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Antioxidant Activity, Vitamin C, and Organoleptic Quality of Flower Kecombrang (*Etlinger elatior*) Kombucha on Variations of Sugar Types and Fermentation Duration

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Abstract: The purpose of this study was to determine the antioxidant activity, vitamin C and organoleptic quality of torch ginger flower kombucha on variationsof sugar types and fermentation duration. This research method was experiment with Completely Randomized Design (CRD) with 2 Factors. The first factor was the variations of sugar types (G): palm sugar (200g) and Javanese sugar (200g). The second factor was fermentation duration (F): 5 days and 7 days and green tea kombucha as control. Organoleptic quality testing included color, aroma, taste, and acceptability carried out 20 respondents. The results of the study showed that the highest of the antioxidant activity and vitamin C levels as well as the best organoleptic quality of the torch ginger flower kombucha were 82.54% and 62.65 mg/100 ml as well reddish brown color, reddish brown color, typical kombucha aroma, sweet and sour taste, and preferred acceptability in the G1F2 treatment (200g palm sugar with fermentation duration of 7 days).
Keywords: Kombucha; torch ginger flower; antioxidant activity; organoleptic quality; vitamin c

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INTRODUCTION

Probiotic drinks are functional beverage containing microorganisms and have positive impact on digestive health. The bacterial strains of probiotic drinks work anaerobically to produce lactic acid and antimicrobial substances that can suppress the growth of pathogenic bacteria (Azizah et al., 2024). One of the probiotic drinks that has the potential to be developed today is kombucha.

Kombucha is probiotic and functional bevarage resulting from the fermentation of sweet tea solution by consortium of microorganisms from the group of acetic acid bacteria *Acetobacter xylinum* and yeast *Saccharomyces* sp. known as SCOBY (*Symbiotic Colony Culture Bacteria & Yeast*) (Yusmita et al., 2021). The bacteria of the scoby will convert sugar into organic acids, while the yeast will break down the sugar into levels co_2 and low ethanol (Fadillah, 2022). The common substrate used as raw material of kombucha is black tea leaf (*Camellia sinensis* L.). However, currently the development of raw materials for kombucha uses flowers and one of the flowers that has the potential to be developed as raw material of kombucha is torch ginger flower.

The torch ginger flower (*Etlinger elatior*) is spice plant of Zingiberaceae family containing saponins, tannins, phenolics, and flavonoids (Arumsari et al., 2019) having the potential as an antimicrobial and antioxidant (Choiriyah, 2020). Torch ginger flowers have high antioxidant components to absorb free radical compounds, thus preventing oxidation, 92.92% on 0.5 g/mL of torch ginger extract with ethanol solvent (Sari et al., 2022). In addition, torch ginger flower extract has been proven to have in vivo antioxidant activity having the potential to increase immunity (Bogoriani et al.,

2022). Torch ginger flowers are used the community as flavor enhancer for cooking and as traditional medicine that can eliminate body odor, bad breath, improve blood circulation, heal wounds and also can increase breast milk of breastfeeding mothers (Harnis & Br. Perangin-angin, 2021). However, currently there has been no previous kombucha research using torch ginger flower as the raw material and the novelty of the research.

One of the factors in the kombucha fermentation process is influenced sugar, different sugar concentrations will affect the growth of kombucha microbes and organic acids (Yanti et al., 2020). Sugar serves as carbon and energy source of SCOBY. The variations of sugar type used in making kombucha will show interactions on pH, antioxidant activity, and organoleptic quality of kombucha products (Sipahutar et al., 2024). Palm sugar is natural sweetener made from the sap of the palm tree which is useful in preventing anemia, helping to increase muscle and nerve relaxation, strengthening the immune system against the threat of free radicals (Sharifi-Rad et al., 2020). Palm sugar contains 84.31% sucrose, 0.53% reducing sugar, 2.28% protein, 3.66% minerals, 368 kcal calories (Yudho, 2021). Javanese sugar is obtained through the process of tapping coconut water and contains complex carbohydrates, 368 kcal calories, magnesium and potassium minerals which are beneficial for the metabolic process and optimizing the work of muscles, heart, and lungs (Faturochman & Anies, 2020).

