

Effects of Corn Silk Extract on Marshmallow Properties: Chemical and Physical Analysis

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ABSTRACT

Marshmallows are soft candies produced using gelling agents such as gelatin, pectin, or starch, and typically contain 12-20% water. Previous research has explored the incorporation of natural antioxidants into marshmallows, identifying corn silk as a particularly promising ingredient due to its high antioxidant content. This study investigates the impact of corn silk extract (*Zea mays* L.) on the physical and chemical properties of marshmallows. Employing a Completely Randomized Design (CRD) with five treatments and four replications, the study varied the concentration of corn silk extract (10%, 20%, 30%, 40%, and 50%). The variables measured included water, ash, vitamin C, tannin, antioxidant activity, texture, and color. The results showed that corn silk extract variation had a significant effect ($p < 0.05$) on the chemical and physical properties of marshmallows including water, ash, sucrose, vitamin C, tannin, and antioxidant activity, texture and color. The best treatment was P5 (50% corn silk extract) with a vitamin C content of 62.87%, tannin 1.96%, antioxidant activity 55.8%, texture 136.16%, L color 65.48, a* color 6.42, and b* color 19.42. This study demonstrates the potential of adding corn silk extract to marshmallows to enhance their nutritional value and functional properties. The findings of this research can serve as a valuable reference for the development of healthier and more nutritious marshmallow products.

Keywords: corn silk, chemical, extract, marshmallow, physical

I. INTRODUCTION

Marshmallow is a soft candy distinguished by its light, airy, and chewy texture, akin to foam. Typically made with a gelling agent like gelatin, pectin, or starch and containing roughly 12% to 20% water, it comes in various shapes, aromas, flavors, and colors. Known for its sucrose and liquid glucose content which imparts a moderately sweet taste (Bayline, 2018), marshmallows have also been the subject of studies exploring the incorporation of antioxidant-rich natural ingredients to enhance their nutritional value.

Corn silk, a low-cost and abundant byproduct of *Zea mays* is a natural ingredient abundant in antioxidants that has received significant attention in recent scientific literature. Notwithstanding its potential applications, the utilization of corn silk waste by

the community remains suboptimal (Haslina et al., 2022). Specifically, corn silk exhibits a total phenolic content ranging from 4813 µg/g to 9346.22 µg/g and demonstrates RSA-DPPH antioxidant activity between 53.03% and 83.57% (Haslina et al., 2022). The presence of saccharide-flavonoid complexes within corn silk suggests its suitability as an ingredient for marshmallows, as the saccharide component can contribute to a desirable soft and chewy texture (Guo et al., 2018). The proportion of natural ingredients employed in marshmallow production varies considerably, with reported values ranging from 84-90% (Jacob et al., 2023), 50-80% (Ginting et al., 2014), 54-58% (Evandani et al., 2018), and 25% (Sari et al., 2020). In the present study, corn silk extract will be utilized at a concentration of 58% of the total formulation. The quantity of gelatin employed will be determined based on the optimal treatment reported by Sari et al. (2020), constituting 6.25% relative to the corn silk extract. This investigation aims to examine the influence of corn silk extract and glucose syrup on the physical attributes and antioxidant capacity of marshmallows.

Research Background

Characterized by its soft, light, and chewy texture reminiscent of foam, marshmallow is a type of confectionery typically produced using a gelling agent such as gelatin, pectin, or starch, with a water content between 12% and 20%, marshmallows are available in a wide array of shapes, aromas, flavors, and colors. Their characteristic moderately sweet flavor arises from their sucrose and liquid glucose composition (Bayline, 2018). Current studies are increasingly focusing on fortifying the nutritional profile of marshmallows through the inclusion of natural, antioxidant-rich components. One such promising ingredient is corn silk, an abundant and low-cost byproduct of corn cultivation recognized for its antioxidant capabilities. Despite these properties, corn silk waste is not yet optimally utilized within the community (Haslina et al., 2022).

Corn silk exhibits a total phenolic content ranging from 4813 µg/g to 9346.22 µg/g and a DPPH radical scavenging activity (RSA-DPPH) of 53.03% to 83.57% (Haslina et al., 2022). This saccharide-flavonoid complex content makes corn silk highly suitable as a raw material for marshmallows, where the saccharide component contributes to a soft and chewy texture (Guo et al., 2018). The regulation regarding the use of natural ingredients in marshmallow production is not definitively established. Existing studies

report varying percentages of natural ingredients. such as 84% to 90% (Jacob et al., 2023), 50% to 80% (Ginting et al., 2014), 54% to 58% (Evandani et al., 2018), or 25% (Sari et al., 2020). In this study, the concentration of corn silk extract used is set at 58% of the total ingredients. The gelatin concentration is based on the optimal treatment identified in the study by Sari et al. (2020), which is 6.25% of the corn silk extract. Therefore, this research will investigate the effect of varying ratios of corn silk extract and glucose syrup on the physical properties and antioxidant activity of the resulting marshmallows.

