

Development of Calamansi (*Citrofortunella Microcarpa*) Gummy Candy

Jessamie E. Antipolo, Melissa V. Bandong, Kathly Cariño, Angela S. Espinosa, Mariella P. Ramos,
Nathalie M. Velasco, Lai M. Niella

Pangasinan State University, Lingayen Campus, Lingayen, Pangasinan, Philippines

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Abstract - This study aimed to develop and evaluate Calamansi Gummy Candy, focusing on consumer acceptability, recipe formulation optimization, and microbial safety. The research addresses the growing interest in innovative confectionery products by utilizing the distinct flavor profile of calamansi. An experimental and quantitative research design was employed, collecting numerical data from a purposive sample of 53 respondents—comprising first- and second-year Bachelor of Technology and Livelihood Education (BTLED) students majoring in Home Economics at Pangasinan State University, Lingayen Campus—who were selected for their background and experience in food-related fields. Frequency counts and percentage distribution were used to analyze the respondents' demographic profiles, while the weighted mean determined the level of acceptability across four product treatments. To assess significant differences in sensory acceptability, Analysis of Variance (ANOVA) with Scheffé Post Hoc Test was utilized. A structured survey questionnaire served as the primary data-gathering tool, capturing the respondents' demographic data (age, sex, and year level) and their evaluation of the Calamansi Gummy Candy's sensory attributes—namely aroma, taste, texture, and overall acceptability—using a 5-point Hedonic Scale. Statistical analysis revealed significant differences in the respondents' acceptability ratings among the four formulations, particularly in terms of texture, aroma, taste, and overall appeal. Notably, "Treatment 2" emerged as the most preferred formulation. In addition, microbial analysis confirmed that the Calamansi Gummy Candy met safety and quality standards, indicating its suitability for consumption. Based on these findings, the study recommends the inclusion of "appearance" as an additional criterion in future sensory evaluations. It also suggests involving a more diverse group of respondents from varying age groups and disciplines to obtain broader insights. Furthermore, researchers are encouraged to explore techniques to minimize the natural bitterness of calamansi and to conduct further studies on the product's physicochemical properties and shelf life for potential commercial viability.

Keywords – Acceptability, Calamansi (*Citrofortunella Microcarpa*), Development, Gummy Candy, Sensory Evaluation

INTRODUCTION

The development of Calamansi (*Citrofortunella microcarpa*) gummy candy represents a valuable contribution to food innovation and functional confectionery.

Calamansi, a citrus fruit native to the Philippines, is widely recognized for its distinct

sour flavor and numerous health benefits, and is often utilized in traditional remedies. Gummy candies, known for their soft, chewy texture, are typically made from gelatin and sugar, making them an ideal base for incorporating natural fruit ingredients. This study aims to explore the potential of calamansi as a key component in

creating a unique, health-oriented gummy product that merges traditional flavors with modern snacking preferences.

The global gummy market has experienced growth at 13.9% CAGR during the historical period from 2018 to 2022. In the forecast period, sales will likely accelerate at 11.8% CAGR. Gummy market evaluation reached US\$ 21.4 billion in the base year 2022. The global gummy market is anticipated to experience growth due to rising demand for different tastes and textures in edible gummies during the forecast period. Consumers increasingly seek diverse flavor options, including exotic and unique tastes, tropical fruits, spices, and savory flavors. (Future Market Insight Inc)

In recent years, there has been a rising demand for functional foods that enhance health and well-being. These growing consumers interest has significantly influenced the confectionery market. Manufacturers are now incorporating new ingredients into their products to meet the needs of health-conscious consumers. Gummy popular among all age groups, serve as an excellent medium for these functional ingredients. Traditionally, gummy is made with sugar, water, and gelatin, which provides a desirable texture and clarity (Heliyon, 2024).

Gummy are composed of gelatin, sweeteners, flavorings, and colorings (Food and Agriculture Organization of the United Nations, 2018). Due to their flexible nature, gummies can be molded into various shapes, with companies like AVEREST offering over 150 different shapes (AVEREST, n.d.). This versatility makes gummies one of the most adaptable confectionery products. Recipes for gummy are created by skilled food technologists and chemists who blend various ingredients to control the candy's texture, flavor, and appearance. Gelatin, a protein derived from animal tissue, is crucial to its chewy consistency, creating thick gels when mixed with water.

