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# Volatile compound profile of lemongrass extract and the effect of lemongrass extract towards physical, chemical, and sensory properties of Es puter (coconut ice cream)

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## ABSTRACT

*Es puter* is an innovation of an Indonesian traditional food product, in the form of ice cream-inspired desserts. Products that are widely known and liked by the public can be elevated through product development by adding ingredients that can improve their quality and functionality. The use of lemongrass extract as one of the additional ingredients in *es puter* can affect the physical quality, functional properties, hedonic quality and organoleptic quality of the product. Addition of lemongrass extract to *es puter* Treatment in the form of adding lemongrass extract, namely the addition of lemongrass extract as much as 0% (P0); 0.2% (P1); 0.4% (P2); and 0.6% (P3). The parameters tested were overrun, melting resistance, color intensity, antioxidant status, phenol compounds, GC-MS, hedonic quality, and organoleptic quality. The addition of lemongrass extract to *es puter* resulted in an overrun value of 3.75–5.41%. Consequently, the increasing overrun value causes a decrease in melting resistance with the values of 96.15–119.99 minutes; the intensity of redness and yellowness color had a significant effect ($p < 0.05$) and lightness had no significant effect ($p \geq 0.05$); antioxidant status IC 50 279.5 ppm – 13,018.5 ppm; GC-MS phenolic compounds were not detected; total phenolic compounds in lemongrass extract were 2.676% and in *es puter* P0, P1, P2, and P3 respectively 0.0285%; 0.029%; 0.0355%: 0.033%. The increase in phenolic compounds may contribute to the decrease in IC50, as they can act as antioxidants in the lemongrass extract. Organoleptic properties in aroma, color, and taste attributes had a significant effect ($p < 0.05$), while texture attributes had no significant effect ($p \geq 0.05$). *Es puter* with the addition of 0.2% lemongrass extract was the most preferred by the panelists.

**Keywords:** lemongrass extract, *es puter*, GC-MS, antioxidant compounds

## INTRODUCTION

People have long utilized local natural resources to meet various needs. Various agricultural and plantation commodities are widely cultivated and distributed within the community for processing into food products. One of the commodities that is often used by the community in food or drinks is lemongrass. Some uses of lemongrass include it as a spice in processed foods, as an ingredient in herbal medicines, and so on **[1]**. In addition to contributing to the taste of processed foods, lemongrass is widely used due to its various properties. Some of the beneficial chemical compounds contained in lemongrass are flavonoids, polyphenols, alkaloids, saponins, and essential oils **[2]**. These compounds are antioxidants that benefit body health, especially in combating free radicals.

The characteristics of lemongrass open up many opportunities for its use in food product innovation. In order to optimize the use of various active compounds in lemongrass, lemongrass is often extracted first. The purpose of extraction is to take secondary metabolites or chemical compounds in a sample **[3]**. The use of lemongrass extract is expected to help increase antioxidant levels compared to the use of juice. One crucial aspect in obtaining optimal lemongrass extract is the selection of extraction methods. The maceration method is the most suitable for avoiding damage to the active compounds in lemongrass because all chemical compounds in lemongrass are classified as heat-resistant **[4]**. The maceration method preserves secondary metabolites during extraction because it does not involve heat. The active compounds in lemongrass extract also need to be avoided from high temperatures so that their integration into a food product innovation needs to be considered carefully. One product that in the manufacturing process does not endanger the content of compounds in lemongrass extract is *es puter*.

*Es puter* or *es dung-dung* is an innovation of food products in the form of desserts inspired by ice cream. The biggest difference between the two lies in their composition. The main raw material for *es puter* is coconut milk, unlike ice cream which generally uses milk as the main ingredient. *Es puter* can be classified as one type of "edible ice". *Es puter* products cannot be considered ice cream because they do not use milk as the main ingredient and *es puter* produces low fat content **[5]**. The use of coconut milk as a source of fat for *es puter* is motivated by the ability of this ingredient to produce a distinctive taste and texture of the product **[6]**. The unique taste and texture of the product result in high consumer interest in *es puter*. The taste of *es puter* is generally savory, with a texture slightly rougher than ice cream. Its relatively cheap price also helps the affordability of *es puter* for all levels of society. All of these factors have resulted in coconut milk-based products being widely known among people from various regions in Indonesia.

Products that are widely known and liked by the public can be elevated through product development. One form of *es puter* product development is by using ingredients that can improve its quality and functionality. The use of lemongrass as an additional ingredient in *es puter* can affect the product's taste, texture, and functional properties. The savory taste of *es puter* can be combined with the distinctive taste of lemongrass to create a unique unity. The content of antioxidant compounds in lemongrass can help add benefits to *es puter*. Food product innovation must go through several stages of testing to determine its quality. The addition of lemongrass extract to *es puter* products can help improve physical characteristics, functionality, and hedonic/organoleptic quality. The functionality of *es puter* with the addition of lemongrass extract can be determined by the antioxidant content and phenol compounds contained in the product. This is due to the various antioxidant compounds found in lemongrass. Lemongrass extract already contains concentrated bioactive components so as to maximize the potential of these ingredients as contributors to functional properties in *es puter*. Some of the contents of lemongrass leaf ethanol extract are flavonoids, phenols, saponins, tannins, alkaloids and steroids **[7]**. Shown below are samples of *es puter* with various concentration of lemongrass extract incorporated (from left to right: 0%;0.2%;0.4%; and 0.6%)