Fermentation duration is factor that influences the kombucha fermentation process. The fermentation duration needed to change the tea solution into kombucha product is around 4-14 days (Gumanti et al., 2023). During fermentation process, bacteria and yeast hydrolyze sucrose into glucose and fructose through invertase and produce ethanol (Maicas, 2020). The longer the fermentation duration, the higher the organic acid produced. This happens because the bacteria get food from the added sugar for their growth and development (Dayanti & Suryani, 2025). Increased acetic acid of kombucha can affect antioxidant activity. Phenolic compounds will be stable in acidic conditions and are difficult to release protons associated with DPPH therefore that antioxidant activity will decrease so that the higher the phenolic content, the antioxidant activity will increase (Khaerah & Akbar, 2019).

This study was aimed to determine the antioxidant activity, vitamin C and organoleptic quality of torch ginger flower kombucha (*Etlinger elatior*) on the variationsof sugar type and fermentation duration.

METHOD

This research was conducted in September 2024 – March 2025 at the Industrial Microbiology Laboratory, Faculty of Teacher and Education, Muhammadiyah University of Surakarta. Antioxidant and vitamin C activity testing was conducted at the Food Quality Analysis Laboratory, Faculty of Health Sciences, Muhammadiyah University of Surakarta. The organoleptic testing was conducted around the UMS campus environment.

The tools used in this study were stove, pan, oven, spoon, sieve, basin, 1 ml measuring cup, jam jar, analytical balance, knife, chopping board, UV-Vis spectrophotometer, rubber band, aluminum foil, pH stick, and label paper. The materials used 48g of torch ginger flowers, 200g of palm sugar, 200g of Javanese sugar, 48g of green tea, 5 mg of DPPH, 11.25g of SCOBY kombucha starter, and 1000 ml of water.

This research method used an experimental method with Completely Randomized Design (CRD) of 2 factors. Factor I was the variation of sugar types (G):

palm sugar (200g) and Javanese sugar (200g). Factor II was the fermentation duration (F): 5 days fermentation and 7 days fermentation and green tea kombucha as the control and each treatment had 3 repetitions.

The tools used in making torch ginger flower kombucha were sterilized by soaking them in hot (boiling) water, such as glass jars. Making torch ginger flower tea by means of wash the torch ginger flowers and cut them into small pieces, then put them in tray dryer on aluminum foil. Drying the torch ginger flowers at temperature of 60°C for 2 hours (Elviana et al., 2024). Making tea solution by taking 1000 ml of mineral water and boiling it until it boils, then add 48g of dried torch ginger flowers for 3 minutes. Next, the torch ginger flower tea solution was filtered and divided into 250 ml/treatment. Then add 200g of palm sugar, 200g of Javanese sugar in the 4 jars/treatment and stir until the sugar dissolves and let stand until warm (Fadhilah, R. et al., 2024). Insert SCOBY 2.25g/jar of torch ginger flower tea solution and cover with aluminum foil, then fermented according to the treatment (5 days and 7 days of fermentation duration) in a room and not exposed to sunlight with temperature of 25°C - 27°C (Fadhilah, R. et al., 2024).

The antioxidant activity of this study was measured using the DPPH radical method 10µL of kombucha sample was added with 1 mL of DPPH and then left for 20 minutes. After that, 97% ethanol was added up to 5 mL. Then, it was vortexed and absorbed at a wavelength of λ = 517 using a UV-Vis spectrophotometer. The same treatment was carried out for the blank solution (DPPH solution without test material). The results of the absorption measurement were analyzed for the percentage of antioxidant activity using the following formula:

$$\text{Inhibitory power (\%)} = \frac{Blank\ abs - sampel\ abs}{abs\ blanko} \text{ x } 100\%$$

Blank abs is absorbance does not contain sample; sample abs is sample absorbance (Yuningtyas et al., 2021).

Testing the vitamin C content of this study used the iodimetric titration method. Put 25 ml of filtrate, 10% 5 ml, and 20 drops of starch indicator into an erlenmeyer flask. Titrate using iodine solution (I2) until a blue color was formed and repeat 3 times, then find the average calculation H_2SO_4. The vitamin c value is determined based on the following formula:

$$\text{\% content} = \frac{vt\ x\ Nt}{0{,}1}\ x\ Equality = A$$

$$\text{In 100 g} = \frac{100\ g}{Berat\ sampel}\ x\ A = B$$

$$\text{Level} = \frac{B}{100}\ x\ 100\% = C$$

Vt is titration volume; Nt is titration normality; C is vitamin C content (Rahmawati, 2024).