Calamansi, also known as golden limes, is an extremely sour citrus fruit scientifically classified as *Citrofortunella microcarpa*. Indigenous to the Philippines, it is one of the country's major fruit crops, cultivated and exported widely (PSA, 2017a). Despite its tartness, many people regularly consume calamansi juice due to its numerous health advantages, which include boosting the immune system, alleviating stomach acidity, aiding weight loss, promoting skin health, detoxifying the body, lowering cholesterol, managing diabetes, and treating respiratory issues (Dr. A.A Khan, 2023).

Candy alternatively called sweets or lollies, is a confection that features sugar as a principal ingredient. The category, also called sugar confectionery, encompasses any sweet confection, including chocolate, chewing gum, and sugar candy. Vegetables, fruits, or nuts that has been glazed and coated with sugar are referred to as candied.

Sensory evaluation involves using our senses—taste, smell, touch, and sight—to assess food acceptability of food. It ensures that food is enjoyable in appearance, aroma, and flavor, thereby contributing to a better quality of life. This is particularly important for individuals on puréed diets due to swallowing difficulties, as taste and aroma become even more critical given the changes in texture and visual appeal (Jamila R. Lepore and Wendy J. Dahl, 2024).

The creation and taste testing of Calamansi Gummy offers an interesting way to combine traditional flavors with modern snack trends. By adding Calamansi, a popular fruit in the Philippines, to Gummy the goal is to see how well consumers like the taste, smell, texture, and overall experience of the Calamansi Gummy.

Exploring the development and sensory evaluation of Calamansi Gummy Candy is essential in creating a product that caters to health-conscious consumers while introducing a unique option in the functional gummy market. This study supports the creation of nutritious,

locally inspired snacks that combine health benefits with enjoyable taste, in line with modern dietary preferences.

OBJECTIVES OF THE STUDY

The primary aim of this study is to develop and evaluate Calamansi (*Citrofortunella microcarpa*) Gummy Candy. Specifically, it seeks to address the following research questions through sensory evaluation and product testing.

1. What is the standardized recipe in developing Calamansi Gummy Candy?

2. What is the level of consumer acceptability of the calamansi gummy candy products based on the following sensory attributes?

- a. Aroma
- b. Taste
- c. Texture/consistency
- d. Overall Acceptability

3. Is there a significant difference in consumer acceptability of the calamansi gummy candy products in terms of the following sensory attributes:

- a. Aroma
- b. Taste
- c. Texture/consistency
- d. Overall Acceptability

4. What is the result of microbial analysis of the Calamansi Gummy Candy?

MATERIALS AND METHOD

For our methodology, we adopted an experimental and quantitative design, involving 53 purposively selected BTLEd – Home Economics students from PSU–Lingayen Campus as our sensory panelists. We developed three formulations with increasing calamansi

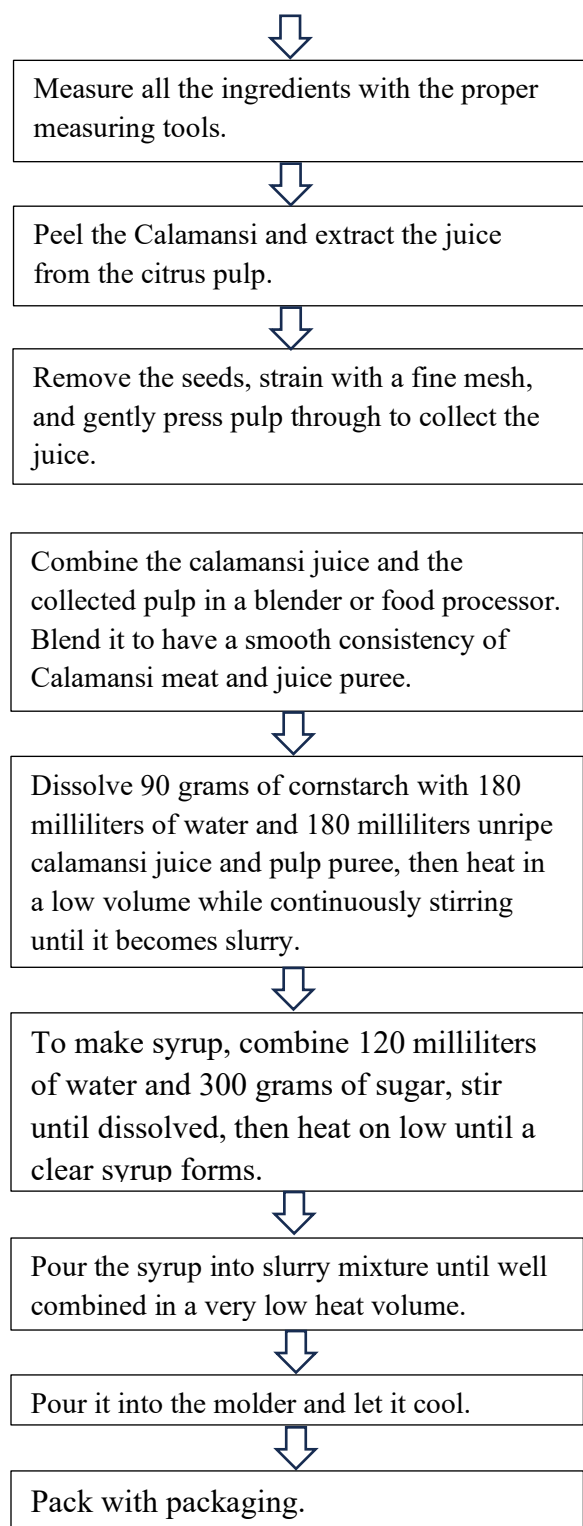
concentrations, and used a 5-point Hedonic Scale to evaluate:

- Aroma
- Taste
- Texture
- Overall Acceptability.

The three treatments and precise measurements of ingredients utilized in the development of Calamansi Gummy Candy.

Treatment 1	Treatment 1	Treatment 1
180 ml unripe calamansi juice and pulp puree	180 ml unripe calamansi juice and pulp puree	180 ml unripe calamansi juice and pulp puree
180 ml water	180 ml water	180 ml water
90g cornstarch	90g cornstarch	90g cornstarch
Syrup: 120 ml of water and 300 g of sugar		

Procedure of Calamansi Gummy Candy



Prepare all the necessary ingredients needed includes water, sugar, cornstarch, and Calamansi.

The gathered demographic data were summarized using frequency and percentage formulas to provide a clear overview of the respondents involved in the formulation process. The level of consumer acceptability of the Calamansi Gummy Candy based on the following sensory attributes—(a) texture/consistency, (b) aroma, (c) taste, and (d) overall acceptability—the researchers calculated the frequency counts, average weighted mean, and standard deviation. Significant difference in consumer acceptability of the Calamansi Gummy Candy products regarding the following sensory attributes—(a) texture/consistency, (b) [next attribute]—the researchers conducted statistical analysis to determine variations in sensory ratings among treatments. Microbial analysis of the Calamansi Gummy Candy, the researchers submitted samples of the treatments to the Regional Standards and Testing Laboratory for evaluation. The results obtained from the testing center were used to assess whether the treatments met acceptable food safety standards and were suitable for consumption.

RESULTS AND DISCUSSION

Demographic Profile of Calamansi Gummy Candy Target Consumer

A majority of the target consumers belong to the 18–21 age group, indicating that the product appeals mainly to early-college students. In terms of sex, females make up 67.9% (36 individuals) of the target consumers, while males account for 32.1% (17 individuals)—suggesting a stronger interest in the product among female students. Academically, the target consumers are composed of 1st-year BTLED students (I-BTLED) who represent 58.5% (31 individuals), and 2nd-year BTLED students (II-

BTLED) making up the remaining 41.5% (22 individuals).

Profile	Categories	Frequency	Percent
Age	18-19 years old	29	54.7%
	20-21 years old	24	45.3%
	22 years old and above	0	0.0%
Sex	Male	17	32.1%
	Female	36	67.9%
Year Level & Section	1st year	31	58.5%
	2nd year	22	41.5%

Level of Acceptability of the Calamansi Gummy Candy Products

Calamansi Gummy Candy on Aroma

Treatm ent	EL	ML	NL/ DL	MD	ED	SD	Mean
	5	4	3	2	1		
	18	12	7	3	13		
Treatm ent 0	34.0%	22.6%	13.2%	5.7%	24.5%	1.594	3.36
	3	11	26	5	8		
Treatm ent 1	5.7%	20.8%	49.1%	9.4%	15.1%	1.071	2.92
	14	20	15	4	0		
Treatm ent 2	26.4%	37.7%	28.3%	7.5%	0.0%	.914	3.83
	6	10	23	6	8		
Treatm ent 3	11.3%	18.9%	43.4%	11.3%	15.1%	1.177	3.00

