Antioxidant Activity and Consumer Acceptance Level of *Sargassum hytsrix* Seaweed Tea Enriched with Lemongrass Powder

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Abstract. *Sargassum hystrix* contains high antioxidant activity, so it has the potential to be a good raw material for product development such as seaweed tea. However it still has a drawback, namely the presence of a fishy aroma that is not liked by the consumers. Therefore to balance the aroma, this study aims to determine the effect of adding lemongrass powder on antioxidant activity and consumer acceptance of *S. hystrix* seaweed tea. The treatments used in this study were variations in the addition of lemongrass powder of 0, 10, 15, 20, and 25%. The tests carried out included water content, total phenol content, antioxidant activity (2,2-diphenyl-1-picrylhydrazyl (DPPH) and ferric reducing antioxidant power (FRAP) methods), hedonic test, and quantitative descriptive analysis (QDA). The results showed that the addition of lemongrass powder affected total phenol content, antioxidant activity, consumer acceptance level, and aroma perception in the QDA test. The best performance was the addition of 20% lemongrass powder with the characteristics of water content of 6.42 ± 0.13%, total phenol content of 8.07 ± 0.2 mg GAE/g, antioxidant activity (DPPH method 84.17 ± 2.19%, FRAP method 22.24 ± 0.56 mM/g). The highest overall hedonic value was obtained by adding 20% lemongrass powder.

1 Introduction

Indonesia is known as the largest maritime country in the world with the second largest seaweed producer after China [1]. *Sargassum* sp. is one type of seaweed that is very abundant in Indonesia [2]. *Sargassum* sp. is rich in secondary metabolite compounds, such as phenolics, flavonoids, tannins, sterols, terpenoids, saponins, alkaloids [3] and glycosides [4]. *Sargassum* sp. also contains various important nutrients, including fiber, vitamins, and minerals and also has antioxidant activity [5]. Thus, this seaweed has the potential to be a good raw material to be made into a product that has benefits for human health. One of the drinks that is beneficial for human health is seaweed tea [6].

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Seaweed tea is a functional food product made from seaweed that is quite simple to make, contains nutrients needed by the body, and is accepted by consumers [7]. However, seaweed tea still has a drawback, namely the presence of a fishy odor [8]. Therefore, efforts are needed to reduce or eliminate the fishy odor, one of which is by adding lemongrass because lemongrass has a unique and fresh aroma like lemon [9]. Lemongrass is expected to be a working masking agent that will neutralize compounds that cause unwanted fishy aromas or tastes.

Lemongrass (*Cymbopogon citratus*) contains flavonoids, saponins, tannins and alkaloids [10]. Lemongrass also contains compounds that can help eliminate the fishy odor in food, including the fishy odor in seaweed. Lemongrass was previously added to patin fish meatball products (15%) to reduce the fishy odor in fish [11]. The presence of this content is expected to reduce the fishy odor in seaweed tea products. This study aims to determine the effect of adding lemongrass on the antioxidant activity and acceptance level of *S. hystrix* seaweed tea.

2 Materials and methods

2.1 Materials

The materials used in this study were fresh samples of *Sargassum hystrix* seaweed obtained from Sundak Beach, Gunungkidul. Other materials that was used in this study are lemongrass powder was obtained from Indoplant Yogyakarta, distilled water (CV Sentra Teknosains Indonesia), ethanol (Merck, USA), Folin reagent (Merck, Milipore), DPPH (Merck, USA), gallic acid (Merck, Germany), acetic acid (Merck, USA), hydrogen chloride (Merck, USA), ascorbic acid (Merck, USA), potassium phosphate(Merck, USA), sodium hydroxide (Merck, USA), TPTZ (Sigma A, Germany), iron(III) chloride hexahydrate (Merck, USA), and ferrous sulfate heptahydrate (Merck, USA).

2.2 Identification and sample preparation

Fresh *S. hystrix* seaweed samples were taken from Sundak Beach, Gunungkidul Yogyakarta. Seaweed samples were taken by cutting the bottom of the thallus with a holdfast. The next step was to clean the samples from dirt and then put them in a plastic clip, and store them in a cool box containing ice cubes. The samples were then taken to the Fish Technology Laboratory, Department of Fisheries, Universitas Gadjah Mada to be cleaned again. After that, some fresh seaweed samples were preserved with 70% alcohol to maintain the morphological structure so that it would not be easily damaged. Furthermore, the samples were identified at the Plant Systematics Laboratory, Faculty of Biology, Universitas Gadjah Mada.

