

Analysis of Functional Groups of Green Tea Kombucha (*Camellia sinensis*) and Telang Flower Kombucha (*Clitoria ternatea* L.) Using FTIR (Fourier Transform Infrared)

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Abstract: Kombucha is a fermented drink that has many health benefits. The basic ingredients that can be used to make kombucha are antioxidant-rich plants, such as green tea and butterfly pea flowers. The aim of this research is to determine the functional groups contained in green tea kombucha and butterfly pea flower kombucha. Kombucha functional group analysis was carried out using a Fourier Transform Infrared (FTIR) instrument. Analysis with FTIR provides a spectrum in the form of characteristic absorption bands for certain functional groups in the sample being measured. The results of the spectra on the analysis of the functional groups of telang flower kombucha using FTIR produce absorptions in the wave number region 1500 cm⁻¹ to 3500 cm⁻¹. The spectra generated from the identification of telang flower kombucha tea samples contain functional groups of alcohol, amines, nitro compounds, and the wide peak shows the presence of stretching vibrations of OH monometric alcohol. As for the results of the analysis on green tea kombucha, alkenes, alkynes, and monometric alcohol groups were obtained. Based on the results of FTIR analysis, that all functional groups contained in the spectrum show the characterization of functional groups in general contained in flavonoid compounds (catechins).

1 INTRODUCTION

Tea is one of the plant commodities that is a source of state income in the non-oil and gas sector (Ginanjari *et al.*, 2019). Tea plants are also basic materials that can be processed into consumer materials in the industrial sector, (Radifan *et al.*, 2017) such as in the fields of cosmetics, beverages, and food (Insanu *et al.*, 2017). One type of tea that thrives in Indonesia is green tea (*Camellia sinensis*). Green tea is one type of herbal tea originating from China. This plant is widely cultivated in Southeast Asia as a raw material for making traditional medicine (herbal medicine). Green tea is very beneficial for human health because it contains secondary metabolite compounds such as saponins, tannins, alkaloids, flavonoids, and glycosides. Secondary metabolites in tea can inhibit enzyme activity, such as angiotensin-I enzyme, amylase, sucrase, maltase, glucosyl enzyme which is an HIV-triggering enzyme, and tyrosinase enzyme. In addition to the content of secondary metabolites, green tea also contains high amounts of polyphenol active compounds, namely 30-40%, higher than black

tea which contains 3-10% polyphenols (Shobri and Rohdiana, 2016).

The habit of drinking tea is a long-standing one in Indonesian society. Tea fermented using microorganisms, or kombucha, has more nutrients and health benefits than regular tea. The definition of kombucha itself is one of the healthy drinks made by fermenting sweet tea for 8-10 days (Filippis *et al.*, 2018). The process of making kombucha is basically influenced by the concentration of substrate (sugar) in inhibiting the growth of pathogenic bacteria (Marwati and Handria, 2013). Generally, kombucha is produced by utilizing black tea or green tea by symbiotic bacterial culture, which consists of acetic acid bacteria and yeast (Villareal-Soto *et al.*, 2019). The presence of acetic acid bacterial culture in kombucha produces alcohol as a metabolite compound and also CO₂ compounds (Filippis *et al.*, 2018). The low level of alcohol that has been produced during the kombucha fermentation process

causes the probiotic drink to have high nutritional value and halal consumption (Rezaldi *et al.*, 2022).

Kombucha culture is a gelatinoid and clay layer like nata with a disk shape (Rinihapsari and Richter, 2019). When viewed from its appearance kombucha is composed of two components, namely the top layer which is cellulose and kombucha liquid at the bottom. Kombucha tea drink has many beneficial compounds for health, including several organic acids, vitamins, minerals, polyphenols, and bioactive compounds (Leal *et al.*, 2018). The concentration of metabolite compounds is influenced by several factors, including the quality of the microorganism culture (Nguyen *et al.*, 2015), the concentration of tea and sugar used (Fu *et al.*, 2014), and the time used for the fermentation process (Jayabalan *et al.*, 2008).