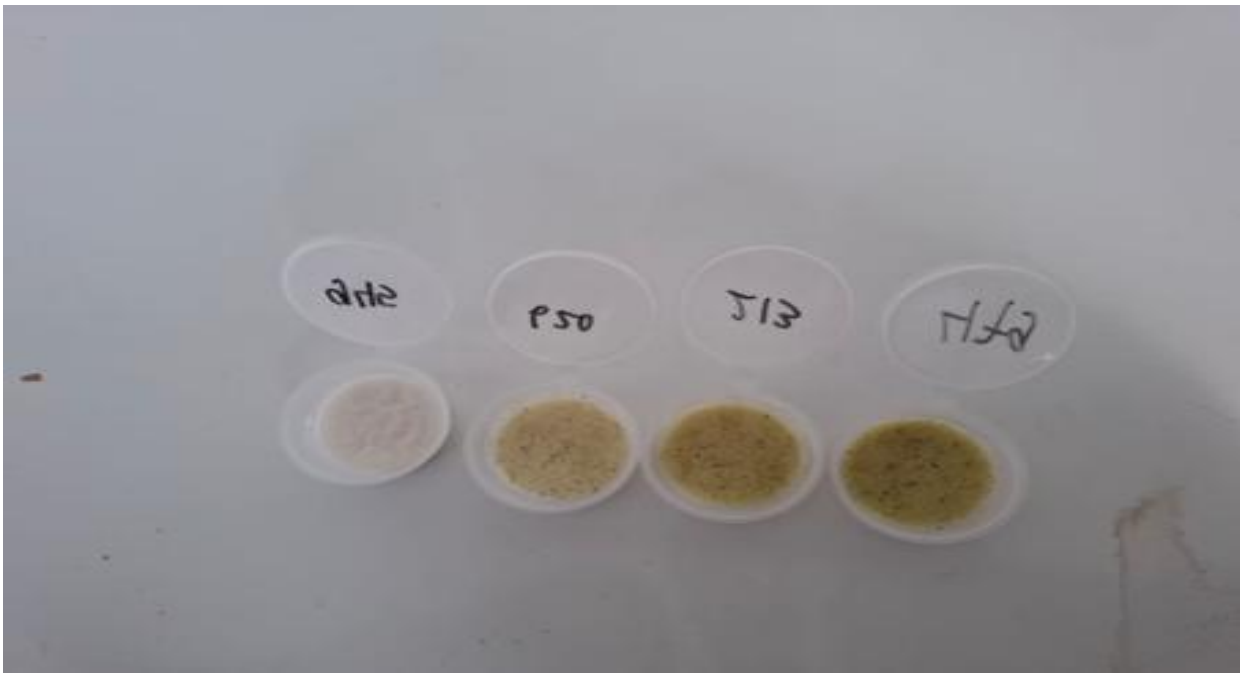

**Figure 1** *Es puter* with various concentration of lemongrass extract.

**Figure 2** *Es puter* Indonesian coconut-based ice dessert.

## Scientific Hypothesis

The incorporation of lemongrass (*Cymbopogon citratus*) extract into *es puter* (Indonesian coconut-based ice dessert) significantly influences its physical (overrun, melting resistance, color), chemical (total phenolics, antioxidant capacity), and sensory (aroma, taste, color, texture) properties in a concentration-dependent manner.

## Objectives

Primary objectives: This research aims to investigate the impact of incorporating lemongrass extract within *es puter*, particularly towards its physical quality (such as overrun, melting resistance, and color intensity), phenolic content and antioxidant status, as well as hedonic and organoleptic quality.

# MATERIAL AND METHODS

## Samples

**Samples description:** The samples consist of *es puter* with various addition percentages of lemongrass extract (0%; 0,2%; 0,4%, and 0,6%). *Es puter* samples were made with coconut milk, mineral water, young coconut water, granulated sugar, CMC, and lemongrass extract.

**Samples collection:** Once the samples were prepared, each sample was then stored in a thin-wall container and kept inside the freezer to preserve its quality.

**Samples preparation:** Lemongrass extract was made as the first step of the research. The making of lemongrass powder began with washing under running water, followed by cutting with a paper cutting machine. Lemongrass cut into 2-3 cm pieces was peeled layer by layer and dried in a dehydrator at 40 °C for 3 days. The next stage was coarse grinding with a blender, followed by re-drying for 3 days. Lemongrass powder was obtained after being refined and filtered with a 40-mesh sieve.

The extraction method used is maceration. 200 g of lemongrass powder was soaked in 1000 ml of 96% ethanol. The lemongrass powder was macerated with 750 ml of ethanol, then covered and left for 24 hours at room temperature, stirring periodically. The extract was filtered with a filter cloth, while the residue was re-macerated with 500 ml of 96% ethanol and left for 48 hours. The filtrate was then passed through a coffee filter, and the resulting solution was concentrated in a rotary vacuum evaporator at 45-55°C. The extract was then weighed. A total of 0.01 g of lemongrass extract was diluted in 10 mL of n-hexane, resulting in a 1000 ppm solution for GC-MS testing.

Once the lemongrass extract is obtained, the process continues with making *es puter* that includes it. A total of 45 g of granulated sugar is dissolved in 112.5 mL of coconut milk and 112.5 mL of mineral water then mixed with 225 mL of young coconut water. The mixture is stirred and then left to stand until the temperature reaches

35 °C. The *es puter* mixture is gradually added to CMC at 0.25% concentration and stirred in a mixer for 7 minutes. The next stage involves adding lemongrass extract according to the treatment, followed by mixing in a mixer for 5 minutes. The mixture is then refrigerated for at least 4 hours to undergo the aging stage. Furthermore, homogenization is 12,000 rpm. The homogeneous mixture is then placed in an ice cream maker that has been cooled for 30 minutes and stirred for 20 minutes. The results are placed in a container and stored in the freezer.

**Number of samples analysed:** 4.

## Chemicals

Analytical ethanol 96%, technical ethanol, DPPH solution, n-hexane solution, Folin-Ciocalteu reagent, and $Na_2CO_3$.

## Animals, Plants and Biological Materials

Animal and biological materials were not used in this study. The plant material used for this study was coconut milk, coconut water, CMC (carboxymethyl cellulose) and lemongrass (*Cymbopogon citratus*).

## Instruments

Chopper (Phillips, Netherlands) was used to grind dried lemongrass into powder. An Ultra-Turrax homogenizer (IKA, Germany) was used to homogenize the ice cream mixture. The refrigerator was used to age the ice cream mixture. The freezer was used to freeze the ice cream. A mixer was used to mix the ice cream ingredients. Ice cream maker (DeLonghi, Italy) was used to make ice cream. A vacuum rotary evaporator (Eyela, Japan) was used to extract the lemongrass.

## Laboratory Methods

The mechanism of the *es puter* overrun test is described by Muse and Hartel **[8]**, namely by measuring the weight of the *es puter* mixture and the weight of the *es puter* in the same container. Overrun is calculated according to formula (1):

$$Overrun\ (\%) = \frac{Weight\ of\ es\ puter\ mix\ withing\ a\ cup - Weight\ of\ es\ puter\ within\ the\ same\ cup}{Weight\ of\ es\ puter\ within\ the\ same\ cup} \times 100\%$$

The melting resistance was measured by taking 50 g of *es puter* that had gone through the aging process for 24 hours and then placing it in a sieve at room temperature until it melted. The time it took for the *es puter* to melt was recorded as the melting time. The color intensity test is based on Istiqomah et al. **[9]**, in which the color reader is attached to the surface of the lemongrass es puter and then the shoot button is pressed 3 times on each sample; the results are then averaged.

The GC-MS testing reported here is based on the research by Khasanah et al. **[10]**. Gas Chromatography–Mass Spectrometry (GC–MS) analysis was carried out using a Trace 1310 Gas Chromatograph coupled with an ISQ 7000 Single Quadrupole Mass Spectrometer (Thermo Scientific, USA). A TG-5MS capillary column (30 m × 0.25 mm, 0.25 µm film thickness) was used at a pressure of 64 kPa. A total of 0.01 g of lemongrass extract was diluted in 10 mL of n-hexane solution, resulting in a concentration of 1000 ppm. The GC–MS system was operated under the following conditions: an injection volume of 1 µL in splitless mode, with the injector temperature maintained at 250 °C. Helium was used as the carrier gas at a constant flow rate of 1.0 mL/min. The oven temperature program was set as follows: an initial temperature of 50 °C held for 2 minutes, followed by sequential increases to 80 °C, 150 °C, 200 °C, and 300 °C at ramp rates of 2 °C/min, 5 °C/min, 10 °C/min, and 20 °C/min, respectively, with a final hold time of 5 minutes. The mass spectrometer was operated over the mass range 40–400 m/z, with the ion source and interface temperatures set to 250 °C and 300 °C, respectively. The resulting data were presented as chromatograms with peaks representing different compounds, which were subsequently identified by comparison with available spectral databases

Testing of total phenol content refers to Marjoni et al. **[11]**, where lemongrass extract of ±0.5 grams will be dissolved in 5 mL of 96% ethanol, then left for 30 minutes. Samples were taken as much as 0.04 mL using a pipette, then 3.16 mL of aquadest and 0.2 mL of Folin-Ciocalteu reagent were added and then homogenized. After being homogenized, the sample was left for 8 minutes, then added with 0.6 mL of 10% $Na_2CO_3$ which was homogenized again. The sample was left at room temperature for 2 hours, then the absorbance was measured at 765 nm.

