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**Submission date:** 06-Apr-2023 10:37AM (UTC+0700)
**Submission ID:** 2057216880
**File name:** 1_Charactertis_marsmalloww.pdf (255.89K)
**Word count:** 3541
**Character count:** 17752

2nd International Conference Eco-Innovation in Science, Engineering, and Technology
Volume 2021
http://dx.doi.org/10.11594/nstp.2021.1409

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# Characteristics of Marshmallow from a Mixture of Watermelon Albedo (*Citrullus vulgaris* Schard) and Rosella Flower (*Hibiscus sabdariffa*) Extract with The Addition of Gelatin

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**ABSTRACT**

Watermelon albedo is a food waste that still has nutrients that can be used. The presence of nutritional compounds causes watermelon albedo potential to be processed into marshmallow products. The addition of rosella flower extract was expected to improve the sensory properties of the marshmallow. This study aims to determine the effect of the ratio of watermelon albedo juice to the rosella flower extract and the impact of the addition of gelatin on the characteristics of marshmallows. This study used a completely randomized design (CRD) with two factors, namely the proportion of watermelon albedo juice: rosella flower extract (60:40, 70:30, 80:20) and the addition of gelatin (10%, 12%, 14%). The data obtained were statistically analyzed using analysis of variance (ANOVA) and continued with Duncan's test (DMRT). The best treatment was obtained in the treatment of the proportions of watermelon albedo juice: rosella flower extract (70:30) with the addition of 14% gelatin which produced marshmallows with a characteristic moisture content of 24.33%; ash content 1.06%; vitamin C content 16.67 mg/100g; antioxidant activity 19.56%; reducing sugar content of 23.15%; hardness 1.07 N; lightness -15,7; redness 5,45; yellowness 0,95 the average value of color preference is 3.50 ( like); aroma 3.45 ( rather like); taste 2.95 (neutral); and texture 3.85 ( like).

*Keywords: Gelatin, marshmallow, rosella flower, Watermelon Albedo*

## Introduction

Watermelon albedo is a white watermelon mesocarp containing several nutritional components that can be utilized. According to Oseni and Oyoke (2013), watermelon albedo contains vitamin C, minerals, soluble fiber, and citrulline (Gladvin et al., 2017). In addition, watermelon albedo is an organic waste with high moisture content, easily becoming damaged. Based on these facts, the processing of watermelon albedo into food or beverage products is needed. Marshmallows are aerated candy resulting from a mixture of sugar, egg whites, gelatin, glucose syrup, and flavorings shaken until fluffy (Petkewich, 2006). In principle, making marshmallows produces air bubbles quickly and traps them to form a stable foam (Sarofa et al., 2019). Making marshmallows using only watermelon albedo will have less attractive color, so it is necessary to add other ingredients to improve the color of the marshmallow. One of the ingredients that can be used is rosella (*Hibiscus sabdariffa*). The Rosella flower has a fairly high anthocyanin pigment content, 88,9 mg/L (Ingrid et al., 2018). Anthocyanins are flavonoid compounds that have the ability as antioxidants. The function of gelatin as a gelling agent in marshmallows is to convert the liquid into an elastic and chewy solid or change the sol's shape into a gel (Ginting et al., 2014). The mechanism of gel formation is the dispersion of a hydrophilic or hydrocolloid polymer or

*How to cite:*
Sarofa, U., Putra, A. Y. T., & Napitupulu, L. K. I. (2021). Characteristics of marshmallow from a mixture of watermelon albedo (*Citrullus vulgaris* Schard) and rosella flower (*Hibiscus sabdariffa*) extract with the addition of gelatin. *2nd International Conference Eco-Innovation in Science, Engineering, and Technology*. NST Proceedings. pages 51-56. doi: 10.11594/ nstp.2021.1409

macromolecule in the water, and the polymer expands. Then there is a process of hydration of water molecules through the formation of hydrogen bonds, where water molecules will be trapped in the complex molecular structure to form a rigid or rubbery gel mass (Herawati, 2018). Gelatin has unique organoleptic characteristics, namely "melt-in-mouth" because it has a melting point below the human body temperature (<35 °C) (Hastuti & Sumpe 2013). The properties of gelatin are in agreement with the characteristics of marshmallows. So that the addition of gelatin is needed to meet the characteristics of the marshmallow.

## Material and Methods

### *Materials*

The material used in this research are watermelon albedo obtained from the traditional market in Sidoarjo, dried rosella flowers, gelatin, citric acid, sucrose, fructose syrup, and cornflour obtained from Bilka supermarket Surabaya. The materials for analysis (DPPH, methanol, $H_2SO_4$, HCl, iodine, amylum, Nelson A reagent, Nelson B reagent, Glucose, NaOH) were obtained from Merck KGaA, Darmstadt, Germany.