II. MATERIALS AND METHODS

Materials and Tools

The materials used in this study included fresh super sweet corn (harvested at approximately 85 days) from Bandungan District. Semarang Regency, along with glucose syrup. edible gelatin. granulated sugar. and Rose Brand cornstarch.

The analytical tools employed were a Radwag AS 110.R2 plus analytical balance, weighing bottles (Pyrex), porcelain crucibles (Pyrex), funnels (Pyrex), boiling chips, erlenmeyer flasks (Pyrex), volumetric flasks, measuring cups (Pyrex), a furnace, an oven, a desiccator (As One 280K200), a reflux condenser (Pyrex), a heater, a cooling tank, a WR18 CIELAB Cielch Digital Colorimeter Ciexyz SRGB, a Brookfield CT3 Texture Analyzer, and a centrifuge.

Experimental Design

A Completely Randomized Design (CRD) was utilized in this study, with a single factor being the varying concentrations of corn silk extract. Each treatment was repeated four times, followed by the Duncan Multiple Range Test (DMRT) at a 5% significance level. The treatments were: P1 (10%), P2 (20%), P3 (30%), P4 (40%), and P5 (50%) corn silk extract.

Research Procedure

The marshmallow-making process commences with the creation of corn silk extract. which involves several crucial stages: sorting the corn silk to eliminate dirt and unwanted materials, weighing it according to the specified treatment to ensure accuracy and consistency, washing it under running water to remove any remaining impurities,

reducing its size to approximately ± 5 cm to enhance the surface area and efficiency of the subsequent process, brewing it with 400 g of water at a temperature of 50°C for 10 minutes to extract the desired components, and finally filtering it using filter paper to obtain a clean corn silk extract ready for use in marshmallow formulations.

To make the marshmallows: 50 g of corn silk extract was mixed with 20 g of gelatin and stirred until evenly combined, then left to sit for 5 minutes. Next, 45 g of sugar and 15 g of glucose syrup were cooked with an additional 50 g of corn silk extract at approximately 100°C for 5 minutes with continuous stirring. After that, the sugar and glucose syrup mixture was combined with the previously prepared gelatin solution and mixed using a mixer at medium speed for 5 minutes until a foam formed. The resulting marshmallow batter was then poured into a mold and refrigerated at around 5°C for 8 hours. Afterward, the marshmallows were cut into 2 x 2 cm pieces and coated with roasted cornstarch. Finally, the corn silk extract marshmallows were analyzed.

III. RESULT AND DISCUSSION

Water Content

Anggains (2025) There is a positive correlation between the increase in water content and the increase in the addition of corn silk. This means that the higher the proportion of corn silk addition to the marshmallow formulation, the higher the water content contained therein. This is because corn silk has a relatively high water content and hydrophilic properties that allow the absorption and binding of water and corn silk can also interact with other components in marshmallows such as sugar and gelatin, to form a complex structure.

Water content is a determinant of the shelf life of marshmallows and determines the water activity of marshmallows. The final water content of marshmallows depends on the heating and stirring process accompanied by the use of granulated sugar. The heating process accompanied by stirring will help the process of trapping water in gelatin and accelerate the process of water evaporation. The use of granulated sugar will absorb water molecules into fructose and glucose molecules,

The increase in water content along with the increase in the addition of corn silk was reported by Rizky et al. (2020), reporting that increasing the addition of corn silk

increases the water content. Singh et al. (2024), stated that increasing the addition of corn silk will increase the water content. This is due to the ability of corn silk to bind water content. It is stated that every 10% increase in the percentage of corn silk will increase the water absorption capacity by 0.1 g. The water content of marshmallows in this study has met the Quality Requirements for Jelly Candy SNI 3547-2-2008 which requires a maximum water content of 20%.

Ash Content

According to Anggaini (2025), It can be seen that the addition of corn silk extract to the P1 to P5 formulations caused a significant increase in the ash content of marshmallows. This is due to the natural mineral content contained in corn silk, such as potassium, magnesium, calcium, phosphorus, and iron. Ash content is a parameter that describes several important aspects in natural materials and processed products. Specifically, ash content can indicate the ability to absorb minerals in natural materials, such as corn silk, as well as the levels of impurities in the process of making food products, such as agar-agar, glucose syrup, and sucrose (granulated sugar), as well as the process of enriching (fortifying) minerals or other nutrients in products, such as sucrose (granulated sugar). Thus, ash content plays an important role in assessing product quality and safety, as well as in developing more balanced and nutritious products. It is known that P1 has the lowest ash content, due to the small amount of corn silk extract added to the manufacture of marshmallows, so that the mineral content of corn silk extract is relatively low. Patel et al., (2023), reported the ash content in corn silk of 3.74%. Meanwhile, Castillo et al., (2020), reported that the ash content in corn silk can reach 5.69%. The ash content of marshmallows in this study has met the Quality Requirements for Jelly Candy SNI 3547-2-2008 which requires a maximum ash content of 3%.