The antioxidant activity test is based on the research by Thamer et al. **[12]**, with modifications. Lemongrass extract and *es puter* were taken as much as 0.1 g and 96% ethanol was added for up to 10 minutes. The solution was macerated for 30 minutes. From the 10,000 ppm stock solution, sample solutions were made with different concentrations. Each solution was pipetted to a final volume of 0.2 ml, and 1 ml of 0.5 mM DPPH solution was added, and the mixture was incubated for 30 minutes in the dark. The solution was then measured for absorbance with a spectrophotometer at 513 nm. The percentage of inhibition was calculated using formula (2):

$$Inhibition\ (\%) = \frac{Blanco\ absorbation\ value - Sample\ absorbation\ value}{Blanco\ absorbation\ value} \times 100$$

The IC50 value is searched using the linear regression equation formula (Y = a + bX) where the percentage of inhibition of 50% is entered into the Y value, while the solution concentration is as the abscissa (X). The concentration of the solution at which the percentage of inhibition reaches 50% is the IC50 value.

The addition of lemongrass extract to *es puter* can add value to the product, enhancing its hedonic quality and measurable by hedonic and organoleptic tests. The hedonic test method refers to research by Ramadhani et al. **[13]** with modifications. The hedonic test was conducted with 25 semi-trained panelists, who assessed the level of preference for the set of parameters. The hedonic test parameters used were color, aroma, taste, texture, and overall. Panelists were instructed to conduct a preference assessment in accordance with the provided instructions. A score of 1 indicates very dislike, a score of 2 for dislike, a score of 3 for like, and a score of 4 for very like. Meanwhile, the organoleptic test refers to Oktaviani.J **[14]** using a scoring method of 1 to 4 on 25 semi-trained panelists. Panelists will later provide an assessment of *es puter* using the organoleptic scale characteristics determined. The characteristics of the organoleptic scale are shown in Table 1.

**Table 1** Organoleptic Scale Characteristics.

| Attribute | Scale Criteria | | | |
|---|---|---|---|---|
| | **1** | **2** | **3** | **4** |
| **Aroma** | No lemongrass scent | Slightly lemongrass scented | Lemongrass scented | Very lemongrass scented |
| **Color** | Not greenish | Slightly greenish | Greenish | Very greenish |
| **Flavor** | No lemongrass taste | It tastes a bit like lemongrass | Lemongrass flavor | Strong lemongrass flavor |
| **Texture** | Not soft | A bit soft | Gentle | Very soft |

Gas Chromatography (Trace 1310), Single Quadrupole Mass Spectrometry (ISQ 7000) by Thermo Scientific for Gas Chromatography-Mass Spectrometry testing. A spectrophotometer (Go Direct SpectroVis Plus, Vernier, United States) was used to measure the absorbance and determine the total phenol content. While the color intensity test (L*a*b*) used a color reader CR-20 calibrated with a white standard under D65 illumination.

## Description of the Experiment

### Study flow

In the first phase of the experiment, we prepared a few kilograms of local lemongrass, dried it, and ground it into powder. Maceration was then proceeded in order to extract the lemongrass. Once the extract was obtained, we formulated and created the *es puter*, incorporating the lemongrass extract. Formerly determined parameters were then tested. `

## Quality Assurance

**Number of repeated analyses:** 5.

**Number of experiment replication:** 1.

**Reference materials:** -

**Calibration:** All instruments used in this study were carefully calibrated prior to each experimental run to ensure the accuracy and reliability of the measurements. Calibration procedures were performed in accordance with standard operating protocols, and routine calibration checks were conducted regularly to maintain instrument performance.

**Laboratory accreditation:** Experiments were not performed in the accredited laboratory.

### Data Access

The data confirming the results of this study are not publicly available.

## Statistical Analysis

Overrun test data, melting resistance, color intensity were analyzed using the Analysis of Variance (ANOVA) test with a significance level of 5% (α = 0.05) and retested using the Duncan Multiple Range Test (DMRT) if there was a significant difference. Hedonic and organoleptic quality were analyzed using the Kruskal-Wallis non-parametric test; if a significant difference was found, we continued with the Mann-Whitney test. The antioxidant test data were analyzed using a descriptive method. The data analysis of this study was carried out using SPSS 26.0 for Windows and Microsoft Excel 2021.

## RESULTS AND DISCUSSION

### Overrun

The overrun value of *es puter* tends to increase with the addition of lemongrass extract and is not significantly different, except in the treatment with 0.6% lemongrass extract. The results of the overrun test can be seen in Table 2.

**Table 2** Results of overrun and melting resistance tests.

| Parameter | Percentage of Lemongrass Extract within the Samples | | | |
|---|---|---|---|---|
| | 0% | 0.2% | 0.4% | 0.6% |
| **Overrun (%)** | 3.75 ± 0.424 ᵃ | 4.28 ± 0.457 ᵃ | 4.19 ± 0.117 ᵃ | 5.41 ± 0.661 ᵇ |
| **Melting Resistance (minutes)** | 119.99 ± 6.172 ᵃ | 117.74 ± 3.526 ᵃ | 108.55 ± 4.799 ᵇ | 96.15 ± 3.177 ᶜ |

Note: *Different lowercase superscripts in the same column indicate significant differences (p-value < 0.05).

Based on the ANOVA results, the lowest overrun value is observed in P0, the control treatment without the addition of lemongrass extract. The highest overrun value is found in P3, the computer treatment with the addition of 0.6% lemongrass extract. However, the overrun value of *es puter* is lower than the overrun of *es puter* in general. This can be caused by the content of *es puter*. The basic ingredient of *es puter* is coconut milk, which contains varying fat content and different types of fatty acids. Fat is an essential content that plays a role in forming the structure of *es puter* because the size of the fat globules that gather into granules will determine the size of the air cavities in the cells **[15]**. High fat content can help increase the overrun value of *es puter*. Higher fat content will cause the spread of fat globules, evenly distributed in the dough, which then gather to form granules that can trap air **[16]**. The use of coconut milk as a raw material for *es puter* can reduce the ability of *es puter* dough to trap air compared to ice cream made from milk. Low overrun values can also be caused by the aging process, which makes the dough thicker.

The ingredients used in making *es puter* can affect the product's overrun, from raw materials to stabilizers and additional ingredients. The use of ingredients will play a role in determining the content of *es puter* and the interaction between one ingredient and another. The content of the ingredients used can contribute to the viscosity of *es puter*, thereby determining the overrun value. Thicker dough will result in less air entering during the aeration stage during freezing, leading to a low overrun value **[17]**. The viscosity of *es puter* is influenced by the content of solid ingredients in the dough such as sugar, non-fat solids, or hydrocolloid content. The high overrun value can be caused by the high fraction of solid ingredients which results in a low ability to form air cavities in the dough that have the ability to trap air **[18]**.