2.3 Seaweed tea production

The production of seaweed tea in this study refers to the method as explained by Larasati & Husni [7] with modifications. The modification made is the use of lemongrass powder when roasting. The manufacture of seaweed tea begins with the *S. hystrix* seaweed sample being washed thoroughly with running water to remove dirt attached to the seaweed. The fresh/wet sample was weighed as much as 200 g then soaked in 2,000 mL of hot water for 16 minutes. The initial temperature of the hot water used was 85°C and the temperature will decrease during the soaking process. After soaking, the wilting process was carried out using a baking sheet. The wilting process was carried out by air-drying the sample for 24 hours at room temperature (±25°C). Furthermore, the sample was roasted for 10 minutes and given a

variation of the addition of lemongrass powder by sprinkling the lemongrass powder in the last 5 minutes. Variations in the addition of lemongrass powder were carried out, namely 0, 5, 10, 15, 20, and 25%, (from the initial weight of seaweed, which is 200 g). During roasting, the sample was stirred to dry evenly. After that, the dried seaweed tea sample was reduced in size to 0.5 ± 0.1 cm flakes. These flakes were made by cutting with scissors. The dried seaweed tea that was already in the form of flakes was put into a tea bag as much as 1 g and sealed. The dried seaweed tea was stored at a temperature of 4°C before use.

2.4 Serving seaweed tea

Seaweed tea was served by brewing one tea bag containing 1 g of dried seaweed sample into 100 mL of boiling water and then left for 6 minutes. During brewing, stirring was carried out 2-3 times and then the tea bag was removed from the solution [5]. The *S. hystrix* tea infusion was then used for testing total phenol levels, antioxidant activity, hedonic tests, and QDA tests.

2.5 Moisture content analysis

The moisture content of dried seaweed tea *S. hystrix* was analyzed using a moisture analyzer. A sample of 0.5 g was placed on the moisture analyzer plate and then the device was closed. Furthermore, the sample was incubated for 2-20 minutes until the drying process was complete. Then the water content value displayed on the analyzer screen was recorded.

2.6 Total phenol content analysis

Total phenol analysis of seaweed tea samples is based on the study conducted by Sinurat & Suryaningrum [8]. The assessment of total phenols commenced with the preparation of a standard gallic acid solution, involving the dissolution of 2 mg of gallic acid in 10 mL of distilled water. Subsequently, a sequence of dilutions ranging from 0 to 100 ppm, including 20, 40, 60, 80, and 100 ppm, was meticulously prepared. To create a sample solution with a concentration of 10 mg/mL, 0.1 g of *S. hystrix* tea was infused in 10 mL of boiling water. Similarly, a lemongrass sample solution with a concentration of 10 mg/mL was concocted by dissolving 0.1 g of lemongrass powder in 10 ml of distilled water, followed by thorough vortexing until uniformity was achieved. The filtrated solutions of *S. hystrix* tea and lemongrass were then combined with 1 mL of the standard gallic acid solution and 96% ethanol, 5 mL of distilled water, and 0.5 ml of 50% Folin Ciocalteu reagent in a container. The amalgam was meticulously mixed until homogeneity was attained and allowed to rest for 5 minutes. Subsequently, 1 mL of 5% sodium carbonate was introduced and homogenized through vortexing, followed by an incubation period in a dimly lit environment for 1 hour. Following this, the absorbance of both the standard solution and sample solution was gauged using a UV-Vis spectrophotometer at a wavelength of 725 nm. The absorbance values obtained from the standard gallic acid solution were utilized to construct a standard curve via the formulation of a linear equation. The absorbance data of the sample was then inputted into this equation to determine the total phenolic content, expressed in mg GAE/g. The formula employed for computing the total phenolic content is as follows:

$$\text{Total phenol (mg GAE/g)} = \text{x}\left(\frac{\text{m}}{\text{v}}\right) \quad (1)$$

Description: x: concentration of test solution (mg mL^{-1}); v: volume of test solution (mL); m: mass of test solution (g)

2.7 Antioxidant activity analysis

2.7.1 DPPH method

Antioxidant activity test using DPPH method was conducted based on research by Muthia [12] with some modifications. DPPH solution of 0.1 mM was made by dissolving 3.9 mg of DPPH powder in 100 mL of ethanol. The solution was then incubated at 4°C for 30 minutes. *S. hystrix* tea sample solution with a concentration of 10 mg/mL was made by brewing 0.1 g of each sample in 10 mL of boiling water. Making a lemongrass sample solution with a concentration of 10 mg/mL was done by dissolving 0.1 g of lemongrass powder in 10 mL of aquadest and vortexing until homogeneous. The dissolved *S.hystrix* tea and lemongrass samples were then filtered with Whatman filter paper number 42. Vitamin C solution with a concentration of 10 mg/mL was made by dissolving 0.1 g of vitamin C in 10 mL of aquadest, then homogenized using vortex. Next, the solution was put into a bottle that had been wrapped in aluminum foil with each: sample solution (1 mL ethanol + 0.7 mL DPPH solution + 0.1 mL sample solution), positive control solution (1 mL ethanol + 0.7 mL DPPH solution + 0.1 mL vitamin C solution), and blank solution (1 mL ethanol + 0.7 mL DPPH solution). The mixture of solutions (vitamin C sample, and blank) was homogenized using a vortex and incubated for 15 minutes in a dark room. Absorbance was measured at a wavelength of 515 nm using a UV-Vis spectrophotometer, then the antioxidant activity was calculated using the following formula:

$$\text{Inhibition of DPPH } (\%) = \left(\frac{\text{Blank absorbance} - \text{Sample absorbance}}{\text{Blank absorbance}}\right) \times 100\% \quad (2)$$

2.7.2 Ferric reducing antioxidant power (FRAP) method

The antioxidant activity test using the FRAP method was carried out as described by Suhaila [13] with some modifications. The preparation of the FRAP reagent began with making a pH 3.6 acetate buffer solution. The buffer solution was made by dissolving 0.775 g of sodium acetate trihydrate with 4 mL of concentrated acetic acid and dissolving it using distilled water until a volume of 250 mL was obtained. The buffer solution was then stored at 4 °C for at least 2 hours. Second, 10 mM/mL of 2,4,6-tripyridyl-s-triazine (TPTZ) solution was made by dissolving 0.15 g of TPTZ in 40 mM/L hydrogen chloride until the solution volume reached 50 mL The resulting TPTZ solution was then stored at 4 °C for at least 30 minutes before use. Third, 0.54 g of iron(III) chloride hexahydrate was dissolved in distilled water until the volume reached 100 mL, to produce a 20 mM L solution. The resulting iron(III) chloride hexahydrate solution was stored at 4°C for at least 30 minutes before use. Furthermore, the FRAP reagent was made by mixing 2.5 mL of TPTZ solution, 25 mL. acetate buffer, and 2.5 mL of iron(III) chloride hexahydrate (1:10:1), then distilled water was added until the solution volume reached 100 mL.

Standard solution (2780 ppm) was made by dissolving 2.78 g of ferrous sulfate heptahydrate in 1000 mL of aquadest. Furthermore, a series of dilutions of 0, 20, 40, 60, 80, 100, 120, 140, 160, 180 and 200 ppm were made. Furthermore, a solution of *S. hystrix* tea samples with a concentration of 10 mg/mL was made by brewing 0.1 g of each sample into 10 mL of boiling water. The preparation of a solution of lemongrass samples with a concentration of 10 mg/mL was done by dissolving 0.1 g of lemongrass powder into 10 mL of aquadest and vortexing until homogeneous. The dissolved *S. hystrix* tea and lemongrass samples were then filtered with filter paper.

A total of 900 µL of FRAP reagent was mixed with 120 µL of each solution and then homogenized using a vortex and left for 15 minutes. Absorbance was measured at a

wavelength of 595 nm using a UV-Vis spectrophotometer. Absorbance data from the standard ferrous sulfate heptahydrate solution was used as a standard curve by creating a line equation. Then the sample absorbance data was entered into the line equation to obtain the FRAP value expressed in mM/g.

2.8 Hedonic test

The consumer acceptance level test was conducted using a hedonic test referring to the research of Yulia [14]. This test used 100 untrained panelists. The steps taken were that tea samples were prepared from the treatment of adding lemongrass powder in the series of concentrations: 0, 10, 15, 20, and 25%. Furthermore, tea brewing was carried out by soaking one tea bag in 100 mL of hot water for 6 minutes. During the brewing process, the tea bag was raised and lowered repeatedly (5 times) into hot water and stirred 2 – 3 times before the tea bag was removed from the solution [5]. Furthermore, 25 mL of S. hystrix tea solution was placed in a small cup, and each sample was randomly coded. Panelists were asked to assess the appearance, aroma, color, and taste with a range of hedonic scale values, namely, 1 = very dislike; 2 = dislike; 3 = somewhat dislike; 4 = neutral; 5 = somewhat like; 6 = like; and 7 = really like

2.9 Quantitative Descriptive Analysis (QDA)

The QDA is a method used to assess a product by describing it and assessing the magnitude of a sensory attribute of a sample by trained panelists [15]. The QDA test conducted refers to Meilgaard. [16] using 10 trained panelist. Based on SNI 01-2346-2006, the minimum number of trained panelists in a descriptive test is 6 panelists. The stages of the QDA test include panelist selection, training, description test, FGD, and QDA testing. The sensory attributes used in the study were the aroma attributes of *S. hystrix* tea samples with the addition of 0, 10, 15, 20, and 25% lemongrass powder.

