Sensory Properties and antioxidant activity of *Chrysanthemum* Flower tea bags with lemon peels and mint leaves

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Abstract. The Covid-19 pandemic has had an impact on many business sectors including the cut-flower of Chrysanthemum. Sales of cut-flowers have decreased and the farmer suffering huge losses. It is necessary to develop a Chrysanthemum product to increase its economic value. This study aims to determine the sensory properties and antioxidant activity of Chrysanthemum tea in bags with the addition of lemon peels and mint leaves. The treatments in this research consisted of 6 formulations of Chrysanthemum: lemon peels: and mint leaves; FI (80%: 0%: 0%); F2 (80%: 20%: 0%); F3 (80%: 0%: 20%); F4 (80%: 10%: 0%); F5 (80%: 0%: 10%) and F6 (80%: 0%: 0%). Sensory properties were determined by hedonic tests (color, aroma, and taste of tea brewed water) with 30 panelists. Antioxidant activity was determined by the DPPH method and polyphenol content by the spectrophotometric method. The results of the hedonic test showed that F2 was the most preferred on the color and aroma parameters, while F2 and F4 had the same average value for the taste parameter. The highest antioxidant activity value was F2 with an IC_{50} value was 134,38 ppm and polyphenol content was 81.42 ppm.

1 Introduction

The pandemic of Covid-19 affected all aspects of people's lives, such as social, economic, health, and psychological. The impact of this pandemic on the society in Indonesia is not much different from the society in other countries that are also facing this pandemic [1]. The policy to control the Covid-19 pandemic in Indonesia through the Large-Scale Social Restriction Policy has an impact on the public activity and movement both nationally and internationally, for example, limiting events such as weddings and birthday parties, and another celebration event. The farmers of Chrysanthemum flowers are among those affected by the restriction policy which limited celebration events causes the demand for this flower to be reduced or even non-existent. Farmers have tried to get the benefits of Chrysanthemum by processing it into herbal tea. *C. morifolium* has been reported to contain numerous bioactive compounds such as phenolics, which possess antioxidant activity include 5-*O*-caffeoylquinic acid (chlorogenic acid), 3-*O*-caffeoylquinic acid,4- *O*-caffeoylquinic acid,

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3,4-di- caffeoylquinic acid, 3,5-di-*O*-caffeoylquinic acid, 4,5- di-*O*-caffeoylquinic acid, caffeic acid, luteolin, luteolin-7-*O*-glucopyranoside, apigenin, apigenin-7-*O*-glucoside, acacetin-7-*O*-rutinoside, acacetin [2].

Some Chrysanthemum tea products of the Indonesian market are sold in simple forms of bulky flower buds and packaged simply using low-grade packaging with unattractive design and uncompleted labels. This causes the product to be less attractive to consumers. In addition, in the bulky form, the different amounts of each brewing process can affect the quality of tea. Therefore, development is needed to increase consumer interest in chrysanthemum tea so that it can increase its economic value. The development of chrysanthemum tea products can be pursued by changing the bulk tea that is packaged in plastic into tea bags. In addition, other materials can be added to improve the organoleptic and functional properties.

Tea bags are widely known by people in Indonesia, but are commonly used for tea (*Camellia sinensis*) products and have been used widely used for Chrysanthemum tea. Tea bag innovation is carried out by packaging the tea in special paper or nylon packaging to shorten the tea brewing process and after brewing the tea dregs can be separated immediately. The main advantage of tea bags is their convenience because each tea bag contains about 2 grams of loose tea leaves which are ideal for making a cup of tea. Other advantages of teabags are also related to their easy availability, the small size of the bags used to pack the right amount of ingredients, which makes them practical compared to regular teas, the ease of mixing different ingredients (herbs) with various health benefits [3].

