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Production and Quality Evaluation of Probiotic Malunggay (*Moringa oleifera* Lam.) Ice Cream

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ABSTRACT

The study aimed to produce probiotic malunggay ice cream. It further aimed to determine and assess the effects of the probiotic malunggay on the sensory quality of the product, its physico-chemical properties, stability, consumer reaction and the cost of production. The research study used a 3 x 3 factorial experimental type of research in Randomized Complete Block Design (RCBD) with two (2) replicates and with three (3) levels of malunggay, namely, 0%, 15%, and 30% (w/v) and three (3) levels of probiotic cultures 0%, 20%, and 40% (w/v). The findings of the study revealed that sensory evaluation showed that only malunggay was significantly affected by the acceptability of the aforementioned sensory evaluation. When Malunggay was subjected to sensory evaluation, High levels of malunggay elicit low acceptability on its color, taste, flavor, and texture. In terms of pH, and TA of the probiotic malunggay, when it was made into ice cream, such was affected by the levels of the probiotic culture, increased levels of probiotic culture correspond to a higher pH and TA values thus, increased levels of probiotic culture could further increase the initial microbial count of the probiotics in the product. Further studies may be conducted to confirm the

storage stability of the probiotic microorganisms over an extended period of frozen storage.

Keywords **—** Malunggay, Probiotic, Ice Cream, Production, Philippines

INTRODUCTION

Production of dairy products should be carefully handled that its good bacteria will be the main source of bodily health of both men and women and thus, food production particularly the probiotics malunggay required precautionary measures to ensure safe and germ-free food process. Dairy products use milk that includes whole fluid milk, flavored milk, butter, cheese, evaporated and with special mentioned in terms of the most popular from among the group of UP students.

The ice cream manufacturing industry was one of the largest in the realm of dairy processing (Kon & Henry, 1949). Ice cream alone comes in many different flavors. Although ice cream has already been widely available, it is not regularly consumed. Barriers from regular consumption include limited health benefits and disadvantageous consumer perceptions. As pointed out by Lauzon, Zhao, and Lacasse (2006), ice cream had nutritional significance yet not considered to have a therapeutic effect. Even though enrichment and fortification in whole milk products with vitamins and minerals have been flourishing, it was not common among in frozen dairy products. Utilization and incorporation of healthful ingredients like malunggay and probiotics could enhance the nutritional benefits of ice cream.

Malunggay was used in addressing malnutrition in developing areas of the world. It has been used successfully to combat nutrient deficiency among infants and women of childbearing age. Scientific research has proven that malunggay leaves were a powerhouse of nutritional value. The high concentrations of iron, protein, copper, beta-carotene, Vitamin C, calcium, potassium and essential amino acids present in malunggay leaves make them effectively ideal as a nutritional supplement (Fahey, 2005).

On the other hand, probiotics are "live microorganisms which when administered in adequate amount confer a health benefit on the host" (FAO, 2001). They contribute to the health of people by improving their intestinal microbial balance (Fuller, 1989). Incorporation of probiotic microorganisms into the ice cream formulation improves the nutritional quality as well as provides a therapeutic value of the product as pointed out by Sarkar (1999).

Buffalo milk which was used to produce the ice cream was a healthy food which provides more nutrients compared to other milk. Buffalo milk is processed into a product of high value. One advantage of buffalo milk is its processing quality. The high contents of fats, proteins, and total solids give it a rich flavor and added value. It has a higher resistance to oxidation which is ideal for preparing traditional sweets (Philippine Carabao Center, 2009). Time after time, participants in tasting trials pick out consumer preferred buffalo milk than cows, goats and artificially manufactured milk (The India Dairy, 2001).

Malunggay contains a generous supply of vitamins and mineral while probiotic microorganisms offer beneficial effects to human health. Adding malunggay and probiotics gives an excellent nutritional value to the product and more health benefits to consumers. Hence this study is conducted.

OBJECTIVES OF THE STUDY

The study aimed to improve the nutritional benefits of ice cream and produce probiotic malunggay ice cream using different levels of malunggay and probiotic culture. Specifically, it sought to; 1) Evaluate the sensory properties of the probiotic malunggay ice cream as affected by the concentration of malunggay and probiotic culture ; and determine the optimum regions; 2) Determine the effects of the level of malunggay and probiotic culture on the physico-chemical properties of the probiotic malunggay ice cream; 3) Determine the stability and development of Lactic Acid Bacteria (LAB) under freezing conditions in the probiotic malunggay ice cream; 4) Assess consumers' reactions toward the optimum product; and, 5) Determine the cost of production of the optimum level of probiotic malunggay ice cream.

MATERIALS AND METHODS

Procurement of Raw Materials

The fresh water buffalo's milk used was provided by the Philippine Carabao Center (PCC) at VSU, Visca, Baybay, Leyte. The ingredients for ice cream production except malunggay were bought from Baybay Public Market. The malunggay leaves were obtained from Pangasugan, Baybay, Leyte.

