



Texture and antioxidant activity of watermelon jelly drink with the addition of watermelon albedo and ciplukan (*Physalis angulata*)

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ABSTRAK

Latar Belakang: Minuman jelly merupakan minuman berpemanis yang umum dikonsumsi oleh remaja dan dianggap tidak sehat. Namun, minuman ini dapat dikembangkan menjadi minuman yang lebih sehat dengan penambahan sumber antioksidan alami seperti semangka dengan daging dan albedonya serta buah ciplukan (*Physalis angulata*). Selain kandungan antioksidan, tekstur khas minuman jelly juga berperan penting dalam menentukan kualitas produk dan daya terima konsumen

Tujuan: Penelitian ini bertujuan untuk mengetahui tekstur dan aktivitas antioksidan (IC50) pada formulasi jelly drink semangka dengan penambahan albedo semangka dan buah ciplukan (*Physalis angulata*).

Metode: Penelitian ini menggunakan metode eksperimental dengan pola RAL (Rancangan Acak Lengkap) dan 4 taraf perlakuan. Perlakuan dalam penelitian ini adalah perbedaan penambahan minuman sari albedo semangka dan minuman sari buah ciplukan (*Physalis angulata*) yaitu F1 (48% : 12%), F2 (36% : 24%), F3 (24% : 36%), dan F4 (12% : 48%). Perbedaan tekstur dan aktivitas antioksidan antar formulasi dianalisis menggunakan Uji ANOVA dan dilanjutkan dengan Uji Tukey HSD (Honestly Significant Different).

Hasil: Hasil penelitian menunjukkan bahwa terdapat perbedaan yang nyata pada tekstur tetapi tidak terdapat perbedaan yang nyata pada aktivitas antioksidan setiap formulasi jelly drink. Semakin tinggi penambahan buah ciplukan (*Physalis angulata*) maka tekstur jelly drink akan semakin keras dan aktivitas antioksidannya semakin lemah.

Kesimpulan: Formulasi minuman jelly ini belum dapat dikatakan sebagai pangan sumber antioksidan karena aktivitas antioksidannya tergolong sangat lemah. Tetapi minuman ini mungkin memiliki keunggulan pada zat gizi lainnya jika dilakukan pengujian laboratorium zat gizi lainnya juga.

KATA KUNCI: albedo; antioksidan; ciplukan (*Physalis angulata*); jelly drink



ABSTRACT

Background: Jelly drinks are sugar-sweetened beverages that are commonly consumed by adolescents and are considered unhealthy. However, it can be developed into a healthier drink by adding natural antioxidant sources such as watermelon flesh, albedo, and ciplukan (*Physalis angulata*) fruit. In addition to antioxidant content, the characteristic jelly texture plays an important role in determining product quality and consumer acceptance.

Objectives: The research's purpose was to determine the texture and antioxidant activity (IC50) of the watermelon jelly drinks with the addition of watermelon albedo and ciplukan (*Physalis angulata*) fruit.

Methods: The research used an experimental method with a CRD (Completely Randomized Design) and 4 levels of treatment. The treatments in this study were based on the variation in the addition of watermelon albedo juice and ciplukan (*Physalis angulata*) juice (F1 48:12, F2 36:24, F3 24:36, and F4 12:48). Differences in texture and antioxidant activity between formulations were analyzed using the ANOVA test and continued with the Tukey HSD test.

Results: The results showed that there were significant differences in texture but no significant differences in antioxidant activity among the jelly drink formulations. Increasing the proportion of ciplukan (*Physalis angulata*) fruit resulted in a firmer jelly drink texture and weaker antioxidant activity.

Conclusions: The formulated jelly drink could not be classified as an antioxidant source due to its very weak antioxidant activity. However, it may provide other nutritional benefits that require further laboratory analysis.

