

Chemical Characteristics of Lemon Cui (*Citrus microcarpa*) Infused Water with Various Combinations of Food Materials and Extraction Time

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Abstract: Lemon Cui (*Citrus microcarpa*) is an Indonesian citrus often found in Sulawesi, especially Gorontalo and North Sulawesi. The purpose of this study was to determine the chemical characteristics (vitamin C content, antioxidant activity, total phenol, and pH) of infused water made from Lemon Cui (Lcui) with various combinations of food materials and extraction time. The study was conducted using a completely randomized design (factorial) consisting of 2 factors, namely the combination of food materials (Lcui-dates, Lcui-cucumber, Lcui-watermelon) and extraction time (2, 4, 6, and 12 hours). Results showed that the chemical characteristics of infused water made from lemon cui in various combinations of food materials and extraction time respectively range from 10.83 – 39.9 mg/100g (vitamin C), 14.38 – 20.11% (antioxidant activity), 0.003 – 0.011% (total phenol), and pH 4.04 – 4.32. The combination of Lemon cui – watermelon and 4 hours extraction time gives the highest chemical characteristics of infused water, namely vitamin C content 37.4 mg/100g, antioxidant activity (RSA) 21.63%, total phenols 0.0112% and pH 4.15. In general, combining food materials and extraction time affected the levels of vitamin C, antioxidants, and total phenol-infused water made from lemon cui. This information can be used to develop drinks containing vitamin C and antioxidants made from local fruit.

Keywords: extraction time, food material, infused water, lemon cui, vitamin c.

Introduction

In the post-Covid-19 pandemic era, maintaining health is a must. One way that can be done is by increasing your intake of food or drinks rich in vitamins which can increase the body's immunity, one of them is vitamin C. Vitamin C is a vitamin that generally plays a role in increasing the body's immunity. This vitamin is water soluble and plays a role in warding off various diseases because it contains antioxidants that function to neutralize free radicals. Vitamin C contains the compound ascorbic acid. A deficiency of ascorbic acid can cause bleeding gums, easily porous teeth, wrinkled/dry skin, fatigue and tiredness, epistaxis, infection, and pain in the hinge (Permana et al., 2018). Based on these needs, currently, most

Indonesians are starting to consume infused water. Besides being easy to make, infused water is reportedly rich in vitamin C because it is made from fresh fruits such as lemons, oranges, strawberries, etc. (Harifah et al, 2017; Fuza and Damayanthi, 2017).

Lemon cui (*Citrus microcarpa*) known as Chinese lemon is a fruit widely used by the community. This lemon is a typical Indonesian fruit that is often found in the Sulawesi region, especially Gorontalo and North Sulawesi. Lemon cui has a small and round shape, with a diameter of about 2-3 cm (BPTP, 2020). Lemon Cui juice is used as a food flavoring, drink freshener, or as a natural herb which has the properties of cough medicine, phlegm easing, and helps the digestive process (Pinontoan et al., 2019).

In making infused water, combination of fruit or herbs used and the extraction time need to be considered. The type of fruit and soaking time not only affect the taste of the infused water but also affect the compound content in the resulting infused water. Research on infused lemon water with a combination of fruit such as blueberries, blackberries, raspberries, grapes, kiwi, pineapple, pomegranate, and strawberries (Harifah et al. 2017; Haitami et al. 2017). However, these fruits are quite expensive and difficult to find in some areas. This research aims to determine the chemical characteristics of lemon cui-infused water combined with easily available food materials (dates, cucumbers, and watermelon) and apply several variations in extraction time.

Materials and Methods

Materials

The research was carried out at the Integrated Agricultural Laboratory, Faculty of Agriculture, Universitas Ichsan Gorontalo. The food materials used were lemon cui (Lcui, figure 1), cucumber, watermelon, dates, water, aquadest, 1% starch solution, 1% Iodine, 96% ethanol, 10% Na₂CO₃, methanol, 0.1 N NaOH, 1% pp indicator, concentrated H₂SO₄, 10% FeCl₃, Follin ciocalteu reagent, DPPH powder, pH 7 buffer, and pH 4 buffer.