The addition of lemongrass extract may cause a decrease of the *es puter*'s viscocity. The use of lemongrass extract with increasing concentration may reduce the viscosity of the *es puter* so that air can more easily enter the dough. Low viscosity will cause a decrease in surface tension by free water that is not bound and cause air to easily enter through the surface of the dough so that *es puter* development is higher **[19]**. Lemongrass ethanol extract also does not contain compounds that can thicken the *es puter* dough. In addition, the overrun value of *es puter* is also influenced by the free water content. The higher the free water content, the lower the overrun value **[20]**.

### Melting Resistance

The melting time of *es puter* decreases with the addition of lemongrass extract to the *es puter*. The results of the melting resistance test can be seen in table 2. The test data show the best melting resistance at P0, which is the treatment without the addition of lemongrass extract with a melting time of ± 119.99 minutes. The lowest melting resistance is observed in P3, the treatment with 0.6% lemongrass extract. *Es puter* with the addition of 0% and 0.2% lemongrass extract shows significantly different melting resistance than the treatments with 0.4% and 0.6% lemongrass extract. *Es puter* with the addition of 0.4% lemongrass extract also shows a significant difference in melting resistance to *es puter* with the addition of 0.6% lemongrass extract. The ingredients used to make *es puter* can affect physical quality such as overrun and melting time. The use of CMC as a stabilizer also affects the melting resistance of *es puter*. The use of stabilizers can bind free water, thereby prolonging the melting time **[21]**.

Melting time can be affected by various factors. One of the factors that affect melting resistance is ice crystals formed during the freezing process and the amount of air entering the *es puter* mixture **[22]**. This also applies to *es puter* products. *Es puter* mixture that binds a lot of air will have a weaker resistance to melting. In addition, the viscosity of *es puter* also affects melting resistance. Melting time is affected by the viscosity and texture of *es puter* **[23]**. Viscosity can increase as solids content increases in the *es puter* mixture.

The addition of lemongrass ethanol extract can make the dough increasingly liquid because most of the lemongrass ethanol extract is liquid. This can result in a decrease in the viscosity of the *es puter* along with the increase in the concentration of lemongrass extract. The low viscosity of the *es puter* dough can cause an increase in the overrun value which results in a decrease in the melting resistance of the *es puter*. Meanwhile, *es puter* with a higher viscosity can increase the melting resistance. *Es puter* with a higher viscosity will have a smoother texture and will not melt easily **[24]**. Therefore, viscosity, overrun and melting time are related to each other. High viscosity and total solids will result in a longer melting time, while high overrun will result in a shorter melting time **[25]**.

## Color Intensity

The color intensity test was carried out using a color reader, with 3 repetitions per sample of *es puter* with the addition of lemongrass extract. This test will be described using 3 color values: lightness value (L*), redness value (a*), and yellowness value (b*). The color intensity test results are shown in Table 3.

**Table 3** Color Intensity Test Results.

| Category | Percentage of Lemongrass Extract within the Samples | | | |
|---|---|---|---|---|
| | 0% | 0.2% | 0.4% | 0.6% |
| **Lightness (L*)** | 71.68 ± 6.76 | 75.80 ± 1.35 | 73.44 ± 2.52 | 72.44 ± 3.41 |
| **Redness (a*)** | -0.52 ± 0.08 $^{a}$ | -0.50 ± 0.07 $^{a}$ | -0.06 ± 0.30 $^{b}$ | 0.28 ± 0.41 $^{b}$ |
| **Yellowness (b*)** | 1.48 ± 0.19 $^{a}$ | 13.58 ± 0.37 $^{b}$ | 18.20 ± 1.17 $^{c}$ | 20.10 ± 1.21 |

Note: *Different lowercase superscripts in the same column indicate significant differences (p-value < 0.05).

a. **Brightness:** Based on the results of the ANOVA test that has been carried out, the treatment of different concentrations of lemongrass extract addition to *es puter* did not have a significant effect ($p \geq 0.05$) on the intensity of the brightness color (L*) of *es puter* with the addition of lemongrass extract. %). The test results showed an average value at P0 of 71.68, at P1 of 75.80, at P2 of 73.44, at P3 of 72.44. The brightness value (L*) has a scale value between 0 - 100, where the higher the L* value indicates the brighter the sample being tested **[26]**. The results of the L* color test ranged from 71.68 to 75.80. This shows that *es puter* with the addition of lemongrass extract has a high brightness value. The slight difference in the average value of each treatment is thought to be caused by the maillard reaction which is almost the same between each treatment during the process of making *es puter*. This reaction occurs when amino acid components and reducing sugars in food ingredients react at elevated temperature, accompanied by a decrease in water content **[27]**. *Es puter* has amino acids from coconut milk protein and reducing sugar in the form of granulated sugar.

b. **Redness:** Based on the results of the Anova test and Duncan test that have been carried out, the treatment of different concentrations of lemongrass extract addition to *es puter* has a significant effect ($p < 0.05$) on the intensity of the reddish color (a*) of es puter with the addition of lemongrass extract. The treatment of adding lemongrass extract to *es puter* has significant results or is significantly different ($p > 0.05$), namely between P0 and P1 with P2 and P3 on the intensity of the reddish color (a*) of *es puter* with the addition of lemongrass extract. From these results, it can be seen that the redness value (a*) differs significantly between P0 and P1, and between P2 and P3. This shows that the addition of lemongrass extract at a concentration difference of 0.2% can affect the intensity of the reddish color (a*).

The redness value (a*) has a positive value with a scale of 0 to 80 and a negative value with a scale of -80 to 0, a positive value indicates a reddish color while a negative value indicates a greenish color **[27]**. The results of the a* color test ranged from -0.52 to 0.28 which showed that the color of the *es puter* sample tended to have a greenish color with P3 which had a slightly reddish color. The data obtained were thought to be caused by differences in the addition of lemongrass extract to *es puter*, which made *es puter* have a slightly greenish color. The kitchen lemongrass extract that is generally made is light green, this color comes from lemongrass which has a natural pale/light green color **[28]**. This green color comes from the chlorophyll pigment in lemongrass which gives the plant a green color

c. **Yellowness:** Based on the results of the ANOVA test and Duncan test that have been carried out, the treatment of different concentrations of lemongrass extract addition to *es puter* has a significant effect ($p < 0.05$) on the intensity of the yellowish color (b*) of *es puter* with the addition of lemongrass extract. The treatment of adding lemongrass extract to *es puter* has significant results or is significantly different ($p \geq 0.05$), both between P0, P1, P2 and P3 on the intensity of the yellowish color (b *) of *es puter* with the addition of lemongrass extract. The yellowness value (b*) is a value that indicates a mixture of blue and yellow chromatic colors, which has a positive value on a scale of 0 to 70 and a negative value on a scale of -70 to 0, a positive value indicates yellow, while a negative value indicates blue **[29]**. The results of the b * color test range from 1.48 to 20.10, indicating that all colors are positive and indicate a yellowish color. The higher the concentration of lemongrass extract addition, the more yellow the *es puter* color becomes, so that the addition of lemongrass extract with a concentration of 0.2% shows a significant effect on the intensity of the b * color. The resulting yellow color is thought to come from the addition of lemongrass extract in the *es puter* which comes from the natural color in lemongrass. Khusna and Syarif **[30]** the yellow color of lemongrass is a natural coloring agent that comes from the geraniol compound in lemongrass.

