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Article

Evaluation of Sensory Attributes of Soft Candy Using Taro Leaf Extract as Influenced by Variations of Gelatin and Glucose Syrup

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ABSTRACT

Although taro is widely grown in Indonesia, it is one of the underutilized crops which is a good source of nutrition. one part of taro that is rarely utilized is the leaves. The objective of this research is to determine the effect of glucose syrup and gelatin concentrations on the organoleptic properties (preference for color, taste, and texture) of soft candy made from taro leaf extract. The method used in this research is experimental which is arranged in a Completely Randomized Factorial Design (CRD) with two factors, which are The concentrations of are (25%, 35%, 45%) and the concentrations of gelatin are (20%, 25%, 30%). Each treatment being repeated three times. The obtained data were analyzed using ANOVA (analysis of variance), and Duncan's test was conducted if significant differences were obtained. The results shows that soft candy with 35% glucose syrup and 25% gelatin had the highest preference for color. The formulation with 35% glucose syrup and 30% gelatin was most preferred for aroma. The formulation with 45% glucose syrup and 30% gelatin received the highest scores for texture (3.90±0.308) and flavor (3.95±0.63). This research demonstrates that optimizing glucose syrup and gelatin concentrations in soft candies made from underutilized taro leaf extract can significantly enhance specific sensory attributes like texture and flavor. This study can contribute in providing valuable insights for future product development and highlighting the potential of taro leaves as a valuable food ingredient.

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1. INTRODUCTION

Soft candy, particularly jelly candy, is a popular type of confectionery favored for its distinctive characteristics. Based on Market Watch report The jelly candies (gummies) market, projected to grow by USD 1.31 billion at a CAGR of 3.29% from 2023 to 2028. Jelly candy is a type of soft candy made from fruit juice and gelling agents, known for its clear and transparent appearance, specific texture, and chewiness (Afriyanto et al., 2016; Rahmawati & Adi, 2017) Various methods can be employed to produce soft candy, with modifications aimed at achieving the best possible characteristics. Jelly candy's texture is enhanced by adding hydrocolloids such as agar, gum, pectin, starch, carrageenan, and gelatin (Soedirga & Marchellin, 2022). Soft candies made from fruits or vegetables offer nutritional benefits compared to those available in the market, which often contain synthetic flavors and sweeteners. Therefore, this study incorporates taro leaf extract to enhance the nutritional value of the resulting soft candy (Ferdaus et al., 2023; Roudbari et al., 2024).

Taro, or taro bogor (*Colocasia esculenta*), is a tuber-producing plant widely cultivated, especially in western Indonesia. Cooked taro leaves are rich in calories, carbohydrates, protein, fat, fiber, vitamins C and A (Temesgen, 2015; Mariam, 2018). Taro leaves are reported to contain 11 -23% protein on a dry weight basis (Aditika et al., 2022; Patel & Singh, 2023). However, the utilization of taro leaves is limited, as most people primarily consume the tuber. Taro tubers have been utilized as raw material for the manufacture of maltodextrin which is a food additive (Sao et al., 2019). In addition, starch from taro is also used in making liquid sugar (Hartiati & Tuningrat, 2020). In addition, taro is also used as a raw material for making various kinds of food, such as noodles, brownies, pudding, etc. (Bohari et al., 2022; Nurhidayanti et al., 2023; Skawanti & Kusumawardhani, 2020). However, the leaves from taro are often underutilized. In Indonesia, taro leaves are used as dishes like buntil, which are not widely popular (Iskandar et al., 2023). Given the significant nutritional content of taro leaves, including a protein content of 23% dry weight and high levels of essential minerals and vitamins, as well as known antibacterial effects, high content of phenolic compounds, there is potential for developing taro leaf-based products that are more appealing to consumers (Aditika et al., 2022; Pranata et al., 2021; Ramayani et al., 2021). Despite the rich nutritional profile and potential health benefits of taro leaves (Pranata et al., 2021; Ramayani et al., 2021), their utilization remains limited compared to the tuber, which is extensively used in various food products. This gap highlights the need for innovative approaches to incorporate taro leaves into mainstream food products, capitalizing on their high protein content and bioactive compounds. To address this gap, one promising avenue is the development of taro leaf extract as a raw material to produce soft candy.