KEYWORDS: albedo; antioxidant; ciplukan (*Physalis angulata*); jelly drink

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INTRODUCTION

Nowadays, the dangers of free radicals continue to pose a threat to public health. Adolescents represent one of the most vulnerable groups because of their activities and lifestyles, which place them at a high risk for exposure to free radicals (1). Free radicals are highly reactive molecules present in the body that can damage surrounding molecules (2). Although naturally produced as a byproduct of cellular metabolism, the presence of free radicals in normal quantities is considered acceptable (3). However, the levels of free radicals can increase with continuous exposure to external sources such as cigarette smoke, radiation, ultraviolet rays, vehicle emissions, and unhealthy lifestyles commonly encountered in daily life (4).

An abnormal quantity of free radicals in the body, without sufficient antioxidant defense, can induce oxidative stress, leading to an imbalance in the body's immune system. This condition may act as a precursor to the development of various diseases, especially degenerative diseases (5). Common degenerative diseases resulting from elevated free radical levels include cancer,

cardiovascular disease, and diabetes mellitus (6). In Indonesia, the prevalence of degenerative diseases has increased annually, reaching 65.7% in 2018, which is categorized as a very high rate (7).

The use of antioxidants as metabolite compounds for preventing degenerative diseases continues to increase, either as components in medicines and cosmetics or as basic ingredients for food or beverages (8). One type of beverage frequently consumed by teenagers today is a calorie-dense sweetened drink, such as a jelly drink. Commercial jelly drinks, commonly known by the public, primarily contain high levels of sugar, which can increase the risk of degenerative diseases if consumed in excess (9)(10). Therefore, the addition of natural food ingredients rich in antioxidants is essential to make this drink safer for consumption and to reduce the risk of degenerative diseases (11).

Watermelon and ciplukan (*Physalis angulata*) fruit are rich sources of antioxidants, easy to find, and have the potential to be used as raw materials for the production of jelly drinks (12)(13).

According to Indonesia's Central Statistic Agency, watermelon production in Indonesia in 2021 reached 414,242 tons, with one of the major production centers located in South Sumatra. The high production of watermelon is accompanied by a significant amount of waste, particularly watermelon albedo. In addition to contributing antioxidants, watermelon albedo also contains potential pectin, which assists the gel formation process of jelly drinks (14).

Ciplukan (*Physalis angulata*) is a wild fruit that is commonly found in forests, swamps, or rice fields. This antioxidant-rich fruit is classified as an herbal plant and is traditionally used as medicine due to its clinically tested bioactive compounds that are beneficial to health. However, its utilization as a raw material for food products that can be consumed daily remains limited (15).

Watermelon is widely utilized in food, including jelly drinks. Research (12) shows that using watermelon alone produces jelly drinks with lower antioxidant activity but desirable physical properties. Therefore, researchers aim to combine the antioxidants from watermelon albedo and ciplukan (*Physalis angulata*) fruit to evaluate the differences in antioxidant activity.

In addition to maximizing bioactive content, consumer acceptance is an important consideration in jelly drink production (16). Jelly drinks that are popular and well-accepted by consumers have a distinctive chewy texture (semi-gel) due to the addition of carrageenan. These drinks can be consumed using a straw, with the gel texture still perceptible in the mouth during consumption (17). Besides carrageenan, other solid ingredients, such as fruit juice and granulated sugar, also influence the texture of the resulting jelly drink (18). Based on the description above, this study aims to determine the texture value and antioxidant activity, expressed as IC_{50} , in a fruit jelly drink formulation enhanced by the addition of watermelon albedo and ciplukan (*Physalis angulata*) fruit.

MATERIALS AND METHODS

This study used an experimental method with a CRD design (Completely Randomized Design) and four levels of treatment. The treatments in this study involved the use of watermelon albedo and ciplukan (*Physalis angulata*) fruit, which were

processed into juice drinks. This research process was divided into several stages, namely the preparation of fruit juice drinks, jelly drink formulation, and laboratory testing. The laboratory tests included texture analysis using a Brookfield Texture Analyzer and antioxidant activity analysis using the DPPH method (19)(20).

The research was conducted at two locations: the Dietetics and Culinary Laboratory of the Faculty of Public Health, Sriwijaya University for formulation and the Agricultural Product Technology Laboratory, Sriwijaya University for laboratory testing. The study was carried out from November to December 2023, covering the entire process from research implementation to data processing and analysis.