Organoleptic quality testing included color, aroma, taste, and acceptability carried out 20 respondents. Organoleptic quality testing (color, aroma, taste, and acceptability) used qualitative methods, while antioxidant and vitamin C activity testing used quantitative descriptive methods with non-parametric tests, the Kruskal-Wallis test.

RESULT AND DISCUSSION

Antioxidant Activity

Antioxidant activity of torch ginger flower kombucha with DPPH radical method. The highest antioxidant activity of torch ginger flower kombucha was 82.54% in the

G1F2 treatment (200g palm sugar with fermentation duration of 7 days). This was because the antioxidant activity of torch ginger flower kombucha increased with the increase of fermentation duration. The antioxidant activity increase of kombucha was caused by the increasing levels of phenol compounds due to the biotransformation process carried out by microorganisms during the fermentation process, so the longer the fermentation duration, the higher the antioxidant activity (Hendrawati, 2020). This was in line with research Istiana (2023), that the highest antioxidant activity of pegagan leaf kombucha was 38.23% in the treatment of 200g of Javanese sugar with fermentation duration of 7 days. However, the lowest antioxidant activity of torch ginger flower kombucha was 62.94% in the G2F1 treatment (200g of Javanese sugar with fermentation duration of 5 days). This was because the organic acid compounds produced were not as much as during the 7 day fermentation duration. This was in line with research Nisak (2023), stated that the amount of acetic acid of black tea kombucha with fermentation duration of 3 days is 42.4% lower compared to the amount of acetic acid of black tea kombucha with fermentation duration of 15 days. The antioxidant activity of torch ginger flower kombucha was 82.54% higher compared to the antioxidant activity level of green tea kombucha (control) of 46.99% in the treatment of palm sugar with fermentation duration of 7 days and 43.09% in the treatment of Javanese sugar with fermentation duration of 7 days.

Tabel 1. Results of antioxidant activity, vitamin C, and pH of torch ginger flower kombucha

Treatment	Antioxidant Activity (%)	pH	Vitamin C (mg/100ml)
G1F1	73.38	4.5	44.59
G1F2	82.54**	4	62.65**
G2F1	62.94*	4.5	37.12*
G2F2	76.94	4	54.89

Description: *) Lowest Antioxidants and Vitamin C
**) Highest Antioxidants and Vitamin C
G1F1 : Palm sugar 200g + fermentation duration 5 days
G1F2 : Palm sugar 200g + fermentation duration 7 days
G2F1 : Javanese sugar 200g + fermentation duration 5 days
G2F2 : Javanese sugar 200g + fermentation duration 7 days

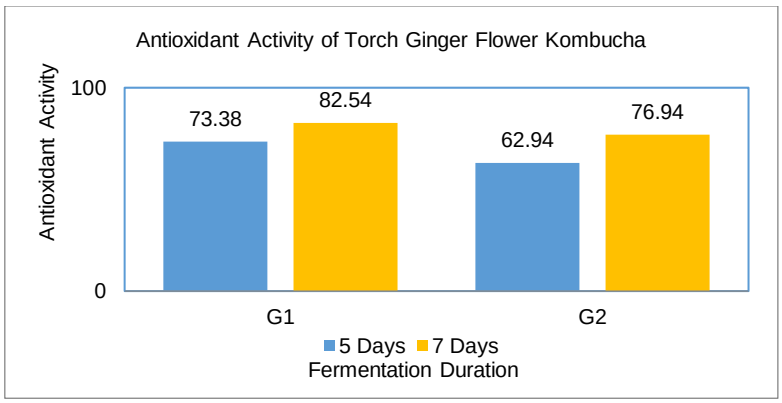

Figure 1. Antioxidant activity of torch ginger flower kombucha

The results of statistical analysis of antioxidant activity of torch ginger flower kombucha with Kruskal-Wallis test. In the variation of fermentation time, the Asymp value was obtained. Sig 0.172 > 0.05, it can be stated that H0 was accepted, this means that there was no significant difference of fermentation duration on the

antioxidant activity of torch ginger flower. In the variation of sugar type, the Asymp value was obtained. Sig 0.004 < 0.005, it can be stated that H0 was rejected, this means that there was significant difference in the variations of sugar type on antioxidant activity of torch ginger flower kombucha. From these results, it showed that variations of sugar type had significant effect on antioxidant activity of torch ginger flower kombucha. However, fermentation duration did not have significant effect on antioxidant activity of torch ginger flower kombucha.