Soft candies are popular confections but contain high-sugar and low-functional ingredients (Pan et al., 2022). Although the production of soft candy using by-products has been previously explored (Altınok et al., 2020), the utilization of taro leaves never been done. The use of glucose syrup and gelatin ratios in several studies has shown an impact on the characteristics of the resulting candy products. Tireki et al. (2021) in their research stated that a glucose syrup to sucrose ratio of 1:1 combined with 6% gelatin produced the best candy texture. Similarly, Nelwan et al. (2016) found that the optimal jelly candy formulation was achieved with a gelatin concentration of 20% and 60% glucose syrup. This involves controlling sugar crystallization conditions and adjusting the ratios of sugar to glucose syrup and sugar to water (Efe & Dawson, 2022). The addition of gelling agents, such as gelatin, is critical in jelly candy production to create a chewy and tender texture. The concentration of gelatin is a key factor; insufficient gelatin will not form a gel, while excessive gelatin results in a rigid texture (Alipal et al., 2019; Nisa et al., 2021).

The bitter taste inherent in taro leaf extracts has limited their incorporation into food products despite their high nutritional value and ease of cultivation, highlighting the need to understand consumer acceptance when added to food products. Based on the above considerations, it is crucial to explore methods to enhance the use of taro leaves (*Colocasia esculenta* (L.) Schott). This research aims to utilize taro leaves as a raw material for soft candy production, investigating the impact of varying concentrations of glucose syrup and gelatin on the organoleptic properties of the taro leaf extract soft candy. Combining scientific knowledge and artistry is essential to modify the properties of sugars and gelling agent as the primary ingredient in candy, to achieve the desired textural effects. Therefore, this study focuses on the effects of varying glucose syrup and gelatin concentrations on the organoleptic properties of taro leaf extract soft candy. This study can contribute to providing valuable insights for future product development and highlighting the potential of taro leaves as a valuable food ingredient.

2. MATERIALS DAN METHOD

2.1. Materials

The materials used in this study included taro leaves, glucose syrup (Selma, Indonesia), sucrose (Gulaku, Indonesia), bovine gelatin (Hakiki, Indonesia), citric acid (Cap Gajah, Indonesia), and mineral water (Le mineral, Indonesia). The equipment utilized comprised a balance scale, blender, sieve, measuring cup, thermometer, and molds.

2.2. Methods

This study employed a factorial completely randomized design (CRD) with two factors, each treatment being repeated three times. Factor A was the concentration of glucose syrup, and Factor B was the concentration of gelatin. The levels for glucose syrup concentration were 25%, 35%, and 45%, while the levels for gelatin concentration were 20%, 25%, and 30%.

2.3. Preparation of Taro Leaf Extract

The taro leaves were washed with clean water to remove surface dirt and separated from the stems. The leaves were then weighed to 100 grams. The cleaned taro leaves were cut into small pieces and blended until smooth. The blended taro leaves were then boiled for 10-15 minutes.

2.4. Preparation of taro leaf extract soft candy

All ingredients were weighed according to the formulation. The taro leaf extract, sucrose, and glucose syrup (25g, 35g, and 45g) were mixed and heated while stirring continuously. Gelatin (20g, 25g, 30g) was dissolved in 50 mL of warm water at 65°C in separate containers. Once the sugar mixture was dissolved, the gelatin solutions were added according to the treatment. The mixture was then reheated to 85°C for approximately 10 minutes until thickened, then removed from heat. The hot candy mixture was poured into molds (17 x 25 cm) with a thickness of 2.5 cm and left to set at room temperature for approximately 2 hours. The set candy was then refrigerated for 24 hours. After refrigeration, the candy was allowed to sit at room temperature for 1 hour before being cut into desired shapes.