Legend: 4.51-5.00 Extremely Liked (EL); 3.51-4.50 Moderately Liked (ML); 2.51-3.50 Never Liked/Disliked (NL/D); 1.51-2.50 Moderately Disliked (MD); 1.00-1.50 Extremely Disliked (ED)

Calamansi Gummy Candy on Taste

Treatm ent	EL	ML	NL/ D	MD	ED	SD	Mean
	5	4	3	2	1		
	22	13	3	4	11		
Treatm ent 0	41.5%	24.5%	5.7%	7.5%	20.8%	1.586	3.58
	3	6	22	14	8		
Treatm ent 1	5.7%	11.3%	41.5%	26.4%	15.1%	1.055	2.66
	14	17	16	5	1		
Treatm ent 2	26.4%	32.1%	30.2%	9.4%	1.9%	1.026	3.72
	2	19	13	14	5		
Treatm ent 3	3.8%	35.8%	24.5%	26.4%	9.4%	1.083	2.98

Legend: 4.51-5.00 Extremely Liked (EL); 3.51-4.50 Moderately Liked (ML); 2.51-3.50 Never Liked/Disliked (NL/D); 1.51-2.50 Moderately Disliked (MD); 1.00-1.50 Extremely Disliked (ED)

Calamansi Gummy Candy on Texture/Consistency

Treatm ent	EL	ML	NL/ DL	MD	ED	SD	Mean
	5	4	3	2	1		
	22	10	6	9	6		
Treatm ent 0	41.5%	18.9%	11.3%	17.0%	11.3%	1.457	3.62
	4	6	21	13	9		
Treatm ent 1	7.5%	11.3%	39.6%	24.5%	17.0%	1.123	2.68
	19	14	10	10	0		
Treatm ent 2	35.8%	26.4%	18.9%	18.9%	0.0%	1.133	3.79
	3	7	15	14	14		
Treatm ent 3	5.7%	13.2%	28.3%	26.4%	26.4%	1.186	2.45

Legend: 4.51-5.00 *Extremely Liked (EL)*; 3.51-4.50 *Moderately Liked (ML)*; 2.51-3.50 *Never Liked/Disliked (NL/D)*; 1.51-2.50 *Moderately Disliked (MD)*; 1.00-1.50 *Extremely Disliked (ED)*

Overall Acceptability

Treatment	EL	ML	NL/DL	MD	ED	SD	Mean
	5	4	3	2	1		
	17	10	3	3	20		
Treatment 0	32.1%	18.9%	5.7%	5.7%	37.7%	1.759	3.02
	1	13	23	8	8		
Treatment 1	1.9%	24.5%	43.4%	15.1%	15.1%	1.033	2.83
	18	20	9	6	0		
Treatment 2	34.0%	37.7%	17.0%	11.3%	0.0%	.989	3.94
	2	13	13	11	14		
Treatment 3	3.8%	24.5%	24.5%	20.8%	26.4%	1.232	2.58
	17	10	3	3	20		
Treatment 0	32.1%	18.9%	5.7%	5.7%	37.7%	1.759	3.02
	1	13	23	8	8		
Treatment 1	1.9%	24.5%	43.4%	15.1%	15.1%	1.033	2.83
	18	20	9	6	0		
Treatment 2	34.0%	37.7%	17.0%	11.3%	0.0%	.989	3.94
	2	13	13	11	14		
Treatment 3	3.8%	24.5%	24.5%	20.8%	26.4%	1.232	2.58

Legend: 4.51-5.00 *Extremely Liked (EL)*; 3.51-4.50 *Moderately Liked (ML)*; 2.51-3.50 *Never Liked/Disliked (NL/D)*; 1.51-2.50 *Moderately Disliked (MD)*; 1.00-1.50 *Extremely Disliked (ED)*

Significant Difference in Consumer Acceptability of the Calamansi Gummy Candy Treatments

Aroma Comparison of Calamansi Gummy Candy

		Sum of Squares	df	Mean Square	F	Sig.
Treatment	Between Groups	27.222	3	9.074	6.141	.001
Aroma	Within Groups	307.358	20	1.478		
	Total	334.580	21			

* The ANOVA significance level (p-value) at the 0.05 level.