### *The Equipment*

The tool used in this research includes Mixer, waring blender, oven, furnace, analytical balance and spectrophotometer UV-Vis, and texture analyzer.

### *Methods*

Preparation of materials includes the manufacture of watermelon albedo juice that is watermelon albedo weighed then blended with the addition of water 10:1 then filtered. The manufacture of rosella flower extract includes washing, weighing, maceration with aquades (1:10) at 5°C for 24 hours with citric acid 2% then filtered. Manufacturing marshmallows consists of three stages. The first stage is the manufacture of sugar syrup, namely 66% sucrose, 41.25% fructose syrup, and 19.8% water heated to boiling for 90 seconds. The second stage is dissolving gelatin (10%, 12%, 14%) with water (T = 80°C) for 3 minutes. The third stage is mixing all the ingredients using a mixer for 15 minutes, then forming. The aging process was carried out for 12 hours at a temperature of 5°C. The last stage is coating the marshmallows with cornstarch. The analyzed product includes moisture, ash, vitamin C, reducing sugar, antioxidant activity, hardness, color, and sensory evaluation. The data was processed using ANOVA 5% and further tested DMRT 5%. Sensory evaluation was carried out by organoleptic test on 25 panelists using the hedonic scale scoring method. The hedonic scale is transformed into a numerical scale according to the panelist's level of preference. The data obtained were processed using the Friedman test at a significance level of 5%. To determine the best treatment based on all parameters, used effectiveness index (De Garmo et al., 1984)

## Results and Discussion

### *Chemical characteristics*

Based on the result of statistical analysis, there is significant interaction ($p \leq 0.05$) between watermelon albedo juice: rosella flower extract proportion and the addition of gelatin in the parameter of moisture content, ash content, and vitamin C content. However, there are no significant interactions in the parameters of reducing sugar and antioxidant activity, but each factor gives a significant effect ($p \leq 0.05$). Table 1 shows the effect of watermelon albedo juice: rosella flower extract proportion and the addition of gelatin on the parameters of water content, ash content, vitamin C content, reducing sugar content and antioxidant activity of marshmallows.

Table 1. Average value of chemical characteristics due to the effect of watermelon albedo juice: Roselle flower extract proportion and the addition of gelatin

| Watermelon albedo juice: Rosela flower extract | Gelatin Addition (%) | Moisture content (%) | Ash Content (%) | Vitamin C Content (mg/100g) | Reducing Sugar Content (%) | Antioxidant Activity (%) |
|---|---|---|---|---|---|---|
| 80 :20 | 10 | 27,37±0,45g | 0,45±0,05 d | 10,15±0,17a | 22,77±0,26 | 11,29±0,40 |
| | 12 | 25,98±0,33 d | 0,73±0,03f | 11,89±0,08 b | 22,90±0,24 | 10,69±0,21 |
| | 14 | 23,23±0,04a | 1,11±0,02i | 12,48±0,23c | 22,70±0,60 | 11,69±0,40 |
| 70:30 | 10 | 28,63±0,45 h | 0,38±0,03 b | 13,25±0,31 d | 23,34±0,42 | 20,16±0,40 |
| | 12 | 26,14±0,16e | 0,56±0,01e | 15,24±0,10e | 23,22±0,36 | 19,96±0,41 |
| | 14 | 24,33±0,14 b | 1,06±0,00 h | 16,67±0,16f | 23,15±0,38 | 19,56±0,31 |
| 60:40 | 10 | 29,08±0,06i | 0,14±0,00a | 18,73±0,27g | 24,57±0,41 | 35,28±0,60 |
| | 12 | 26,27±0,16f | 0,41±0,00c | 20,01±0,19 h | 24,11±0,40 | 36,90±0,61 |
| | 14 | 24,91±0,12c | 0,95±0,03g | 21,06±0,25i | 23,98±0,3 25 | 36,09±0,61 |

Description: The average value accompanied by different letters expresses a real different (p≤0.05).

*Moisture content*

Table 1 shows that the higher the proportion of rosella flower extract, the water content of the marshmallows will increase. In contrast, the increase in the addition of gelatin will cause the water content of the marshmallows to be lower. The water content of marshmallows is influenced by the strength of the gel produced by gelatin, while the pH affects the strength of the gel. Takayanagi et al. (2002) stated that the gel strength of gelatin would be optimal at pH 5. Increasing the proportion of rosella flower extract will reduce the marshmallow's pH so that the gelatin's gel strength will be lower. It causes gelatin cannot bind water optimally, and the measured free water becomes higher. Meanwhile, the higher the addition of gelatin, the lower the moisture content. The gel matrix formed is getting stronger and more water is bound, making it difficult to evaporate.