Ice Cream Formulation

The method used for the production of probiotic ice cream was patterned from the process of Sarkar (1999) as modified by Lauzon, Zhao, and Lacasse

(2006). The amount of ingredients needed was calculated accurately, and the ingredients were mixed carefully to give its proper composition. There were three levels of malunggay and probiotic medium used, which were 0%, 10%, and 20% and 0%, 20%, and 40% (w/v), respectively.

Malunggay Paste Preparation

The malunggay leaves were first separated from the stalks. The leaves were then blanched into hot water and removed immediately after it was thoroughly soaked. The blanched water was added at 1: 1 malunggay and water ratio to facilitate homogenizing on the electric blender. The process for preparing malunggay paste is shown in Figure 1 below.

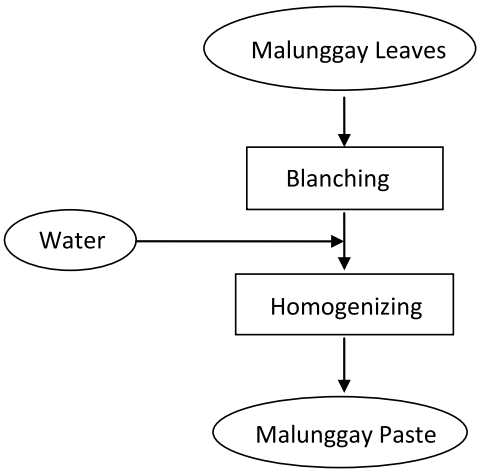

Figure 1. Showing the Schematic diagram of malunggay paste preparation

Ice Cream Preparation

Milk was pasteurized at 72°C (161.6 °F) for 15 seconds. Homogenized malunggay leaves were added according to the calculated milk-malunggay ratio. The rest of the ingredients were then added to the malunggay-milk mixture. The mixture was then heated for ten minutes at 80-85°C (176-185°F) with constant stirring. The probiotic culture was added after the mixture has cooled down to approximately 30°C (86°F).

The ice cream mixture was subjected to low temperature at about 0 to -4°C (32-24.5°F) with constant beating to incorporate more air. It was then

alternately beaten and aged for about 10 minutes. The partially frozen ice cream was transferred in the freezer for complete final freezing. The complete process is shown in Figure 2 next page.

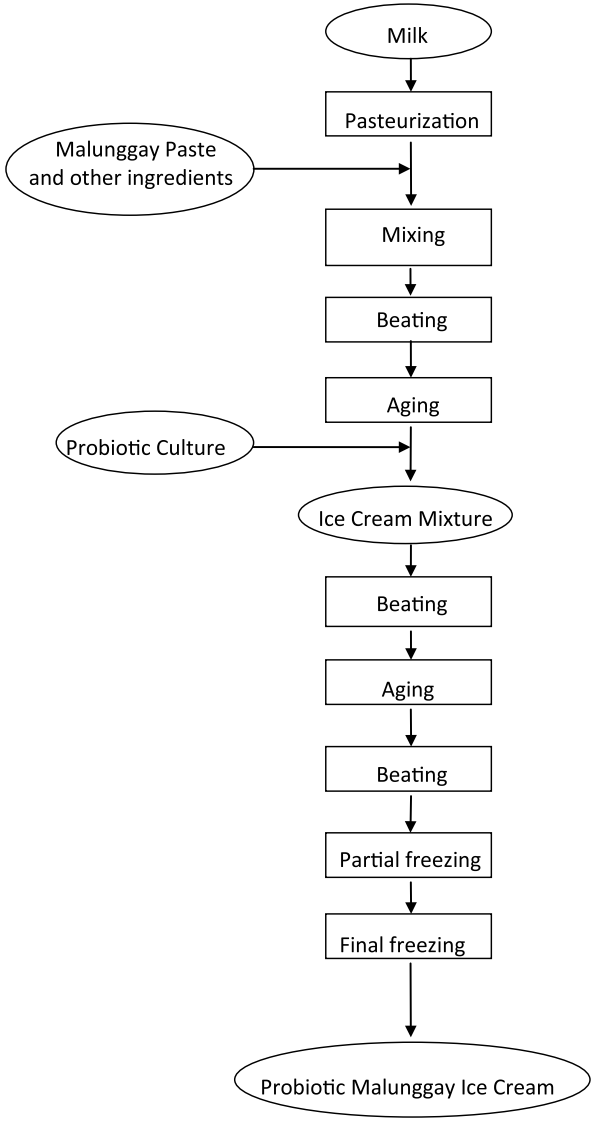

Figure 2. The process flow for processing probiotic malunggay ice cream.

Treatments and Experimental Design

A 3 x 3 factorial experimental design in Randomized Complete Block Design (RCBD) in 2 blocks or replicates with three levels of malunggay, namely, 0%, 15%, and 30% (w/v) and three levels of probiotic cultures namely 0%, 20%, and 40% (w/v) was used in the study. Table 1 shows the different treatments that were used in the study.

Table 1. Experimental treatments

TREATMENT	MALUNGGAY (%)	PROBIOTIC CULTURE (%)
1	0	0
2	10	0
3	20	0
4	0	20
5	10	20
6	20	20
7	0	40
8	10	40
9	20	40

Sensory Evaluation

Sensory evaluation of the different treatments was carried out using a laboratory test panel composed of 48 fourth-year and third-year BSFT students of VSU. Samples were coded with the three-digit number and presented to the panelists. Panelists were asked to evaluate the product according to their color, taste, flavor, and texture using the quality scoring and the 9-point Hedonic scale for the acceptability evaluation.