2.5. Organoleptic Testing Using Hedonic Method

The organoleptic test using the hedonic method involves evaluating preferences and acceptance using 20 untrained panelist. Panelists rated their likes and dislikes of the presented product using a scale from 1 to 5. Twenty panelists conducted the organoleptic test, assessing parameters such as taste, color, aroma, and texture using a questionnaire. The ratings were based on a 5-point scale: (1) Strongly dislike, (2) Dislike, (3) Neutral, (4) Like, and (5) Strongly like.

2.6. Data Analysis

The data obtained from the experiment were analyzed using Analysis of Variance (ANOVA) to determine any significant differences among the treatments. When significant differences were found, further analysis was conducted using Duncan's Multiple Range Test to pinpoint specific differences between treatment means. The statistical analyses were performed using the software SPSS.

3. RESULTS AND DISCUSSION

3.1. Organoleptic Texture

This study found that, the texture most favored by panelists was achieved with a glucose syrup concentration of 45% and a gelatin concentration of 30%, resulting in a soft candy that balanced chewiness and sweetness well, significantly enhancing its overall organoleptic appeal, as indicated in Table 1. ANOVA results showed a significant effect ($p<0.05$) of glucose syrup and gelatin concentrations on texture preference. Higher concentrations of glucose syrup and gelatin resulted in sweeter and chewier taro leaf extract soft candy. The high gelatin content provided a robust gel structure, ensuring the candy had a consistent and appealing texture. Additionally, the substantial glucose syrup concentration contributed to the sweetness (Nelwan et al., 2016), which was well-received by the panelists.

Table 1. Average scores for texture preference test of soft candy

Glucose (%)	Gelatin (%)			Averages
	20	25	30	
25	2.60 ± 0.503	3.10 ± 0.308	3.25 ± 0.444	2.98 ± 0.504[a]
35	2.90 ± 0.308	2.95 ± 0.394	3.35 ± 0.489	3.07 ± 0.446[a]
45	3.45 ± 0.510	3.55 ± 0.510	3.90 ± 0.308	3.63 ± 0.48[b]
Averages	2.98 ± 0.567[a]	3.20 ± .0480[b]	3.50 ± 0.504[c]	

Note: Values marked with different letters in the same column indicate significant differences (P<0.05) between treatments

The least preferred combination, with an average score of 2.60, was found at a glucose syrup concentration of 25% and a gelatin concentration of 20%. This lower preference can be attributed to the insufficient gelatin, which failed to create the desired chewy texture, and the lower glucose syrup content, which resulted in a less sweet product. The texture was likely too soft and not as cohesive, which diminished its appeal to the panelists (DeMars & Ziegler, 2001; Jiamjariyatam, 2018). Gelatin functions as a gelling agent with excellent gel strength, and the sweetness is imparted by glucose syrup. The unique texture of jelly candy is largely determined by the gel structure formed due to the optimal combination of pectin, gelatin, sugar, and acid (Avallone et al., 2022; Nurwantoro et al., 2022; Sari et al., 2022). Gelatin and sucrose work together to form a good gel by leveraging their unique properties. Gelatin, when dissolved in hot water and then cooled, forms a three-dimensional network that traps water and creates a gel. Sucrose, added for sweetness, increases the viscosity and reduces water activity, enhancing the firmness and stability of the gel (Avallone et al., 2022; Dash et al., 2013). The analysis also revealed that the higher the concentrations of glucose syrup and gelatin, the more favorable the candy's texture became. This outcome aligns with previous findings that indicate the critical role of gelatin as a gelling agent, which provides the necessary chewiness and structural integrity to soft candies. Moreover, glucose syrup acts as a humectan, maintaining moisture and preventing the candy from becoming too hard over time. The interplay between these two components is essential in crafting a product that meets consumer expectations for both taste and texture (Jiamjariyatam, 2018; Kurt et al., 2022)

3.2. *Organoleptic color*

The results of this study indicate that, the most preferred color by panelists was observed with an average score of 3.05 at a glucose syrup concentration of 35% and a gelatin concentration of 25% as shown in Table 2. This combination resulted in a visually appealing color that resonated well with the panelists. In contrast, the least preferred color combination, with an average score of 2.70, was found at a glucose syrup concentration of 45% and a gelatin concentration of 30%.

