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The Effect of Purple Sweet Potato Starch Variation on Marshmallow Characteristics

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Abstract

Purple sweet potato contains antioxidants such as betacarotene and anthocyanins that have health benefits. This study utilizes purple sweet potato that has been processed into starch as a raw material for making marshmallows. This study aims to determine the best variation of purple sweet potato starch on marshmallow characteristics and its effect by referring to standards on soft confectionery. The research conducted was experimental with a Completely Randomized Design (CRD). The tests carried out include water content test, organoleptic test, acidity (pH) test and antioxidant activity. In the organoleptic test, there were significant differences in taste and texture, while in color and aroma there were no significant differences. Hedonic test showed that panelists preferred the taste of marshmallow with 10 grams of purple sweet potato starch in sample a1. The best moisture content was found to be 17.74% in sample a1 dp and 17.81% in sample a2. The acidity (pH) value was found to be 6.88 in samples a1 and a1 dp and 6.5 in sample a3. Antioxidant activity in sample a1 was 50.11% and sample a3 was 38.73%. Based on the results of all tests, the results are in accordance with SNI 3547.2: 2008.

Keywords: Marshmallow, Purple Sweet Potato Starch, Purple Sweet Potato, Kruskall Wallis Test

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Ubi jalar ungu mengandung antioksidan seperti betakaroten dan antosianin yang memiliki manfaat bagi kesehatan. Penelitian ini memanfaatkan ubi jalar ungu yang telah diolah menjadi pati sebagai bahan baku pembuatan marshmallow. Penelitian ini bertujuan untuk mengetahui variasi pati ubi jalar ungu yang terbaik terhadap karakteristik marshmallow dan pengaruhnya dengan mengacu pada standar tentang kembang gula lunak. Penelitian yang dilakukan bersifat eksperimental dengan Rancangan Acak Lengkap (RAL). Pengujian yang dilakukan meliputi uji kadar air, uji organoleptik, uji keasaman (pH) dan aktivitas antioksidan. Pada uji organoleptik, terdapat perbedaan yang signifikan pada rasa dan tekstur, sedangkan pada warna dan aroma tidak terdapat perbedaan yang signifikan. Uji hedonik menunjukkan bahwa panelis lebih menyukai rasa marshmallow dengan pati ubi jalar ungu 10 gram pada sampel a1. Kadar air terbaik ditemukan sebesar 17,74% pada sampel a1 dp dan 17,81% pada sampel a2. Nilai keasaman (pH) ditemukan sebesar 6,88 pada sampel a1 dan a1 dp dan 6,5 pada sampel a3. Aktivitas antioksidan pada sampel a1 sebesar 50,11% dan sampel a3 sebesar 38,73%. Berdasarkan hasil dari seluruh uji didapatkan hasil sesuai dengan SNI 3547.2:2008.

Kata Kunci: Marshmallow, Pati Ubi Ungu, Ubi Ungu, Uji Kruskall Wallis

INTRODUCTION

Purple sweet potato shows a deep purple color from the relatively high content of anthocyanins, especially cyanidin or peonidin as its aglycone [1]. Ethyl acetate extract of purple-purple sweet potato tubers was shown to provide very strong antioxidant activity where phenolics and flavonoids were the main contributors to the antioxidant activity of these sweet potato varieties [1]. Purple sweet potato contains antioxidants such as beta-carotene and anthocyanins, which are types of flavonoids known for their health benefits. Purple sweet potato can be processed into starch by extracting starch from the sweet potato. Purple sweet potato starch provides an attractive natural color, and can increase its nutritional value because it contains antioxidants such as anthocyanins. The utilization of purple sweet potato starch can be used as a raw material for marshmallow production due to its high anthocyanin content, which is about 519 mg per 100 g wet weight [2].

Marshmallow is a snack that has the form of soft candy. Marshmallows are made from egg whites, sugar, gelling agents, colors and flavorings and a very high air composition [3]. With the composition of these ingredients, marshmallows have a chewy foam-like texture, which feels elastic and soft when chewed. Marshmallow is included in confectionery products with various variations in shape, color, taste and aroma. A problem that often occurs in making marshmallows is that the texture is not enough soft and chewy and that the mass is too light. Therefore, in making marshmallows, it is necessary to add ingredients that function as gelling agents [4]. A gelling agent is a food additive which functions as a thickener and stabilizer for various food products such as candies, jellies and desserts. The ability of gelling agents to form food texture determines its functionality. In general, gelling agents are made up of polysaccharides. A commonly used gelling agent is gelatin. However, other ingredients with similar properties, such as modified starch, can also serve as gelling agents. It is necessary to explain the requirements for a material to be considered a gelling agent. These requirements include the ability to form a gel structure when dissolved in water, stability under various conditions (such as temperature and pH), and compatibility with other ingredients in the food product. Additionally, the gelling agent should be safe for consumption and meet regulatory standards [5].

