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The Analysis of Antioxidant Capacities and Sensory in Sea Grapes *(Caulerpa racemosa)* Powdered Drink as a Therapeutic Obesity

Analisis Kapasitas Antioksidan dan Sensori Minuman Serbuk Anggur Laut sebagai Terapeutik Obesitas

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ABSTRACT

Background: Obesity is a global problem which increasing simultaneously. The high-fat accumulation in the body will result from mild chronic inflammation. Developing a local drink based on seagrapes *(Caulerpa racemose)* is thought to have a high antioxidant capacity and the potential to become an alternative therapeutic drink for obese people. Seagrapes are easily damaged, so proper drying is needed to maintain antioxidant potential and assisted by adding gum arabic to increase the acceptability.
Objectives: To analyze the antioxidant capacity and sensory of sea grapes powder drink *(Caulerpa racemose)*.
Methods: The design experiment research was utterly randomized and only used one gum Arabic treatment with a 2.5, 5, and 10% concentration and three replication as sea grapes powder drink samples. The samples were analyzed to seek the antioxidant capacity of DPPH (2,2-diphenyi-1-picrylhydrazyl), CUPRAC (Cupric Ion Reducing Antioxidant Capacity), and FRAP (Ferric Reducing Antioxidant Power). Then research data were analyzed by employing ANOVA and Duncan's follow-up test.
Results: The higher concentration of gum Arabic has significantly increased the antioxidant capacity. DPPH, CUPRAC, and FRAP values in 10% gum Arabic concentration were 13.21±0.1 mg/100 g, 25.26±0.5 mg, and 2.89±0.3mg/g. Based on the sensory test results, the panelists preferred the 10% gum Arabic concentration because the color is lighter, can minimize odor and viscosity, and taste better.
Conclusions: Seagrapes powder drink with a concentration of 10% gum Arabic has the potential as a therapeutic obesity with the highest antioxidant capacity and is sensory acceptable.

INTRODUCTION

Today's evolving lifestyles, such as high calorie and fat intake, with energy imbalance, have increased the prevalence of obesity and its comorbidity to become a significant health problem[1]. Based on a meta-analysis review shows a parallel trend between increased consumption of high-calorie drinks and epidemics of obesity, diabetes mellitus, hypertension, and a high risk of cancer at a young age and in adults[2,3]. In obesity conditions, the occurrence of excess calories causes fat accumulation in adipose tissue, stimulating the release of inflammatory mediators such as tumor necrosis factor (TNF) and interleukin 6, suppressing adiponectin production, predisposing to pro-inflammatory and oxidative stress states[4]. Obesity also enlarges adipose tissue, and when this condition happens for a long time, it will become hypoxic and trigger an inflammatory chain reaction[5].

The prevalence of obesity worldwide is 1.9 billion persons, with 39% overweight and 13% obese[6]. The increasing number of obesity cases also occurs in developing countries, including Indonesia[7]. According to Basic health research, obesity has increased by 11.8% in the 11 years from 2007 to 2018 in Indonesia[8].

One prevention strategy for obesity is to improve the food consumption pattern by increasing the foods containing antioxidants[9]. The result of the epidemiological study showed that countries with a low number of obesity cases have their people consuming seaweed at regular frequency; thus, the low number of obesity cases was caused by the antioxidant content in seaweed[10]. Indonesian government efforts to develop and accelerate food based on local ingredients have become a strategic plan in 2020-2024[9]. Local food containing bio active compounds can serve as a functional food for the human body, one of which is sea grapes. According to Regulation of the Head POM Agency

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Number: HK.03.1.23.11.11.09909 of 2011, the definition of functional food is processed food contains one or more food components based on the scientific studies that own certain physiological functions beyond their essential functions and has proven to be harmless and beneficial to the human health[11].

Sea grapes (*Caulerpa racemosa*) were discovered in 1926 on the coast of Tunisia in the Mediterranean waters, the Atlantic Islands (Canary Islands), and green macroalgae commonly known as green caviar[12,13]. Currently, sea grapes *(Caulerpa racemosa)* are found in several coastal areas of Indonesia, have already been consumed by local people, and can be cultivated where one of the cultivation places is located in the Takalar Regency, South Sulawesi Province[14]. The sea grapes harvest has fulfilled the needs of these surrounding communities[15]. Sea grapes have many different names in various regions in Indonesia, such as in Makassar, known as *Lawi-Lawi. I*n Bali, as *Bulung Boni,* and in Java region is known as *Latoh. Caulerpa sp.* is similar to caviar fish eggs, resembling grapes. Therefore, in the Indonesian language known as Sea grapes[16,17]. Sea grapes can be consumed directly (edible seaweed) and have a specific characteristic of fresh seaweed scent[18].