Incomplete Block Design (IBD) as laid out by Cochran and Cox (1957) was used during the sensory evaluation using a score sheet. It was carried out in four runs with a total of 48 panelists wherein each treatment was evaluated by 32 individuals. The set plan of t = 9, k = 6, r = 8, b = 12, E = 0.94 type II was followed where t refers to the number of treatments; k, the number of samples presented to the panelists; r, the number of replications; b, the number of blocks and; E, the efficiency factor.

Stability of Lactic Acid Bacteria (LAB)

The stability of lactic acid bacteria (LAB) at freezing condition was determined by culturing the frozen probiotic malunggay ice cream using the

MRS (de Mann, Rogosa, and Sharpe) agar. Sampling was done for 6 days with 2 days interval for the optimum formulation.

Statistical Analysis

Results of the sensory evaluation were subjected to analysis using the Response Surface Regression (RSREG) using the Statistical System (SAS, 1985) program package in determining the effects of the independent variables on the sensory qualities of the product and the optimum processing conditions for each independent variable for the response studied. Effects of the independent variables were clarified by contour plots produced by the analysis. Optimum conditions were defined for processing the product using the highest possible product acceptability common to all sensory qualities evaluated.

Physico-Chemical Quality Evaluation

Total Soluble Solids

The total soluble solid was measured using the calibrated handheld refractometer (ATAGO ATCIE Model) A drop of sample was placed on the refractometer for TSS reading in °Brix.

pH

The pH was measured using the digital pH meter using the Model pH 600 available at the National Abaca Research Center (NARC) VSU, Baybay, Leyte.

Titrable Acidity

TA was calculated as % lactic acid using the formula below.

$$\%\ \text{lactic acid} = \frac{\text{ml NaOH} \times N_{NaOH} \times \frac{90}{1000}}{\text{g sample}} \times 100$$

Microbial Evaluation

The microbial evaluation was carried out to determine whether the initial microorganisms inoculated were the same microorganisms found in the final product. Cultures from the commercial yogurt and from the final product were examined by gram staining and visual microscopic examination. The figures of the isolated lactic acid bacteria were compared in terms of morphology and gram reaction.

Consumer Acceptability Test

The optimum formulation and the treatment with the highest level of malunggay and probiotic culture were subjected to consumer evaluation employing 100 consumers composed of 25 elementary students, 25 high school students, 25 college students and 25 adults.

Cost Analysis

Corresponding production cost was determined for the optimum formulation of probiotic malunggay ice cream considering the prevailing market prices of ingredients, labor, and other processing costs.

RESULTS AND DISCUSSION

Sensory Evaluation

Sensory evaluation was carried out to nine different treatments utilizing different levels of malunggay and probiotic culture. The treatments were in Figure 3 as presented below.

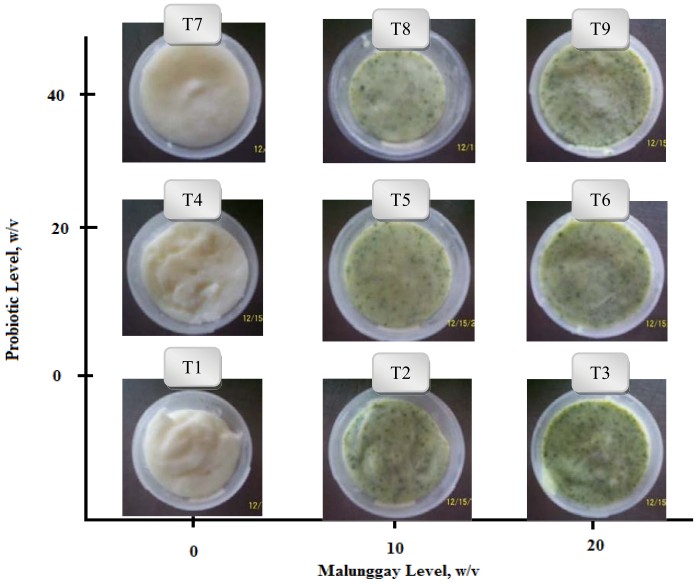

Figure 3. The different probiotic malunggay ice cream affected by the levels of malunggay and probiotic culture.

Color

The color description of probiotic malunggay ice cream ranged from "light green" to "green" as described by 60.07% of the panelists (Table 2). The color acceptability had an overall response mean of 6.85 which corresponds to "like slightly" to "like moderately" in the 9-point Hedonic Scale.