Based on the background, you should conduct research on the impact of different concentrations of purple sweet potato starch on the texture, flavor, and overall acceptability of marshmallows. This research aims to not only expand the variety of snack products available but also highlight the health benefits of using natural ingredients. By incorporating purple sweet potato starch, the study addresses the increasing consumer demand for healthier and more natural food options.

MATERIALS AND METHODS

Materials

The materials used in this study were purple sweet potato, corn starch, and cooking oil. The purple sweet potato was sourced from local farms, maizenaku corn starch from (egafood) and cooking oil from (Kunci Mas brand). Solvents and reagents used included distilled water from (Sakura Medical Dental Laboratory & Chemical), water, bovine gelatin from (Sumber Jaya Kimia), glucose syrup from (TROS-Bandung) and sucrose from (Gulaku brand).

Methods

The method used in this research was experimental research with a Completely Randomized Design (CRD), conducted with 6 trials.

Preparation of purple sweet potato starch

1 kg of purple sweet potatoes were first cleaned off impurities such as soil, sand and others through washing under running water. The skin of the sweet potatoes was peeled using a knife and peeled potatoes were then washed with running water to clean off mucus found on the outer layer. The sweet potato flesh was then cut using a knife into roughly 1×1 cm cubes to allow an easier mashing process. The cut sweet potatoes were washed under running water then soaked in water with a 1:1 ratio of sweet potato to water with the aim of softening the sweet potato tissue. The soaked sweet potato was then drained to remove the remaining soaking water. The sweet potato was then mashed using a blender, resulting in a sweet potato starch. The sweet potato pulp was filtered with a filter cloth, allowing the starch to pass through the filter as a starch suspension, while the pulp remained on the filter cloth. The starch suspension was allowed to settle in a settling container for 8 hours. Then drained to separate the starch from the liquid. The starch precipitate was dried using an oven at 100°C for 1.5 hours and then cooled using a desiccator for 15 − 30 min. The coarse starch was pulverized using a blender, The particles were separated by size using a sieve. The results of the crushing were sieved with a 90 mesh sieve. Smooth purple sweet potato starch was produced.

Marshmallow making

Water 75 g was heated and gelatin 15 g was added. Sucrose 110 g, glucose syrup 26 g and water 75 g were heated to 112°C for 5 minutes. The sugar solution and gelatin solution were mixed. Purple sweet potato starch with varying concentrations (10, 20 and 30 g) was mixed. The mixture was then whipped well using a mixer for 10 min at high speed. After the whisking process with a mixer, the marshmallow batter was molded in a pan that had been greased with cooking oil. Before the marshmallows were removed from the pan, they were coated with corn starch 30 g to prevent sticking. Finally, the aging process was carried out on the marshmallow for 5 hours at room temperature until the texture became stiff [6]. The marshmallows that had been formed can be cut as needed, then dusting was done to avoid stickiness between marshmallows. The finished product was subjected to chemical analysis, physical analysis and organoleptic test.

Moisture content analysis of purple sweet potato starch and marshmallow

Analysis of the moisture content of purple sweet potato starch and *marshmallow* was carried out using the gravimetric method with oven heating.

Organoleptic analysis

Organoleptic analysis on *marshmallow* was conducted on 15 panelists using hedonic scale which includes characteristics of color, taste, texture and aroma. The rating scale used was from 1 (strongly dislike) to 4 (strongly like).

Analysis of acidity (pH)

Analysis of acidity (pH) of *marshmallow* samples was carried out using a pH meter calibrated with pH 4 and 7 buffer solutions before use. This measurement was carried out with 6 samples with variations in purple sweet potato starch.

Analysis of marshmallow antioxidant content

At the initial stage of the test, a standard curve for DPPH (2,2 diphenyl-1- picrylhydrazyl) solution was first made. A total of 1 mg of DPPH was put into a 25 mL volumetric flask and dissolved in methanol solvent. The DPPH solution made has a concentration of 40 ppm, then diluted in a 10 mL volumetric flask to a concentration of 5, 10, 20 and 25 ppm. The absorbance value was measured at a wavelength of 515 nm.

Analysis Data

Based on the observation data, the moisture content of both the marshmallow sample and the purple sweet potato starch can be calculated using the following equation:

$$\text{moisture content (\%)} = \frac{W1 - W2}{W} \times 100\% \quad (1)$$

Where W1 represents the initial weight of the sample and W2 represents the weight of the sample after drying. By applying this formula to the observed weights, we can determine the percentage of moisture content in both the marshmallow sample and the purple sweet potato starch.

Based on the observation data, the antioxidant activity of the marshmallow samples can be calculated using the following equation:

$$\text{Antioxidant activity} = \frac{\text{A blank} - \text{A sample}}{\text{A blank}} \times 100\% \quad (2)$$

Where Absorbance of blank it is the absorbance of DPPH solution without sample. This value represents the maximum absorbance of DPPH free radicals. Sample absorbance, represents the absorbance of the DPPH solution after mixing with the sample. This value indicates the reduced amount of DPPH free radicals inhibited by the antioxidants in the sample.