Sea grapes can produce a source of antioxidants[17]. The natural antioxidant protects cells and body organs and detoxifies the human body from ROS by counteracting free radicals, donating hydrogen and electrons, breaking down peroxides, reducing singlet oxygen, and inhibiting enzymes and metal chelating agents[19]. Sea grapes will produce bio active components to protect themselves from damage caused by UV radiation and free radicals, so they possess adequate active components, including antioxidant components and ultraviolet absorbers[13]. The ability of sea grapes as an antidote to ultraviolet (UV) radiation indicates these green seaweed capable of producing antioxidants because it contains phenolic acids, thiamine, tannins, and carotenoids, such as xanthophylls which are involved in modulating oxidative stress and regulating transcription factors so that they can suppress inflammation[1]. There are several methods to test the potential of antioxidant capacity based on electron transfer, such as 2,2-diphenyi-1-picrylhydrazyl (DPPH) to reduce free radicals, Cupric Ion Reducing Antioxidant Capacity (CUPRAC) to reduce copper (Cu2+) and Ferric Reducing Antioxidant Power (FRAP) to reduce Iron (Fe^{3+})[20].

The elaborate effort by using seaweed in local food products has multiplied in the last few decades. Fresh sea grapes, *Caulerpa racemose,* have the highest antioxidant activity compared *to Caulerpa scalpelliformis* and *veravelensis*[21]. Sea grapes characteristics that are safe for consumption and have been utilized by the coastal communities as fresh vegetables become the basis assumption for this seaweed can be explored more as a source of natural antioxidant[21]. Sea grapes are perishable because of the high water content, so they will not last longer, and their quality is easy to decrease[17]. The creation of an instant powder drink is a way to prevent any damage to the seaweed through several methods. A drying technique by a vacuum evaporator can reduce seaweed water content by a lower temperature to maintain its nutritional value[22]. Applying the evaporation method with temperature under 1000C does not require high costs and is easier to implement[23]. Evaporation is a simultaneous process of heat and mass transfer. The working principle of the vacuum evaporator machine is to lower the pressure causing the boiling point to decrease more quickly[24]; hence the contact time of the material with the tool becomes faster and more efficient, and the quality of the material is maintained[23]. Making powdered drinks can reduce the water content, thereby inhibiting the growth of microorganisms[25].

Development of powdered beverage products using encapsulation agents functions as coatings for flavor components, increasing the total amount of solids and volume, shortening the drying process, and minimizing damage due to heating[26]. Commonly used encapsulating agents are Arabic gum, dextrin, and maltodextrin[27]. Arabic gum is widely applied as a food additive, increasing shelf life, micro encapsulation, and nanotechnology[28]. Furthermore, it can be added to drinks due to its high solubility in water. Hence, It is more suitable for producing powdered beverages and improves the stability of delicate chemical substances[29]. Unfortunately, until now, no publication is available about sea grapes drink. Therefore, the researchers are interested in developing a product based on sea grapes and analyzing the antioxidant and sensory capacities of sea grapes powder drink as a drink for obesity therapeutic.

METHODS

The design in this study was a laboratory scale experiment with a completely random design with the treatment of gum Arabic concentration levels of 2,5 %, 5 %, and 10 % to the weight of sea grapes and conducted in three repetitions. The sea grapes powder drink acts as the experimental unit. Whereas research sites were the PAU IPB laboratory for the preparation and manufacture of powder drinks; the Biochemistry Laboratory, Department of Pharmacy, Faculty of Medicine and Health Sciences, UIN Alauddin Makassar for chemical analysis of antioxidant capacity; and the Organoleptic Laboratory of the Department of Community Nutrition, Faculty of Ecology and Humans, IPB Bogor for the implementation of sensory analysis.

Tools and Materials

The tools used in this research were a vacuum evaporator, blender, 60 mesh filter, desiccator, Erlenmeyer, measuring cup, dropper, micropipette, analytical balance, vortex, uv-vis spectrophotometry, test tube, vial, spatula, and glass funnel, Thermometer. The research types of equipment for sensory analysis were plastic cup containers, small plastic spoons, trays, large bottles, and large spoons. The primary food ingredient was sea grapes harvested from ponds in Takalar Regency, South Sulawesi Province. The secondary food ingredients were gum Arabic, lemon essence, and low-calorie sweetener sucralose, purchased from a pastry shop in Bogor, and stratagem flavor from PT. Firmenich. For chemicals compound applied in this research were Gum Arabic, Ethanol 96%, DPPH (1,1diphenyl-1-picrylhydrazyl), Ammonium acetate, CuCl2.2H2O,

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NeucoprineFeCl3.6H¬2O and TPTZ (2,4,6-Tripyridyl-S-Triazine).