Table 2. Frequency count of the descriptive scores on the color of probiotic malunggay ice cream

DESCRIPTIVE SCORE		COUNT	PERCENTAGE
1	white	51	8.85
2	milky white	88	15.28
3	light green	197	34.20
4	green	149	25.87
5	dark green	91	15.80

Color description of the different treatments was in Table 3. Treatments 1, 4, and 7, with 0% malunggay got a color description ranging from "white" to "milky white." Treatments with malunggay, 2, 3, 6, 8 and 9 exhibited a shade of green, whose intensity corresponds to the levels of malunggay added. However, the addition of probiotic culture repressed the green color contributed by the malunggay. Treatments 5, 6, 7 and 8 which had probiotic culture had a receding intensity of the green color. Color acceptability is higher in treatments 1, 4, and 7 (without malunggay) whose color description ranged from "white" to "milky white." The high acceptability rating of the ice cream without malunggay is attributed to the fact that the sensory panelists are not used to green-colored ice cream.

Table 3. Color description and mean[1] acceptability rating[2] of probiotic malunggay ice cream as influenced by the levels of malunggay and probiotic culture

Treatment	% Malunggay	% Probiotic Culture	Description	Acceptability[3]
1	0	0	white-milky white	7.47b
2	10	0	light green	6.72cd
3	20	0	green-dark green	6.16e
4	0	20	milky white	7.72ab

5	10	20	light green	6.84c
6	20	20	green-dark green	5.69f
7	0	40	milky white	7.89a
8	10	40	light green	6.70cd
9	20	40	light green-green	6.44de

[1] N = 48
[2] Acceptability Score:
9 – like extremely 6 – like slightly 3 – dislike moderately
8 – like very much 5 – neither like nor dislike 2 – dislike very much
7 – like moderately 4 – dislike slightly 1 – dislike extremely
[3]Means with the same letters do not significantly differ from each other at 0.05 level of significance.

Response Surface Regression Analysis revealed a highly significant linear effect on malunggay levels. This linear effect indicates that malunggay alone has contributed to the significant change in color acceptability on the probiotic malunggay ice cream. The green color of malunggay was brought about by the pigment chlorophyll found in the leaves of green plants.

Taste

The taste of probiotic malunggay ice cream was described to be "sweet" to "well-blended sweet and sour" by 75.17% of the panelists (Table 4). The taste acceptability rating of the product had an overall response mean of 7.04 which corresponds to "like moderately" category in the 9-point Hedonic scale.

Table 4. Frequency count of the descriptive scores of taste attribute of probiotic malunggay ice cream

Descriptive Score		Count	Percentage
1	others	7	1.21
2	sweet	205	35.59
3	well blended sweet and sour	228	39.58
4	sour	79	13.72
5	bittersweet	57	9.90

Taste description of the different treatments is in Table 5. Treatments with malunggay exhibited a slightly bitter taste, but it was no longer perceptible in treatments with both the probiotic culture and the malunggay except in treatment 6 wherein the level of malunggay is still perceptible which means that the probiotic culture added is not enough to mask the bitter taste of malunggay. The sour taste of the product can be due to the lactic acid produced by the probiotic culture which is naturally sour. Although treatments with malunggay have lower mean taste acceptability rating. However, their mean acceptability scores still fall on the acceptable level of the 9-point Hedonic scale.

Response Surface Regression analysis revealed a significant linear effect of malunggay on the taste acceptability of probiotic malunggay ice cream. The taste contributed by malunggay significantly affected the taste acceptability of the product. Higher levels of malunggay result in lower mean taste acceptability of the probiotic malunggay ice cream.

Table 5. Taste description and mean[1] acceptability rating[2] of probiotic malunggay ice cream as influenced by the levels of malunggay and probiotic culture

Treatment	% Malunggay	% Probiotic Culture	Description	Acceptability[3]
1	0	0	sweet	7.39b
2	10	0	sweet-bittersweet	6.91c
3	20	0	sweet-bittersweet	6.22d
4	0	20	sweet-well blended sweet sour	7.86a
5	10	20	sweet-well blended sweet sour	7.33b
6	20	20	well blended sweet sour-bittersweet	6.22d
7	0	40	well blended sweet sour-sour	7.78a
8	10	40	well blended sweet sour-sour	6.92bc
9	20	40	well blended sweet sour-sour	6.72cd

[1] N = 48

[2] Acceptability Score:

9 – like extremely	6 – like slightly	3 – dislike moderately
8 – like very much	5 – neither like nor dislike	2 – dislike very much
7 – like moderately	4 – dislike slightly	1 – dislike extremely

[3]Means with the same letters do not significantly differ from each other at 0.05 level of significance.

Flavor

The flavor of probiotic malunggay ice cream was described to have "imperceptible malunggay flavor" to "well-blended malunggay milk flavor" by 56.25% of the panelists (Table 6). The flavor acceptability had an overall response mean of 6.95 which corresponds to "like moderately" category of the 9-point Hedonic scale.

Table 6. Frequency count of the descriptive scores of color attribute of probiotic malunggay ice cream

	Descriptive Score	Count	Percentage
1	others	12	2.09
2	imperceptible malunggay flavor	176	30.56
3	well blended malunggay milk flavor	148	25.69
4	Slightly perceptible malunggay flavor	117	20.31
5	moderately perceptible malunggay milk flavor	123	21.35

Flavor description for the different treatment is in Table 7. Increased level of malunggay resulted in a higher intensity of the malunggay flavor. Treatments 1, 4 and 7 have no perceptible malunggay flavor and have higher flavor acceptability compared to the other treatments evaluated which have a distinct malunggay flavor.