Figure 1. Lemon cui (*Citrus microcarpa*)

Procedures

Making infused water was carried out by referring to research from Harifah et al., (2017) and Siallagan et al., (2023) with modifications. The research activity began by washing the food materials such as lemon cui (Lcui), dates, cucumber, and watermelon. Then the fruit is cut (slices) and weighed with a mass of 30g each Lcui: 20g dates; 30g Lcui: 20g cucumber; and 30g Lcui: 20g watermelon. Next, put the fruit pieces into a bottle and add 200 mL of water. The fruit mixture was extracted for 2, 4, 6, and 12 hours in the refrigerator at a cold temperature of ± 4 °C. After that, it was filtered and analyzed for vitamin C levels (iodometric titration method), antioxidant activity (Siallagan et al. 2023), total phenols (Fatemeh et al. 2012) and pH (AOAC, 1984).

Research design

The study was conducted using a completely randomized design (factorial) consisting of 2 factors, namely the combination of food materials (Lcui-dates, Lcui-cucumber, Lcui-watermelon) and extraction time (2, 4, 6, and 12 hours).

Data analysis

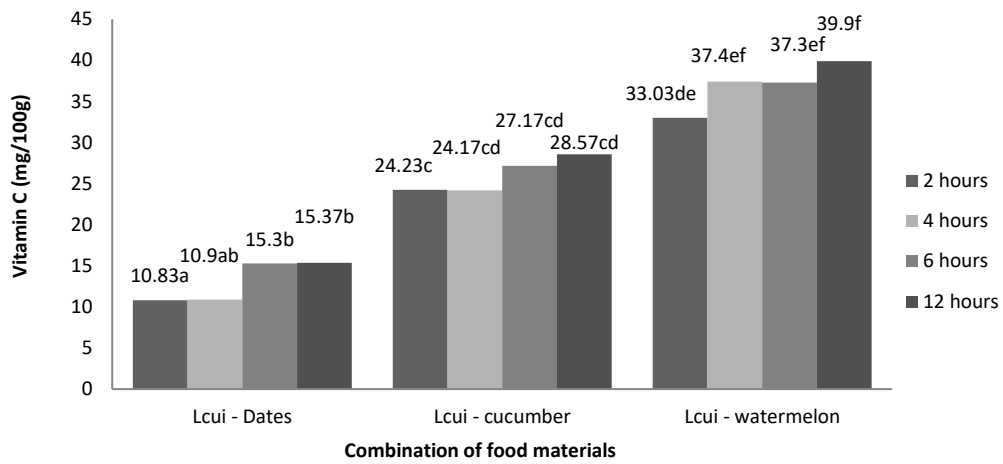
The data obtained was tested using two-way ANOVA and Duncan's test ($\alpha = 0.05$).

Results and Discussion

Results

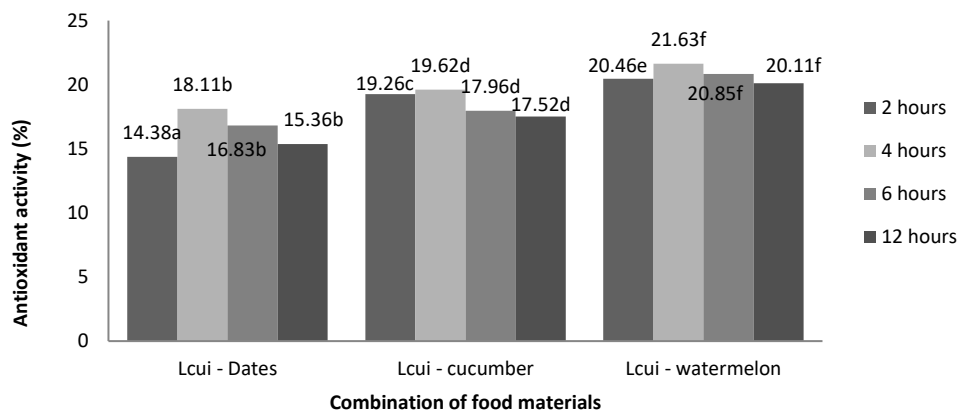
Chemical Characteristics

Results showed that the chemical characteristics of infused water made from lemon cui in various combinations of food materials and extraction time respectively vitamin C was 10.83 – 39.9 mg/100g (Figure 2), antioxidant activity 14.38 – 20.11% (Figure 3), total phenol 0.003 – 0.011% (Figure 4), and pH 4.04 – 4.32 (Figure 5).