The Production of Sea Grapes Powder Drink

The sea grapes were washed to eliminate dirt, soaked in 3 % lemon water for an hour, blanched with hot water in 900C for 20 seconds, then blended while adding the Arabic gum, taste gem flavor powder, essence, and essence low-calories sweetener. After the mixture became a suspension, the mixture was then dried by a vacuum evaporator at the temperature of 40^{0}C for approximately 45-60 minutes, so the suspension changed into coarse sheets. The next step was crushing the sheets with a dry blender to change them into sea grape powder. The final stage of this experiment was sieving 60 mesh to obtain the powder. In brief, the stages of making a powdered drink from sea grapes will be illustrated in Figure 1. The formulation for making sea wine products is a modification of the previous research[23,30] and can be observed from Table 1.

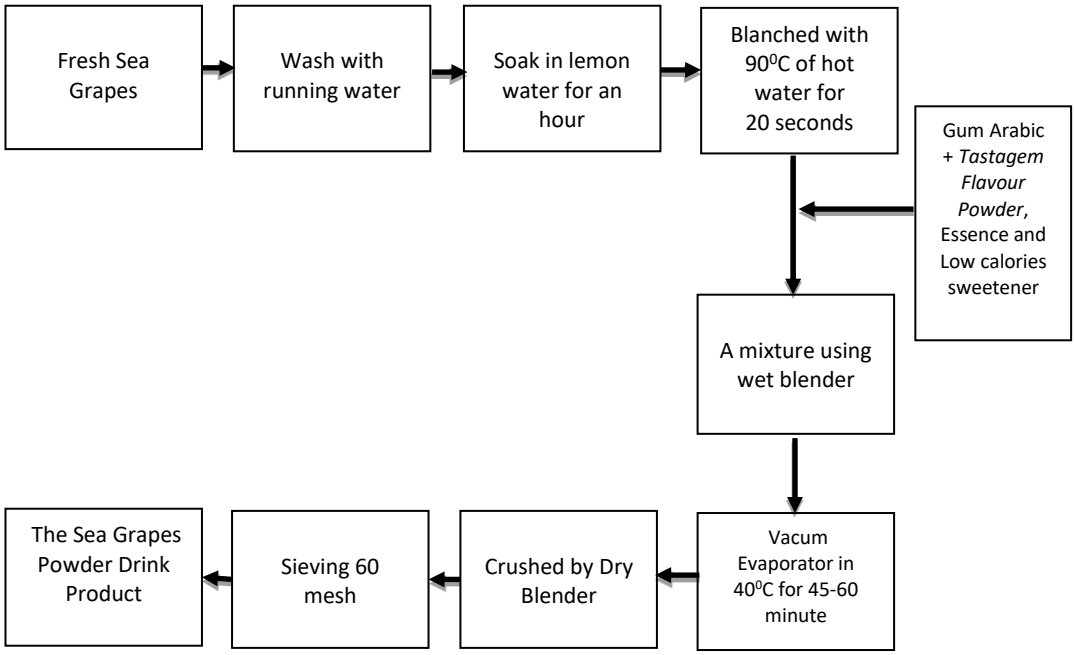

Figure 1. Flow chart of the stages of the procedure for making sea grapes powder drink products

Table 1. The formulation of sea grapes powder drink

Material (g)	Gum Arabic Concentration		
	F1	F2	F3
Sea Grapes	1000	1000	1000
Gum Arabic	25	50	100
Tastagem Flour	1	1	1
Essence	1	1	1
Low-calories sweetener	0,5	0,5	0,5

The Analysis of Antioxidant Activities Capacities

The Analysis 2,2-diphenyl-1-picrylhydrazyl (DPPH)[31]

The test for this research began by creating a mother liquid solution of 0.1 mM DPPH by weighing 40 mg of DPPH and dissolving it in 1000 ml of methanol. The 10,000 ppm test solution is prepared by weighing 10 mg of sea grapes powder drink to be dissolved in 1000 µl of dimethyl sulfoxide, then heated and mixed using a vortex. 50 µl of the test solution was put in a test tube, and then added by 450 µl of methanol was used to obtain 1000 ppm concentration.

The next step of this experiment was preparing a standard solution of ascorbic acid 200 ppm by weighing 20 mg of vitamin C which dissolved in 100 ml of 96% ethanol. Then, the solution was made into several concentrations; 200, 160, 120, 80, and 40 ppm by using a pipette to the solution of 200 ppm of an ascorbic acid solution of 500, 400, 300, 200, and 100 µl. Then, it was added by 0, 100, 200, 300, and 400 µl of methanol in sequential order. Each test and standard solution were added with 3 ml of DPPH solution and incubated at 37^{0}C for 30 minutes. Then, the absorbance level was measured by UV-Vis spectrophotometry at a wavelength of 517 nm. Later, the absorption of the blank (no sample/standard) was also measured (A_{blank}). From the absorbance, the percent inhibition was calculated with the following formula:

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$$\%\ inhibition = \frac{blanc\ absorbance - sample\ absorbance}{sample\ absorbance} \text{x } 100\%$$

Then the standard curve (linear) of ascorbic acid was made to explain the relationship between the amount of vitamin C (mg) to the percentage of inhibition. The equivalence of the extract to vitamin C was calculated against the standard curve of ascorbic acid for the DPPH assay.