QDA is conducted in multiple phases: 1) Selection of panelists. The process of panelist selection unfolds in several stages. Initial selection involves administering a questionnaire to gauge willingness to participate. Subsequent stages consist of panelist selection through the triangle test, with each stage comprising 7 sets of tests, resulting in a total of 21 tests conducted. Panelists are tasked with discerning samples based on the intensity of their aroma. Following the fourth stage of selection, individuals who remain are deemed qualified as trained panelists. Data processing for the triangle test employs a binomial model, wherein correct responses are assigned a score of 1, while incorrect responses receive a score of 0. Upon completion of all triangle tests, sequential analysis is carried out by plotting the cumulative correct responses from the panelists [17]. 2) Training of panelists. Training of panelists involves conducting scoring tests using *S. hystrix* tea samples with varying concentrations of lemongrass powder (0%, 10%, 15%, 20%, and 25%). Six samples of *S. hystrix* tea are presented, with 2 samples featuring identical levels of lemongrass powder. Panelists are required to rank the tea samples from the least to the most concentrated in lemongrass powder. The objective of the panelist training phase is to refine the sensory acuity of panelists and heighten their sensitivity to the aroma attributes of the tea samples to be evaluated subsequently. 3) Descriptive assessment. Following panelist training, a descriptive test is conducted to elucidate the aromas emanating from the *S. hystrix* tea samples without external influence. This descriptive evaluation aims to ascertain the benchmark product based on the aromas delineated by the panelists. 4) Forum group discussion (FGD). FGD serves as a forum for group deliberation with the aim of reaching a consensus on the predominant aroma attributes of *S. hystrix* tea. The agreed-upon aroma characteristics are then utilized to identify the reference product for the evaluation. 5) QDA evaluation. Trained panelists

undertake comparisons between the test samples and the reference products established in the preceding stage to assess the intensity of the aroma attributes in each *S. hystrix* tea treatment. The evaluation outcomes are recorded on a provided scoresheet utilizing a 15 cm linear scale. A higher rating indicates a greater resemblance in aroma intensity between the sample and the reference product. Conversely, a lower rating signifies a lesser likeness in aroma intensity. The assessment results from all panelists are analyzed and presented in the form of a spider diagram to facilitate a comparative analysis of the sensory attributes of *S. hystrix* tea.

2.10 Data analysis

This study used a Completely Randomized Design with 5 treatments and 3 replications. The independent variable used was the concentration of lemongrass powder added to *S. hystrix* seaweed tea, while the dependent variable was water content, total phenol, antioxidant activity (DPPH and FRAP methods), and sensory properties of *S. hystrix* seaweed tea. The data obtained were processed using Microsoft Excel and IBM SPSS Statistics 20. The data were analyzed using the One-Sample Kolmogorov-Smirnov Test to determine the distribution of the data. If the data was normally distributed ($p>0.05$) then it was further tested with ANOVA. Meanwhile, if the data was not normally distributed then it was further tested with the Kruskal-Wallis Test. If the ANOVA test results showed a significant difference ($p<0.05$) then it was analyzed with the Tukey further test to determine the differences between treatments. The hedonic test data were analyzed using the Kruskal-Wallis Test and further tested using the Mann-Whitney Test to determine the differences between treatments. The QDA test result data were processed using Microsoft Excel and presented in the form of a spider web to compare the intensity of sensory attributes of *S. hystrix*.

3 Results and discussion

3.1 Seaweed tea water content

The water content of *S. hystrix* seaweed tea pertains to the quantity of water present in the tea. Test results indicate that the water content of *S. hystrix* seaweed tea samples treated with varying amounts (0%, 10%, 15%, 20%, and 25%) of lemongrass powder were 8.70 ± 0.94%, 7.75 ± 0.15%, 7.24 ± 0.48%, 6.42 ± 0.13%, and 6.21 ± 0.10%, respectively (refer to Table 1). The incorporation of lemongrass powder into *S. hystrix* seaweed tea exhibits a notable impact on its water content. According to the SNI 3836:2013 standard, the water content of packaged dry tea should be maximum 8%. Consequently, the moisture content of *S. hystrix* seaweed tea with lemongrass powder additions aligns with regulatory requirements. The recorded moisture content in this seaweed tea study surpasses the findings of Sinurat & Suryaningrum [8] at 2.14%, yet falls short of Kartikaningsih [18] results at 14.122%. Various factors influence water content, including ambient humidity, storage duration, and room temperature [19]. Moreover, elevated temperatures and extended drying periods yield diminished water content levels [20].

