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Physico-Chemical Characteristics of Squash (Cucurbita Maxima) Jelly De Leche

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Abstract: This study aimed to develop and evaluate jelly de leche from squash (*Cucurbita moschata*) fibrous strands, focusing on sensory acceptability, proximate composition, and mineral content. One hundred (100) adult consumers from Lagonoy, Camarines Sur, assessed the product using a 9-point hedonic scale for appearance, aroma, texture, flavor, and overall acceptability. Results indicated that all treatments were well-received, with Treatment 3 achieving the highest overall liking score of 8.24 ("like very much"), suggesting that squash fibrous strands can be effectively used to produce an acceptable jelly de leche. Proximate analysis showed a moisture content of 68.90%, carbohydrates at 25.42%, fat at 3.03%, protein at 2.08%, and ash at 0.57%, indicating a carbohydrate-rich, low-fat, and low-protein product. Mineral analysis revealed appreciable levels of potassium (227 mg/100 g), sodium (73 mg/100 g), and calcium (42 mg/100 g), enhancing the nutritional value of the jelly. The high moisture content indicates potential susceptibility to microbial spoilage, highlighting the need for proper packaging and shelf-life evaluation. Overall, the study demonstrates that squash fibrous strands, a common by-product, can be transformed into a nutritious, consumer-acceptable, and value-added product, contributing to the efficient utilization of agricultural resources and promoting innovation in functional foods. These findings provide a basis for further product development and commercialization of squash-based jellies.

Keywords*: Jelly De Leche, Characteristics, Physico-Chemical, Squash.*

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I. INTRODUCTION

Squash (*Cucurbita* spp.) is a widely cultivated agricultural crop recognized for its nutritional value, versatility, and adaptability to various culinary and food processing applications. Native to the Americas, squash is now grown in many parts of the world and is an important source of vitamins A and C, niacin, riboflavin, and iron. Its wide diversity in color, texture, and form further enhances its appeal and usability in both fresh and processed food products (New World Encyclopedia,2008 [1]. Despite these advantages, squash is still primarily utilized as a cooked vegetable, and its potential for processed and value-added products remains underexplored.

Food preservation through jelly production has long been practiced as a means of extending shelf life, improving product stability, and reducing postharvest losses. Jelly making depends on the interaction of fruit juice, sugar, acid, and pectin to produce a clear and stable gel with desirable sensory characteristics (Cruess, 1958; Day, 1962) [2]. Standards established by the United States Department of Agriculture emphasize proper formulation and soluble solids concenation to ensure quality and safety of jelly products (Smith, 2003) [3]. Traditionally, jelly production has focused on fruits with natural pectin content, while alternative plant materials are rarely utilized.

Given the increasing demand for innovative and resource-efficient food products, there is a growing need to explore non-traditional raw materials for jelly production. Squash fibrous strands, which are often discarded during preparation, represent a potential source of functional components suitable for jelly processing. This study, therefore, aims to develop **jelly de leche from squash fibrous strands,** demonstrating the feasibility of transforming squash into a value-added product and expanding its utilization beyond conventional vegetable consumption.

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II. MATERIAL AND METHODS

A. Research Procedures

The study employed developmental, experimental, descriptive–evaluative, and descriptive–analytical research methods. A new food product, jelly de leche, was developed using a combination of squash fibrous strands, Nestlé cream, condensed milk, eggs, sugar, "gulaman" powder, vanilla, and water.

Five treatments with varying formulations of squash and other ingredients were prepared and tested to determine the most desirable and preferred proportion of ingredients (Table 1). Each Jelly de Leche formulation was poured into jelly molders, properly packaged, labeled, and tightly sealed.

The sensory attributes of the developed Jelly de Leche products were then evaluated. The specific formulations for each treatment are presented in Table 1.

Table 1. Formulation of developing Squash Jelly de Leche

Ingredients	**T1**	**T2**	**T3**	**T4**	**T5**
Squash Fibrous Strands(g)	500	500	500	500	500
Nestle Cream(g)	300	280	260	240	220
Condensed Milk(g)	240	240	240	240	240
Eggs(g)	300	300	250	250	250
Sugar(g)	250	220	200	180	160
Gulaman Powder(g)	25	25	25	25	25
Vanilla(g)	8.4	8.4	8.4	8.4	8.4
Water (g)	120	120	120	120	120

B. Preparation of the Squash for jelly de leche.

The squash seeds were separated from the fibrous strands and thoroughly drained. The jelly (gulaman in local name) was dissolved in water and heated until completely melted. All ingredients were accurately measured, combined, and blended using a mechanical blender to obtain a homogeneous mixture.