The Analysis Cupric Ion Reducing Antioxidant Capacity (CUPRAC)[32]

CUPRAC reagent is a selective reagent because it has a low reduction potential value of 0.17 V. CUPRAC reagent was made fresh by mixing CuCl210x10-2 M solution, Neocuproine solution 7.5 x 10-2 M, and ammonium acetate buffer solution pH 7 with 1:1:1 ratio.

The initial stage was creating a $CuCl_2$ solution, a solution of ammonium acetate, and a solution of neocuproine. 1200 mg $CuCl_2.2H_2O$ was weighed and dissolved in 750 ml of distilled water. A total of 57.750 mg of ammonium acetate was weighed and then dissolved in 75 ml of aqua dest, and the last one, a total of 0.039 g of neocuproine, was weighed and then dissolved in 250 ml of 70% ethanol.

The next stage is preparing a test and standard solutions for this research. The test solution is made from a concentration of 10,000 ppm: 10 mg of sea grapes powder drink which was weighed and then dissolved in 1000 µl of DMSO while mixed using a vortex. A total of 20 µl of the test solution was taken and put into a test tube with 980 µl of methanol to obtain a concentration of 200 ppm. As the preparation for 200 ppm ascorbic acid standard solution: 20 mg of vitamin C was weighed and dissolved in 100 ml of 96% ethanol. The solution then was made into several concentrations, namely 50, 40, 30, 20, 16, and 12 ppm concentrations which were taken from 250, 200, 150, 100, 80, and 60 µl added by methanol concentration under doses of 750, 800, 850, 900, 920 and 940 µl. Next, the test and standard solutions were added with 3 ml of reagent solution and incubated at room temperature for 30 minutes. Afterward, The absorbance was measured by UV-Vis spectrophotometry at a wavelength of 450 nm. Later, the absorbance data was used to make a standard (linear) curve of ascorbic acid as the relationship between the amount of vitamin C (mg) to its absorbance. The extract equivalence for vitamin C was calculated against the standard curve of ascorbic acid for the CUPRAC assay.

The Analysis Ferric Reducing Antioxidant Power (FRAP) Test [31]

The FRAP reagent was prepared new by mixing a $FeCl_3$ solution of 2.0 x 10-2 M, a solution of TPTZ (2,4,6-Tripyridyl-S-Triazine) 1.0 x 10-2 M, and ammonium acetate butter solution with pH of 3.6 in a ratio of 1 : 1: 10.

In the Initial stage, a FeCl3 solution, an ammonium acetate solution, and a TPZ solution of 324 mg of $FeCl_3.6H_2O$ were weighed and added by 1.2 ml of 1 M hydrochloric acid and 60 ml of aqua-dest. As many as 187.2 mg of TPTZ solution were weighed and dissolved in 60 ml of 96% ethanol. A total of 1.86 grams of sodium acetate was then weighed and added to 9.6 ml of glacial acetic acid and 600 ml of aqua-dest. Meanwhile, the preparation for the test solution with a concentration of 10,000 ppm was 10 mg of sea grapes powder drink weighed and dissolved in 1000 µl of DMSO while mixed using a vortex. 50 µl of the test solution was then put into a test tube, and 950 µl of methanol was added until it obtained a concentration of 500 ppm as the test solution. The preparation for 200 ppm ascorbic acid standard solution was started by weighing 20 mg of vitamin C to be dissolved in 100 ml of 96% ethanol. Then, the solution was made into several concentrations (20, 16, 12, 8, and 4 ppm) by taking 100, 80, 60, 40, and 20 µl in sequences to add with methanol with doses of 900, 920, 940, 960 and 980 µl. Afterward, the test and standard solutions were added with 3 ml of reagent solution and incubated at room temperature for 30 minutes. Then the absorbance was measured using UV-Vis spectrophotometry at a wavelength of 595 nm, and a standard (linear) curve of ascorbic acid was made, which became the relationship between the amount of vitamin C (mg) and its absorbance. The equivalence of the extract to vitamin C was calculated against the standard curve of ascorbic acid for the FRAP assay.

The Sensory Analysis

A sensory analysis using organoleptic sense was conducted by 39 semi-trained panelists of students from the Nutrition Science Study Program, Department of Community Nutrition, Faculty of Human Ecology and Food Science Study Program, Faculty of Agricultural Technology, IPB University. The inclusion criteria of the panelists were in good health, had taken previous sensory tests, and had received material about sensory tests (semi-trained). Parameters tested on sea grapes powder drink were the color, aroma, viscosity, and flavor by the hedonic test method.