Post Hoc test: Scheffe

Dependent Variable	(I) Treatment	(J) Treatment	(I-J) Mean Difference	Sig.
Aroma	Treatment 0	Treatment 1	.434	.340
		Treatment 2	-.472	.266
		Treatment 3	.356	.513
	Treatment 1	Treatment 2	-.906*	.003
		Treatment 3	-.075	.992
	Treatment 2	Treatment 3	.830*	.007

* The mean difference is significant at the 0.05 level

Taste Comparison of Calamansi Gummy Candy

		Sum of Squares	df	Mean Square	F	Sig.
Treatment Taste	Between Groups	71.184	3	23.728	15.626	.000
	Within Groups	315.849	208	1.519		
	Total	387.033	211			

* The ANOVA significance level (p-value) at the 0.05 level.

Post Hoc Test: Scheffe

Dependent Variable	(I) Treatment	(J) Treatment	(I-J) Mean Difference	Sig.
Taste	Treatment 0	Treatment 1	.943*	.002
		Treatment 2	-.169	.918
		Treatment 3	1.169*	.000
	Treatment 1	Treatment 2	-1.113*	.000
		Treatment 3	0.226	.827
	Treatment 2	Treatment 3	1.339*	.000

* The mean difference is significant at the 0.05 level

Texture/Consistency Comparison of Calamansi Gummy Candy

		Sum of Squares	df	Mean Square	F	Sig.
Treatment Texture	Between Groups	39.717	3	13.239	9.044	.000

Within Groups	304.491	208	1.464
Total	344.208	211	

* The ANOVA significance level (p-value) at the 0.05 level.

Post Hoc Test: Scheffe

		Sum of Squares	df	Mean Square	F	Sig.
Treatment Overall Acceptability	Between Groups	55.962	3	18.654	11.209	.000
	Within Groups	346.151	208	1.664		
	Total	402.113	211			

Dependent Variable	(I) Treat ment	(J) Treat ment	(I-J) Mean Differen ce	Sig.
Treatment Texture	Treat ment 0	Treatm ent 1	.924*	.002
		Treatm ent 2	-0.132	.957
		Treatm ent 3	0.604	.089
	Treat ment 1	Treatm ent 2	-1.056*	.000
		Treatm ent 3	-0.321	.602
		Treatm ent 0	0.132	.957
	Treat ment 2	Treatm ent 3	.736*	.022

* The mean difference is significant at the 0.05 level.

Comparison of Overall Acceptability of Calamansi Gummy Candy

Dependent Variable	(I) Treatment	(J) Treatment	(I-J) Mean Difference	Sig.
overall	Treatment 0	Treatment 1	.189	.904
		Treatment 2	-.924*	.004
		Treatment 3	.434	.394
	Treatment 1	Treatment 2	-1.113*	.000
		Treatment 3	.245	.811
	Treatment 2	Treatment 3	1.359*	.000

* The mean difference is significant at the 0.05 level.

The aroma ratings of the Calamansi Gummy Candy, indicate varied target consumer's preferences across the four treatments. Treatment 2 emerged as the most favorable in terms of aroma, achieving the highest mean score of 3.83, which falls within the Moderately Liked (ML) range. A majority of target consumers (64.1%) rated it as either Extremely Liked (26.4%) or Moderately Liked (37.7%), and notably, no target consumer rated it as Extremely Disliked. This suggests a strong, positive reception for this treatment's aroma. The taste ratings of the Calamansi Gummy Candy, reflect clear distinctions in target consumer's preferences across the four treatments based on the hedonic scale. Treatment 2 received the highest mean score of 3.79, placing it in the Moderately Liked (ML) range. These findings align with the results of Halim et al. (2020)