The decrease in moisture content of *S. hystrix* seaweed tea upon the addition of lemongrass powder can be explained by the hygroscopic nature and antimicrobial properties of the essential oils in lemongrass. Lemongrass contains key volatile compounds like citral, citronella, and geraniol, which are known for their antimicrobial activity. These compounds inhibit the growth of microorganisms that would normally require water to proliferate. By reducing microbial activity, lemongrass helps in limiting water retention within the product, as microbes often rely on moisture to thrive [21]. Additionally, essential oils have a

preservative effect, which contributes to a decrease in water activity in the tea. Water activity is a crucial factor in microbial growth; reducing a water activity through the incorporation of lemongrass powder effectively limits moisture retention. As microorganisms are inhibited by the antimicrobial compounds in lemongrass, less moisture is needed or retained for microbial metabolism, leading to a lower overall moisture content in the seaweed tea. Furthermore, the essential oils from lemongrass can interact with and bind water molecules, thus reducing the availability of free water in the product. This mechanism also contributes to moisture reduction and enhances the shelf life of the tea by making the environment less favorable for microbial growth [21].

Table 1. The effect of adding lemongrass powder on the water content and total phenol of *Sargassum hystrix* seaweed tea

Addition of lemongrass powder (%)	Water content (%)	Total phenol content (mg GAE/g)
0	8.70 ± 0.94^{c}	1.42 ± 0.09^{a}
10	7.75 ± 0.15^{bc}	5.37 ± 0.26^{c}
15	7.24 ± 0.48^{ab}	6.42 ± 0.21^{d}
20	6.42 ± 0.13^{a}	8.06 ± 0.20^{e}
25	6.21 ± 0.10^{a}	9.26 ± 0.08^{f}
Lemongrass powder	-	4.13 ± 0.13^{b}
SNI	Max 8	Min 5,2

Mean value ± standard error (n = 3). Different superscript letters in the same column are significantly different ($p < 0.05$).

3.2 Total phenol content

Determination of total phenol content of *S. hystrix* seaweed tea samples was calculated using the equation Y = 0.0085x - 0.0134 obtained from the standard curve of gallic acid. The X value obtained from the equation was then used to determine the total phenol content expressed in mg Gallic Acid Equivalent (GAE)/g. The total phenol content of *S. hystrix* tea can be seen in Table 1.

Table 1 shows that the addition of lemongrass powder has a significant effect on the total phenol content. The total phenol content of *S. hystrix* seaweed tea samples with the addition of lemongrass powder of 0, 10, 15, 20, and 25% were 1.42, 5.37, 6.42, 8.07, and 9.26 mg GAE/g, respectively. The highest total phenol content was produced from the *S. hystrix* seaweed tea sample with the addition of 25% lemongrass powder, while the lowest total phenol content was obtained from the *S. hystrix* seaweed tea sample with the addition of 0% lemongrass powder. The results of the total phenol content showed that the *S. hystrix* seaweed tea sample with the addition of lemongrass powder had a value according to the requirements of SNI 3836:2013 concerning dry tea in packaging where the polyphenol content is at least 5.2 mg GAE/g.

Kartikaningsih [18] stated that the total phenolic content in *S. hystrix* seaweed tea with soaking treatment in $CaCO_3$ solution was 0.18 ± 0.05 mg GAE/g. Meanwhile, *Sargassum* sp. seaweed tea with soaking treatment in hot water for 5 minutes had a total phenol content of 2.22 mg GAE/g [8]. Thus, the total phenolic content of *S. hystrix* seaweed tea with the addition of lemongrass powder was higher when compared to the two previous studies [8,

18]. In this study, the results showed that the more lemongrass powder added, the more total phenolic content in *S. hystrix* seaweed tea could increase. Lemongrass (*Cymbopogon citratus*) have natural compounds in the form of phenolic compounds such as flavonoids, saponins, tannins and alkaloids [10].

3.3 Antioxidant activity

The effect of adding lemongrass powder on the antioxidant activity of *S. hystrix* seaweed tea can be seen in Table 2. The DPPH inhibition levels for the treatments of adding lemongrass powder of 0, 10, 15, 20, and 25% were 72.98 ± 13.23, 77.32 ± 2.59, 83.82 ± 4.81, 84.17 ± 2.19, and 84.41 ± 1.37%, respectively. Meanwhile, the DPPH inhibition activity by vitamin C and lemongrass powder was 92.33 ± 2.51% and 72.05 ± 1.64%. The addition of 25% lemongrass powder to the *S. hystrix* seaweed tea sample produced the highest antioxidant activity, while the lowest antioxidant activity was obtained in the treatment without the addition of lemongrass 71.98 ± 13.23%. The antioxidant activity of the *S. hystrix* seaweed tea was lower when compared to vitamin C.