The blended mixture was then cooked over low heat until properly set. After cooking, the Jelly de Leche was poured into jelly molders, properly packaged, labeled, and tightly sealed to prevent contamination.

The prepared products were subjected to sensory evaluation. Selected samples were also submitted to the Department of Science and Technology for chemical analysis and nutritional fact determination.

C. Sensory evaluation.

The finished product underwent sensory evaluation by 100 consumer-panelists to determine its acceptability in terms of appearance, texture, flavor, and aroma. A descriptive–analytical method was employed to describe the nature and characteristics of the product by examining its individual components. The five (5) formulations were subjected to a preference test using a 9-point hedonic scale (1 = dislike extremely, 5 = neither like nor dislike, and 9 = like extremely). The formulation with the highest overall acceptability score was selected as the most preferred and was further evaluated for its sensory attributes, namely appearance, aroma, texture, flavor, and overall acceptability.

D. Proximate and Nutritional Analysis.

The most preferred Jelly de Leche squash formulation was submitted to the Department of Science and Technology V for proximate and nutritional analysis. The analysis was conducted following the official methods of the **Association of Official Analytical Chemists (AOAC)**.

The proximate analysis included the determination of **moisture, crude protein, crude fat, crude fiber, and ash content**. Mineral analysis was performed to quantify essential minerals such as **calcium, phosphorus, and iron**, using standard AOAC procedures. Nutritional composition, including **carbohydrates and energy content**, was calculated based on proximate results. All analyses were performed in triplicate to ensure accuracy and reliability of the results.

E. Statistical Analysis.

Sensory evaluation data obtained from the 9-point hedonic scale were analyzed using analysis of variance (ANOVA) to determine significant differences among the five Jelly de Leche formulations in terms of appearance, aroma, texture, flavor, and overall acceptability. Statistical significance was set at $p < 0.05$. When significant differences were observed, appropriate post hoc comparisons were employed to identify differences among treatment means.

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II. RESULT AND DISCUSSION

A. Consumer Acceptance Test of the Developed Squash Jelly De Leche

One hundred (100) participants residing in Lagonoy, Camarines Sur were recruited for the consumer evaluation based on the following criteria: respondents were between 18 and 60 years old, regular consumers of jelly de leche, and health conscious. The sensory evaluation instrument consisted of a product acceptability test and a purchase intent questionnaire for the developed squash-based jelly de leche. Each respondent was served a 50 g sample on a platter.

Consumer evaluation focused on appearance, aroma, texture, flavor, and overall acceptability, using a 9-point hedonic scale, where 9 indicated "like extremely" and 1 indicated "dislike extremely," following the method of Peryam and Pilgrim (1957) [4].

As shown in Table 2, only Treatment 4 was rated as "like slightly," while the other treatments were rated from "like very much" to "like extremely." The influence of squash fibrous strands on consumer liking scores for appearance, flavor, texture, aroma, and overall acceptability at different ingredient levels is presented in Table 2. The highest liking score for appearance was obtained by Treatment 1 (7.99). For flavor and texture, Treatment 3 recorded the highest scores, with mean values of 8.15 and 8.10, respectively. The highest liking score for aroma was observed in Treatment 1 (7.96), closely followed by Treatment 3 (7.93).

In terms of overall acceptability, Treatment 3 achieved the highest mean score of 8.24, which corresponds to the descriptive rating "like very much." These results indicate that squash fibrous strands have strong potential as a raw material for jelly de leche production, yielding a product that is highly acceptable to consumers across multiple sensory attributes.