The ingredients used in the jelly drink formulation included watermelon flesh and albedo, ciplukan (*Physalis angulata*) fruit, water, kappa carrageenan, and sugar. The materials used for the antioxidant activity test using the DPPH method were DPPH powder and methanol. The equipment used for the antioxidant activity test included a Jenway 6305 UV-visible spectrophotometer, beaker, spatula, stirring rod, beaker, and rotary evaporator. The texture analysis was performed using the CT-3 Brookfield Texture Analyzer LFRA tool and probe. This study has received ethical approval from the Ethics Commission Faculty of Public Health, Sriwijaya University (426/UN9.FKM/TU.KKE/2023).

Preparation of Fruit Juice Drinks

In the process of making fruit juice drinks, the main ingredients were fruits, especially the watermelon flesh, watermelon albedo, and ciplukan (*Physalis angulata*) fruit. These ingredients were mixed with water. The first step involved washing the fruits under running water. Subsequently, the fruits were cut, and the usable and non-usable parts were separated and weighed. Water was added in a ratio of 1:2 (water to fruit), and the mixture was blended until smooth. After blending, the fruit juice was filtered to separate it from the fruit pulp, and the resulting juice was measured using a measuring cup.

Formulation of Jelly Drink

Referring to the method described by Novidahlia et al (12), the jelly drink was prepared

by combining watermelon flesh juice, watermelon albedo juice, ciplukan (*Physalis angulata*) fruit juice, carrageenan powder, and granulated sugar in a saucepan. The formulation ratios of watermelon albedo juice and ciplukan (*Physalis angulata*) fruit juice used in this study are

presented in **Table 1**. The mixture was heated and cooked for 3 minutes with gentle stirring until all ingredients were thoroughly homogenized. After cooking, the jelly drink was poured into cups and allowed to cool at 26°C for 1 hour. Once cooled, the jelly drink was ready for consumption.

Table 1. Treatment Matrix on Jelly Drink Formulation

| Materials | Formula (%) | | | |
|-------------------------|-------------|-----|-----|-----|
| | F1 | F2 | F3 | F4 |
| Watermelon flesh juice | 40 | 40 | 40 | 40 |
| Watermelon albedo juice | 48 | 36 | 24 | 12 |
| Ciplukan fruit juice | 12 | 24 | 36 | 48 |
| Total (%) | 100 | 100 | 100 | 100 |

Notes : Comparison of watermelon, albedo and ciplukan (*Physalis angulata*) for each formula is F1 (40:48:12), F2 (40:36:24), F3 (40:24:36), dan F4 (40:12:48)

Texture Analysis

In the texture test, each jelly drink sample used is 100 ml. The texture analysis was performed using the CT-3 Brookfield Texture Analyzer LFRA tool and the cylinder probe. The jelly drink sample was placed into a wide-mouthed container to facilitate the insertion of the probe; in this case, a 12 oz plastic cup was used. Furthermore, the sample was positioned parallel to the cylindrical probe to ensure accurate measurement of the texture value. The texture value results appeared on the texture analyzer display. The texture value obtained was recorded as the final load, expressed in units of gF (gram force).

homogenized, it was incubated for 30 minutes. The absorbance of the mixture of the sample solution and DPPH was measured at the optimum wavelength, and the IC₅₀ was determined. To ensure consistency, each solution was tested in duplicate. Antioxidant activity was expressed as IC₅₀ with units of ppm (Part per Million). A higher IC₅₀ value indicated weaker antioxidant activity in the sample. Antioxidant activity was categorized as follows: very strong if IC₅₀ < 50 ppm, strong if 50-100 ppm, moderate if 100-150 ppm, weak if 150-200 ppm, and very weak if >200 ppm (Molyneux, 2004 in (21)).