The panelists were collected and asked to fill out the attendance list, and then the researchers explained the purpose of the research and some related materials which the panelists must understand. Next, the panelists were asked to fill out the informed consent form as the willingness to participate in the sensory analysis activities that refer to Helsinky Declaration[33]. The researchers explain the procedure for filling out the product form, which will later be evaluated. They also asked the panelists to observe, flavor, and smell the product using their senses and assess it on a scale of 1 – 7. The lowest scale will be an assessment of strongly dislike, while the largest scale is an assessment of strongly like. Finally, they were asked for their personal opinion about their preferences or vice versa, and the assessment results were written on the form provided.

Data Analysis

The results obtained were statistically processed using Excel and SPPS and analyzed using analysis of variance (CI = 95%), which was then continued using the Duncan Test (CI=95%) to observe or to see different sample pairs.

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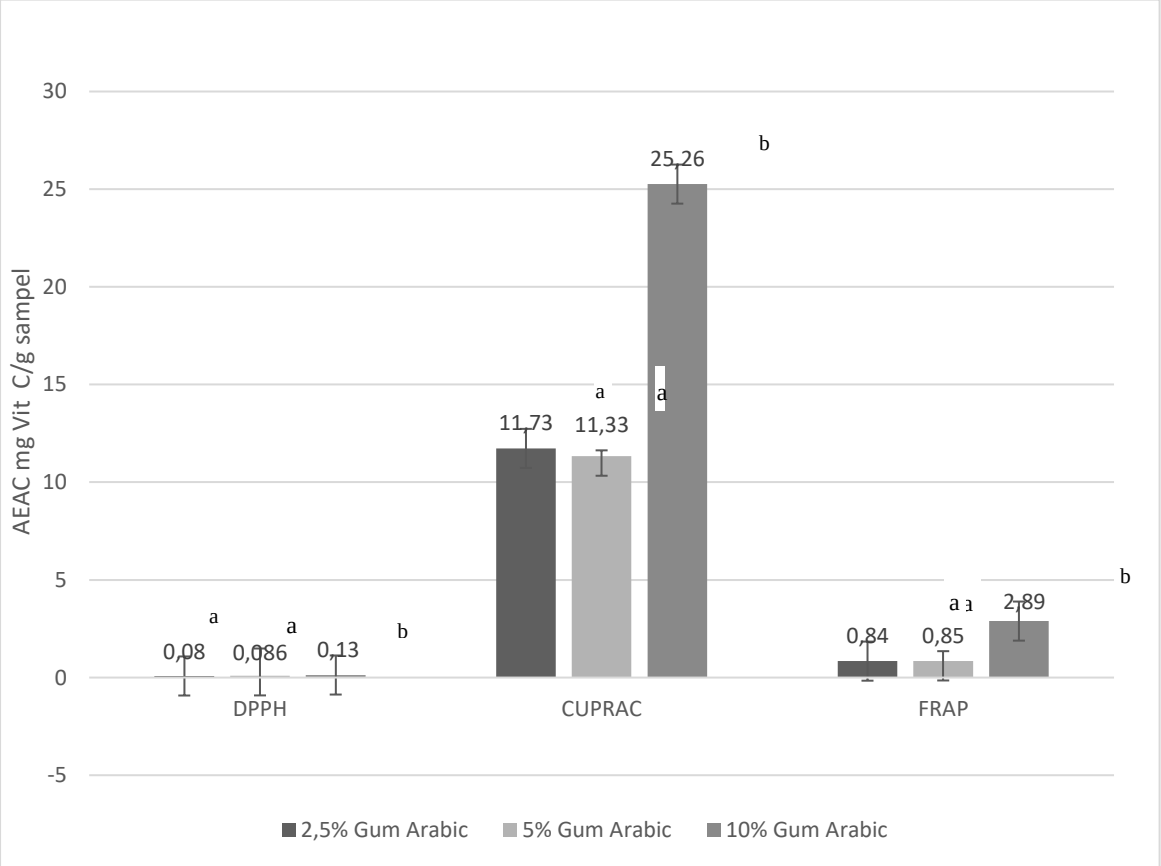
RESULT AND DISCUSSION

The Antioxidant Capacity of 2,2-diphenyl-1-picrylhydrazyl (DPPH)

According to Figure 2, gum Arabic treatment significantly affects the antioxidant capacity of the DPPH method ($p<0.05$). The 10% Arabic gum treatment had the highest antioxidant capacity, equivalent to 0.13±011 mg vitamin C/g of drink powder. The effect of gum Arabic concentration provides excellent protection on the antioxidant content of the sea grapes powder drink. It was also reported that research on rosella juice showed that increasing concentrations of gum Arabic could maintain antioxidant properties[34]. This finding aligns with Agatha et al. (2021), who stated an increase in DPPH antioxidant activity and phenolic content by using a 10% Arabic gum concentration in a red dragon fruit kombucha powder drink product. The addition of gum arabic was used as an alternative encapsulation agent to maintain the function of antioxidant vitamin components and phenolic compounds in the manufacture of grapefruit powder[35].