*Ash content*

In Table 1 shows that the higher the proportion of watermelon albedo juice, the higher the marshmallow ash content. This is because the mineral content in watermelon albedo juice is higher than rosella flower extract. Likewise, gelatin also contains several minerals, so the addition of gelatin will increase the ash content of marshmallows.

*Vitamin C content*

Table 1 shows that the higher the proportion of rosella flower extract and the addition of gelatin, the higher the vitamin C content. This is because rosella flower extract has higher levels of vitamin C than watermelon albedo juice, which is 28.16 mg/100g, while the vitamin C content

of watermelon albedo juice is 15.84 mg/100g. Meanwhile, the addition of gelatin can protect vitamin C from damage by heat treatment. Belitz et al. (2009) stated that gelatin is a hydrocolloid that can bind the particles contained in fruit juice, including water-soluble vitamin C. During the gel formation process, the gelatin molecular bonds will be opened so that cross-links are formed with free water molecules.

*Reducing sugar content*

Table 1 shows that the higher the proportion of rosella flower extract, the higher the reducing sugar content of marshmallows. This is because the low pH of roselle flower extract causes more sucrose inversion to occur so that the resulting reducing sugar is higher. Sucrose is non-reducing because it does not have a reactive free OH group, but during cooking in the presence of an acid, sucrose will be hydrolyzed into inverted sugar, namely fructose and glucose, which is a reducing sugar. The inversion speed is affected by temperature, heating time, and solution pH. Therefore, the pH of an acidic solution can increase the reducing sugar content (Suwarno et al., 2015). Meanwhile, the addition of gelatin did not have a significant effect on reducing sugar content.

*Antioksidan activity*

Table 1 shows that the higher the proportion of rosella flower extract, the higher the antioxidant activity of marshmallows. This is because roselle flowers have high antioxidant activity (80.5%). Rosella flowers contain bioactive compounds with high levels of anthocyanins. Anthocyanins belong to a class of flavonoid compounds that can act as natural antioxidants, inhibit free radicals, and prevent cell degeneration and other diseases. (Ariviani, 2010). Meanwhile, the addition of gelatin did not have a significant effect on the antioxidant activity of marshmallows.

***Physical characteristics***

Based on the result of statistical analysis, there is significant interaction ($p \leq 0.05$) between watermelon albedo juice: rosella flower extract proportion and the addition of gelatin in the parameter of hardness. However, in the 29rameters of color, there is no significant interaction, but each factor gives a significant effect ($p \leq 0.05$). Table 2 shows the effect of watermelon albedo juice: roselle flower extract, and the addition of gelatin on the parameters of hardness and color of marshmallows.

Table 2. Average value of physical characteristics due to the effect of watermelon albedo Juice: roselle flower extract proportion and the addition of gelatin

| Watermelon albedo juice: Rosela flower extract | Gelatin Addition (%) | Hardness (N) | Color | | |
|---|---|---|---|---|---|
| | | | Lightness | Redness | Yellowness |
| 80:20:00 | 10 | 0,65±0,01c | -15,1±0,40 | 2,20±0,04 | 2,45±0,02 |
| | 12 | 1,00±0,00e | -10,2±0,26 | 1,80±0,03 | 2,10±0,02 |
| | 14 | 1,67±0,45h | -10,0±0,45 | 2,35±0,04 | 2,25±0,03 |
| 70:30:00 | 10 | 0,59±0,05b | -18,1±0,28 | 6,50±0,05 | 1,20±0,02 |
| | 12 | 0,89±0,00e | -17,0±0,35 | 5,25±0,03 | 1,50±0,02 |
| | 14 | 1,07±0,02g | -15,7±0,42 | 5,45±0,03 | 0,95±0,01 |
| 60:40:00 | 10 | 0,55±0,00a | -23,7±0,41 | 8,60±0,04 | -1,30±0,02 |
| | 12 | 0,81±0,00d | -17,6±0,35 | 7,80±0,04 | -1,15±0,02 |
| | 14 | 1,02±0,01f | -16,0±0,29 | 8,10±0,04 | -1,60±0,02 |

Description: The average value accompanied by different letters expresses a real different ($p \leq 0.05$).