Table 2. Mean Scores on the Results of Sensory Evaluation of 5 Treatments of Squash Jelly de Leche

	Treatments									
Attributes	**T1**	**D**	**T2**	**D**	**T3**	**D**	**T4**	**D**	**T5**	**D**
Appearance	7.99	LVM	7.77	LVM	7.93	LVM	6.15	LS	7.84	LVM
Flavor	7.81	LVM	7.96	LVM	8.15	LVM	5.68	LS	6.06	LS
Texture	7.9	LVM	7.92	LVM	8.1	LVM	5.7	LS	6.11	LS
Aroma	7.96	LVM	7.25	LM	7.93	LVM	5.72	LS	7.07	LM
General Acceptability	7.69	LVM	7.96	LVM	8.24	LVM	6.72	LM	7.19	LM

Legend: LVM-Like Very Much, LE Like Extremely, LM- Like Moderately, LS- Like Slightly D-Description

The results of the present product development are consistent with the findings of Akter et al. (2019) [5] in their study on the development of squash jelly. Their sensory evaluation results showed mean scores of 7.5 for taste, 7.2 for texture, and 8.0 for color, indicating a high level of consumer acceptability. Similarly, the developed jelly de leche from squash fibrous strands in the present study obtained favorable sensory ratings across major attributes. These comparable results suggest that squash fibrous strands can be effectively utilized as a raw material for jelly de leche production, yielding a product that is acceptable to consumers.

A. Significant Difference on the Sensory Attributes of of Jelly de Leche squash

The results of the sensory evaluation were subjected to **Analysis of Variance (ANOVA)** using the **F-test** at a five percent (5%) level of significance ($\alpha = 0.05$). This statistical procedure was employed to determine whether significant differences existed among the treatments in terms of sensory attributes, including appearance, aroma, texture, flavor, and overall acceptability. The computed F-values were compared with the critical F-value at the 0.05 level of significance to test the null hypothesis of no significant difference among treatments. The results of the F-test for the sensory attributes of the bottled squash jelly de leche are presented in Table 3.

As reflected in Table 3, the p-values for all sensory attributes were greater than the 0.05 level of significance ($p > 0.05$); therefore, the null hypothesis was accepted. This indicates that there were no significant differences among the treatments in terms of appearance, aroma, texture, flavor, and overall acceptability. The result implies that jelly de leche made from squash fibrous strands can be processed using different ingredient formulations without significantly affecting consumer acceptability. Overall, the squash fibrous strand jellies de leche was found to be acceptable to consumers.

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Table 3. Results of Analysis of Variance (ANOVA) on the Different Sensory Attributes of Squash Jelly de Leche

Attributes	*F*	*P-value*	Decision
Appearance	55.12525	1.9438	Not Significant
Flavor	102.2553	2.2263	Not Significant
0Texture	99.16496	6.1162	Not Significant
Odor	68.25961	5.3946	Not Significant
G. acceptability	45.03088	2.9432	Not Significant

Despite the favorable acceptability results, it is recommended that the product be subjected to shelf-life analysis, as storage duration may influence the keeping quality, physicochemical properties, and sensory attributes of the jelly de leche. Changes during storage could potentially affect aroma, texture, flavor, and appearance, which are critical factors in consumer acceptance.

The sensory qualities of the squash fibrous strand jelly de leche—namely aroma, flavor, texture, and appearance—were observed to strongly influence overall acceptability. However, statistical analysis revealed no significant difference ($p > 0.05$) among treatments with respect to overall acceptability. The mean overall acceptability scores for Treatments 1 to 5 were 7.69, 7.96, 8.24, 6.72, and 7.19, respectively. These values correspond to a descriptive rating of “like very much” to “like extremely” for all treatments except Treatment 4, which received a comparatively lower but still acceptable rating.

The findings of the present study differ from those reported by Bajwa et al. (2002) [6], who observed a decline in overall acceptability of grape and apple marmalade from 8.80 to 7.96 during storage. Similarly, Bajwa et al. (2003) [7] reported decreasing trends in overall acceptability scores of fruit jam from 9.00 to 7.00 over storage time. In contrast, the present study focused on initial product acceptability, and the consistently high sensory scores across treatments suggest that squash fibrous strands are a promising raw material for jelly de leche production prior to storage evaluation.

B. Proximate Chemical Analysis of Squash (Cucurbita maxima) Jelly de Leche

Proximate analysis is an essential method for determining the basic chemical composition of food products, providing quantitative information on moisture, ash, lipid, protein, and carbohydrate contents. These parameters are critical in assessing the nutritional value, quality, and stability of food products. Proximate composition data are widely used in food product development, quality control, labeling, and regulatory compliance, as they allow comparison of newly developed products with existing food standards and similar products reported in the literature (Association of Official Analytical Chemists, 2005) [8].

Furthermore, proximate analysis aids in classifying food materials and evaluating their suitability for processing and storage. Knowledge of moisture and lipid contents, for example, is particularly important in predicting shelf life and susceptibility to spoilage, while protein and carbohydrate contents contribute to the overall nutritional and functional properties of food products (James, 1995) [9]. Thus, proximate analysis serves as a fundamental tool in food science research and product evaluation.