Response Surface Regression Analysis revealed a highly significant quadratic effect of malunggay levels on flavor acceptability. This quadratic effect indicates that malunggay has contributed to the significant change in flavor acceptability of the probiotic malunggay ice cream. Higher levels of malunggay result in lower flavor acceptability.

Table 7. Flavor description and mean[1] acceptability rating[2] of probiotic malunggay ice cream as influenced by the levels of malunggay and probiotic culture

Treatment	% Malunggay	% Probiotic Culture	Description	Acceptability[3]
1	0	0	Imperceptible malunggay flavor	7.16bc
2	10	0	Slightly perceptible malunggay flavor – well blended malunggay milk flavor	7.09ac
3	20	0	well blended malunggay milk flavor - Moderately perceptible malunggay flavor	6.17e
4	0	20	Imperceptible malunggay flavor	7.53a
5	10	20	Slightly – moderately perceptible malunggay flavor	7.52ab
6	20	20	Well blended malunggay milk flavor – moderately perceptible malunggay flavor	6.11e
7	0	40	Imperceptible malunggay flavor	7.56a
8	10	40	Slightly perceptible malunggay flavor – well blended malunggay milk flavor	6.94cd
9	20	40	Slightly – moderately perceptible malunggay milk flavor	6.45de

N = 48

[2] Acceptability Score:

9 – like extremely	6 – like slightly	3 – dislike moderately
8 – like very much	5 – neither like nor dislike	2 – dislike very much
7 – like moderately	4 – dislike slightly	1 – dislike extremely

[3]Means with the same letters do not significantly differ from each other at 0.05 level of significance.

[3]Means with the same letters do not significantly differ from each other at 0.05 level of significance.

Texture

The texture of probiotic malunggay ice cream was described to be "firm" to "soft but firm" by 70.48% of the panelists (Table 8). The texture acceptability had an overall response mean of 7.23 which corresponds to "like moderately" to "like very much" category in the 9-point Hedonic scale.

Table 8. Frequency count of the descriptive scores of texture attribute of probiotic malunggay ice cream

Descriptive Score		Count	Percentage
1	very firm	48	8.33
2	firm	134	23.26
3	soft but firm	272	47.22
4	soft	85	14.76
5	very soft	37	6.42

Texture description of the different treatments of probiotic malunggay ice cream is in Table 9. Treatments 1, 4 and 7, without malunggay, were described to be soft while treatments with malunggay exhibited a firm texture. These findings can be due to the tiny fibrous particles of malunggay which reduces the stability of the mixture, therefore, limiting the formation of air cells. Acceptability means are found to be higher in treatments with a soft texture.

Response Surface Regression analysis revealed a linearly significant malunggay level. This linear effect indicates that the presence of malunggay has affected the texture quality and acceptability of the product.

Table 9. Texture description and mean[1] acceptability rating[2] of probiotic malunggay ice cream as affected by the levels of malunggay and probiotic culture

Treatment	% Malunggay	% Probiotic Culture	Description	Acceptability[3]
1	0	0	Soft	7.36bc
2	10	0	Soft and firm – firm	7.09cd
3	20	0	Firm – very firm	6.95cd
4	0	20	Soft	7.64ab
5	10	20	Soft and firm – firm	7.25bcd
6	20	20	Firm – very firm	6.95cd
7	0	40	Soft	7.80a
8	10	40	Soft and firm – firm	7.16cd
9	20	40	Soft – soft and firm	6.89d

[1] N = 48

[2] Acceptability Score:

9 – like extremely	6 – like slightly	3 – dislike moderately
8 – like very much	5 – neither like nor dislike	2 – dislike very much
7 – like moderately	4 – dislike slightly	1 – dislike extremely

[3]Means with the same letters do not significantly differ from each other at 0.05 level of significance.

General Acceptability

The general acceptability had an overall response mean of 7.07, which corresponds to "like moderately." Response Surface Regression analysis a significant linear effect of malunggay levels. This effect implies that the malunggay levels have significantly affected the general acceptability of the probiotic malunggay ice cream.

Table 10 shows the corresponding mean general acceptability rating of each treatment. Treatment means ranged from 6.17 to 7.92, which fall between "like slightly" to "like very much" category of the 9-point Hedonic scale.

Table 10. Mean[1] general acceptability ratings[2] of probiotic malunggay ice cream as influenced by the levels of malunggay and probiotic culture

Treatment	% Malunggay	% Probiotic Culture	Acceptability[3]
1	0	0	7.20bc
2	10	0	7.02cd
3	20	0	6.17e
4	0	20	7.92a
5	10	20	7.33b
6	20	20	6.28e
7	0	40	7.81a
8	10	40	7.12bc
9	20	40	6.61de

[1] N = 48

[2] Acceptability Score:

9 – like extremely	6 – like slightly	3 – dislike moderately
8 – like very much	5 – neither like nor dislike	2 – dislike very much
7 – like moderately	4 – dislike slightly	1 – dislike extremely

[3]Means with the same letters do not significantly differ from each other at 0.05 level of significance.