RESULTS AND DISCUSSION

Preparation of purple sweet potato starch

The process of making starch is quite simple and can be done on a household or small industry scale. It involves cleaning, peeling, cutting, and drying to a certain moisture content. Processing purple sweet potato in the form of starch is one of the efforts to preserve sweet potato. The processing of purple sweet potato into starch has many advantages, including being durable, flexible, and can be obtained throughout the year [7].

The raw material used in the manufacture of purple sweet potato starch was purple sweet potato processed through several stages, as described in the procedure section. The detailed steps of sorting, cleaning, soaking, mashing, filtering, settling, draining, drying, and sieving were followed to produce fine purple sweet potato starch. The resulting starch was then analyzed for its physicochemical properties. After the purple sweet potato flour was produced, its pH was measured using a calibrated pH meter. The pH meter was calibrated using standard buffer solutions of pH 4 and 7 before use. About 5 grams of starch was mixed with 50 mL of distilled water to make a starch suspension, and the pH was measured by dipping the pH meter into the suspension. The resulting pH of the purple sweet potato starch was pH 5. The moisture content of the starch was also determined using the gravimetric method of heating using an oven and resulted in a moisture content of 18.36% purple sweet potato starch.

Factors that can affect the pH of purple sweet potato starch are anthocyanin compounds, organic acids, enzymes and interactions between molecules. Purple sweet potato is rich in anthocyanin compounds, a natural pigment that gives purple color to sweet potatoes. That at pH 1-2 anthocyanins are dominant in the form of flavylium cations which are red in color, at pH < 6 they turn into carbinol and partly into quinonoidal which is blue so that it is purple, at pH > 9 the yellow-colored calcone [8]. The presence of anthocyanins in purple sweet potato starch can reduce the pH of the solution to reach 5. Purple sweet potatoes also contain organic acids such as citric, malic, and oxalic acids. These organic acids can contribute to the decrease of starch pH. At pH 5, these organic acids contribute H^+ ions that lower the pH. Phosphatase enzymes found in purple sweet potato can hydrolyze phytic acid into inositol and phosphoric acid. Phosphoric acid is acidic and has a pKa of about 2.1 and 7.2. Interactions between starch and protein molecules in purple sweet potato starch can also affect pH. These interactions can cause changes in the charge of starch and protein, thus affecting their ability to bind H^+ ions [9].

According to Padmawati [10], at high heating, the stability and durability of anthocyanin dyes change and result in anthocyanin damage. The percentage decrease in anthocyanin content on a dry basis in various processed products of purple sweet potato flour is 86.95% [11]. This is because purple sweet potato starch looks like ordinary flour and its light purple color transforms into a dark color when exposed to water. In making sweet potato starch, it is necessary to pay attention to the drying process to produce high-quality starch. The effect of drying on the physicochemical properties of sweet potatoes is that it can eliminate or damage the nutritional value and the anthocyanin content, which is a color-forming pigment in purple sweet potatoes, to desecrate or fade. Based on this understanding, it is necessary to evaluate the physicochemical and sensory properties of sweet potato starch, particularly purple sweet potato starch, using various drying processes. This evaluation aims to determine which drying process yields physicochemical and sensory properties that are acceptable to consumers. Anthocyanin levels can also determine the color of purple sweet potato starch. The stability of anthocyanins is influenced by the initial process of washing, heating, and drying. The color of purple sweet potato starch is shown in **Figure 1**.

Figure 1. Displays the appearance of purple sweet potato starch. It shows the color, texture, and other visual characteristics of the sweet potato flour used in this study.

Starch content was significantly affected by the type of sweet potato used. The highest value in sweet potatoes is strongly related to the starch content of fresh tubers which is also the highest. In addition, starch content is also influenced by the extraction method, so that the bonding of other compounds such as protein, fat, fiber is evident in purple sweet potato, which has the lowest starch content, even though the starch content of fresh tubers is quite high. The carrying of purple pigment compounds (anthocyanins) into starch during extraction reduces the purity level of starch. This can happen because anthocyanin compounds are water soluble [2].

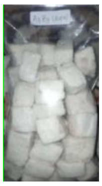
Marshmallow making

Marshmallow products are generally made from sucrose and glucose syrup. Sugar (sucrose) in candy making process functions as a sweetener, texture determinant and appearance determinant because it affects color through caramelization. Sucrose can increase the boiling point of the solution and dissolve in water. Sucrose also acts as a preservative because it can reduce water activity (A_w) and cause cell plasmolysis in bacteria. According to Arizona [12], glucose provides a plastic texture and can prevent the formation of sugar crystals, while a greater amount of sucrose will experience hardness (crystallization of the outer sugar) which results in increased hardness in soft candy.