Table 2. Average scores for color preference test of soft candy

Glucose (%)	Gelatin (%)			Averages
	20	25	30	
25	2.75 ± 0.444	2.85 ± 0.366	2.90 ± 0.308	2.83 ± 0.376[a]
35	2.95 ± 0.224	3.05 ± 0.224	2.85 ± 0.489	2.95 ± 0.341[a]
45	2.85 ± 0.366	2.95 ± 0.394	2.70 ± 0.657	2.83 ± 0.493[a]
Averages	2.85 ± 0.360[a]	2.95 ± 0.341[a]	2.82 ± 0.504[a]	

Note: Values marked with different letters in the same column indicate significant differences (P<0.05) between treatments

ANOVA results indicated no significant (p>0.05) effect of glucose syrup and gelatin concentrations on color preference. Panelists generally disliked this darker, potentially less appetizing color, influenced by the higher glucose syrup content. This might because the color intensity of the candy, some studies found that color intensity significantly affects sweetness perception, with darker colored solutions perceived as sweeter than lighter ones, so this perception of color intensity and taste may not be as desirable to the panelists (Johnson & Clydesdale, 2006).

The dark green color of the soft candy, intensified with increased gelatin powder, occasionally led to a yellowish hue due to the gelatin's addition. Gelatin and sucrose generally do not impart color to jelly candy on their own. Gelatin is typically colorless or slightly yellow, while sucrose is colorless when dissolved in water (Nelwan et al., 2015). However, they can influence the final appearance of the candy. Gelatin's transparency can enhance the vibrancy of added food colors or natural fruit juices, while sucrose's interaction with heating processes can affect the candy's overall clarity and potentially contribute to mild caramelization, which might impart a slight golden hue. Overall, their roles primarily affect the transparency and perception of added colors rather than directly contributing color themselves (Avallone et al., 2022). This color change might have negatively affected the candy's appeal, as discussed by (Chalchisa et al., 2022; Nuh et al., 2020), who suggested that higher sugar levels could diminish color appeal. Therefore, the least favored color preference by panelists was associated with the highest glucose syrup concentration.

3.3. Organoleptic Aroma

This research provides evidence that, the preferred aroma among panelists was highest in the 35% glucose and 30% gelatin treatment, scoring an average of 3.15 as shown in Table 3. This blend utilized a 35% glucose syrup concentration and 30% gelatin, resulting in a pleasing aroma likely enriched by the balanced essence of taro leaf extract and other additives. Conversely, the least favored aroma, averaging 2.85, was found in the 35% glucose and 20% gelatin treatment, where the glucose syrup concentration was 35% and gelatin was 20%. Statistical analysis indicated that variations in glucose syrup and gelatin concentrations did not significantly impact aroma preference. This lower rating suggests that the aroma may have been less distinctive or less appealing to the panelists.

Table 3. Average scores for aroma preference test of soft candy

Glucose (%)	Gelatin (%)			Averages
	20	25	30	
25	2.86 ± 0.366	2.90 ± 0.308	2.95 ± 0.394	2.90 ± 0.354[a]
35	2.85 ± 0.366	3.10 ± 0.447	3.15 ± 0.587	3.03 ± 0.486[a]
45	3.05 ± 0.224	2.90 ± 0.308	3.00 ± 0.459	2.98 ± 0.344[a]
Averages	2.92 ± 0.334[a]	2.97 ± 0.367[a]	3.03 ± 0.486[a]	

Note: Values marked with different letters in the same column indicate significant differences (P<0.05) between treatments

The aroma of the soft candy exhibited a distinct taro leaf fragrance, which was subtly integrated and generally well-received across the different experimental conditions. This aroma was primarily influenced by the addition of taro leaf extract, with minimal discernible effects from the differing glucose syrup and gelatin ratios. Food aromas play a pivotal role in stimulating olfactory senses and enhancing appetite, influenced by the formation of volatile compounds through enzymatic or chemical processes. The findings of this study support previous research by Wulandari (2015) who found that the value of aroma parameters was quite low for soft candy products enriched with leaf extracts.