Summary of Critical Values of Predictor Variables and Predicted Optimum Sensory Attribute Acceptability of Probiotic Malunggay Ice Cream

Table 11 shows the summary of the critical values of malunggay and probiotic culture level for the predicted acceptability scores of the sensory attributes of

probiotic malunggay ice cream at stationary point. The acceptability rating of the sensory attributes revealed a minimum response for color acceptability while a maximum response for taste, flavor and general acceptability at the stationary point. Texture acceptability is a saddle at stationary point.

Table 11. Critical and predicted response values at the stationary point of sensory qualities of probiotic malunggay ice cream

Response	Critical Values		Predicted Values At Stationary Point
	Malunggay (%)	Probiotic (%)	
Color Acceptability	37.614039	18.772724	5.54^{min}
Taste Acceptability	-213.753142	-1.831234	14.33^{max}
Flavor Acceptability	1.646431	27.723086	7.55^{max}
Texture Acceptability	22.455906	7.543503	6.98^{s}
General Acceptability	-11.064142	35.440115	8.03^{max}

Results showed that the predicted optimum value ranged from 0 to 37.61% malunggay and 0 to 35.44% probiotic culture.

Physico-Chemical Evaluation

pH

The overall response mean for pH is 5.92. This mean is relatively lower than the standard pH of fresh milk which is ranged from 6.5 to 6.7. This can be attributed to the production of lactic acid by the probiotic culture thus lowering the pH of the product.

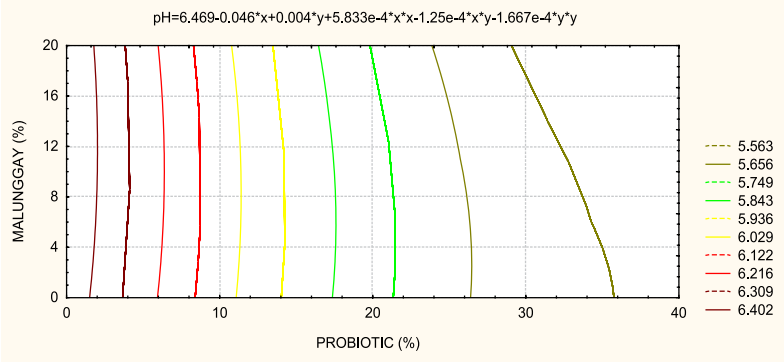

Figure 4. Contour plot for the pH of probiotic malunggay ice cream

Response Surface Regression analysis shows that probiotic culture has a significant linear and quadratic effect on the pH of the probiotic malunggay ice cream. This effect indicates that the varying levels of probiotic culture are the determinant of the product's acidity. Figure 4 shows that increasing amount of probiotic culture corresponds to a lower pH.

Titratable Acidity

The overall response mean for titrable acidity is 0.23. Response Surface Regression analysis showed that probiotic culture has a highly significant linear and quadratic effect on the TA of probiotic malunggay ice cream. Interaction of the formulation variables shows a significant effect on the TA of the product. Figure 11 shows that an increased amount of probiotic culture and a slight increase in malunggay result in the rise of the titrable acidity of the product.

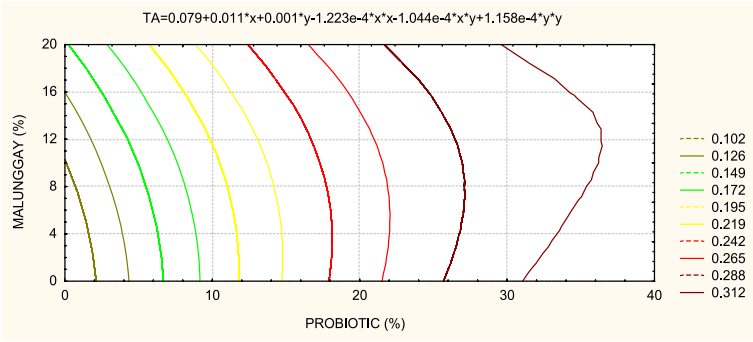

Figure 5. Contour plot for TA of probiotic malunggay ice cream

TSS

Response mean for total soluble solids is 29.08. Response Surface Regression analysis showed that malunggay has a significant quadratic effect on the TSS of the product. However, this effect is not defined on the contour plot (Figure 6).

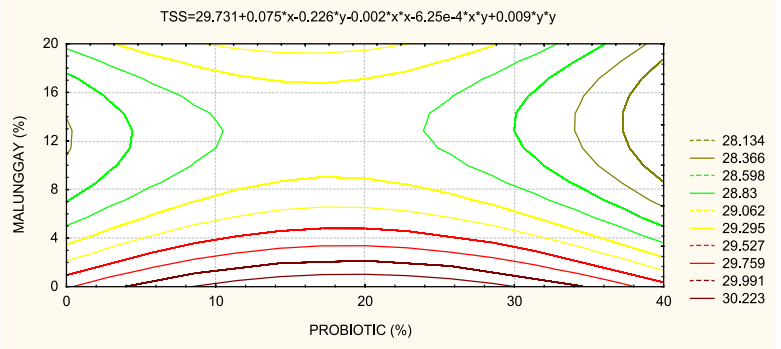

Figure 6. Contour plot for the TSS of probiotic malunggay ice cream

Stability of Lactic Acid Bacteria (LAB)

Microscopic examination was done to determine the morphological characteristics and the gram reaction of the bacteria isolated from the probiotic culture and the probiotic malunggay ice cream. Results showed that the bacteria found in the product are same bacteria used as a starter culture (Figure 7) next page.