Glucose syrup functions as a preservative, prevents sugar crystallization, gives a smooth texture, and prevents food products from spoiling [12]. Glucose syrup can control the level of hardness in soft candy. Glucose syrup has the property of being difficult to crystallize and can avoid the product from hard texture. The use of glucose syrup mixed with sucrose together can increase sweetness when compared to the use of either component alone [12]. According to BSN [13] for sweet potato, it is critical to adjust the amount of sucrose and glucose syrup in soft candy production to prevent product deviations. Marshmallow is aromatic due to the heating of sugar which is the basic ingredient of marshmallow. Sugar-based products when heated will melt and if the liquid sugar continues to be heated it will have a unique flavor and fragrance.

Gelling agent is a food additive used to thicken and stabilize and give food texture through gel formation. In general, what is used as a basic ingredient in making marshmallows is gelatin. Gelatin is a hydrocolloid that has the property of reversibly changing into a gel, which melts when heated and gels again when cooled. Gelatin in marshmallows is a basic ingredient that functions to improve texture and chewing ability [12]. **Table 1.** Shows the composition of marshmallows produced using varying concentrations of purple sweet potato starch. This data is essential for understanding how different concentrations of purple sweet potato starch affect the physicochemical properties of marshmallows.

Table 1. Marshmallow Composition Variations with Various Concentrations of Purple Sweet Potato Starch

Sample Code	Pictures	Description
a_1		Very white color, very soft texture, fragrant aroma and sweet taste
a_3		Very white color, very soft texture, fragrant aroma and sweet taste

Moisture content analysis

Moisture content is a parameter that has a major role in the quality stability of a product. High moisture content or moisture content exceeding the standard makes it easy for bacteria, molds, and yeasts to multiply, so that changes in food ingredients [12]. Marshmallow is a semi-wet food product, which according to Indonesian National Standard falls under soft confectionery and has a maximum moisture content limit of 20%. The water analyzed in the determination of water content is free water in the material. In this case, it also includes physically bound water, namely water contained in gelatin gel micelles in marshmallows. There are several factors that affect water binding capacity, such as protein concentration, pH, ionic strength, temperature, the presence of other food components, fat, salt, rate and duration of heat treatment. Gelatin is a protein that has the ability to bind water and form a gel structure. The more gelatin added, the more water can be bound in its structure. Purple sweet potato starch also has the ability to bind water, but it is lower than gelatin. When purple sweet potato starch is added to marshmallows, its water binding effect competes with gelatin. If the amount of gelatin is greater, the gelatin will dominate the water binding. This will reduce the amount of water bound by the purple sweet potato starch. If the amount of purple sweet potato starch is more, the purple sweet potato starch will bind more water. This can reduce the effect of water binding by gelatin [12]. The lowest result in the analysis of water content is sample a1 dp of 17.74% with a variation of 10 g of purple sweet potato starch while the highest result in the analysis of water content is sample a2 of 17.81% with a variation of 20 g of purple sweet potato starch. The analysis result of Marshmallow content is shown in **Figure 2.**

Too high of a moisture content will reduce the durability of the product because microbes will multiply more easily. It was stated that the cooking process at high temperatures and long cooking times can cause caramelization of sugars, resulting in a brownish color in the product [14]. This change in color is due to the breakdown of sugars and is not directly related to the moisture content of the product.

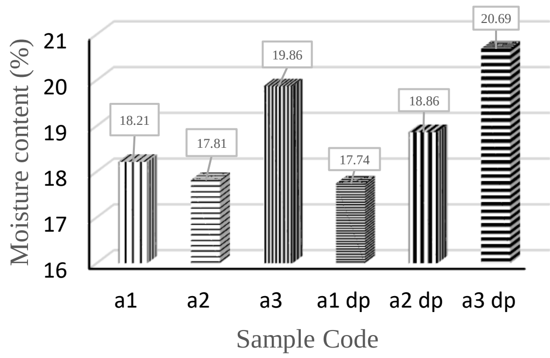


Figure 2. Analysis of *marshmallow* moisture *content*

Organoleptic analysis

Sensory (organoleptic) tests were carried out using the Hedonic Scale Scoring method which includes color, aroma, texture and taste parameters. The organoleptic test was conducted by 15 panelists. The organoleptic test of the marshmallow produced aimed to determine the panelists' assessment of the marshmallow based on the varied in purple sweet potato starch. The panelists' preferences were observed using a rating scale: 1 (very dislike), 2 (dislike), 3 (like), 4 (very like).

1. Color

Color plays an important role in the acceptance of sensory characteristics. Color is the first organoleptic parameter seen in the presentation. Attractive colors can invite panelists or consumers to taste a product. The results of panelist assessment of color parameters can be seen in **Figure 3**.