## Gas Chromatography-Mass Spectrometry (GC-MS)

The results of the Gas Chromatography-Mass Spectrometry (GC-MS) test detected 141 compounds, as shown in Illustration 5. The compounds were grouped based on the largest and highest amounts, and the compounds that should have been found in the tested lemongrass extract samples, resulting in 30 compounds. The compounds grouped are shown in Table 4 below.

The compounds obtained can be grouped by class and by their properties. Based on their class, compounds can be divided into hydrocarbon compounds, esters, alcohols, aldehydes, ketones, terpenes and terpenoids, and acids **[31]**. Meanwhile, based on their properties, compounds can be divided into two groups: volatile and non-volatile.

The simplest compound group, but a large compound, is a hydrocarbon compound, which is composed of H, which is hydrogen, and C, which is carbon **[32]**. In the GC-MS results for the lemongrass extract, several hydrocarbon compounds were found. Some hydrocarbon compounds are Limonene, Caryophyllene, Trans-α-Bergamotene, β-Caryophyllene, Cis-β-Farnesene, Longifolene-(V4), β-Candinene, Octahydronaphthalene, (1R,4aS,8aR)-1-Isopropyl-4,7-dimethyl-1,2,4a, 5,6,8a-hexahydronaphthalene, Delta-Cadinene, Bisabolene, Cis-β-Farnesene, Longifolene-(V4), and β-Candinene. Ester compounds are compounds resulting from esterification, which are the result of the reaction of carboxylic acid with alcohol and usually in the reaction using an acid catalyst, this makes the ester contain the -COOR' group **[33]**. In the GC-MS analysis of lemongrass extract, two ester compounds were identified. The two compounds are 2,6,10-Dodecatriene-1,12-diol, 6-(hydroxymethyl)-10-methyl-2-(4-methyl-3-penten-1-yl)-, 1-acetate and Geranic Acetate.

Alcohol compounds are organic compounds with hydroxyl groups (-OH) bound to carbon atoms, where these carbon atoms are bound to hydrogen atoms or other carbon atoms **[34]**. In the GC-MS analysis conducted, several alcohol compounds were found, namely Linalool, Geraniol, Globulol, Guaiol, Eudesmol, Selin-6-en-4a-ol, τ-Cadinol, Patchouli Alcohol, 1-Heptatriacotanol, α-Cadinol, 2-((4aS,8R,8aR)-4a,8-Dimethyl-3,4,4a,5,6,7,8,8a-octahydronaphthalen-2-yl)propan-2-ol. Aldehyde compounds are simple organic compounds containing carbonyl groups (C=O) at the end of the carbon chain and also bound to one or two hydrogen atoms **[35]**. The GC-MS analysis identified several aldehyde compounds, namely Citronellal, citral, E-Citral, Isoneral, and 6-Methyl-4,6-bis(4-methylpent-3-en-1-yl)cyclohexa-1,3-dienecarbaldehyde. Ketone compounds are compounds that are almost the same as aldehyde compounds. However, ketone compounds have a carbonyl group bound to two alkyl groups that do not contain hydrogen **[36]**. The results of the GC-MS analysis carried out on lemongrass extract obtained one ketone compound, namely 6-Methyl-5-Hepten-2-one. In the GC-MS analysis that has been carried out on lemongrass extract, no acid compounds were found in it

Terpene compounds are a group of hydrocarbons, while terpenoid compounds are compounds derived from dehydrogenation and oxygenation of terpene compounds or are derivatives of terpene compounds, both of which are found in plants **[37]**. The results of GC-MS analysis on lemongrass extract found several terpene and terpenoid compounds. Terpene compounds are divided into two, namely monoterpenes consisting of limonene and sesquiterpenes consisting of Caryophyllene, Trans-α-Bergamotene, β-Caryophyllene, Cis-β-Farnesene, Longifolene (V4), β-Cadinene, δ-cadinene, and (1R,4aS,8aR)-1-isopropyl-4,7-dimethyl-1,2,4a, 5,6,8a-hexahydronaphthalene, and Bisabolene. Terpenoid compounds are also divided into two, namely monoterpenoids consisting of 6-Methyl-5-Hepten-2-one, Linalool, Citronellal, Geraniol, Citral, E-citral, Geranic Acetate, and Isoneral and sesquiterpenoids consisting of Globulol, Guaiol, Eudesmol, Selin-6-en-4a-ol, τ-Cadinol, Patchouli Alcohol, 2-((4aS,8R,8aR)-4a,8-Dimethyl-3,4,4a,5,6,7,8,8a-octahydronaphthalen-2-yl)propan-2-ol, α-Cadinol, 6-Methyl-4,6-bis(4-methylpent-3-en-1-yl)cyclohexa-1,3-dienecarbaldehyde, 1-Heptatriacotanol, and 2,6,10-Dodecatriene-1,12-diol, 6-(hydroxymethyl)-10-methyl-2-(4-methyl-3-penten-1-yl)-, 1-acetate.

**Table 4** Results of GC-MS Analysis of Lemongrass Extract.

| No | Compound Name | R. Time (min) | Rel. Area (%) | Rel. Height (%) |
|---|---|---|---|---|
| **1** | 6-Methyl-5-Hepten-2-one | 17.315 | 0.14 | 0.04 |
| **2** | Linalool | 22.712 | 0.16 | 0.07 |
| **3** | Citronellal | 24.750 | 0.06 | 0.04 |
| **4** | Geraniol | 26.133 | 0.05 | 0.02 |
| **5** | Citral | 27.724 | 6.31 | 4.79 |
| **6** | E-citral | 28.642 | 9.25 | 6.43 |
| **7** | Geranium acetate | 31.115 | 0.66 | 0.24 |
| **8** | Isoneral | 31.257 | 0.49 | 0.50 |
| **9** | Limonene | 32.047 | 0.70 | 0.94 |
| **10** | Caryophyllene | 32.747 | 2.01 | 1.51 |
| **11** | Trans-α-Bergamotene | 32.980 | 1.86 | 2.37 |
| **12** | β-Caryophyllene | 33.172 | 0.04 | 0.09 |
| **13** | Cis-β-Farnesene | 33.299 | 0.42 | 0.73 |
| **14** | Longifolene-(V4) | 34.003 | 2.47 | 1.78 |
| **15** | β-candinene | 34.095 | 0.99 | 1.45 |
| **16** | (1R,4aS,8aR)-1-Isopropyl-4,7-dimethyl-1,2,4a,5,6,8a-hexahydronaphthalene | 34.247 | 1.10 | 1.61 |
| **17** | Octahydronaphthalene | 34.515 | 2.32 | 3.47 |
| **18** | Delta-cadinene | 34.642 | 4.26 | 5.48 |
| **19** | Bisabolene | 34.733 | 0.86 | 1.27 |
| **20** | Globulin | 35.103 | 4.42 | 5.02 |
| **21** | Guaiol | 35.534 | 1.87 | 2.60 |
| **22** | Eudesmol | 35.980 | 1.51 | 1.56 |
| **23** | Selin-6-en-4a-ol | 36.223 | 11.74 | 10.50 |
| **24** | τ-Cadinol | 36.537 | 1.18 | 1.33 |
| **25** | Patchouli Alcohol | 36.750 | 4.19 | 4.34 |
| **26** | α-Cadinol | 37.105 | 5.95 | 4.42 |
| **27** | 2-((4aS,8R,8aR)-4a,8-Dimethyl-3,4,4a,5,6,7,8,8a-octahydronaphthalen-2-yl)propan-2-ol | 37.926 | 4.40 | 5.07 |
| **28** | 2,6,10-Dodecatriene-1,12-diol, 6-(hydroxymethyl)-10-methyl-2-(4-methyl-3-penten-1-yl)-, 1-acetate | 38.737 | 2.67 | 4.57 |
| **29** | 1-Heptatriacotanol (sesquiterpene alcohol) | 38.838 | 6.60 | 6.07 |
| **30** | 6-Methyl-4,6-bis(4-methylpent-3-en-1-yl)cyclohexa-1,3-dienecarbaldehyde | 40.176 | 4.53 | 6.52 |
| **31** | Other compounds | - | 16.79 | 15.17 |
| **Total** | | | 100.00 | 100.00 |