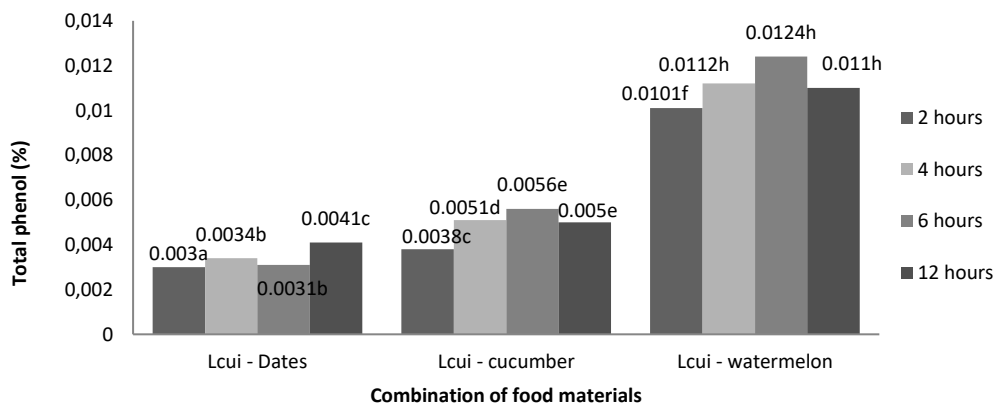
Note: average values accompanied by different letters indicate significant differences ($p < 0,05$)

Figure 2. Vitamin C of Lemon cui infused water in various combinations of food materials and extraction times.



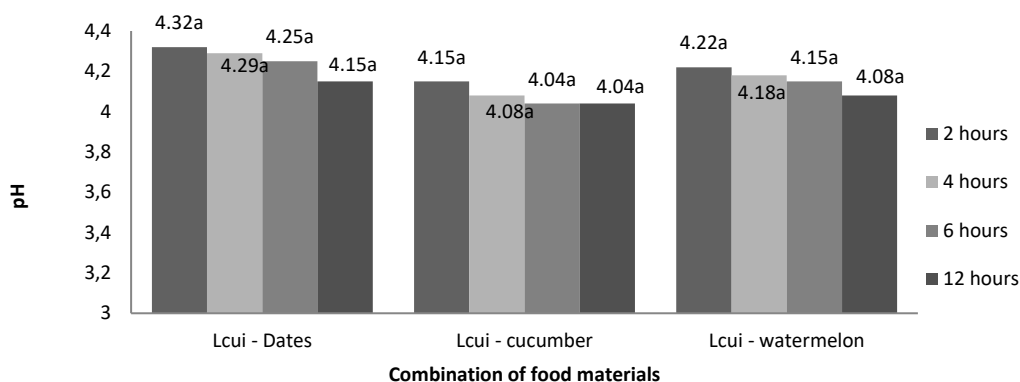
Note: average values accompanied by different letters indicate significant differences ($p < 0,05$)

Figure 3. Antioxidant activity of Lemon cui infused water in various combinations of food materials and extraction times.



Note: average values accompanied by different letters indicate significant differences ($p < 0,05$)

Figure 4. Total phenol of Lemon cui infused water in various combinations of food materials and extraction times.



Note: average values accompanied by same letters indicate not significant differences ($p > 0,05$)

Figure 5. pH value of Lemon cui infused water in various combinations of food materials and extraction times.

Discussion

Vitamin C

The results showed that the vitamin C content of lemon cui-infused water combined with food ingredients and extraction time was 10.83 – 39.9 (mg/100g). The highest content of vitamin C in this study were found in infused water treated with a combination of Lcui-Watermelon with an extraction time of 12 hours (39.9 mg/100g). The results of statistical tests show that it affects the content of vitamin C-infused water produced. There is an interaction between treatments. Duncan's further test results showed that the Lcui-watermelon treatment with an extraction time of 12 hours was not significantly different from the treatments with an extraction time of 4 and 6 hours, while the other treatments were significantly different. These results are in line with research by Fuza & Damayanthi (2017) which reported that there was an interaction between the length of soaking treatment and the infused water formula (lemon-mint leaves) with the addition of dates. Chairunnisa et al., (2019) stated that factors that influence the success of solvent extraction include extraction time, temperature, type of solvent, ratio of ingredient and solvent, and particle size.