DPPH solution as a stable free radical determines the capacity to catch organic radical compounds[30]. The working principle of DPPH as the recipient of a hydrogen atom (H) from the scavenger molecule, namely an antioxidant, will result in the reduction of DPPH to diphenyl pickerel hydrazine[31]. When DPPH is mixed with a substance that can donate hydrogen atoms, there will be a reduction in the color intensity from purple to a pale yellow color by the following chemical reaction: DPPH+ + InH → DPPH- + $In_{ox}+H^{+}$ [20].



Note: Different Letter Notation show differences in real number ($P<0,05$); AEAC= AscorbicAcid Equivalent Antioxidant Capacity

Figure 2. The graph of gum Arabic concentration to antioxidant capacity and sea grapes powder drink

The Antioxidant Capacity of Cupric Ion Reducing Antioxidant Capacity (CUPRAC)

The antioxidant capacity tested by the CUPRAC method in Figure 2 shows the result of Arabic gum treatment has a significant effect on the antioxidant capacity, and the 10 % Arabic gum concentration is evident to have the highest antioxidant capacity of 25.26 ± 0.5 mg vitaminC/g in powder drink when compared to other treatments. This finding aligns with the research on making black carrot encapsulation powder using three secondary materials: maltodextrin, Arabic gum, and tapioca starch. The antioxidant capacity of CUPRAC with Arabic gum and maltodextrin encapsulation is higher than tapioca flour due to the higher viscosity ability of maltodextrin and Arabic gum compared to tapioca flour[27]. Gum arabic has a low polymerization ability, which can minimize the opportunity for changes in the structure and configuration of a food compound; thus, gum arabic can provide strong protection against oxidation[36].

In the CUPRAC method, the bisneocuproin-copper(II) complex as the chromogenic reagent will

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oxidize antioxidant compounds from an extract and be reduced into a complex bond of bis-neocuproin-copper(I). The CUPRAC method also measured hydrophilic and lipophilic antioxidants such as carotene and tocopherol[37]. CUPRAC reagent is a selective reagent due to its (potential) low reduction value. From the visual appearance, the early color of the solution, which was turquoise, later changed into yellow color under a chemical reaction of $nCu(Nc)_2^{2+} + A_R(OH)_n \rightarrow nCu(Nc)_2^{2+} + A_R(=H)_n + nH^+$ [36].

The Antioxidant Capacity of Ferric Reducing Antioxidant Power (FRAP)

The antioxidant capacity tested by the FRAP method in Figure 2 shows that gum arabic treatment significantly affects the antioxidant capacity, where the 10% concentration of gum arabic has the highest antioxidant capacity equivalent to 2.89 ± 0.3 mg vitamin C/g in drink powder. From this data, an increased dose in gum Arabic concentration will give a higher AEAC value. In other experiments, a drying method for pineapple extract using gum arabic and maltodextrin encapsulated has the best FRAP antioxidant capacity compared to inulin. After six months of storage time, gum arabic encapsulation can minimize a decrease in its phenolic capacity better than maltodextrin and inulin[38].

The Frap method uses iron-ligand2,4,6-tripyridyl-triazine $Fe(TPTZ)_2^{3+}$ as a complex reagent with blue color and functions as an oxidizing agent and is going to be reduced to Fe(TPTZ)2 so the color will turn to yellow by the following chemical reaction: $Fe(TPTZ)_2^{3+} + AROH \rightarrow Fe(TPTZ)_2^{2+} + H^+ + AR=O$ [36].

In general, the ANOVA results from three test methods of DPPH, CUPRAC, and FRAP gave the same results; the 10 % of gum Arabic concentration had a significantly higher AEAC value when compared to the 2.5 % and 5 % gum Arabic concentrations ($p<0.05$), but the AEAC values from the three methods gave mixed results where the CUPRAC AEAC value was higher than the FRAP AEAC value. The FRAP AEAC value was higher than the DPPH value. It happens because there was an influence from the reaction mechanism from each test that produced different results, and also from the reagent's ability to react with antioxidant and free radical sources[37]. Moreover, it happened because vitamin C has a free hydroxy group acting as a free radical scavenger, and when vitamin C owns a polyhydroxy group, the antioxidant activity will be increased[20].