The addition of pandan leaf powder to *Sargassum* sp. seaweeed tea is known to have the highest DPPH inhibitory activity of 68.38 ± 0.44% [22]. In another study on *Sargassum* sp. seawweeed tea with a 5-minute soaking treatment, it had a DPPH inhibitory activity of 18 ± 2.01% [8]. The results of the study showed that the more lemongrass powder added, the higher the DPPH inhibitory activity. This is in line with the research of Widiastuti [23] which stated that the more lemongrass added to lemongrass syrup with stevia sweetener, the higher the antioxidant activity.

Table 2. The effect of adding lemongrass powder on antioxidant activity (DPPH and FRAP method) of *Sargassum hystrix* seaweed tea.

Addition of lemongrass powder (%)	DPPH (%)	FRAP (mM/g)
0	72.98 ± 13.23^{a}	10.24 ± 0.40^{b}
10	77.32 ± 2.59^{b}	15.44 ± 0.63^{c}
15	83.82 ± 4.81^{b}	18.13 ± 0.24^{d}
20	84.17 ± 2.19^{b}	22.24 ± 0.56^{e}
25	84.41 ± 1.37^{b}	25.33 ± 1.58^{f}
Lemongrass powder	72.05 ± 1.64^{a}	20.15 ± 0.17^{a}
Vitamin C	92.33 ± 2.51^{b}	27.15 ± 0.31^{g}

Mean value ± standard error (n = 3). Different superscript letters in the same column are significantly different ($p < 0.05$).

The antioxidant activity of *S. hystrix* seaweed tea was calculated using the equation $Y = 0.0063x + 0.0607$ obtained from the $FeSO_4.7H_2O$ standard curve. The X value obtained from the equation was then used to calculate the antioxidant activity in (mM/g). The higher the intensity of the blue color produced, the higher the antioxidant potential. Table 2 shows that the addition of lemongrass powder significantly affected the antioxidant activity of the FRAP method. The antioxidant activity of *S. hystrix* seaweed tea with the addition of lemongrass powder of 0, 10, 15, 20, and 25% were 10.24 ± 0.40, 15.44 ± 0.63, 18.14 ± 0.24, 22.24 ± 0.56, and 25.33±1.58 mM/g, respectively. The highest antioxidant activity was found in the

addition of 25% lemongrass powder, while without the addition of lemongrass powder. This study also used vitamin C concentration of 10 ppm as a comparison with antioxidant activity of 17.63 ± 1.56 mM/g. When compared with vitamin C, the *S. hystrix* seaweed tea sample has lower antioxidant activity. In previous research, namely Tyas [22] on the addition of pandan leaf powder to seaweed tea, the highest antioxidant activity results were obtained at 24.27 ± 0.26 mM/g. Based on these results, it is concluded that the addition of lemongrass powder to seaweed tea has higher antioxidant activity compared to previous studies.

3.4 Consumer acceptance level

Based on Table 3, it is known that the addition of lemongrass powder has a significant effect on the level of color preference. The highest color preference value was obtained in the treatment of adding 25% lemongrass powder with a value of 4.16 ± 1.58 (preferred). While the lowest value was obtained from the treatment without the addition of lemongrass powder with a value of 3.01 ± 1.25 (somewhat preferred). Lemongrass produces a green color because it has a high total chlorophyll content [24]. The addition of lemongrass powder will give a green color to the *S. hystrix* seaweed tea. This green color makes the color of *S. hystrix* seaweed tea more attractive.

The addition of lemongrass also had a significant effect on the taste of *S. hystrix* seaweed tea (Table 3). The highest taste preference value was obtained in the treatment of adding 20% lemongrass powder with a value of 4.38 ± 1.26 (like). Meanwhile, the lowest value was obtained from the treatment without the addition of lemongrass powder, which was 3.44 ± 0.87 (disliked). The more lemongrass powder was added, the stronger the lemongrass taste and could reduce the astringent taste of the *S. hystrix* seaweed tea. However, at a concentration lemongrass of 25%, the hedonic value decreased, this means that if too much lemongrass powder was added to the product, it would reduce the hedonic value of the tea taste. The astringent taste produced in the product tended to decrease along with the addition of lemongrass powder.

Table 3. The effect of adding lemongrass powder on consumer acceptance level of *Sargassum hystrix* seaweed tea.

Addition of lemongrass powder (%)	Color	Taste	Aroma	Overall
0	3.01 ± 1.25^{a}	3.44 ± 0.87^{a}	3.09 ± 0.78^{a}	3.94 ± 1.08^{a}
10	3.99 ± 1.25^{b}	3.32 ± 1.11^{a}	3.62 ± 0.97^{b}	4.35 ± 1.24^{b}
15	3.95 ± 1.23^{bc}	4.25 ± 1.38^{b}	4.70 ± 0.99^{c}	4.74 ± 1.48^{c}
20	3.75 ± 1.72^{c}	4.38 ± 1.26^{c}	4.83 ± 1.27^{cd}	5.22 ± 1.18^{d}
25	4.16 ± 1.58^{d}	3.90 ± 1.13^{d}	4.65 ± 1.24^{d}	4.50 ± 1.21^{e}

Mean value ± standard error (n = 3). Different superscript letters in the same column are significantly different ($p < 0.05$).