Table 4. Comparison of Proximate Chemical Analysis of Squash Jelly de Leche

Parameters	Squash Jelly de Leche In Glass Jar	Method Used
Ash %	.57	TM-CHE-001 with reference to AOAC 900.02A, 21ST Ed.
Total Fat %	3.03	TM-CHE-001 with reference to AOAC 900.02A, 21ST Ed.
*Protein %	2.08	TM-CHE-001 with reference to AOAC 900.02A, 21ST Ed.
Moisture %	68.90	TM-CHE-001 with reference to AOAC 900.02A, 21ST Ed.
**Carbohydrates %	25.42	Computation by different
**Energy	137	Computation

Legend: *Protein Factor =5.5 **Test not within the scope of accreditation

According to Enneb et al. (2020) [10], squash (*Cucurbita moschata*) is widely utilized in healthy diets and traditional medicine in many countries due to its nutritional value and the presence of bioactive compounds in its seeds and fruits. These nutritional and functional properties make squash a suitable raw material for the development of value-added food products.

The results of the proximate analysis of the composite squash fibrous strand jelly de leche are presented in Table 4. The moisture content of the product was found to be 68.90%. This relatively high moisture content may be attributed to the boiling temperature, processing conditions, and variation in ingredient formulation used during jelly preparation. High moisture levels in jelly products are critical because they may increase susceptibility to microbial growth and consequently affect shelf life and product stability.

The present findings are not consistent with the results reported by Bajwa et al. (2003) [11], who observed a

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decreasing trend in moisture content in grape and apple marmalade during storage. Similarly, Anjum et al. (2000) [12] reported a reduction in moisture content from 79% to 77% after 60 days of storage in dried apricot jam. In contrast, the moisture content reported in the present study reflects the initial proximate composition of freshly prepared squash fibrous strand jelly de leche, further supporting the need for shelf-life evaluation to monitor changes in moisture and overall product quality during storage.

Ash content provides an overall estimate of the total mineral content present in a food sample, reflecting the presence of essential elements that play key roles in biochemical reactions and support major physiological and metabolic processes in the body (Ashaye & Adeleke, 2009) [13]. The ash content of the squash fibrous strand jellies de leche was found to be 0.57%, which is relatively low. This lower value may be attributed to the proportion of squash fibrous strands used in the formulation, as variations in ingredient ratios can influence the total mineral content of the final product. Despite its low value, the ash content indicates that the jelly contributes modestly to the mineral intake of consume

The fat content of the squash fibrous strand jellies de leche was measured at 3.03%, which is considered low. Similarly, the protein content was found to be 2.08%, also relatively low. These results indicate that the jelly is not a significant source of protein. In comparison, the protein content of prickly pear pulp jam has been reported to range from 7.02% to 8.51%, which is considerably higher than that of the squash-based jelly (Atef et al., 2013) [14].

In contrast, the carbohydrate content of the jelly was high, recorded at 25.42%. This can be attributed to the natural carbohydrate content of the squash fibrous strands and the added jelly powder. The finding is consistent with studies on jams and jellies produced from blends of pineapple, watermelon, and apple, where carbohydrate levels were similarly elevated (Augstburger et al., 2000) [15]. The high carbohydrate content in the squash jelly de leche is largely due to the sucrose added during preparation, which significantly contributes to the total carbohydrate content. Additionally, ingredients such as dates contain nearly half of their sugar in the form of fructose, along with dietary fibers and other nutrients, which may also influence the carbohydrate composition of the final product (Ali et al., 2009) [16].

The moisture content of the squash fibrous strand jellies de leche was recorded at 68.90%. According to Chakriya et al. (2021) [17], a relatively low moisture content in fermented vegetable products (below 60%) indicates a longer shelf life. Therefore, since the moisture content of the jelly de leche is close to 70%, the product is prone to microbial spoilage, particularly if not properly packaged or stored. The high moisture content may be attributed to the addition of brine and sugar during jelly preparation, as well as potential decomposition by fermenting microorganisms. This observation is consistent with the findings of Oboh & Akinndahunsi (2003) [18] in their study on the fermentation of melon seeds, where increased moisture was linked to microbial activity.