Antioxidant Activity Test

The first step of the antioxidant activity test using the DPPH method involved mixing DPPH powder with a methanol solvent. Subsequently, the preparation of the sample solution was conducted by using 2 ml of each sample solution, which was placed into a vial, followed by the addition of 2 ml DPPH solution. The mixture was then homogenized. Once the solution was

RESULTS AND DISCUSSIONS

Texture

Texture analysis of the watermelon jelly drink was conducted using duplo analysis and two repetitions to determine product consistency across treatments. The highest texture value was observed in formulation F4 (12% watermelon albedo juice drink : 48% ciplukan juice drink), while the lowest texture value was found in formulation F3 (24% watermelon albedo juice : 36% ciplukan juice).

Table 2. Result of Statistical Analysis on Texture Jelly Drink

| Parameter | Result of Texture Jelly Drink (gF) | | | |
|-----------|------------------------------------|----------------------------|--------------------------|---------------------------|
| | F1 | F2 | F3 | F4 |
| Texture | 240.4 ± 15.8 ^c | 166.8 ± 15.6 ^{ab} | 128.4 ± 4.2 ^a | 634.6 ± 16.9 ^d |

Source: Laboratory Result, 2023

Notes : Comparison of watermelon, albedo and ciplukan (*Physalis angulata*) for each formula is F1 (40:48:12), F2 (40:36:24), F3 (40:24:36), dan F4 (40:12:48)

a,b,c = similar letter notation means no significant difference at the Tukey HSD test level with a value of 5%

Based on the results of the Tukey HSD (Honestly Significant Different) test, as presented in **Table 2**, no significant difference in texture was observed between formulation Fa and F3 ($\mu_i - \mu_j \leq$ Tukey HSD value). In contrast, significant differences in texture ($\mu_i - \mu_j >$ Tukey HSD value) were found between F1 and F2, F1 and F3, F1 and F4, F2 and F4, as well as F3 and F4. The main factor that influenced the texture of the jelly drink was the presence of carrageenan as one of the raw materials, as carrageenan was able to bind large amounts of water and form a very sturdy gel matrix structure (13). However, in this study, the composition of carrageenan in all formulas remained the same because no treatment was applied.

Other factors that affected the texture of food were acidity, sugar, and pectin, which were interrelated (22). In this study, one possible factor that might have influenced the texture of the jelly drink was the presence of solid ciplukan (*Physalis angulata*) juice mixed during the cooking process. In addition, ciplukan (*Physalis angulata*) fruit contains many seeds, so when mashed with water, it forms a liquid with a lot of solute sediment. These precipitates were at risk of being filtered out in the filtration process, which could have thickened the final product of ciplukan (*Physalis angulata*) fruit juice and improved the texture of the jelly drink. This was consistent with the results of research (23), which stated that the higher the addition of ciplukan (*Physalis angulata*) fruit, the harder and chewier the marshmallow texture became.

The presence of pectin in food also affected gel formation. Pectin functions by forming elastic

solids and enhancing the resulting texture (24). Pectin in watermelon albedo was classified as low methoxyl pectin, resulting in a less significant effect on the texture of the jelly drink (25). This was consistent with research(26), which stated that watermelon albedo had an influence on viscosity, though not significantly, as its low methoxyl pectin could not thicken water kefir.

Both watermelon albedo and ciplukan (*Physalis angulata*) fruit were found to influence the texture of the resulting jelly drink. The combination of watermelon albedo and ciplukan (*Physalis angulata*) fruit juice proportions that produced the softest jelly drink texture was F3 (24% watermelon albedo juice: 36% ciplukan (*Physalis angulata*) fruit juice), as the final load was close to the commercial jelly drink texture value of 128.4 gf. The differences in the texture values between the commercial jelly drinks and those in this study were thought to be caused by variations in the basic ingredients and the composition of the gelling agent used.

Antioxidant Activity

The antioxidant activity of the jelly drink, as measured by the DPPH method, was indicated by the IC₅₀ value. The antioxidant activity of the watermelon jelly drink was analyzed using duplo analysis and two repetitions to determine the consistency of the product in each treatment. Based on the result of the ANOVA test, it was found that the F count < F table, indicating no significant difference in antioxidant activity (IC₅₀) among the jelly drink formulations. The results of the antioxidant activity test on jelly drinks are presented in **Table 3**.