Table 3 also shows that the addition of lemongrass powder has a significant effect ($p<0.05$) on the level of preference for the aroma of *S. hystrix* seaweed tea. The highest aroma preference value was in the treatment of adding 20% lemongrass powder with a value of 4.83±1.27 (like). Meanwhile, the lowest value was obtained from seaweed tea without the addition of lemongrass powder with a value of 3.09±0.78 (dislike) because there was still a fishy aroma from the seaweed. In the study of Kartikaningsih [18], the sensory attributes of the aroma of *S. hystrix* seaweed tea with the treatment of soaking in a $CaCO_3$ solution of pH

11 for 6 hours had an average of 5.7 ± 0.22 (rather like). The results of the aroma value from the treatment of adding 20% lemongrass powder tended to be more preferred when compared to the study of Kartikaningsih [18]. In the taste parameter, it is concluded that the more lemongrass powder is added, the hedonic value of the product will increase, but if it is too much, it will give a dominant lemongrass aroma that is less preferred. The fragrant aroma of lemongrass is produced from citronella contained in lemongrass where citronella is the main compound that provides a fresh and citrus aroma.

Based on Table 3, it can be seen that the highest overall preference value for *S. hystrix* seaweed tea was obtained from the treatment of adding 20% lemongrass powder with a value of 5.22 ± 1.18 (like). While the lowest value was obtained from the treatment without adding lemongrass powder with a value of 3.94 ± 1.08 (dislike). The addition of lemongrass powder has a different effect on the overall preference level of *S. hystrix* seaweed tea, where the more lemongrass powder added, the higher the average preference level. Based on this, it can be concluded that the best treatment is *S. hystrix* seaweed tea with the addition of 20% lemongrass powder. Lemongrass has a fresh and sharp aroma and taste that comes from the chemical compounds in it, especially from essential oils containing citronella, geraniol, citronellal, and nerol [25].

3.5 Quantitative descriptive analysis (QDA)

The QDA is a method used to assess a product by describing it along with the value of a sensory attribute of the sample by trained panelists [16]. The results of the QDA (Fig. 1) on *S. hystrix* seaweed tea without the addition of lemongrass powder showed a dominant fishy aroma perception so that other aroma perceptions were covered. *S. hystrix* seaweed tea with the addition of 10% lemongrass powder showed a dominant fishy aroma which was still present, namely 5.62, followed by the aroma of regular tea infusion of 4.71 and the aroma of lemongrass infusion of 4.28. *S. hystrix* seaweed tea samples with the addition of 15% lemongrass powder showed that the aroma of regular tea infusion had the highest average intensity value of 5.13, followed by the aroma of brewed lemongrass of 4.71 and then the fishy aroma of 4.54. The *S. hystrix* seaweed tea with the addition of 20% lemongrass powder showed that the aroma of ordinary tea brewing had the highest average intensity value of 6.04, followed by the aroma of brewed lemongrass at 5.45 and then the fishy aroma that was almost covered by 2.81. The results of the *S. hystrix* seaweed tea with the addition of 25% lemongrass powder showed that the aroma of ordinary tea brewing had the highest average intensity value of 6.43, followed by the aroma of brewed lemongrass at 5.69 and then the fishy aroma that was almost covered by 1.79.

The fishy aroma in the *S. hystrix* seaweed tea comes from the presence of volatile compounds in seaweed where seaweed itself is the main raw material used. Meanwhile, the aroma of lemongrass in the *S. hystrix* seaweed tea appears because lemongrass contains compounds that can help eliminate the fishy odor in food, including the fishy odor in seaweed. Some of these compounds include citronella and geraniol. In general, it can be concluded that the more lemongrass powder added to the sample, the stronger the aroma of regular tea infusion followed by the stronger lemongrass scent, but the fishy aroma caused by seaweed is increasingly covered.

The dominant flavors produced by *S. hystrix* seaweed tea are fishy taste, ichi ocha (green tea) taste and regular brewed tea without sugar. The dominant flavors recognized by trained panelists were then used to determine the reference product to be used in the QDA. The selection of reference products was based on the closest impression of the existing taste perception. The reference products used were fresh seaweed for fishy taste, ichi ocha (green tea), and regular brewed tea. After getting used to tasting the reference products, the panelists

then gave a taste assessment of the *S. hystrix* seaweed tea into the QDA sheet using a 10 cm line scale.