Sucrose Content

Anggaini (2025) It is known that the sucrose content of P1 to P5 decreased gradually, this is due to the instability of the reducing sugars contained in corn silk. Reducing sugar is a sugar component that is widely bound or becomes part of other molecules. In corn silk, the sugar component is part of the polysaccharide and is heavily bound to the saponin type flavonoid component, so it is unstable when heated, causing the sugar content to fluctuate. This is due to the chemical structure of the sugar and

flavonoids contained in corn silk. When heated, the chemical bonds between sugar and flavonoids can break, causing the sugar content to be unstable. Corn silk does not contain much sucrose, but rather monosaccharide sugars such as glucose and fructose, resulting in relatively low sucrose levels (Wen & Yue. 2015; and Patel et al. 2023). The sucrose content of marshmallows in this study has met the Quality Requirements for Jelly Candy SNI 3547-2-2008 which requires a minimum sucrose content of 27%.

Vitamin C

Variations in corn silk extract treatment significantly affected vitamin C content. as shown by analysis of variance (ANOVA) ($p < 0.05$). Duncan's Multiple Range Test (DMRT) at $p < 0.05$ further revealed significant differences between these treatments. The vitamin C analysis results are presented in Table 1.

Table 1. Average Vitamin C Corn Silk Extract Marshmallow

Treatment	Vitamin C (mg/g)
P1 (10%)	41.86±0.12 ^a
P2 (20%)	50.66±1.16 ^b
P3 (30%)	52.44±0.61 ^c
P4 (40%)	59.09±0.69 ^d
P5 (50%)	62.87±0.42 ^e

Note: Different lowercase superscripts in the same column indicate significant differences ($p < 0.05$) between treatments

A significant difference in vitamin C content between treatments is shown in Table 1. Specifically, the P5 treatment. with a 50% corn silk concentration, yielded the highest vitamin C content (62.87 mg/g). while the P1 treatment, containing only 10% corn silk, resulted in the lowest (41.86 mg/g). This observation highlights a positive correlation between corn silk concentration and vitamin C content, likely stemming from the inherent vitamin C present in corn silk. Therefore, the increase in corn silk concentration directly contributed to a higher vitamin C content in the marshmallows, a result that corroborates previous research by Zulfajri (2018).

Tannin

Analysis of variance (ANOVA) revealed that the different corn silk extract treatments had a significant effect on tannin content ($p < 0.05$). Subsequent analysis using Duncan's Multiple Range Test (DMRT) at a significance level of $p < 0.05$ demonstrated

significant differences between the treatments. The results of the tannin content analysis are presented in Table 2.

Table 2. Average Tannin Corn Silk Extract Marshmallow

Treatment	Tannin (%)
P1 (10%)	0.80±0.00 ^a
P2 (20%)	1.09±0.02 ^b
P3 (30%)	1.20±0.01 ^c
P4 (40%)	1.62±0.01 ^d
P5 (50%)	1.96 ±0.42 ^e

Note: Different lowercase superscripts in the same column indicate significant differences ($p < 0.05$) between treatments

Table 2 illustrates that tannin content varied significantly across the treatments. The highest tannin content (1.96%) was observed in treatment P5, which utilized a 50% corn silk extract concentration, while the lowest (0.80%) was found in treatment P1 with a 10% corn silk extract concentration. A positive correlation was observed between corn silk extract concentration and tannin content. This increase is due to the increasing concentration of corn silk use. This increasing trend causes the tannin content to increase according to the concentration given. Corn silk extract contains alkaloids, flavonoids, phenols, glycosides, tannins and saponins. This is in line with the results of research conducted by Jannah et al., (2018) which found that corn silk extract contains tannins and flavonoids.

Antioxidant Activity

The analysis of variance (ANOVA) revealed that variations in corn silk extract treatment significantly affected antioxidant activity ($p < 0.05$). Furthermore, Duncan's Multiple Range Test (DMRT) at a significance level of $p < 0.05$ indicated significant differences among the treatments. The results of the antioxidant activity analysis are presented in Table 3.