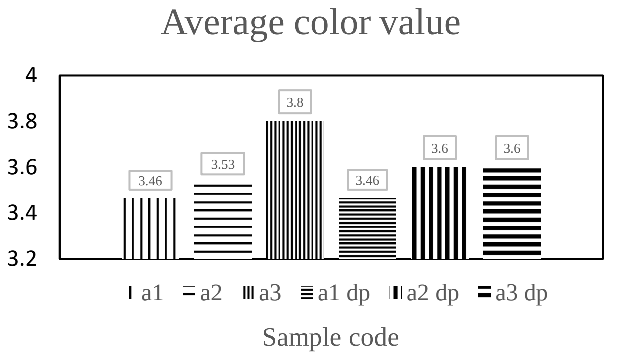


Figure 3. Color organoleptic results

Based on **Figure** 3, it shows that marshmallows with 30 g of purple sweet potato starch have a whiter color than marshmallows with 10 and 20 g of purple sweet potato starch. This is because the color of gelatin. According to BSN [13] is colorless, so the dominant color in this study is the white color produced from gelatin. The highest average value in the color parameter is in the a3 treatment of 3.8 with a variation of 30 g of purple sweet potato starch, while the lowest value in the color parameter is in the a_1 and a1 dp treatment, which is 3.46 with a variation of 10 g of purple sweet potato starch.

Based on the results of the Kruskall Wallis test on marshmallow color, the Asymp. Sig value of 0.171 > 0.05. So, it can be concluded that H_0 is accepted and H_a is rejected, this indicates that the sample treatment of marshmallows has no significant effect on marshmallow color.

2. Taste

Taste is the second factor that most influences judgment using the sense of taste. A product can be well received if it has the desired taste [4]. Taste in food is one of the factors that determine consumer decisions to accept or reject a food product [15]. The results of the panelists' assessment of the taste parameters can be seen in **Figure 4**.

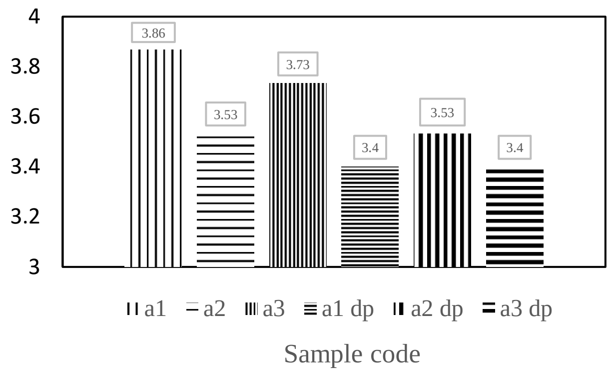


Figure 4. Organoleptic results of taste

Based on **Figure** 4, it shows that taste affects the level of panelists' liking for marshmallows. Marshmallows with 10 g of purple sweet potato starch have a very sweet taste compared to marshmallows with 20 and 30 g of purple sweet potato starch. The highest value in the taste parameter was in treatment a1 of 3.86 with a variation of 10 g of purple sweet potato starch, while the lowest is found in the a1 dp and a3 dp treatments, which is 3.4 with a variation of 10 g of purple sweet potato starch for the a1 dp sample and 30 g of purple sweet potato starch for the a3 dp sample. The addition of purple sweet potato starch affects the panelists' level of liking for marshmallows because purple sweet potatoes contain various taste compounds that can affect the taste of marshmallows. These taste compounds include anthocyanins, carotenoids, and flavonoids. Anthocyanins impart a sweet and slightly sour flavor, carotenoids impart a sweet and nutty flavor, and flavonoids impart a bitter flavor. According to Sarofa [16] high levels of sucrose and glucose syrup can reduce the appearance of flavor. According to Padmawati [10] gelatin has a neutral taste that is generally acceptable to consumers. Therefore, the dominant flavor in the marshmallow comes from the sweetness of the added sugar.

Based on the results of the Kruskall Wallis test on marshmallow taste, the Asymp. Sig value is 0.016 < 0.05. So, it can be concluded that H_0 is rejected and H_a is accepted, which means that there is an influence between sample treatments on marshmallow taste.

3. Texture

The texture of bovine gelatin-based marshmallows is softer and the surface is soft, smooth, not hard, and easy to swallow. This softness is obtained from the reversible nature of gelatin with the principle of rapidly forming air bubbles and absorbing them to form foam. The more gelatin added, the chewier the marshmallow. This is in accordance to Sarofa [16] which states that the addition of gelatin to the dough can reduce the surface tension at the air-liquid interface, resulting in foam formation and giving a chewy texture to the final product. As revealed in research of Arizona [12] the addition of excessive gelatin can cause the texture to become hard while the amount of gelatin that is less can produce marshmallows with a texture that is too soft, therefore the amount of gelatin addition in making marshmallow candy must be adjusted to the desired level of hardness in the final product. The lowest results in the texture organoleptic test were in samples a1 and a1 dp of 3.53 with a variation of 10 g of purple sweet potato starch while the highest results were in samples a2, a3 and a3 dp of 3.66 with variations in purple sweet potato starch a2 of 20 g, a3 and a3 dp of 30 g. The results of the panelists' assessment of the organoleptic can be seen in **Figure 5**.