pH of Kombucha

The acidity level (pH) of torch ginger flower kombucha was 4.5 in the treatment of palm sugar and Javanese sugar with fermentation duration of 5 days, while the acidity level (pH) of torch ginger flower kombucha was 4 in the treatment of palm sugar and Javanese sugar with fermentation duration of 7 days. At the beginning ,the slow decrease of pH in the fermentation process was due to the yeast which was still in the adaptation stage and the stage of breaking down sugar into its monomers which will be source of carbon and nutrients for bacteria (Rahmi Hafsari et al., 2021). This was in line with research Rindiani (2023), which stated that the kombucha pH of ground cherry leaf was 4 in the treatment of palm sugar with fermentation duration of 5 days, while the kombucha pH of ground cherry leaf was 3 in the treatment of coconut sugar and Javanese sugar with fermentation duration of 7 days. The cause of the pH decrease was due to the length of the fermentation process so that the concentration of acetic acid will be higher (Kartika & Sa'diyah, 2024). The role of yeast during the fermentation process will synthesize sugar into ethanol converted into organic acids, resulting in pH decrease.

Vitamin C Levels

The highest vitamin C content of torch ginger flower kombucha was 62.65 mg/100 ml in the G1F2 treatment (200g palm sugar with fermentation duration of 7 days). This was because the sugar of kombucha utilized by the scoby in the fermentation process so that the vitamin C content can increase. This is in line with research Yuningtyas (2021) stated that during the kombucha fermentation process, biotransformation process of simple sugars into vitamin C will occur caused by the enzyme in *Acetobacter xylinum*. This was also supported by research Kamelia (2023) stated that sugar will be reduced to D-sorbitol and will change form to L-sorbose which will then be fermented further into ascorbic acid or vitamin C. The lowest vitamin C content of torch ginger flower kombucha was 37,12 mg/100 ml in the G2F1 treatment (200g of brown sugar with fermentation duration of 5 days).

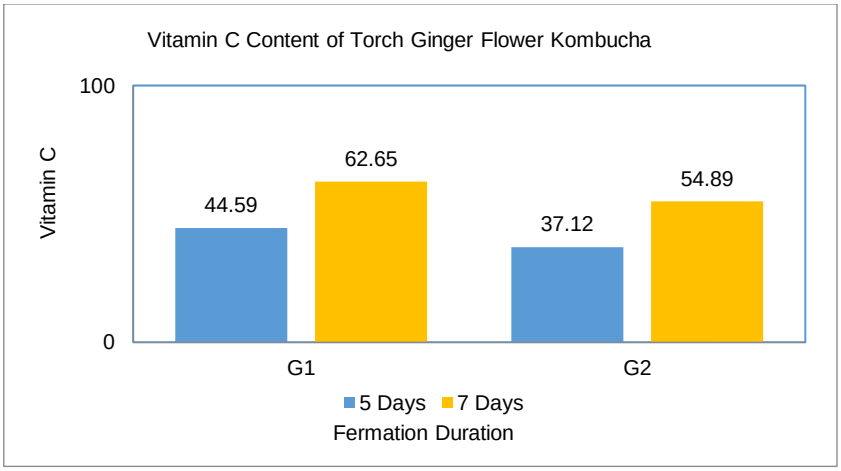

Figure 2. Vitamin C content of torch ginger flower kombucha

The fermentation duration affected the vitamin C content of kombucha, the longer the fermentation duration, the higher the vitamin C content. This supported by research Halim (2025) which stated that the increase of vitamin C levels was caused by the activity of acetic acid bacteria microbes playing an important role in increasing vitamin C levels along with the duration of kombucha fermentation. In this study, the highest levels of vitamin C and antioxidant activity of torch ginger flower kombucha were 82.54% and 62.65 mg/100 ml in the same treatment, namely the G1F2 treatment (200g palm sugar with fermentation duration of 7 days), as well as the lowest levels of vitamin C and antioxidant activity of 62.94% and 37.12 mg/100 ml in the G2F1 treatment (200g palm sugar with fermentation duration of 5 days).

