 21st Ed. Official Method 925.10. For ash by gravimetric method was Official Methods of Analysis of AOAC International (2019) 21st Ed. Official Method 923.0. For crude protein by Kjeldahl Block Digestion Method and Steam Distillation.

Sample Description	Parameter	Result g/100mL
250 g sample in a plastic food container labeled as: Chestnut and Squash Muffin with Malunggay Leaves	Moisture	84.20
	Ash	0.24
	Crude Protein	0.28
	Total Fat	0.00
	Carbohydrate	15.28
	Energy	62 kcal

Table 9. Proximate Analysis of Chestnut and Squash Muffin with Malunggay Leaves.

For total fat by Soxhlet Method using Petroleum Ether with Acid Hydrolysis. For carbohydrate is computed by difference (100-sum of moisture, ash, protein and fat) was Official Methods of Analysis of AOAC International (2019) 21st Ed. Official Method 986.25E. And for energy in kilocalories per 100 grams was the sum of protein, fat and carbohydrate multiplied by the general Atwater factors 4-9-4 respectively.

As shown in the result, Chestnut and Squash Muffin with Malunggay Leaves had the moisture content of 31.84 gram/100g. For ash, it got the result of 1.64 gram per 100g, the crude protein the result of 5.05 gram per 100g, the total fat content the result of 15.31 gram per 100g, the carbohydrate the result of 46.16 gram per 100g, the energy the result of 343 kcal per 100g. The result given in the report were those obtained at the time of examination and referred only to the particular sample submitted.

V. CONCLUSION AND RECOMMENDATION

Based on the findings of the study, the following conclusions were formulated: a) Chestnut fruit can be produced into powder and used as the main ingredient in making muffins, b) Squash vegetables can be used as extenders for the flour and for the fineness of the texture of the muffin, c) Malunggay leaves can be used as an added flavor for the muffin, (d) The five (5) treatments based on the product formulation were acceptable in terms of sensory qualities, (e) The seventy (70) consumers who evaluated the product in the acceptability level considering the five (5) treatments were described as “liked very much” by them, (f) The chestnut and squash muffin with malunggay leaves was acceptable considering its sensory qualities. The result for the significant difference of the product was found not significant considering its five treatments in terms of four sensory qualities and general acceptability. The shelf-life of Treatment E of chestnut and squash muffin with malunggay leaves when stored at room temperature could last for three (3) days with no changes in the sensory attributes when completely sealed. Therefore, the chestnut and squash muffin with malunggay leaves was safe for human consumption as the results of microbial analysis of the product and based on the BFAD standard for microorganism test for products belonging to the baked goods category

Based on the conclusions, the following recommendations were formulated: (a) Cake flour is recommended as flour in making chestnut and squash muffin with malunggay leaves since it has a light and fluffy texture effect in the muffin, (b) Chestnut powder is also recommended as the main ingredient in making muffins due to its unique nutty flavor and taste, (c) The chestnut and squash muffin with malunggay leaves is recommended to bakers, pastry makers, food enthusiasts, bakery industries, food business owners, and children since it is cheaper, healthier, and more nutritious than the usual muffin prepared in the market, (d) The product can be exhibited to more consumers to discover the new and unique flavor and taste of muffins using chestnut powder, squash, and malunggay leaves, (e) Chestnut and squash muffin with malunggay leaves must be undergone a vacuum sealing process to prolong its shelf-life since it was stored at room temperature, (f) Chestnut and squash muffin with malunggay leaves is recommended to undergone a vacuum sealing process to prolong its shelf-life under chilling temperature. Accurate drying of chestnut is recommended since the product is prone to higher molds and yeast formation due to its other fresh vegetables added. Other researchers may try other variants/factors not covered in the current study.

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