Chrysanthemum flower plants are popular in Indonesia as ornamental flowers and have not been optimally used as herbal tea beverages products. Improvement quality of Chrysanthemum tea can be carried out by combining tea with new materials or ingredients that can enrich the organoleptic quality of tea. Ingredients that potentially can be added to Chrysanthemum tea are lemon peels and mint leaves. Lemon peels have a bright color and contain chemical compounds that are beneficial for the body as antioxidants. Orange peels contain different compounds, depending on the variety, so the aroma is different. However, the dominant compound is limonene ($C_{10}H_{16}$) that varies for each citrus variety. Lemon is a plant that has benefits as natural antioxidants because it contains vitamin C, citric acid, essential oils, bioflavonoids, polyphenols, coumarins, flavonoids, and volatile oils in the skin such as limonene (± 70%), -terpinene, -pinene, -pinene, as well as coumarins, and polyphenols [4]. Mint leaves are also widely used for drinks. Mint leaves have a fresh effect and distinctive aroma due to a large number of menthol compounds [5]. The aqueous extract and EO of the mint plant are potent natural antioxidants [6]. This study aims to determine the sensory properties and antioxidant activity of Chrysanthemum tea in bags with the addition of lemon peels and mint leaves.

2 Material and Method

2.1 Materials

Chrysanthemum tea was obtained from PT Rahmat Purnama Farm, Sukaresmi Cianjur. Fresh lemon and mint leaves were purchased from the local market in Bogor. Dried chrysanthemum was grounded by using a blender to a particle size of 20-mesh. Lemon peels were cut into small pieces and dried at 60-70ºC for 7 h, and dried lemon peels were grounded by using a blender to a particle size of 20-mesh. Mint leaves were dried at 60-70ºC for 2-3 h, were also grounded by using a blender to a particle size of 20-mesh. All materials were mixed according to the formulation and put into bags of 2 grams/bag. The formulation of chrysanthemum tea can be seen in Table 1. As the sample for analysis, tea bags were brewed in hot water as much as 200 ml for 5 minutes.

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Table 1. Formulation of Chrysanthemum tea, Lemon peels, and Mint leaves.

Material	Percentage (%)					
	F1	F2	F3	F4	F5	F6
Chrysanthemum tea	100	80	80	90	90	80
Lemon Peels	0	20	0	10	0	10
Mint leaves	0	0	20	0	10	10

2.2 Methods of Analysis

2.2.1 Sensory analysis

Sensory tests are performed by the hedonic testing method on color, aroma, and taste parameters. The test was conducted by 30 untrained panelists with ages ranging from 17 to 55 years old. The panelists were asked to evaluate (aroma, taste, and color) and give scores to each sample of Chrysanthemum tea bag based on the panelist's preference. The rating scale used for the hedonic test is a 5-point hedonic scale, 1: Dislike very much, 2: Dislike slightly, 3: Neutral, 4: Like 5: Like very much. The data of this research were analyzed by Analysis of Variance (ANOVA) and further test using the Duncan Multiple Range Test (DMRT).

2.2.2 Determination of antioxidant activity

Antioxidant activity testing was carried out on 6 formulations of Chrysanthemum tea with the addition of lemon peels and mint leaves. Tea bag based on each formulation were brewed at 90ºC then moved up and down for 5 minutes and the tea bags were removed. The tea solutions were then diluted with methanol for different concentrations from 20 ppm, 40 ppm, 60 ppm, 80 ppm. and 100 ppm. The antioxidant activity test of the sample was carried out by taking 0.2 ml of the test solution added by 3.8 ml of a solution of 1.1-diphenyl-2-picrylhydrazyl (DPPH) in methanol. The solution was homogenized with vortex and then incubated in a dark place for 30 minutes. Then the absorption was measured by Ultraviolet-visible (UV-Vis) spectrophotometer at a wavelength of 518 nm. As a blank, the same treatment was carried out with the sample was replaced with methanol [7]. The absorbance data was calculated as an antioxidant activity with the following equation:

$$AA\ (\%) = \frac{A-B}{A} x\ 100$$

Note :
AA = Inhibition activity
A = Absorbance of control
B = Absorbance of sample

DPPH scavenging activity of the sample was made into a regression curve to obtain the regression equation used to measure IC_{50} that refers to the concentration of the sample which is required to scavenge 50% DPPH free radicals. The formulation treatment thatgave the highest IC_{50} result was followed by a polyphenol content test to determine the number of polyphenol compounds in Chrysanthemum tea bags.