The highest antioxidant capacity of the seagrape powder drink is equivalent to 25.26 ± 0.5mg of vitamin C by the CUPRAC method. The Recommended Dietary Allowance of vitamin C for adults is 90 mg[39], and a vitamin C intake of 10 mg is required for every 10 kg weight gain in obesity/day[40]. Therefore per gram of sea grapes powder drink sample fulfilled, 25% contributes to the need for antioxidants.

The research of sea grapes powder drink can potentially be an antioxidant drink, particularly for the 10% gum Arabic treatment. The antioxidant capacities of this drink can be evaluated by applying the DPPH, CUPRAC, and FRAP[31]. The DPPH antioxidant capacity methods seem to have the lowest capacity compared to other methods because DPPH is very sensitive to light and pH and has some types of solvents that easily coagulate and make some types of antioxidants run slower than other methods[41]. Further, the DPPH method is only able to measure the hydrophobic antioxidants. In contrast, the FRAP method is more active for measuring antioxidants found only in hydrophilic conditions, and the CUPRAC method can measure the hydrophilic and lipophilic antioxidants in the forms of carotene, carotenoids, tocopherols, and phenols. Therefore, in the CUPRAC method, there will be more antioxidants that can be detected[37].

The radical scavenging capacity from sea grapes powder is suspected to derive mostly from components of bioactive compounds of carotenoids, phenols, flavonoids, alkaloids, and tannins contained in sea grapes[42,43]. The natural antioxidant contents from foodstuffs are therapeutic in protecting against free radicals that can trigger inflammation and oxidative stress[44]. Besides these benefits, the bioactive compounds in sea grapes also function as antibacterial, antidiabetic, and antitumor[43]. This finding is supported by several studies showing that sea grapes reduce hypercholesterolemia, inhibit the formation of fat tissue (adipogenesis), reduce oxidative stress, and repair inflammatory markers[45].

Sensory Analysis

A powder drink is a way to preserve a product so it is not easily damaged, having an attractive presentation and making the distribution easier[46]. The sea grapes powder drink product in this study applies three formulas which had been added with gum arabic concentration in sequential order of 2.5% (F1), 5% (F2), and 10% (F3) and were intended as the food product innovations based on local food ingredients for obesity therapeutics, displayed in Figure 3.

(a) (b) (c)

Figure 3. The sea grapes powder drink (a)= 2.5 % of gum arabic concentration ; (b)= 5% of gum arabic concentration; (c) = 10% of gum arabic concentration

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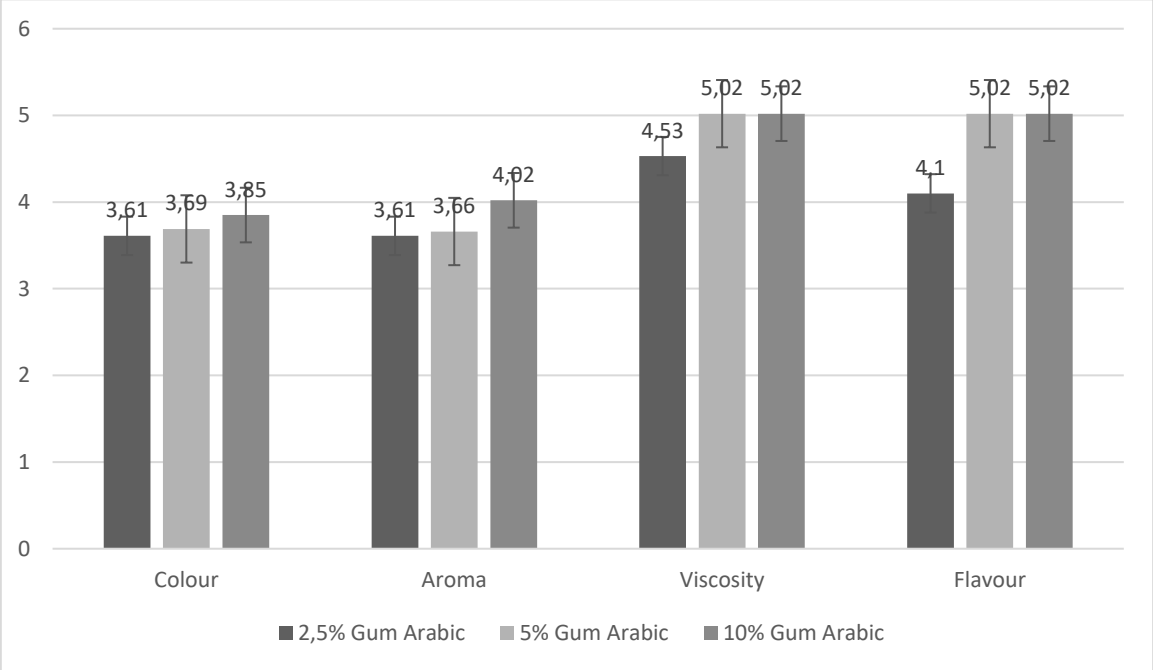