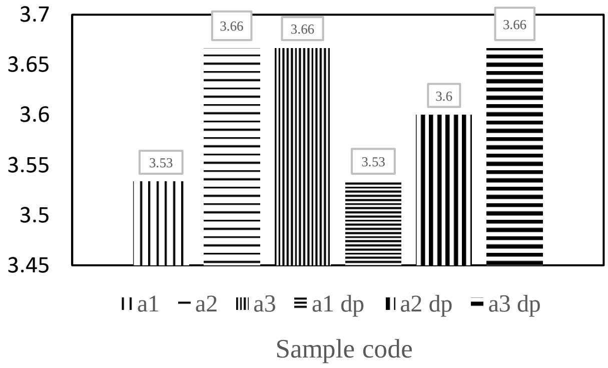


Figure 5. Organoleptic results of texture

Based on the results of the Kruskall Wallis test on the marshmallow texture test, it is known that the Asymp. Sig value is 0.024 < 0.05. So, it can be concluded that H_0 is rejected and H_a is accepted, which means that there is an influence between sample treatments on marshmallow texture.

4. Aroma

The organoleptic test of the aroma parameter aims to determine the level of panelist preference for aroma. Aroma is one of the important parameters because, in general the taste of a food or beverage product is largely determined by it. The results of panelist assessment of aroma parameters can be seen in **Figure 6**.

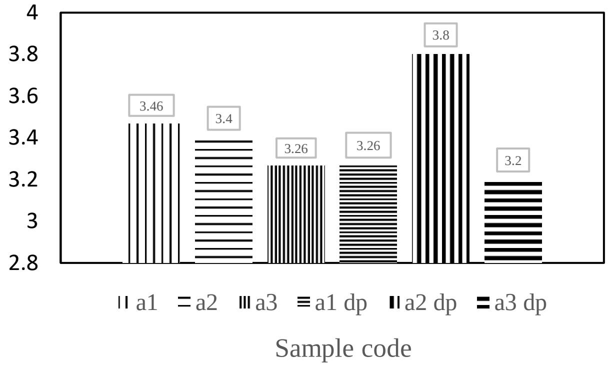


Figure 6. Organoleptic results of aroma

Based on **Figure** 6 above, it shows that marshmallows with 20 g of purple sweet potato starch have a distinctive aroma compared to marshmallows with 10 and 30 g of purple sweet potato starch. Aroma also affects the level of panelists' liking for marshmallows. The highest value in the aroma parameter was found in treatment a2 dp of 3.8 with a variation of 20 g of purple sweet potato starch and the lowest value was found in treatment a3 dp of 3.2 with a variation of 30 g of purple sweet potato flour. Actually, the addition of purple sweet potato flour does not affect the aroma of marshmallows. The aroma of marshmallows is influenced by the additional ingredients used, namely roasted corn flour, this is because corn has a strong aroma. This shows that the aroma produced is the same between one treatment and another. The more dominant aroma is basically the aroma of gelatin which is considered normal (acceptable to consumers) and does not have a distinctive aroma. Aroma testing is considered important because it can quickly provide an assessment of whether or not a product is accepted by consumers [17].

Based on the results of the Kruskall Wallis test on marshmallow aroma, the Asymp. Sig value is 0.278 > 0.05. So, it can be concluded that H_0 is accepted and H_a is rejected, which means that there is no effect of sample treatment on marshmallow aroma.

Analysis of acidity (pH)

pH measurement was done to determine the acidity level of a product. The results of *marshmallow* pH measurements can be seen in **Figure 7.**

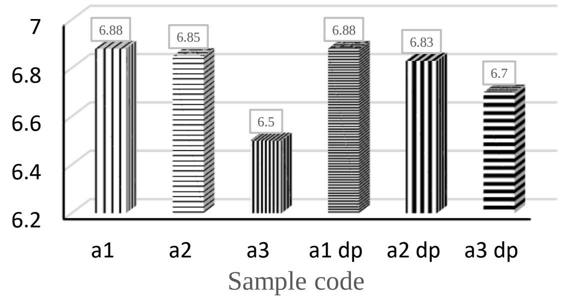


Figure 7. Results of marshmallow pH

Based on the picture above, the analysis shows that the addition of purple sweet potato starch affects the pH of the marshmallow. Purple sweet potato starch can reduce the pH value of the resulting marshmallow. This is due to the anthocyanin content and purple sweet potato starch which is acidic. The highest pH value is found in samples with the average results of samples a1 and a1 dp of 6.88. While the lowest pH value is in the sample with the average result of sample a3 of 6.5. Based on the results obtained, it is close to the pH according to BSN [18], which generally ranges from 6 to 7. pH describes the strength of the acid, the lower the pH value, the stronger the acid and the higher the pH, the weaker the acid strength [19]. Factors that can affect marshmallows come from the ingredients, the manufacturing process to storage.