Table 3. Result of Analysis Average Antioxidant Activity

| Sample | IC ₅₀ (ppm) |
|----------|------------------------|
| F1 (731) | 38507.5 |
| F2 (455) | 58775.0 |
| F3 (402) | 44353.0 |
| F4 (508) | 51868.0 |

* Source: Laboratory Result, 2023

Notes : Comparison of watermelon, albedo and ciplukan (*Physalis angulata*) for each formula is F1 (40:48:12), F2 (40:36:24), F3 (40:24:36), dan F4 (40:12:48)

The results of the antioxidant activity test showed that the highest IC₅₀ jelly drink was observed in F4 (12% watermelon albedo juice drink : 48% ciplukan juice drink), indicating the weakest antioxidant activity. Conversely, the

lowest IC₅₀ jelly drink value was found in F1 (48% watermelon albedo juice drink : 12% ciplukan juice drink), which exhibited the strongest antioxidant activity among the four formulas. A higher IC₅₀ value in the jelly drink sample indicated weaker

antioxidant activity. The antioxidant activity of the four jelly drink formulations was classified as very weak because the IC₅₀ values were greater than 200 ppm.

The weak antioxidant activity might have been caused by the high temperature used during the cooking process of the jelly drink. Antioxidant activity in food decreased by more than 10% when heated at temperatures above 70°C. This occurred because some of the antioxidant components were more easily oxidized at high temperatures (27). These findings were consistent with previous research (12), which explained that the low antioxidants in watermelon and tomato jelly drinks were influenced by non-optimal temperatures for antioxidants that are vulnerable and highly sensitive to high temperatures.

In addition to the temperature factor, antagonistic interactions among the secondary metabolite groups contained in the ingredients might have also affected the total antioxidant activity of the jelly drink. (28). Lutein in watermelon flesh and albedo was thought to have antagonistic interactions with beta-carotene in ciplukan (*Physalis angulata*) fruit. This was consistent with research (29), which stated that an antagonistic interaction occurred between lutein and beta-carotene.

The difference in IC₅₀ values of watermelon flesh, watermelon albedo, and ciplukan (*Physalis angulata*) fruit also contributed to the variation in total antioxidant activity in the jelly drink, although not significantly. Among watermelon flesh and albedo, ciplukan (*Physalis angulata*) fruit had the weakest antioxidant activity, with an IC₅₀ of 63,46 ppm (13). This caused F4, with the highest addition of ciplukan (*Physalis angulata*) fruit juice at 48%, to be the jelly drink formula with the weakest antioxidant activity. This finding was in line with research (23), which stated the higher the proportion of ciplukan (*Physalis angulata*) fruit added to ciplukan (*Physalis angulata*) and orange marshmallows, the higher the IC₅₀ value and the lower the antioxidant activity.

Watermelon jelly drink with the addition of watermelon albedo and ciplukan (*Physalis angulata*) fruit could not be classified as a food source of antioxidants because the IC₅₀ value was very high, and the antioxidant activity was very weak. However, watermelon jelly drink with the

addition of albedo and ciplukan (*Physalis angulata*) fruit was considered healthier to consume compared to commercial jelly drink because it was made from natural ingredients. Commercial jelly drinks typically did not include information on antioxidant activity, and if antioxidant activity was present, it was most likely derived from synthetic ingredients such as BHT (Butylated Hydroxytoluene) (30).

CONCLUSION AND RECOMMENDATION

Based on the results of the texture test and antioxidant activity of the jelly drink, there was a significant difference in the texture of each jelly drink formula but no significant difference in the antioxidant activity of each jelly drink formula. The selected jelly drink product is F3 (24% watermelon albedo and 36% ciplukan (*Physalis angulata*) fruit) with a texture value of 128.4 gf and antioxidant activity (IC₅₀) 44353 ppm. Therefore, this jelly drink cannot be classified as an antioxidant-functional drink, but it is considered healthier to consume compared to commercial jelly drinks because it is made from natural ingredients. It is suggested that further research on antioxidant beverage research should monitor the stability of the temperature during heating, ensuring that the temperature remains below 70° until the heating process is complete.

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