Table 3. Average Antioxidant Activity Corn Silk Extract Marshmallow

Treatment	Antioxidant Activity (%)
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P1 (10%)	39.05±0.11 ^a
P2 (20%)	43.72±1.00 ^b
P3 (30%)	48.42±0.56 ^c
P4 (40%)	52.42±0.61 ^d
P5 (50%)	55.80±0.37 ^e

Note: Different lowercase superscripts in the same column indicate significant differences ($p < 0.05$) between treatments

The data in Table 3 reveal a significant difference in antioxidant activity across the treatments. Notably, treatment P5. with the highest corn silk concentration (50%). displayed the peak antioxidant activity (55.80%), while treatment P1. containing the lowest corn silk concentration (10%). exhibited the minimum (39.05%). This suggests a positive correlation between corn silk concentration and antioxidant activity, likely stemming from the presence of beneficial compounds such as phenolic compounds. especially flavonoid, which are established antioxidants. Chemica Vo et al. (2021) underscore corn silk as a valuable, yet often overlooked, source of antioxidants. The antioxidants in marshmallows are obtained from the added corn silk extract.

Texture

Analysis of variance revealed a significant effect ($p < 0.05$) of corn silk extract variations on texture. Duncan's Multiple Range Test (DMRT) at $p < 0.05$ further indicated significant differences between treatments. The texture analysis results are presented in 4.

Table 4. Average Antioxidant Activity Corn Silk Extract Marshmallow

Treatment	Texture (gf)
P1 (10%)	240.43±28.01 ^b
P2 (20%)	194.30±26.92 ^{ab}
P3 (30%)	191.00 ±49.33 ^{ab}
P4 (40%)	179.94±46.78 ^a
P5 (50%)	136.16±27.12 ^a

Note: Different lowercase superscripts in the same column indicate significant differences ($p < 0.05$) between treatments

Table 4 reveals a statistically significant variation in marshmallow texture among the different treatments. Treatment P5. incorporating a 50% corn silk concentration. exhibited the lowest texture value (136.16). Conversely, treatment P1. with a 10% corn silk concentration. displayed the highest value (240.43). Furthermore, the data indicate a negative correlation between the concentration of corn silk and the chewiness of the marshmallow. as well as a negative correlation between the concentration of corn silk extract and its elasticity. This phenomenon could be due to the acidic components within the corn silk extract. potentially interfering with the thickener's ability to function effectively. thereby producing a softer texture (Irianto et al. 2020). That increasing the proportion of corn silk in jelly candy led to a softer texture. while a higher gelatin content resulted in a chewier texture.

Color

Analysis of variance revealed that variations in corn silk extract treatment significantly affected the color parameters L. a. and b ($p < 0.05$). Subsequent Duncan's Multiple Range Test (DMRT) at $p < 0.05$ indicated significant differences between treatments. The L values from the color analysis are presented in Table 5.

Table 5. Average Colors Corn Silk Marshmallow

Treatment	Warna L	Warna a*	Warna b*
P1 (10%)	70.34 $\pm$ 2.19 ^b	1.21 $\pm$ 0.36 ^a	8.37 $\pm$ 0.49 ^a
P2 (20%)	72.47 $\pm$ 2.48 ^b	2.51 $\pm$ 0.17 ^b	10.99 $\pm$ 0.49 ^b
P3 (30%)	69.84 $\pm$ 1.27 ^b	3.35 $\pm$ 0.19 ^c	13.00 $\pm$ 0.73 ^c
P4 (40%)	70.60 $\pm$ 0.85 ^b	4.06 $\pm$ 0.66 ^d	13.19 $\pm$ 1.58 ^c
P5 (50%)	65.48 $\pm$ 1.24 ^a	6.42 $\pm$ 0.53 ^e	19.41 $\pm$ 1.41 ^d

Note: Different lowercase superscripts in the same column indicate significant differences ($p < 0.05$) between treatments

Table 5 demonstrates that the L color value of marshmallow P5 is significantly different from those of P1. P2. P3. and P4. The L* color values were observed to range between 65.48 and 70.34. Furthermore. the a* color values ranged from 1.21 to 6.42. with a positive correlation observed between corn silk concentration and a* values. suggesting a tendency towards a reddish color. In parallel. the b* color values ranged from 8.37 to 19.41. with higher corn silk concentrations also leading to increased b* values. indicating a more yellowish color.

CONCLUSION

- a. Corn silk extract variation had a significant effect ($p < 0.05$) on the chemical properties of marshmallows. including water. ash. sucrose. vitamin C. tannin. and antioxidant activity. as well as the physical properties of texture and color (L. a*. and b*).
- b. Increasing the concentration of corn silk extract in marshmallows resulted in a decrease in texture chewiness. while water. ash. vitamin C. tannin. antioxidant activity. and color intensity increased.
- c. The best treatment was P5 (50% corn silk extract) with a vitamin C content of 62.87%. tannin 1.96%. antioxidant activity 55.8%. texture 136.16%. L color 65.48. a* color 6.42. and b* color 19.42

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