Marshmallow antioxidant activity analysis

Antioxidant activity in purple sweet potato is dominantly caused by the content of anthocyanins and at least one acylated caffeoyl group. The presence of conjugated double bonds in the anthocyanin structure makes anthocyanins not only function in plants but also function as natural free radical scavenging compounds (antioxidant compounds) in anthocyanins contributing high radical activity [20]. The purpose of this test is to analyze antioxidant levels in marshmallows using the DPPH method. Based on research of Prasetyo and Winardi [20], they found the DPPH inhibition level of purple sweet potato starch reached 63.33%. This inhibition level indicates that purple sweet potato starch has strong antioxidant activity. The best marshmallows based on organoleptic test (a1 and a3) were then selected to be tested for antioxidant activity. Antioxidant analysis of marshmallow was conducted on samples a1 and a3. Sample a1 with 10 g of purple sweet potato starch variation produced antioxidant activity of 50.11% while sample a3 with 30 g of purple sweet potato starch variation produced antioxidant activity of 38.73%. The results of the panelists' assessment of the antioxidants can be seen in **Figure 8**.

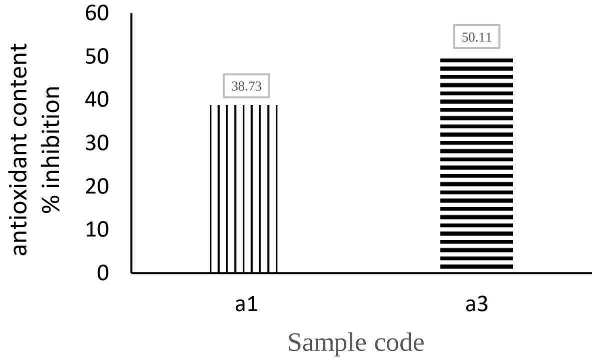


Figure 8. Analysis of marshmallow antioxidants

CONCLUSION

The use of purple sweet potato starch in marshmallows produces products with moisture content and pH that comply with SNI 3547.2:2008 standards, as well as increasing nutritional value and consumer preference, especially at a concentration of 10 grams. The best results were achieved in sample a1 with a moisture content of 17.74%, pH 6.88 and antioxidant activity of 50.11%, opening up opportunities for the development of purple sweet potato-based functional food products.

REFERENCES

[1] H. Suhendy, L. N. Wulan, dan N. L. D. Hidayati, "Pengaruh Bobot Jenis Terhadap Kandungan Total Flavonoid Dan Fenol Ekstrak Etil Asetat Umbi Ubi Jalar Ungu-Ungu (*Ipomoea batatas L.*)," *Journal of Pharmacopolium*, vol. 5, no. 1, pp. 18–24, 2022, doi: 10.36465/jop.v5i1.888.

[2] A. Kurniawan, Wiadnyani, A. A. I. S., dan K. A. Nocianitri, "Pengaruh Perbandingan Tepung Ubi Jalar Ungu (I*pomoea Batatas L.*) dan Terigu Terhadap Karakteristik Cilok," *Itepa Journal Ilmu dan Teknologi Pangan*, vol. 12, no. 1, pp. 195–208, 2023.

[3] R. Cahyaningrum, K. K. Safira, G. N. Lutfiyah, S. I. Zahra, dan A. A. Rahasticha, "Potensi Gelatin Dari Berbagai Sumber Dalam Memperbaiki Karakteristik Marshmallow: Review," *Pasundan Food Technology Journal*, vol. 8, no. 2, pp. 39–44, 2021, doi: 10.23969/pftj.v8i2.4035.

[4] F. S. Pranata, "Potensi Aktivitas Antioksidan Ubi Jalar (*Ipomoea Batatas L.*) Ungu dan

Ekstrak Bunga Telang (Clitoria Ternatea L.) Dalam Pembuatan Permen Jeli," *Pasundan Food Technology Journal*, vol. 8, no. 3, pp. 95–105, 2021, doi: 10.23969/pftj.v8i3.4615.

[5] M. Iuga dan S. Mironeasa, "A Review Of The Hydrothermal Treatments Impact On Starch Based Systems Properties," *Critical Reviews in Food Science and Nutrition*, vol. 60, no. 22, pp. 3890–3915, 2020, doi: 10.1080/10408398.2019.1664978.

[6] C. P. Adi, S. B. Prasetyati, E. A. B. Sebayang, dan A. Aripudin, "Utilitization Of Catfish Bone Gelatin (*Pangasius Sp*.) In Marshmallow Products," *Barakuda'45 Jurnal Ilmu Perikanan dan Kelautan*, vol. 4, no. 2, pp. 141–150, 2022, doi: 10.47685/barakuda45.v4i2.266.

[7] C. Morais, M. Utpott, S. Flores, et al., "Nutritional, Antioxidant and Sensory Evaluation of Calcium-high Content Cookies Prepared with Purple Sweet Potato (*Ipomoea Batatas L*.) And Kale (*Brassica Oleracea Var. Acephala*) Flours," *Journal of Culinary Science & Technology*, vol. 19, no. 5, pp. 373–389, 2021. doi: 10.1080/15428052.2020.1777919.