Based on their properties, compounds are grouped into volatile compounds and non-volatile compounds. Volatile compounds are compounds that contribute to aroma and are secondary metabolites that readily evaporate at room temperature **[38]**. Meanwhile, non-volatile compounds are difficult to evaporate. Based on the results of GC-MS analysis, almost all compounds were volatile compounds, while only three non-volatile compounds were found. The non-volatile compounds found in this lemongrass extract consist of Octahydronaphthalene, 2,6,10-Dodecatriene-1,12-diol, 6-(hydroxymethyl)-10-methyl-2-(4-methyl-3-penten-1-yl)-, 1-acetate, and 1-Heptatriacotanol. Other compounds identified in the GC-MS analysis of lemongrass extract are volatile. GC-MS testing is generally carried out to analyze volatile compounds, but derivatization methods enable analysis of non-volatile compounds with low molecular weight **[39]**.

In the GC-MS test results, no phenol compounds were detected in the lemongrass extract. This can occur because phenol compounds themselves are not volatile, while the GC-MS test was carried out to identify volatile compounds in the sample. Even so, the GC-MS test can still detect some non-volatile compounds. In addition, this is thought to be due to the use of high temperatures in the GC-MS analysis and to the 50-minute test duration. Fillianty et al. **[40]** phenol compounds at a brewing temperature of 100°C cannot be maintained because the temperature is too high.

## Total Phenol Content

The test results for total phenol levels in lemongrass extract and in *es puter* containing lemongrass extract are shown in Table 5.

**Table 5** Results of Total Phenol Content Testing.

| Sample | mg GAE/100 grams | %Phenol |
|---|---|---|
| **P0 (0%)** | 18.008 | 0.0285 |
| **P1 (0.2%)** | 29.251 | 0.029 |
| **P2 (0.4%)** | 34.148 | 0.0355 |
| **P3 (0.6%)** | 40.295 | 0.033 |
| **Lemongrass Extract** | 2673.785 | 2.676 |

The results of the total phenol content test showed that lemongrass extract contained 2.676% total phenols. The total phenol content will increase along with the increasing concentration of lemongrass extract, but at P3 there was a slight decrease in total phenol in *es puter*. Based on the results obtained, it can be seen that *es puter* without the addition of lemongrass extract itself already contains a total of 0.0285% phenol and lemongrass extract contains a total of 2.676%. This shows that *es puter* with the addition of lemongrass extract did not provide a significant increase, although there was an increase in total phenol in each treatment. This increase can be caused by several phenol compounds in lemongrass extract being lost during the process of making *es puter*, so that a number of total phenols cannot be maintained. A number of these lost phenol compounds are thought to be caused by the presence of phenol bound to protein so that in the process of testing the total phenol content using the Folin-Ciocalteu reagent, the phenol compounds cannot be accessed. This can occur due to the formation of a non-covalent complex between the protein from coconut milk and phenolic compounds in lemongrass extract. Nemli et al. **[41]** Phenolic compounds that can donate hydrogen will form hydrogen bonds between the phenol compound and the carboxyl group of the protein, so that the nitrogen or oxygen molecules in the phenol compound will bind to each other in this bond. There will be hydrophobic interactions between the aromatic ring in the phenol compound and non-polar molecules.

Lemongrass extract derived from the lemongrass plant itself contains several phenolic compounds in the form of gallic acid, p-coumaric acid, caffeic acid, vanillic acid, catechin, quercetin, syringic acid, and other compounds **[31]**. However, based on the GC-MS test that has been carried out, no phenolic compounds were found in it. This indicates that GC-MS does not capture the expected volatile phenolic compounds. These compounds are like syringic acid compounds which are derivatives of syringol which are phenolic compounds with volatile properties, although semi-volatile. Supit et al. **[42]** there are several volatile phenolic compounds such as guaiacol and its derivatives, phenylpropane such as eugenol or isoeugenol and its derivatives and vanillic acid.

## Antioxidant Status

The data from the antioxidant status test showed that the higher the amount of lemongrass extract added, the lower the IC50 value obtained. The IC50 results for lemongrass extract and ice puter, with the addition of lemongrass extract, are shown in Figure 1.

Based on the data, the Inhibition Concentration (IC50) value decreases with the addition of lemongrass extract to the *es puter* sample with the largest value of 13,009.53 ppm found in P0 (*es puter* without the addition of lemongrass extract) and the smallest value found in P3 (*es puter* with the addition of 0.6% lemongrass extract). The IC50 value can serve as a reference for a product's antioxidant activity. The IC50 concentration is the concentration of the sample that reduces 50% of DPPH free radicals **[43]**. The lower the IC50 value, the more effective the antioxidant activity. The addition of lemongrass extract in higher concentration causes a higher antioxidant activity as shown through the decrease in IC50 value. Despite this, all treatments are considered to have very weak antioxidant activity based on their IC50 values. A compound has weak antioxidant activity if the IC50 value is between 150-200 ppm, moderate if the IC50 value is 101-150 ppm, strong if the IC50 value is between 50-100 ppm, and very strong if the IC50 value is less than 50 ppm **[44]**. Thus, despite the decrease of IC50 value along with the addition of more lemongrass extract, the antioxidant activity is still considered very weak throughout all treatments.

The use of solvents significantly affects the composition of the extract. Polar compounds will dissolve in polar solvents such as ethanol. Lemongrass contains flavanol antioxidants and various phenolic compounds, including catechol, quercetin, elemicin, glycosides, kaempferol, luteolin, caffeic acid, and chlorogenic acid **[45]**. Polar antioxidant compounds dissolved in ethanol will contribute to the functional value of the lemongrass extract obtained. Several previous studies have shown that lemongrass leaf extract contains compounds such as flavonoids, phenols, tannins, saponins, alkaloids, and steroids, which act as antioxidants because they can inhibit free radicals 2,2-diphenyl-1-picrylhydrazyl, commonly called DPPH **[46]**. Weak antioxidant activity in the extract may be due to poor solubility of antioxidant compounds in the solvent. Lemongrass methanol extract contains more phytochemicals than lemongrass ethanol extract, indicating that the extraction method used affects phytochemical detection **[47]**. This may indicate that the ethanol solvent has not been effective in binding functional compounds massively in this study. Ethanol concentration can also affect the flavonoid levels and antioxidant activity of the extract **[48]**.