The body will get many benefits from kombucha if you consume it, especially to help stabilize the body's metabolism which prevents fat from accumulating. Kombucha contains chemical metabolites, including B vitamins of both types B1 (thiamine), B2 (riboflavin), B3 (niacin), B6 (pyridoxine), B12 (cyanocobalamin), vitamin C, and polyphenols. One of its metabolites is niacin, which has the potential to control lipid metabolism and lower LDL, triglycerides, and HDL. Catechin-type polyphenols are another ingredient in kombucha that helps control lipid metabolism. These polyphenols function as antihypertensives, reduce the amount of lipids deposited in the body, accelerate cholesterol excretion through waste matter, and protect the body from free radicals. Therefore, catechins can also reduce the risk of cardiovascular disease. Niacin has a significant role in lowering cholesterol and vasodilating the surface of blood vessels (Rezaldi *et al.*, 2022). The results of research by Nasution & Nasution, 2022) also stated that the increase in phenolic compounds was higher during kombucha fermentation, and thus the higher the antioxidant activity.

Kombucha can basically be produced from other plant materials besides tea, which have high bioactive components in producing metabolites. Another material that has the potential to be developed as a raw material for kombucha fermentation is telang flowers (Rezaldi *et al.*, 2022). Telang flower with the scientific name *Clitoria ternatea* is a flower that has a high content of antioxidants. Telang flowers can often be found in forests, garden edges, and even in home yards. Telang flowers are often referred to as medicinal plants by the community because they are high in antioxidants (Sumartini, 2020). Telang flowers are legumes that belong to the Fabaceae

family. Telang flowers spread to grow in tropical and subtropical parts of the world on the continents of Asia and the Pacific, America and the Caribbean, Australia, and Africa. All parts of the telang flower from the roots to the flowers have the effect of treating and strengthening organ performance (Marpaung, 2020). Generally, telang flowers are used as a fever-reducing medicine, eye medicine, bladder and urinary tract irritation, and even as a medicine to remove phlegm in chronic bronchitis. The majority of Indonesians use telang flowers as food coloring (Jeyaraj *et al.*, 2011).

The nature of kombucha and telang flowers, which have high antioxidant content, opens up opportunities to be developed as functional drinks, active ingredients, or medicinal raw materials (Fadillah *et al.*, 2022). According to the results of research on kombucha of telang flowers by Rezaldi *et al.* (2021), that kombucha of telang flowers has the potential as an antibacterial both gram-positive and gram-negative because the 40% sugar concentration used is the best sugar concentration in inhibiting the growth of pathogenic bacteria. The various roles of telang flower extract include anti-diabetes, anti-obesity, anti-inflammatory, anti-microorganism, hepatoprotector, and rich in antioxidants which are useful for warding off free radicals (Marpaung, 2020).

Antibacterials in kombucha come from the content of organic acids in the form of acetic acid. The fermentation of acetic acid itself produces various antioxidant compounds that are beneficial to the body, including acetic acid, ethanol, lactic acid, glucose, fructose, and others (Widianto *et al.*, 2013). The purpose of this research is to see the difference in the content of antioxidant compounds contained in green tea kombucha and telang flower kombucha by analyzing their functional groups using FTIR (Fourier Transform Infra Red) instrument. FTIR is one of the instruments that uses spectroscopic principles. Spectroscopy is equipped with fourier transformation for detection and analysis of spectrum results (Baharuddindkk., 2023). Infrared spectroscopy is used for the identification of organic compounds because it has a complex spectrum, which consists of many peaks. The number of peaks indicates that there are functional groups characterized by wave numbers. In addition, each functional group absorbs infrared light at a certain frequency.

2 METHODS

Tools and Materials

The tools and materials used in this research are green tea kombucha, bay flower kombucha, dropper pipette, alcohol standard solution as a blank, and Fourier Transform Infrared (FTIR) tool.