highlighted that a 0:1 water-to-calamansi juice ratio produced the best flavor, emphasizing the role of juice concentration and hydrocolloids in sensory appeal. This supports the current study's finding that Treatment 2's balanced calamansi extract and gelling agents enhanced taste acceptability. Treatment 2 received the highest mean score of 3.72, falling within the Moderately Liked (ML) range, indicating a generally favorable perception of its texture. These findings align with the study by Pangerapan et al. (2016), which emphasized the importance of sugar composition—specifically the balance between sucrose and glucose in determining the organoleptic qualities of calamansi-based candy. In their study, the most favored treatment was also a middle-ratio blend (60% sucrose and 40% glucose), noted for having a rather hard texture that contributed to its sensory acceptability. Similarly, the favorable texture score of Treatment 2 in the current study may suggest a comparable optimal formulation that balanced firmness without being too tough or sticky. Treatment 2 demonstrably achieved the highest level of target consumers' preference. It garnered the highest mean score of 3.94 and the lowest standard deviation of 0.989, signifying a strong and consistent positive reception. This result aligns with the study conducted by Teixeira-Lemos et al. (2021), who developed healthy gummy jellies using natural fruit extracts. Their work revealed that even health-oriented formulations could gain consumer acceptance, as long as they retained desirable sensory attributes like flavor, texture, and color. This aligns with the present study's observation that Treatment 2 achieved high acceptability even without artificial additives, possibly due to the natural tang and aroma of calamansi, reinforcing its potential for use in functional, natural gummy products.

Microbial Analysis

Microbial	Test Method	Result	Standard Limit (if	Interpretation
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Parameter			applicable)	
Aerobic Plate Count	3M Petrifilm, AOAC Method	<250 CFU/g	$\leq 10^5$ CFU/g (general limit)	Within safe limits; low microbial load
Total Coliform Count	Pour Plate Method (MPN)	<3.0 MPN/g	<10 MPN/g (FDA PH)	Absence indicates proper sanitation
Yeast and Mold Count	3M Petrifilm, AOAC Method	<10 CFU/g	<100 CFU/g (typical limit)	No fungal growth detected

Based on the results of microbial analysis it indicates that the Calamansi Gummy Candy is microbiologically safe and meets standard requirements for ready-to-eat confectionery. The aerobic plate count was significantly lower than the typical limit of 10^5 CFU/g, reflecting good hygienic conditions during production and packaging. The absence of coliform bacteria (<3.0 MPN/g) indicates effective sanitation, with no fecal contamination detected. Moreover, yeast and mold counts were below detectable levels (<10 CFU/g), suggesting the product has good resistance to fungal spoilage, which is crucial for shelf stability. These findings support the safety and quality of the formulated product at the time of testing.

CONCLUSION AND RECOMMENDATION

Based on the results and discussions, the researchers successfully developed a standardized recipe for Calamansi Gummy Candy that integrates a locally abundant citrus fruit into a functional and appealing confectionery product. Sensory evaluation results revealed that one particular formulation (Treatment 2) was significantly preferred in terms of

texture, aroma, taste, and overall acceptability, reflecting its alignment with consumer preferences. The demographic profile of the target consumers—primarily female BTLED students aged 18–21—provided valuable insights into the acceptability and market potential of the product. Statistical analysis confirmed significant differences among treatments, highlighting the importance of ingredient composition in achieving favorable sensory characteristics. Additionally, microbial testing validated the product's safety for consumption, showing compliance with acceptable microbial standards. Overall, the study demonstrates that calamansi can be effectively utilized in gummy candy production, offering a nutritious and safe alternative to commercially available sweets. The findings contribute to food innovation using local ingredients and open opportunities for further research in shelf-life extension, large-scale production, and consumer preference across broader demographics.

It is recommended that further refinement of the formulation be explored, particularly in minimizing the natural bitterness of calamansi through appropriate techniques or balancing agents. This could enhance the palatability of the product while maintaining its nutritional benefits. To improve overall sensory appeal, appearance should be included as an additional sensory parameter in future evaluations. This will allow researchers to address color uniformity and visual presentation—factors that strongly influence consumer preference. Broader consumer testing is encouraged by including participants from various age groups, food-related majors, and faculty members. This will provide more diverse and comprehensive insights into product acceptability, supporting more inclusive product development. Given the observed significant differences across treatments in terms of sensory attributes, it is recommended that future formulations focus on optimizing the most preferred treatment while addressing the shortcomings of the lower-rated variants. Enhancing consistency in ingredient quality and precise measurement may also help reduce variability in product performance. To ensure extended shelf life and consistent safety, future studies should investigate the physicochemical properties of the gummy candy. This includes detailed analysis of vitamin content, pH levels,

moisture content, texture stability, and the potential use of natural preservatives. These efforts will help maintain product quality over time and support commercial viability.

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