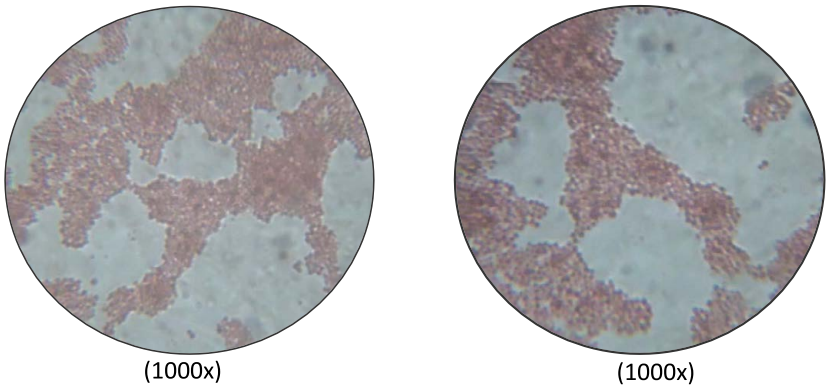

Figure 7. Microscopic examination and gram reaction of Lactic Acid Bacteria on the probiotic culture and probiotic malunggay ice cream

Results in microbial evaluation revealed that the microbial growth during the frozen storage of probiotic malunggay ice cream was declining. The growth of lactic acid bacteria has gradually reduced after six days of storage (Figure 8).

The decrease in the microbial count is imminent since lactic acid bacteria are thermophiles, their optimum survival temperature is from 41-48°C. It is possible that during freezing, some bacterial cells were killed in the freezing process, if not become dormant. When taken in, the organisms were brought back to warm temperatures within the body, thus become active, grow, multiply and impart the same health benefits as a regular probiotic product (Davidson, Duncan, Hackney, Eigel, & Boling, 2000).

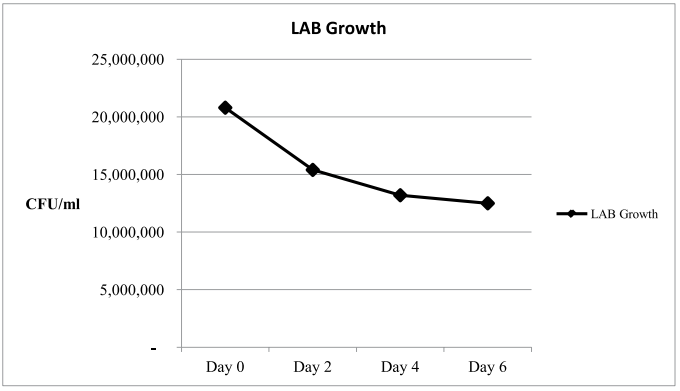

Figure 8. Lactic acid growth in probiotic malunggay ice cream

Consumer Acceptability and Preference Test

Consumer acceptability evaluation employing 100 respondents divided into four categories, elementary, high school, college, and adults. The samples subjected to consumer evaluation were the optimum formulation with 2% malunggay and 38% probiotic culture and T_9 with 20% malunggay and 40% probiotic culture. Treatment 9 which has high malunggay content and, therefore, has high nutrient value. The probiotic culture level of both samples was almost the same.

Figure 9 next page shows the graphical presentation of consumer's acceptability towards the optimum formulation. Almost all of the respondents from each category expressed a positive response toward the product.

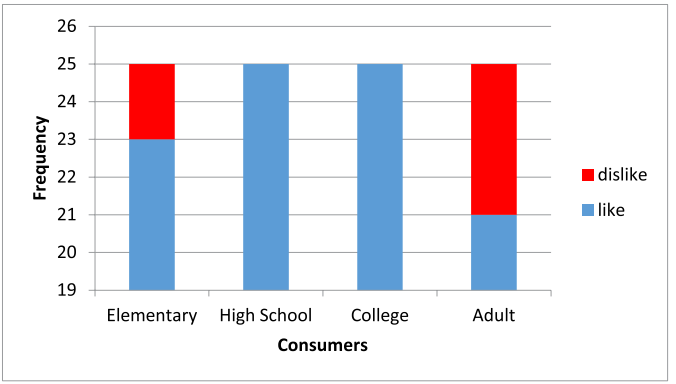

Figure 9. Graphical interpretation of consumer preference towards the optimum formulation

Figure 10 shows consumer response towards T_9. 16% of respondents from each category of consumers disliked the product although most of them liked it. The frequent reason mentioned for disliking is the distinct malunggay flavor in the product.