Organoleptic Quality

The organoleptic quality of torch ginger flower kombucha (color, aroma, taste, and acceptability) was as follows:

Table 2. Result of organoleptic quality of torch ginger flower kombucha

Treatment	Organoleptic Quality Aspects			
	Color	**Aroma**	**Flavor**	**Acceptance**
G1F1	Brown	Quite typical of kombucha	Quite sour	Like
G1F2	Reddish brown	Typical of kombucha	Sweet and sour	Like
G2F1	Brown	Quite typical of kombucha	Quite sour	Like
G2F2	Reddish brown	Typical of kombucha	Sour	Like

The organoleptic quality of torch ginger flower kombucha including color, aroma, taste, and acceptability in 20 panelists varied in each treatment. The color of torch ginger flower kombucha was reddish brown in treatments G1F1, and G2F1, while the color of torch ginger flower kombucha was brown in treatments G1F2 and G2F2. The color change of torch ginger flower kombucha was caused microbes in the color degradation that occurred during the fermentation process. This was supported by research Sintyadewi (2021) that the color change of kombucha was influenced the length of fermentation time, the longer the fermentation time,the color clearer of the kombucha caused by the microbial consortium in degrading the color.

The aroma of torch ginger flower kombucha was quite typical of kombucha in the G1F1 and G2F1 treatments, while the aroma of torch ginger flower kombucha was typical of kombucha in the G1F2 and G2F2 treatments. The aroma found in torch ginger flower kombucha tended to be sour due to the fermentation process. This was reinforced through research Wahyuningtias (2023), that the distinctive sour aroma was produced from the metabolic activity of sugar carried out bacteria and yeast during the fermentation process and forms volatile compounds that can be sensed by the sense of smell. The aroma of kombucha was also caused by organic compounds produced such as gluconic acid, acetic acid, and glucuronic acid. The higher the acetic acid content produced, the stronger and more pungent the aroma of kombucha will be. In line with research Nurhayati (2020) stated that the longer the fermentation, the stronger the sour aroma appearing in kombucha due to the increasing amount of organic acids formed.

The taste of torch ginger flower kombucha with variation types of sugar and fermentation duration was different. The taste of torch ginger flower kombucha was quite sour in the G1F1 and G2F1 treatments, while the taste of torch ginger flower kombucha was sour in the G1F2 and G2F2 treatments. This showed that the fermentation duration affected the taste of torch ginger flower kombucha. This was in line with research Kushargina (2023) stated that the fermentation of kombucha carried out by lactic acid bacteria and yeast would cause the taste of kombucha to become

sour with distinctive kombucha aroma. This was supported by research Naufal (2023) stated that the longer the fermentation time, the pH lower of kombucha and the stronger the sour taste.

The acceptability of torch ginger flower kombucha was liked in all treatments. Panelists stated that torch ginger flower kombucha had sweet and sour taste also no too strong in all treatments. This was supported by research Gumanti (2023) stated that the sweet taste of kombucha was influenced by the sugar content and starter, the higher the sugar concentration given, the higher the reducing sugar content of kombucha. The rapid decomposition process by microorganisms of SCOBY caused sweet taste of kombucha. That way, the longer the fermentation time, the sour and strong sour taste produced from the fermentation process wss replaced sweet taste.

CONCLUSION

Based on the research findings, it can be concluded that the highest antioxidant activity and vitamin C content as well as the best organoleptic quality of torch ginger flower kombucha were 82.54% and 62.65 mg/100 ml with reddish brown color, typical kombucha aroma, sweet and sour taste, and preferred acceptability in the G1F2 treatment (200g palm sugar with fermentation duration of 7 days).

RECOMMENDATION

Future research is recommended to compare different types of sugars (such as palm sugar, coconut sugar, and honey) and to evaluate the effects of longer fermentation durations (10–14 days) on the antioxidant activity, vitamin C content, and organoleptic quality of torch ginger flower kombucha. This aims to identify the optimal combination of ingredients and fermentation time to produce the highest quality product.

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