Figure 4. Sensory analysis of sea grapes powder drink

The result in Figure 4 showed that the analysis of sensory with ANOVA test to sea grapes in the gum Arabic concentration color attribute was no significant effect. However, the panelists prefer more to the sea grapes powder drink treated with 10% gum Arabic with the highest hedonic average value of 3.85 ± 0.2. After all, the color is not too dark compared to other concentrations, as is evident in Figure 3, which shows the sea grapes powder drink at 10% concentration has lighter color because the gum arabic solution was put more in the powdered powder drink. The sea grapes drink has dark green color because of the chlorophyll contents (5.48 mg/g of chlorophyll and 3.06 mg/g of b chlorophyll) equal to *tencha* leaves specifically used in the manufacture of matcha powder (with a chlorophyll content of 5.65 mg/g and b chlorophyll content of 4.33 mg/g)[47]. Environmental influences (heat, light, oxygen, and acid conditions) can quickly de Chlorophyll compounds (heat, light, and acid conditions)[48]. Research on *Caulerpa racemose* cream soup shows that the content will be lower due to heating[49]. It was caused by the release of many organic acids in the tissues, which impacted the formation of pheophytin. This reaction changes the chlorophyll color from green to brown as the Mg ion in the center of the chlorophyll is released and replaced with H ions[48,50]. The heating process also affects the chlorophyllase and lipoxygenase enzyme activities, and the chlorophyllase enzyme is an enzyme that accelerates the degradation rate of chlorophyll and becomes active at a temperature of 65-75^{0}C when dissolved into water[48]. Therefore, the appropriate drying technology to maintain its stability is a vacuum evaporator which uses a low temperature[50].

The sensory analysis in the sea grapes to the concentration of gum arabic in Figure 4 was conducted by ANOVA test and resulted in no effect on the aroma attributes (p>0.05). However, the panelists chose the 10% Arabic gum concentration treatment compared to other treatments. The highest average rating of the aroma attributed to the sea grapes powder drink was found in a concentration of 10% gum arabic (4.02 ± 0.2) because more gum arabic put into the concentration could minimize the distinctive aroma of sea grapes. Research on the manufacture of *cendol* drink with sea grapes also showed that the addition of sea grapes gives the effect of a pungent aroma and is less favored by the panelists because of its (sea grapes) distinctive and specific aroma[18]. The usage of gum Arabic in this research has the potential to minimize the effect of a less bright aroma, as said by the panelists.

The results obtained from the ANOVA test showed that the sensorial analysis of the sea grapes powder drink by adding gum arabic concentration did not affect the viscosity attribute (p>0.05). However, the panelists preferred the 5% and 10 % gum Arabic concentrations with an average value of 5.02 ± 0,1. In another study, it was shown that there was an effect of the addition of gum Arabic on the viscosity of making guava juice honey where the higher the value of the stabilizer weight given, the more viscosity of the product will increase[51].

The other result of the ANOVA test showed that the gum arabic concentraion did not significantly affect the flavor attributes. Panelists tended to like the 5 % and 10 % gum Arabic concentration treatments, as indicated by an average rating of 5.02, and it happens because the gum Arabic is an encapsulating agent with no flavor. Therefore, its addition to any food product will not affect the flavor of the food product[52]. This finding is supported by another study which also showed that adding gum Arabic amount into a pumpkin powder drink did not

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significantly affect the sample drink flavor on the sensory analysis done by panelists[53].

The sensory ANOVA results from the sea grapes powder drink in Figure 4 showed that the gum Arabic concentration does not have a significant effect on all attributes ($p>0.05$) because the amount of the concentration only has minor differences, so there is no significant changes occurred and no effect on the sensory viscosity.

The level of Arabic gum treatment had no statistical effect on all the sensory attributes of the panelists. However, the panelists tended to prefer sea grape powder drinks with a concentration of 10% gum Arabic on all attributes. This aligns with Tuan Azlan et al. (2020) research that the administration of Arabic gum does not affect the panelists' senses. Another study showed that the use affected instant coconut carrot drinks[54] and can increase satiety. It reduces glucose levels and can be used as an alternative to food product innovation for obesity[29].

However, there were limitations in the experimental investigation since only one type of treatment was conducted in Arabic gum. Furthermore, it did not compare the antioxidant content of sea grapes based on seasonal factors, which opens up opportunities for future studies.

CONCLUSIONS

The highest antioxidant capacity for the DPPH method was 0.13 mg/g, the CUPRAC method was 25.26 mg/g, and the FRAP method was 2.89 mg/g with a treatment of 10% of gum arabic concentration. The sensory analysis showed that gum arabic concentration did not affect flavor, color, aroma, or viscosity attributes. The panelists preferred adding a 10% gum Arabic concentration to the sea grapes powder drink.

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