Figure 2 also shows that an increase in content of vitamin C-infused water was observed with increasing extraction time for each combination of food ingredients. The longer the extraction time, the more time is available for the solvent to penetrate the cell walls and come into contact with

the active substances of the food being extracted (Fitrah et al., 2014). Besides, Vitamin C content in infused water are also influenced by the type of food extracted. The addition of dates, cucumber, and watermelon contributes to increasing the vitamin C content of lemon cui-infused water produced for each combination of food materials. Vitamin C levels in dates, cucumbers, and watermelon are 0.4 mg/g each; 2.8 mg/100g, and 8.1 mg/100g (Azis et al., 2018; USDA, 2020; USDA, 2019).

Antioxidant activity

The results show that the antioxidant activity of infused lemon cui water with a combination of food ingredients and extraction time ranges from 14.38 - 21.63%. The antioxidant activity of infused water showed a decrease after 4 hours of extraction. The highest antioxidant activity in this study was found in infused water with a combination of Lcui-Watermelon treatment at 4 hours of extraction, namely 21.63%. These result align with the vitamin C and total phenol content which also increased for this combination. The results of the variance analysis showed that the combination of food materials and the extraction time affected the antioxidant levels of the resulting infused water. There is an interaction between fruit combination treatment and extraction time. Duncan's further test results showed that the antioxidant activity of the Lcui-watermelon-infused water at an extraction time of 4 hours was not significantly different from the extraction time

treatment of 6 and 12 hours. The vitamin C content and phenolic compounds contained in lemon cui, dates, cucumbers, and watermelon can act as antioxidants (Makmun et al, 2020). The compound's ability to act as an antioxidant is due to its ability to donate the H atom from the hydroxyl group to radical compounds (Triyani et al, 2021).

Total phenol

The total phenol value shows the number of phenolic compounds in the sample. In this study, the total phenol content of the infused water produced ranged from 0.003 – 0.0124%. The statistical results show that the combination treatment of food ingredients and the extraction time affect the antioxidant levels of the resulting infused water. There is an interaction between the fruit combination treatment and the extraction time. The highest total phenol content in this study was found in infused water with the Lcui-watermelon combination treatment at 6 hours of extraction, namely 0.0124%. Duncan's further test results showed that the Lcui-watermelon-infused water treatment with an extraction time of 6 hours was not significantly different from the extraction time of 4 and 12 hours. This total phenol values are lower than the infused water research from Harifah et al., (2017), namely 27.65 – 46.20%. This due to differences in the ratio and types of food materials used.

pH value

The pH value indicates the presence of acid compounds contained in food ingredients that are extracted in the solvent used (water). The pH value in this study ranged from 4.04 - 4.32. Ascorbic acid is a type of acid that is often found in oranges or lemons (Fitriyana, 2017). Ascorbic acid has the property of being easily soluble in water, so the longer the extraction time, the lower the pH value of the infused water for all treatments, which means the acidity increases. Farikha et al., (2013) reported that the acid stability of ascorbate will increase with decreasing pH value.

Conclusions

The chemical characteristics of lemon cui infused water in various combinations of food materials and extraction time respectively range from 10.83 – 39.9 mg/100g (vitamin C); 14.38 – 20.11% (antioxidant activity), 0.003 – 0.011% (total phenol) and pH 4.04 – 4.32. The combination of lemon cui-watermelon and 4 hours extraction time gives the highest chemical characteristics of infused water, namely vitamin C content of 37.4 mg/100g; antioxidant activity (RSA) 21.63%, total phenols 0.0112% and pH 4.15.

Acknowledgements

The author would like to thank the Faculty of Agriculture, Universitas Ichsan Gorontalo for assistance with research facilities.

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