3.4. Organoleptic Flavor

This study found that it is evident that the flavor preference for the soft candy formulations varied significantly with different concentrations of glucose syrup and gelatin. The highest average score, 3.95, was observed for the formulation with a 45% glucose syrup and 30% gelatin ratio as seen in Table 4. This indicates a marked preference for this specific combination, likely due to the optimal balance of sweetness and chewiness provided by the high glucose syrup concentration and moderate gelatin content. Conversely, the least preferred formulation had an average score of 2.45, which corresponded to a 25% glucose syrup and 20% gelatin ratio. The analysis of variance (ANOVA) results confirmed a significant difference ($p<0.05$) between the treatments, underscoring the critical role of glucose syrup and gelatin concentrations in determining flavor preference. The lower preference for this formulation could be attributed to insufficient sweetness and an inadequate chewy texture, which failed to meet the panelists' expectations.

Table 4. Average scores for aroma preference test of soft candy

Glucose (%)	Gelatin (%)			Averages
	20	25	30	
25	2.45 ± 0.510	2.75 ± 0.444	3.10 ± 0.308	2.77 ± 0.500[a]
35	2.85 ± 0.366	2.95 ± 0.224	3.25 ± .550	3.02 ± 0.431[b]
45	3.35 ± 0.489	3.60 ± 0.681	3.95 ± 0.63	3.14 ± 0.650[c]
Averages	2.88 ± 0.585[a]	3.10 ± 0.602[b]	3.43 ± 0.647[c]	

Note: Values marked with different letters in the same column indicate significant differences ($P<0.05$) between treatments

The significant differences between treatments suggest that the concentration of these ingredients directly impacts the organoleptic properties of the soft candy, influencing the overall sensory experience. In addition to the basic flavor components, the soft candy also contained taro leaf extract, citric acid, and sucrose. These additional ingredients were incorporated to mask the slightly bitter taste of the taro leaf, with citric acid providing a tangy balance and sucrose enhancing the overall sweetness. According to Nuh et al. (2020), an increased sugar content positively correlates with higher organoleptic scores for flavor, which supports the findings of this study. The findings highlight that for optimal consumer satisfaction, a higher concentration of glucose syrup combined with a moderate amount of gelatin is preferable. This combination not only enhances the sweetness but also ensures a desirable chewy texture, crucial for the acceptance of soft candies (Rivero et al., 2021). The results of this study are significant for the development of soft candy recipes, providing a scientific basis for ingredient optimization to achieve maximum flavor preference among consumers.

4. CONCLUSIONS

The hedonic test results for texture, color, aroma, and flavor preferences in soft candy showed generally neutral preferences. These results underscore the critical role of optimizing glucose syrup and gelatin concentrations to enhance specific sensory attributes of soft candies. The significant impact on texture and flavor highlights the necessity for precise formulation adjustments to satisfy consumer preferences. In contrast, the lack of significant differences in aroma and color preferences indicates these attributes are less sensitive to variations in glucose syrup and gelatin concentrations. Further research is needed to investigate the interaction between different ingredients and their collective impact on the sensory profile of soft candies. This study provides foundational insights into how ingredient proportions influence sensory attributes, offering valuable guidance for developing soft candy products that meet consumer preferences. this research provides foundational knowledge that can inform the development of innovative soft candy products tailored to consumer preferences and market demands.

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6. DECLARATIONS

Author Contributions

All authors contributed equally as major contributors to this paper. All authors read and approved the final paper.

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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