*Hardness*

Table 2 shows the higher the proportion of rosella flower extract, the lower the marshmallow hardness value. An increase in the proportion of rosella flower extract will reduce the pH of the product. This condition will result in the lower gel strength of the gelatin so that the product becomes more brittle and the force required to press the product becomes smaller. While the increase in the addition of gelatin will cause the foam formed to be stiffer so that the force required to press the product is greater. Ann et al. (2012) stated that the aging mechanism produces a strong bond so that the gel formed becomes stronger with the addition of gelatin.

*Color*

Lightness (L) indicates the interval of appearance of the marshmallow from light to dark. The lower the reading number, the darker the marshmallow will appear. On the other hand, the larger the reading, the brighter the marshmallow will appear. Redness (a) indicates the intensity of the red color in the product. Interval numbers with a positive value indicate the color of the product is getting redder, whereas if it is negative, it indicates the color of the product is getting greener. Yellowness (b) indicates the intensity of the yellow color on the product. The more negative yellowness value indicates the color of the product is getting bluer. Conversely, the more positive yellowness value shows the color of the product is getting yellower. In Table 2, both the treatment of watermelon albedo: roselle flower extract proportion and the addition of gelatin gave a significant effect on lightness, redness, and yellowness.

***Sensory evaluation***

Based on the Friedman test, it showed that the treatment of watermelon albedo: roselle flower extract and the addition of gelatin had a significant effect ($p \leq 0.05$) on the aroma, taste, and color of the marshmallow product. The results of the sensory evaluation can be seen in Table 3.

Table 3. The average value of preference in sensory test with parameters of aroma, taste, and color of the marshmallow product

| Watermelon albedo juice: Rosela flower extract | Gelatin Addition (%) | Preference Average Score | | |
|---|---|---|---|---|
| | | Aroma | Taste | Color |
| 80:20:00 | 10 | 3,55 | 3,95 | 2,60 |
| | 12 | 3,50 | 3,10 | 3,20 |
| | 14 | 3,65 | 3,80 | 2,85 |
| 70:30:00 | 10 | 3,05 | 2,70 | 3,40 |
| | 12 | 3,10 | 3,45 | 3,35 |
| | 14 | 3,45 | 2,95 | 3,50 |
| 60:40:00 | 10 | 2,60 | 2,35 | 4,15 |
| | 12 | 2,55 | 1,85 | 3,70 |
| | 14 | 3,00 | 2,40 | 3,60 |

Table 3 shows that the treatment of watermelon albedo: rosella juice (60:40) with the addition of 12% gelatin had the lowest level of preference. In comparison, the proportion of watermelon albedo: rosella juice (80:20) with 14% gelatin had the highest level of preference. The higher the proportion of rosella juice, the sourer the marshmallow aroma. The panelists favor this less. The decrease in the panelists' preference for the taste of marshmallows also occurred along with the increase in the rosella juice ratio. This is because rosella juice has a pH of 2.8 (Ali et al., 2013), which makes the marshmallows more acidic. These results indicate that the more acidic marshmallows are less favored by the panelists. In the preference for marshmallow color, the preference value increases with the increase in the proportion of rosella juice. In addition, this result also shows that the panelists prefer marshmallows with a darker color than marshmallows

with a paler color. The increase in the proportion of rosella juice causes the marshmallow color to become redder. The anthocyanin content in roselle flowers will give a red to purple color (Ingrid et al., 2018).

***Effectivity test***

An effectivity test was conducted to determine the best treatment. Based on the results of the Effectivity test on all research parameters, including the chemical and physical characteristics and sensory evaluation, the treatment of watermelon albedo juice: rosella flower extract proportion (70:30) with the addition of 14% gelatin is the best treatment, which produced marshmallows with a characteristic moisture content of 24.33%; ash content 1.06%; vitamin C content 16.67 mg/100g; antioxidant activity 19.56%; reducing sugar content of 23.15%; hardness 1.07 N; lightness -15,7; redness 5,45; yellowness 0,95 the average value of color preference is 3.50 ( like); aroma 3.45 ( rather like); taste 2.95 (neutral).

## Conclusion

The treatment of watermelon albedo juice: roselle flower extract proportion and the addition of gelatin affected chemical, physical and sensory characteristics. The best treatment was obtained at the ratios of watermelon albedo juice: rosella flower extract proportion (70:30) with the addition of 14% gelatin which produced marshmallows with a characteristic moisture content of 24.33%; ash content 1.06%; vitamin C content 16.67 mg/100g; antioxidant activity 19.56%; reducing sugar content of 23.15%; hardness 1.07 N; lightness -15,7; redness 5,45; yellowness 0,95 the average value of color preference is 3.50 ( like); aroma 3.45 ( rather like); taste 2.95 (neutral).

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