[8] A. Mahmudatussa'adah, D. Fardiaz, N. Andarwulan, dan F. Kusnandar, "Karakteristik Warna Dan Aktivitas Antioksidan Antosianin Ubi Jalar Ungu [Color Characteristics and Antioxidant Activity of Anthocyanin Extract from Purple Sweet Potato]," *Jurnal Teknologi dan Industri Pangan*, vol. 25, no. 2, pp. 176–184, 2014, doi: 10.6066/jtip.2014.25.2.176.

[9] F. Habibah, S. Yasni, dan S. Yuliani, "Karakteristik Fisikokimia Dan Fungsional Pati Hidrotermal Ubi Jalar Ungu," *Jurnal Teknologi dan Industri Pangan*, vol. 29, no. 1, pp. 69–76, 2018, doi: 10.6066/jtip.2018.29.1.69.

[10] I. G. A. Padmawati, I. D. P. Kartika Pratiwi, dan A. Agung I. Sri Wiadnyani, "Pengaruh Penambahan Ekstrak Bunga Telang (*Clitoria ternatea Linn*) Terhadap Karakteristik Marshmallow," *Itepa Journal Ilmu dan Teknologi Pangan*, vol. 11, no. 1, pp. 43, 2022, doi: 10.24843/itepa.2022.v11.i01.p05.

[11] A. Kurniawan, D. F. Ayu, dan E. Rossi, "Karakteristik Sensori dan Fisiko-Kimia Es Krim Kefir dan Ubi Jalar Ungu," *Warta Industri Hasil Pertanian*, vol. 38, no. 1, pp. 89, 2021, doi: 10.32765/wartaihp.v38i1.6365.

[12] K. Arizona, D. T. Laswati, dan K. S. A. Rukmi, "Studi Pembuatan Marshmallow Dengan Variasi Konsentrasi Gelatin Dan Sukrosa," *Agrortech: Jurnal Ilmiah Teknolologi Pertanian*, vol. 3, no. 2, pp. 11–17, 2021, doi: 10.37631/agrotech.v3i2.279.

[13] Badan Standardisasi Nasional. (1998). SNI 01-4493-1998: Ubi Jalar. Dokumen tidak diterbitkan. Jakarta, Indonesia: Penulis. Diperoleh dari https://akses-sni.bsn.go.id/viewsni/baca/1974.

[14] D. A. P. K. Dewi, I. G. A. Ekawati, dan A. A. I. S. Wiadnyani, "Pengaruh Penambahan Puree Buah Nangka (*Artocarpus heterophyllus*) Terhadap Karakteristik Marshmallows," *Itepa Journal Ilmu dan Teknologi Pangan*, vol. 11, no. 2, pp. 272, 2022, doi: 10.24843/itepa.2022.v11.i02.p09.

[15] Z. Putra, S. Suhardi, dan Z. Abdurrahman, "Perbandingan Fisik dan Organoleptik Antara Marshmallow dengan Bahan Dasar Gelatin yang Berbeda," *Tropical Animal Science*, vol. 3, no. 1, pp. 13–18, 2021, doi: 10.36596/tas.v3i1.375.

[16] U. Sarofa, Rosida, dan L. P. D. Wulandari, "Karakteristik Marshmallow Dari Kulit Pisang Raja (*Musa Textilia*): Kajian Konsentrasi Gelatin Dan Putih Telur," *Jurnal Teknologi Pangan*, vol. 13, no. 1, pp. 20–27, 2019, doi: 10.33005/jtp.v13i1.1505.

[17] Y. Marhayuni dan A. N. Syakina, "Kajian Ikan Tuna (*Thunnus*.) Sebagai Sumber Gelatin Halal," *Pros. Konf. Integr. Interkoneksi Islam dan Sains*, vol. 5, no. 3314, pp. 63–68, 2023.

[18] Badan Standardisasi Nasional. (2008). SNI 3547.2-2008: Kembang gula – Bagian 2: Lunak. Jakarta, Indonesia: Penulis. Diperoleh dari https://akses-sni.bsn.go.id/viewsni/baca/3577.

[19] I. Syariffudin, Y. Purwanti, M. Fera, dan Wadli, "Pengaruh Lama Perendaman Eksrak Buah Nanas Terhadap Sifat Fisik (pH Dan Susut Masak) Dan Uji Sensori Daging Entok," *Journal of Technology and Food Processing*, vol. 3, no. 02, pp. 52–61, 2023, doi: 10.46772/jtfp.v3i02.1282.

[20] H. A. Prasetyo dan R. Winardi, "Antioksidan pada Pembuatan Tepung dan Cake Ubi Jalar Ungu (*Ipomoea batatas L*.)," *Jurnal Agrica Ekstensia*, vol. 14, no. 1, pp. 25–32, 2020.