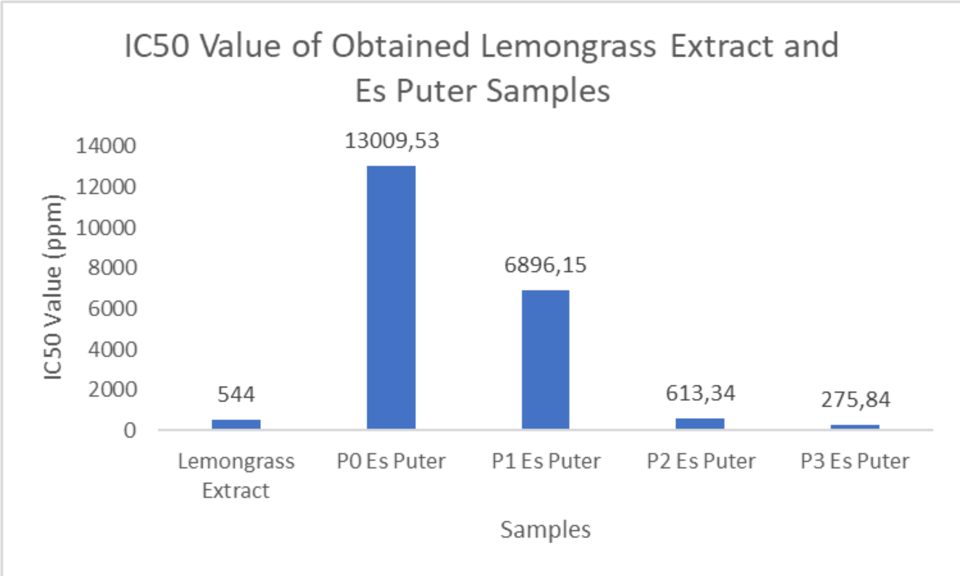


**Figure 1** IC50 Values of Lemongrass Extract and *Es puter* with the Addition of Lemongrass Extract.

The functional properties of lemongrass extract as an antioxidant can be utilized by incorporating it into food products as part of functional food product development. The application of lemongrass extract to es puter products can enhance the product's functionality by providing antioxidant compounds that improve its chemical quality. Phenolic and flavonoid compounds function as antioxidants because they are able to act as hydrogen atom donors from hydroxyl to radical compounds and cause these radical compounds to be more stable **[49]**. Tannin compounds can precipitate proteins and chelate metals, suggesting they are biological antioxidants **[50]**. Saponin compounds in lemongrass ethanol extract can also act as antioxidants. Saponins can reduce superoxide by forming hyperoxide intermediates, thereby preventing biomolecular damage caused by free radicals and thus acting as antioxidants **[51]**.

## Hedonic Quality

The hedonic test of *es puter* with lemongrass extract showed significant differences in color, aroma, and overall. The average preference value is shown in Table 6.

**Table 6** Hedonic Test Results.

| Percentage of Lemongrass Extract within the Samples (%) | Parameter | | | | |
|---|---|---|---|---|---|
| | Color | Aroma | Taste | Texture | Overall |
| 0 | 1.68 ± 0.786 [a] | 2.20 ± 1.020 [a] | 2.48 ± 0.985 | 2.56 ± 1.098 | 2.12 ± 0.993 [a] |
| 0.2 | 3.08 ± 0.688 [b] | 2.96 ± 0.720 [ab] | 3.00 ± 0.784 | 3.16 ± 0.709 | 3.24 ± 0.709 [b] |
| 0.4 | 3.08 ± 0.627 [b] | 2.84 ± 0.784 [ab] | 2.96 ± 0.871 | 2.72 ± 1.001 | 2.84 ± 0.731 [ab] |
| 0.6 | 3.32 ± 0.733 [b] | 3.24 ± 0.907 [b] | 2.96 ± 0.916 | 2.96 ± 1.076 | 2.88 ± 0.993 [ab] |

The test results showed a significant effect on the color parameters of *es puter* ($p < 0.05$). The color of the product has the greatest influence on the quality of food ingredients **[52]**. Color is closely related to perception by the sense of sight. Panelists liked the greenish color of *es puter* caused by the addition of lemongrass extract. The green color comes from the chlorophyll compound in lemongrass leaves. Grass-type plants (Poaceae) such as kitchen lemongrass (Cymbopogon citratus) can contain chlorophyll compounds **[53]**. Green plants generally contain two types of chlorophyll, namely chlorophyll a and chlorophyll b. Both can be classified as pigments that give lemongrass its color. Chlorophyll a is green-blue and is a less polar or non-polar compound, while chlorophyll b is green-yellow and is a polar compound **[54]**. The use of ethanol as a solvent can also extract chlorophyll so that lemongrass extract contains green pigment when applied to *es puter* products. The addition of lemongrass extract to *es puter* is directly proportional to the strength of the green pigment in the product. The high content of lemongrass extract will cause the *es puter* to appear greener. Panelists also liked the color of *es puter* with the addition of lemongrass extract which was greener.

Based on the hedonic test results, the addition of lemongrass extract has a significant effect ($p<0.05$) on the aroma aspect of *es puter*. Aroma can be smelled when volatile compounds in a food product enter the nose and are received by the olfactory system and then continued to the brain **[55]**. *The computer with the aroma most preferred by consumers is P3, which includes* 0.6% lemongrass extract. *Es puter* with this treatment has a stronger lemongrass aroma than other treatments. The distinctive aroma of lemongrass comes from the essential oil content in lemongrass extract. The composition of compounds in lemongrass essential oil includes citral, geraniol, and citronellal **[56]**. These volatile compounds are present in lemongrass extract, giving it a distinctive aroma. Citral is more polar due to the presence of oxygen in its chemical structure. At the same time, most other compounds in lemongrass, such as geraniol, citronellol, and citronellal, are oxygenated **[57]**. Oxygenated compounds are compounds that have organic molecules with oxygen content. The presence of these compounds in lemongrass extract gives *es puter* a distinctive aroma that panelists like.

The hedonic quality test results showed that adding lemongrass extract did not significantly affect the taste of the *es puter* ($p \geq 0.05$). Data from the panelists showed that *es puter* with lemongrass extract was well-liked, as evidenced by the high score for the taste attribute. This suggests a tendency among panelists to prefer *es puter* with lemongrass flavor. The essential compounds contained in lemongrass can help improve the taste of food products **[58]**. Lemongrass content, such as citronellal, citronellol, and geraniol, can produce a sour, slightly sweet, and fresh taste **[59]**.