In addition, the jelly de leche exhibited a high carbohydrate content, which is nutritionally important because carbohydrates provide glucose, the primary energy source for supporting bodily functions and physical activity. However, excessive consumption of refined, simple, or low-quality carbohydrates can negatively affect physical and mental health and has been associated with the development of many chronic diseases prevalent in the 21st century (Bigueja, M. C., 2019) [19]. Thus, while the carbohydrate content contributes to the energy value and taste of the product, it also emphasizes the importance of moderation and careful formulation in product development.

D. Mineral Composition of Squash (Cucurbita maxima) Jelly de Leche

The mineral composition of the squash fibrous strand jellies de leche is presented in Table 5. Minerals play a crucial role in maintaining proper physiological functions and overall health. Inadequate dietary intake of essential minerals has been associated with increased susceptibility to infectious diseases due to weakened immunity. Plants, animal foods, and drinking water are primary sources of these essential elements (Chaturvedi, Shrivastava & Upreti, 2004) [20].

Table 5. Comparison of the Mineral composition of Squash of Jelly de Leche

Parameters	**Squash Jelly de Leche**	**Method Used**
Sodium, mg/100g	73	TM-CHE-049 with reference to Agilent 4200 MP-AES Method
Potassium, mg/100g	227	TM-CHE-049 with reference to Agilent 4200 MP-AES Method
Calcium, mg/100g	42	TM-CHE-049 with reference to Agilent 4200 MP-AES Method
Iron, mg/100g	.59	TM-CHE-049 with reference to Agilent 4200 MP-AES Method
Zinc, mg/100g	.56	TM-CHE-049 with reference to Agilent 4200 MP-AES Method
*Crude fiber	.35	TM-CHE-001 with reference to AOAC 978.10, 21ST Ed.
*PH	7.08	TM-CHE-001 with reference to AOAC 981.12, 21ST Ed.

*Test not within the scope of accreditation

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The jelly de leche developed in this study was enriched with potassium, calcium, and sodium. The highest potassium content was observed at 227 mg/100 g, while sodium and calcium contents were 73 mg/100 g and 42 mg/100 g, respectively. For healthy adults, the recommended dietary allowance (RDA) for sodium is 1,500–2,400 mg/day, and for potassium, 4,700 mg/day (USDA, 2005) [21]. The sodium content of fruits and vegetables can vary depending on soil composition, with black soils often containing higher amounts of sodium (Qureshi et al., 2000; Sajib et al., 2014) [22,23].

Calcium is a fundamental mineral for bone health, playing a key role in bone mineralization, structural formation, and maintenance of skeletal rigidity (Cobayashi, F., 2004; FAO/WHO Joint Expert Committee on Food Additives, 1998) [24,25]. Dietary calcium absorption depends on the balance between intake, absorption, and excretion (Branca, F., 2001) [26]. The presence of these minerals in the squash fibrous strand jelly de leche contributes to its nutritional value and supports its potential role as a functional food ingredient.

Additionally, high potassium and moderate sodium contents can help maintain electrolyte balance and support cardiovascular health, while adequate calcium intake is essential for long-term skeletal integrity (Bigueja, M. C., 2019) [19].

III. CONCLUSION

The squash fibrous strand jellies de leche was well-received by consumers, with most treatments rated from “like very much” to “like extremely” in terms of appearance, aroma, texture, flavor, and overall acceptability. Treatment 3 obtained the highest overall acceptability score (8.24), indicating that the formulation was most preferred. There were no statistically significant differences among treatments ($p > 0.05$), suggesting that variations in the ingredient levels did not negatively affect consumer acceptability.

The developed jelly de leche had a high moisture content (68.90%) and carbohydrate content (25.42%), with low levels of fat (3.03%) and protein (2.08%), and a low ash content (0.57%). These results indicate that the product is a carbohydrate-rich, low-fat, and low-protein food product. The jelly de leche contained appreciable amounts of essential minerals, including potassium (227 mg/100 g), sodium (73 mg/100 g), and calcium (42 mg/100 g), contributing to its nutritional value and functional benefits.

The study demonstrated that squash fibrous strands are a viable raw material for producing jelly de leche. They contribute to the product’s sensory acceptability and nutritional composition while offering a potential way to utilize squash by-products

The relatively high moisture content indicates that the product may be prone to microbial spoilage if not properly processed, packaged, or stored. This underscores the importance of evaluating shelf-life stability in future studies.

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