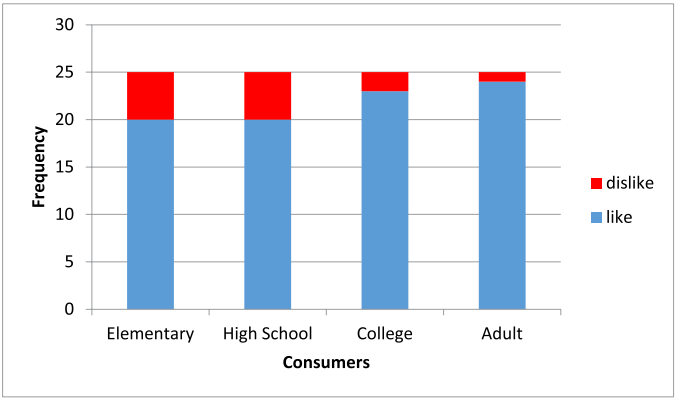

Figure 10. Graphical presentation of consumer preference on Treatment 9

Figure 11 shows the consumer preference towards the products. Consumers who preferred T_9 over the optimum formulation reasoned that it has higher nutritive value, assessed from the darker green color of the product. Reasons

for not choosing T_9 is due to its distinct malunggay flavor. Of the 43% who preferred T_9, 17 of them are adults while of the 57% who favored the optimum formulation only 8 are adults. More adults preferred Treatment 9 despite the distinctive malunggay flavor. Preference is because adults are more conscious of the nutrient value of the product despite its flavor. Most of the respondents who preferred the optimum formulation belong to the younger category.

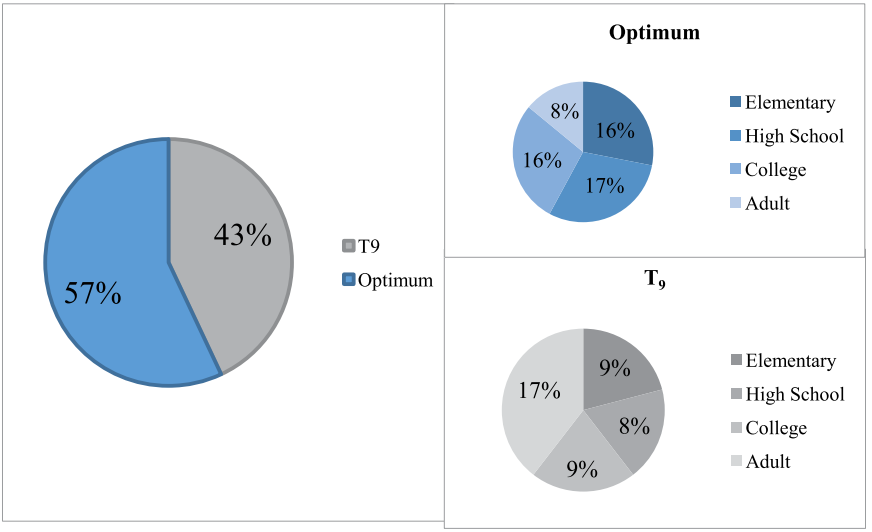

Figure 11. Consumer preference on the optimum formulation and on Treatment 9

Production Cost

Table 12 shows the cost of producing 1.5-liter probiotic malunggay ice cream. The total production cost is Php 151.75. This price is found to be lower than that of the existing market price of commercial ice cream which costs about Php 225.00 per 1.5-L. The addition of the probiotic culture has contributed to the increase in production cost of the probiotic malunggay ice cream. Considering the health benefits people can get from the probiotic malunggay ice cream, it is not difficult to promote the product since consumers nowadays are already health conscious.

Table 12. Production cost for probiotic malunggay ice cream

Ingredients	Quantity	Price/ Unit Cost	Amount Php
Fresh Milk	1 L	60.00 Php/1 L	60.00
Malunggay	20 g	10.00 Php/100 g	2.00
Probiotic Culture	380 g	80.00 Php/1000 g	30.50
Other Ingredients	-	20.00 Php	20.00
Electricity	0.5 Kwh	8.50 Php/Kwh	4.25
Labor	1 hr	200 Php/8hr	25.00
LPG	-	800 Php/tank	10.00
		Total	151.75

Around 57% of the 100 consumers chose the optimum probiotic malunggay ice cream, while 43% preferred T_9 which has 20% malunggay and 40% probiotic culture. The optimum product's processing cost was Php 151.75.

The study was limited only on the production and quality evaluation of probiotic malunggay ice cream as affected by the levels of malunggay at 0%, 10%, 20% w/v and probiotic culture at 0%, 20%, 40% w/v.

CONCLUSION

Sensory results revealed that high levels of malunggay have a significant effect on the acceptability as well as the description of the sensory attributes evaluated of the probiotic malunggay ice cream. The levels of probiotic culture and the interaction of both formulation variables do not have any significant effect on the sensory attributes of the ice cream.

An increase in the levels of probiotic culture corresponds to the increase in pH and TA of the ice cream, while an increase in the levels of malunggay lowers the TSS of the probiotic malunggay ice cream.

Based on microscopic examination, the morphology and the gram reaction of the bacteria used as starter culture were the same as that found in the product. The stability and development of Lactic Acid Bacteria gradually decline during the frozen storage of the probiotic malunggay ice cream.

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