The QDA results on *S. hystrix* seaweed tea without the addition of lemongrass powder showed a dominant fishy taste and also the same ichi ocha taste of 7.68 followed by the taste of regular tea brewing of 1.44 which was almost covered. *S. hystrix* seaweed tea with the addition of 10% lemongrass powder showed the fishy taste had the highest intensity value of 5.62 followed by the ichi ocha taste of 5.25 and then the taste of brewed tea 3.91. *S. hystrix* seaweed tea with the addition of 15% lemongrass powder showed the taste of regular tea brewing had the highest intensity value of 4.64 followed by the fishy taste of brewing 4.54 and then the ichi ocha taste of 3.88. The results of *S. hystrix* seaweed tea with the addition of 20% lemongrass powder showed the taste of regular tea brewing had the highest intensity value of 5.4 followed by the fishy taste and ichi ocha which were almost covered. The *S. hystrix* seaweed tea with the addition of 25% lemongrass powder showed that the taste of ordinary tea brewing had the highest intensity value, namely 6.36, followed by the fishy taste and ichi ocha which were almost covered.

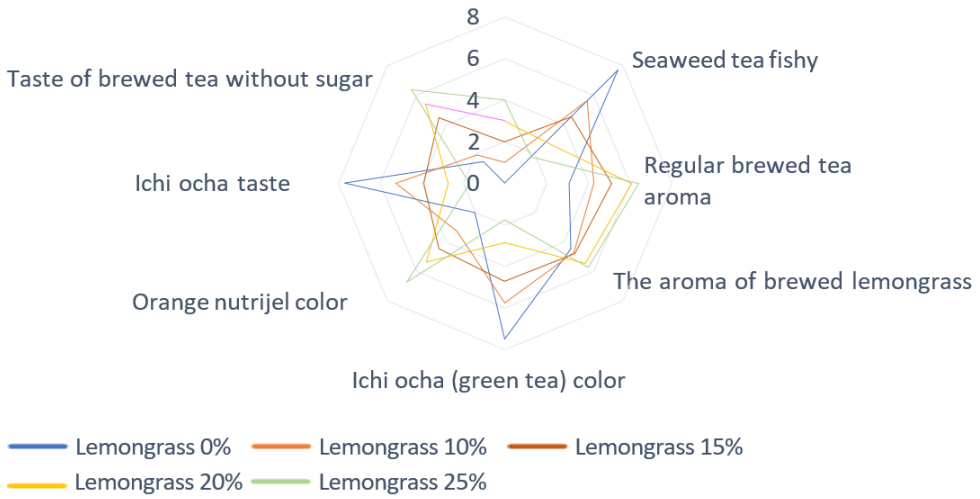

Fig. 1. Spider web QDA of *Sargassum hystrix* seaweed tea

The dominant colors produced from *S. hystrix* seaweed tea are ichi ocha color and orange nutrijel color. The dominant colors recognized by trained panelists were then used to determine the reference product to be used in the QDA. The selection of reference products was based on the closest impression of the existing color perception. The reference products used were ichi ocha and orange nutrijel. After getting used to tasting the reference products, the panelists then gave a color assessment of the *S. hystrix* seaweed tea into the QDA sheet using a 10 cm line scale. The results of the QDA on the *S. hystrix* seaweed tea with the addition of 0 and 10% lemongrass were closer to the ichi ocha color. With the addition of 15% lemongrass, the color was almost the same where the ichi ocha color got a value of 4.72 and the orange nutrijel color was 4.46. With the addition of 20% and 25% lemongrass powder, the color of the orange Nutrijel more closely resembled the specific color of "Ichi Ocha" (possibly a reference to a green or yellow tea-like color). In other words, increasing the concentration of lemongrass brought the product's color closer to the desired tea-like hue, possibly due to the pigments in lemongrass powder, such as chlorophyll or other natural compounds, that affect the overall color of the gel.

4 Conclusion

The addition of lemongrass powder up to a concentration of 25% can increase the antioxidant activity of *Sargassum hystrix* seaweed tea where the addition of 25% lemongrass powder has an antioxidant activity of DPPH method 84.41 ± 1.37% and FRAP method 25.33 ± 1.58 mM/g. The addition of lemongrass powder up to 25% can increase consumer acceptance of the color, aroma, taste, and overall of *S. hystrix* seaweed tea. The results of the QDA also showed a positive change in the acceptance of aroma perception. The addition of 20% lemongrass powder was most preferred by consumers with hedonic values of color, aroma, taste, and overall parameters in sequence, namely 3.75 ± 1.72, 4.83 ± 1.27, 4.38 ± 1.26, and 5.22 ± 1.18.

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