Research Procedure

Analysis of bayang flower kombucha and green tea kombucha was carried out using FTIR (Fourier Transform Infrared) spectrophotometry, which is by knowing information related to chemical bonds in the sample through its wave number, so that it can show what functional groups are present in the sample. The

way FTIR works is as follows: The sample to be tested is placed on the sample holder after the FTIR tester is turned on. Each infrared ray will pass through the sample and comparator. Then successively passes through the chopper, and proceeds to convert it into an electrical signal which is then recorded by the recorder into a spectrum with different peaks.

3 RESULTS and DISCUSSIONS

Green Tea and Telang

The results of the analysis of green tea functional groups using an infrared spectrophotometer (FTIR) provide absorption in the wavenumber region (cm-1) which can be seen in Figure 1.

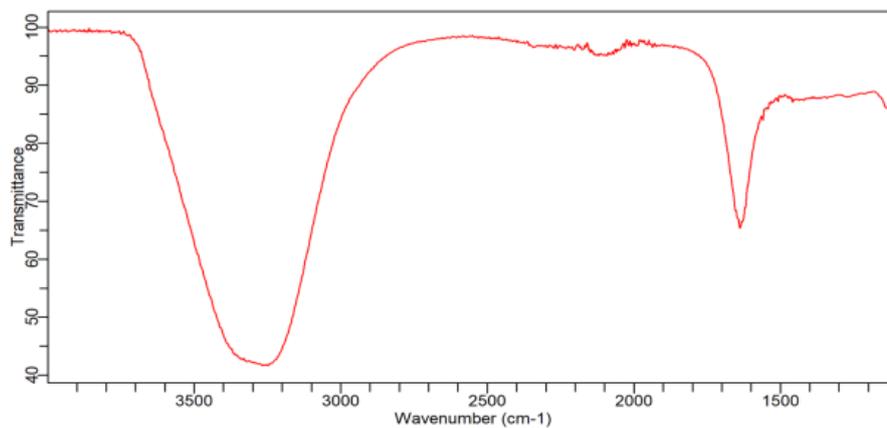


Figure 1: Green Tea Analysis Results

The results of the wave number absorptions using FTIR are then interpreted in Table 1 below.

Table 1: Interpretation of FTIR Spectra of Green Tea

Wafenumber (cm ⁻¹)		Intensity	Functional Groups
Theoretical	FTIR Result		
3000-3700	3267,01	Width	O-H
1500-1675	1638,16	Sharp	C-C aromatic

The absorption results indicate the presence of certain functional groups in the green tea sample. Analysis of functional groups using FTIR with a wave number

limit of 1000-4000 cm-1. The results of wave number absorption in this green tea sample are at wave number 3267.01 cm-1 with wide intensity and 1638.16 cm-1 with sharp intensity. The absorption at 3267.01 cm-1 with wide intensity indicates the presence of O-H functional groups, while the absorption at 1638.16 cm-1 with sharp intensity indicates the presence of C-C aromatic functional groups.

The results of the analysis of functional groups in rosella samples can be seen in Figure 2 and their interpretation in Table 2.