The hedonic quality test data showed that adding lemongrass extract did not significantly affect *es puter* texture ($p \geq 0.05$). One factor that affects *es puter* texture is its fat content. The higher the fat content, the softer the *es puter* texture will be **[60]**. This also applies to *es puter*. The high fat content in *es puter* can increase its viscosity, resulting in a smoother texture. However, one general characteristic of *es puter* is its slightly rough texture, due to the use of coconut milk as a fat source and the large size of the ice crystals. Larger ice crystals will produce a rougher texture. However, adding a stabilizer can help soften *es puter*'s texture and reduce the size of ice crystals formed during manufacturing. The stabilizer acts as an emulsifier, binding fat, air, and water molecules into globules **[61]**.

The overall aspect is the panelists' final assessment of a product's hedonic attributes. Based on the results of the hedonic test, it is known that the addition of lemongrass extract has a significant effect ($p< 0.05$) on the *es puter*'s overall sensory aspect. Panelists tend to prefer *es puter* P1, which is treated with 0.2% lemongrass extract. This is reflected by the superiority of *es puter* with this treatment in terms of color, aroma, taste, and texture compared to other treatments. Some of the characteristics of *es puter* P1 are light green color, a lemongrass aroma that is smelled but not too strong, a lemongrass taste that is not too strong, and a slightly rough texture.

## Organoleptic Properties

Organoleptic testing of *es puter* with the addition of lemongrass extract was conducted on 4 attributes: aroma, color, taste, and texture. The results of the organoleptic testing carried out are displayed in the form of an average which can be seen in Table 7.

Based on the results of the Kruskall Wallis test conducted using ANOVA, it can be seen that the treatment of different lemongrass extracts in *es puter* had a significant effect on aroma, color, and taste, while the texture had no significant effect.

Based on the results of the Mann-Whitney follow-up test, it shows that most of the treatments of adding lemongrass extract to *es puter* that are significant or significantly different ($p <0.05$), namely P0 and P1, P0 and P2, P0 and P3, P1 and P2, and P1 and P3 on the aroma attributes of *es puter* with the addition of lemongrass extract which is organoleptically tested. Meanwhile, the treatment of adding lemongrass extract to *es puter* that is not significant or not significantly different ($p \geq 0.05$) is in P2 and P3. Sufyan et al. **[62]** essential oil in lemongrass has a main compound in the form of a citral compound which gives an aroma like the aroma of lemon. In addition to citral, lemongrass essential oil contains other compounds, namely citronellal and geraniol. Wilis et al. **[56]** reported that lemongrass plants produce 30-45% citronellal and 65-90% geraniol in the essential oil obtained. This means that the higher the concentration of lemongrass extract added to the es puter, the stronger and more pungent the lemongrass aroma will be.

**Table 7** Organoleptic Properties Test Results.

| Attribute | Adding Lemongrass Extract to *Es Puter* | | | |
|---|---|---|---|---|
| | 0% | 0.2% | 0.4% | 0.6% |
| Aroma | 1.00 ± 0.000 [a] | 2.84 ± 0.554 [b] | 3.32 ± 0.557 [cd] | 3.48 ± 0.510 [d] |
| Color | 1.00 ± 0.000 [a] | 2.64 ± 0.569 [b] | 3.20 ± 0.500 [cd] | 3.48 ± 0.510 [d] |
| Flavor | 1.12 ± 0.332 [a] | 2.68 ± 0.557 [b] | 3.20 ± 0.577 [c] | 3.68 ± 0.476 [cd] |
| Texture | 2.68 ± 1.282 | 2.80 ± 0.707 | 2.68 ± 0.852 | 3.00 ± 1.041 |

In the color attribute continued with the Mann-Whitney test, it can be seen that the addition of lemongrass extract to *es puter* is significant or significantly different ($p < 0.05$), namely P0 and P1, P0 and P2, P0 and P3, P1 and P2, and P1 and P3 on the color attribute of *es puter* with the addition of lemongrass extract which is organoleptically tested. Meanwhile, the treatment of adding lemongrass extract to *es puter* that is not significant or not significantly different ($p \geq 0.05$) is in P2 and P3. Adding lemongrass extract to *espresso tends to give it* a greenish color. Rinaldi et al. **[63]** conducted a study with the results that the extraction of lemongrass using ethanol produces lemongrass extract that is pale green/light green. The green color is due to the fresh lemongrass used to make the extract. This is because fresh lemongrass is light green, which is caused by lemongrass containing chlorophyll or pigments in plants that give color to plants **[64]**. This means that the higher the concentration of lemongrass extract added to the *es puter*, the greener the *es puter* will be.

Based on the results of the Mann-Whitney follow-up test, it can be seen that in the taste attribute, each treatment of adding lemongrass extract to *es puter* has significant or significantly different results ($p<0.05$), both P0 and P1, P0 and P2, P0 and P3, P1 and P2, P1 and P3, and P2 and P3 on the taste attribute of *es puter* with the addition of organoleptic lemongrass extract. The addition of a higher concentration of lemongrass extract to *es puter* makes the lemongrass flavor in *es puter* stronger/more pronounced. Lemongrass offers a distinctive flavor and aroma, characterized by a slightly bitter taste, a spicy sensation, and a unique aftertaste. Lemongrass extract can provide a bitter taste, which bitter taste comes from the characteristics of lemongrass itself, there is also a spicy sensation given by lemongrass from volatile compounds of essential oils from the lemongrass extraction process, and the presence of a unique *aftertaste* such as a blend of grass and lemon combined with a bitter taste that remains and the presence of tannin compounds that make lemongrass extract have a characteristic bitter taste **[65]**.

In the texture attribute, adding lemongrass extract to *es puter* has no significant effect or is not significantly different across treatments. These results indicate that the higher the concentration of lemongrass extract given, the less it affects the texture of the resulting *es puter*. Ideally, the texture of *es puter* that is good and preferred by consumers is a smooth *es puter* texture with small, homogeneous and even solids **[66]**. The addition of extract to *es puter* increases the solids content, making the mixture thicker. The thicker the mixture, the more it will prevent the formation of coarse ice crystals, because more water is bound, resulting in softer ice **[67]**.

## CONCLUSION

Based on the research conducted, it is known that the addition of lemongrass extract to *es puter* products can affect the physical, chemical, hedonic, and organoleptic quality of *es puter*. *Es puter* overrun tends to increase as lemongrass extract is added. The addition of lemongrass extract to *es puter* resulted in an overrun value of 3.75–5.41% Subsequently, melting resistance tends to decrease along with the addition of lemongrass extract within *es puter* with melting time ranging from 96.15–119.99 minutes; in contrary to the increasing overrun. The redness value increased from −0.52 to 0.28, and the yellowness value increased from 1.48 to 20.10; this increase occurred with the addition of higher concentrations of lemongrass extract in e*es puter*. GC-MS analysis found several compounds in lemongrass extract. The total phenolic content of *es puter* increased from 0.0285% to 0.0355% as the lemongrass extract concentration increased. The antioxidant IC50 value shows better results in *es puter* with more addition of lemongrass extract with results of IC50 ranging from 279.5 ppm – 13,018.5 ppm. *Es puter* with the addition of 0.2% lemongrass extract was the most preferred by the panelists. The organoleptic results showed that *es puter* exhibited a stronger lemongrass aroma and flavor, as well as a greener color, as lemongrass extract concentration increased.

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