3 Results and Discussion

3.1 Sensory Properties

3.1.1. Aroma hedonic test

Aroma is one of the critical aspects of tea quality which can determine acceptance or rejection of a tea before it is tasted [8]. The aroma of a food and beverage product can be determined by the sense of the nose through the smell caused by the presence of volatile compounds. The average value of hedonic aroma taste for tea bags with the formulation of Chrysanthemum, lemon peels, and mint leaves is shown in Table 2.

Table 2. The hedonic score of Aroma of Chrysanthemum tea with the addition of lemon peels and mint leaves

No.	Treatment	Average Score of Aroma
1	F1	3.17^{ab}
2	F2	3.47^{b}
3	F3	3.05^{a}
4	F4	3.37^{ab}
5	F5	3.10^{ab}
6	F6	3.13^{ab}

Note: Different notation showed significant differences (α=0.05)

Based on the result of Analysis of Variance (ANOVA), the formulation of Chrysanthemum, lemon peels, and mint leaves in F1, F4, F5, and F6 have no significant effect on the panelist's preference on aroma parameters because the addition of lemon peels and mint leaves to Chrysanthemum tea is 10%. Meanwhile, treatment of F2 and F3 is significantly different because the addition of lemon peels is 20% and contributes a strong aroma to the Chrysanthemum tea bags. Lemon peels have complex volatile essential oils that give a distinctive aroma [9]. Twenty-six volatile compounds in the lemon peels oils were identified by GC-MS and can be grouped into four main chemical families: (i) monoterpenes (20 compounds); (ii) sesquiterpenes (3 compounds); (iii) aldehydes (2 compounds), and (iv) esters (1 compound) [10]. The constituents of citrus essential oils include limonene, β-myrcene, α-pinene, p-cymene, β-pinene, and terpinolene are the main aromatic compounds [11].

According to Table 2, it was found that the higher proportion of mint leaves, the lowest score of panelist's preference. Mint leaves contain menthol compounds and essential oils that give the tea a fresh aroma when brewed. In fresh peppermint leaves, 36 components were identified in total that accounting for 93.84% of the total volatiles. In the fresh mint leaves, the principal components were menthol (44.39%), menthone (15.36%), menthofuran (10.27%), 1.8-cineole (5.81%), menthyl acetate (4.78%), neoisomenthol (2.37%), and limonene (1.87%) and drying of the peppermint leaves at ambient air as well as hot air temperatures of 50ºC, 60ºC, and 70ºC can be recommended for high oil yield and resulted in a better-quality product in terms of menthofuran, neoisomenthol, and 1.8-cineole [12]. Peppermint leaves hold a resilient sweetish odor and a spicy flavor with a freshening after mastication [13]. There are 58 types of volatile compounds contained in

Chrysanthemum flowers, including -Humulene, Ledene oxide-(I), cis-Z-α- Bisabolene epoxide, 3.4-Dihydro-2.2-dimethyl-2H- 1-benzopyran, trans-limonene oxide, and limonene. *C. morifolium* Ramat flower is rich in flavonoids luteolin-7-glucoside and quercitrin as well as volatiles β-humulene and ledene oxide-(I), this B- Humulene has been described as having a woody-spicy, dry, clove-like tenacious odor and somewhat bitter taste [14]. This result shows that mint leaves are not suitable to mix with Chrysanthemum tea which each material has a unique and distinctive aroma.

3.1.2. Taste hedonic test

Besides aroma, the taste of tea is an important factor in determining the quality of tea. The taste of tea is related to its ingredients or composition. Based on the analysis of variance on the taste parameters, the significance value of the sample was 0.295 or more than α (0.05), this result showed that there is no significant effect of formulation on the taste of tea bags. The average taste score of hedonic taste is shown in Table 3 with a value ranging from 2.85 (dislike slightly) to 3.2 (neither like nor dislike).