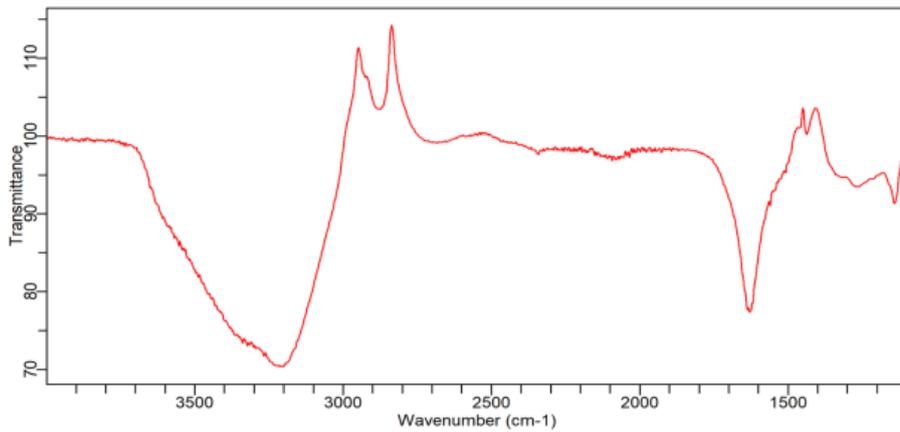


Figure 2: Analysis Results of Telang Kombucha Tea

Table 2: Interpretation of FTIR Spectra of Telang Kombucha Tea

Wafenumber (cm ⁻¹)		Intensity	Functional Groups
Theoretical	FTIR Result		
3000-3700	3201,78	Width	O-H
1500-1675	1628,85	Sharp	C-C aromatic

The results of wave number absorption in the green kombucha telang sample are found at wave number 3201.78 cm-1 with wide intensity and 1638.85cm-1 with sharp intensity. The absorption wave at 3201.78 cm-1 with wide intensity indicates the presence of O-H functional groups, while the absorption wave at 1638.85 cm-1 with sharp intensity indicates the presence of C-C aromatic functional groups. The results of FTIR analysis on telang kombucha tea have almost the same functional group content as green tea.

Green tea with telang kombucha tea both contain OH groups. However, the stretching of the transmittance band in telang kombucha tea is wider than that of green tea. Basically, the tea sample already contains OH groups and C = C aromatic which characterizes flavonoid compounds (catechins) in green tea (Sukaesih, 2021). According to Abriyani et al. (2023) that the flavonoid standard is the absorption of the OH (hydroxyl) wave at 3372 cm-1. In general, catechins are found in young tea leaf shoots. The concentration of catechins in tea leaf shoots will decrease as the tea leaves get older. (Nugraheni et al., 2022).

In the telang kombucha tea sample, the stretching of the OH group is wider due to the influence of microbiological activity in the manufacturing process. The process of making kombucha tea using a 7-21 day fermentation process using microbial

assistance, one of which is using the *Saccharomyces cerevisiae* yeast (Priyono & Riswanto, 2021). The alcohol content of kombucha tea from several sources can be seen in Table 3. Basic tea content that already contains OH groups (catechins) coupled with alcohol content as an effect of the fermentation process, makes the FTIR spectrum stretch wider in the 3000-3700 cm-1 wave number range.

Kombucha beverage products are tea solution beverages by fermentation using microbes as fermentation agents. The pH value of kombucha tea ranges from 3.0-5.5 depending on the length of fermentation. The pH value in kombucha tea is influenced by the accumulation of acids formed during fermentation (Saputra et al., 2017). The results obtained in this study show that there is a difference in pH between green tea and telang kombucha tea. The pH value of telang flower kombucha tea drops can be caused by the sugar substart that turns into alcohol and organic acid products during the fermentation process. The metabolic activity of bacteria and yeast also causes a decrease in pH (Siregar et al., 2023).

Table 3: Alcohol Content of Kombucha Tea from Several Sources

Alcohol Content	Source
0,297-0,621%	(Pratiwi et al., 2012)
1,61-5,12%	(Simanjuntak et al., 2016)
0,7-1,3%	(Kapp & Sumner, 2019)
0,2-3,5%	(Jakubczyk et al., 2020)
0,06-1,95%	(Tan et al., 2020)

4 CONCLUSIONS

Based on the results and discussion, it can be concluded that FTIR analysis of green tea and telang kombucha tea shows the presence of O-H and C-C aromatic functional groups. The analysis showed that rosella kombucha tea has a wider OH group content compared to green tea, which is due to the influence of microbiological activity in the process of making kombucha tea. The fermentation process used in making kombucha tea using microbes such as *Saccharomyces cerevisiae*, produces alcohol content which contributes to the stretching of the FTIR spectrum. The content of OH and C-C aromatic groups in telang kombucha tea indicates the presence of catechins, which are flavonoid compounds present in green tea.

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