Table 3. Hedonic score of taste of Chrysanthemum tea with the addition of lemon peels and mint leaves

No.	Treatment	Average Score of Taste
1	F1	3.10
2	F2	3.22
3	F3	2.98
4	F4	3.22
5	F5	3.03
6	F6	2.85

Table 3 showed the formulation of F2 has the same hedonic taste score with F4 indicating that the panelist prefers the taste of Chrysanthemum tea with lemon peels than mint leaves. The lowest score on hedonic taste was observed in sample F6. Based on the researchby Shofiati, 2014 [15], Lemon peels was added to the red dragon fruit peels tea bags and the result was the addition of 40% lemon peels gives the highest taste value and the addition of lemon peels is very influential on the taste of the red dragon fruit peels tea bags. The bitter taste of orange peels is due to the presence of hesperidin and naringin [16]. The addition of peppermint extract provides freshness and has a distinctive minty taste when brewed due to the menthol content on peppermints but the higher concentrations above 4% will cause a bitter taste and cause a spicy taste when brewed [17]. The astringent and bitter taste in beverages with the addition of mint leaves is caused by compounds catechins and alkaloid compounds found in the leaf. The content of tannins in a material determines qualities related to color, taste, and steeping aroma because tannins can coagulate protein to produce an astringent taste in steeping water [18].

3.1.3 Color hedonic test

The consumers' preference for food and beverage products is also determined by color. The average hedonic score for color is presented in Table 4 with the score range was 2.67-3.55 means the preference of panelists is from slightly dislike to like. The formulation of F2 has the highest score for the panelist's preferences 3.55 and F6 has the lowest score of 2.67. Panelists prefer chrysanthemum tea with light yellow lemon peel compared to brown chrysanthemum tea which is influenced by the addition of mint leaves. The color hedonic score of Chrysanthemum tea with the addition of lemon peels and mint leaves can be seen in Table 4.

Table 4. The color hedonic score of Chrysanthemum tea with the addition of lemon peels and mint leaves

No.	Treatment	Average Score of Color
1	F1	3.27^{b}
2	F2	3.55^{b}
3	F3	3.22^{b}
4	F4	3.35^{b}
5	F5	3.28^{b}
6	F6	2.67^{a}

Note: Different notation showed significant differences (α=0.05)

The original chrysanthemum tea has a slightly tea yellow color. Based on Table 4, the color of the formulation F2 and F4 have a higher average score (3.55 and 3.35) than other formulations. These data indicate that the addition of lemon peels to chrysanthemum tea resulted in the color of the tea that was preferred by the panelists. The addition of lemon peels gives yellowness to the chrysanthemum tea, with the higher amount of addition, the color is yellow turns to orange. Chrysanthemum flowers are known for their beautiful flowers with different colors including yellow, orange, orange-red, which are mainly contributed by carotenoids that are responsible for the deep yellow and orange coloration in the chrysanthemum flower [19]. Citrus peels are subdivided into the epicarp or flavedo and mesocarp or albedo. The flavedo is the colored peripheral surface of the peel while the albedo is the white soft middle layer of the peel [20].

The statistical analysis results of sensory tests (α=0.05) for color parameters showed that there was no significant difference of color based on the panelist's preference between the formulation F1 until F5 but there were significant differences between those formulations with F6. Lemon peels have carotenoid pigments that contribute to lightness and yellowness in tea [21]. The brewed tea of formulations F3 and F5 has a slightly brown color with the higher the percentage of mint leaves addition causes the color of the tea brew to be darker. Mint leaves contain chlorophyll 3.21-8.49 g chlorophyll-a; 0.66 - 1.79 g chlorophyll b; and 10.3 mg carotene/100 g [22]. Drying in the processing of mint leaves powder and brewing with hot water causes a change in the color of the mint leaves. The longer the drying time, the more the chlorophyll pigment will fade because of the heating. Based on the research of Mg2+ ions contained in the chlorophyll of mint and stevia leaves will be released and replaced by hydrogen ions (H+) and form pheophytin compounds which are light green in color and will cause the green color of the mint and stevia leaves to turn brown so that the color of the resulting filtrate tends to be dark [23]. At the next level, the change of the C atom with a hydrogen atom causes pheophytin to be converted into pyro pheophytin which has a brown color [24]. However, the combination of lemon peels and mint leaves in F6 has the lowest preference value because the color of tea that was produced has a less bright brown ten to dark color.

3.2 Antioxidant activity test

Nowadays, consumers are increasingly aware of the importance of maintaining health, therefore they prefer to consume healthy foods and beverages such as products that contain antioxidants. Antioxidants are compounds that can inhibit oxidation reactions by binding to free radicals and highly reactive molecules. Free radicals can damage macromolecules leading to cause many diseases. The antioxidant activity test in this study was conducted to determine the formula of Chrysanthemum tea bags with high antioxidant activity as an advantage for this tea product. Antioxidant activity test using the 1.1-diphenyl-2-

picrylhydrazyl (DPPH) method which is easy, fast, and sensitive to test the antioxidant activity of plant extracts. The changing color of DPPH solution from purple to yellow determines the antioxidant activity in the sample against DPPH measured by UV-Vis spectrophotometer to obtain the value of IC_{50} as the antioxidant concentration required to obtain 50% radical inhibition [25]. The percentage of inhibition activity was measured for each formulation and the result is shown in Table 5.

Table 5. Percentage of inhibition of Chrysanthemum tea with the lemon peels and mint leaves

Concentration (ppm)	% Inhibition Activity of Antioxidant					
	F1	F2	F3	F4	F5	F6
20	9.27	7.20	11.24	10.65	10.45	0.99
40	22.29	10.26	18.44	16.17	10.85	12.72
60	24.65	24.85	21.79	26.53	21.30	16.47
80	34.62	38.36	26.82	27.22	31.16	19.63
100	43.79	47.73	33.93	46.84	41.32	26.63

The inhibition activity of each formulation on five varying concentrations (20, 40, 60, 80, and 100 ppm) was demonstrated in Table 5 that shows the inhibition activity of each extract of the formulation was increased with the increasing concentration of the sample. The 100 ppm of Chrysanthemum tea bags showed the best antioxidant activity. Based on Table 5 The best formulation that contributes the highest percentage of inhibition is F2 (80% Chrysanthemum tea and 20% lemon peels). Citrus peels are described as a rich source of unique phenolic compounds to citrus, especially the characteristic flavanone glycosides (mainly naringin, hesperidin, narirutin, and neo hesperidin). Citrus peels are a good source of phenolic compounds that can be extracted and employed as natural antioxidants to prevent oxidation of some foods or may be utilized in designing functional foods, Huge amounts of flavanones and many polymethoxylated flavones which are very rare in other plants are contained in citrus peels [26].

IC_{50} value is the concentration of samples that are required to scavenge 50% DPPH free radicals. The IC_{50} value of each sample formulation is calculated by using the regression equation of the log dose inhibition curve (Table 6).

Table 6. IC_{50} value of Chrysanthemum tea with the lemon peels and mint leaves

Treatment	IC_{50} (ppm)
F1	166,42
F2	134,38
F3	431,54
F4	183,34
F5	218,27
F6	550,26

The lower value IC_{50} refers to the higher antioxidant activities. Based on Table 6 can be known that the formulation of F2 is the treatment with the highest antioxidant activities based on DPPH assay and F6 is the lowest antioxidant activity. For further information, to determine the content of polyphenols that support the antioxidant activity of formula F2, a polyphenol test was carried out by spectrophotometric methods with results showing that the content of polyphenols of F2 was 81.42 ppm. The citrus peels are rich in nutrients and contain many phytochemicals that can act as antioxidants and protect cells against free radical damage, e.g. polyphenols, carotenoids. Phytochemicals are known to display their health-protective effects in diverse ways with strong potential for use in drug production or as food supplements [27].

4. Conclusion

This study aims to determine the sensory properties and antioxidant activity of Chrysanthemum tea in bags with the addition of lemon peels and mint leaves. The results of the hedonic test showed that the formulation F2 was the most preferred by panelists on the color and aroma parameters, while F2 and F4 had the same average value for the taste parameter. The highest antioxidant activity value was F2 with an IC_{50} value was 134,38 ppm and polyphenol content was 81.42 ppm

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