Comparison Of Functional Groups in Green Tea Kombucha (Camellia sinensis) and Lavender Flower Kombucha (Lavandula angustifolia L) Using Fourier Transform Infrared Spectroscopy (FTIR)

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Abstract: Kombucha is a fermented beverage produced through the fermentation process of tea and sugar by SCOBY (Symbiotic Culture of Bacteria and Yeast). Kombucha can be produced from various raw materials such as green tea (*Camellia sinensis*) and lavender (*Lavandula angustifolia* L.), which have different chemical compositions. The aim of this study is to compare the functional groups of green tea kombucha and lavender kombucha. The method used is Fourier Transform Infrared Spectroscopy (FTIR). The results of this study indicate that both green tea kombucha and lavender kombucha show the presence of phenolic and flavonoid compounds. Additionally, both have the same functional groups, namely O-H (alcohol), C=C (alkena), and C≡C (alkuna). The FTIR results of lavender kombucha also show the presence of C-H (alkana) groups, indicating the presence of nonpolar compounds such as terpenoids and steroids.

1 INTRODUCTION

Kombucha is a traditional beverage produced from the fermentation of tea and sugar solution using kombucha microbial starter which is a symbiosis between bacteria and yeast. The fermentation process of kombucha tea lasts for 4-12 days (Falahuddin et al., 2017). Various types of bacterial and yeast cultures used during the fermentation process include *Acetobacter xylinum, Acetobacter aceti, Brettanomyces* sp., *Pichia* sp., *Saccharomyces* sp., *Zygosaccharomyces kombuchaensis, Torulopsis* sp., *Zygosaccharomyces bailii; Schizosaccharomyces, Saccharomycodes, Torulaspora*, and *Candida* (Khamidah & Antarlina, 2020).

Kombucha is often referred to as tea with 1001 benefits or longevity tea because it has various health properties. This drink contains several organic acid compounds as well as a number of other compounds such as acetic acid, lactic acid, glucoronic acid, phenolic acid, ethanol, B vitamins, and enzymes (Rosada et al., 2022). Organic acids in kombucha are the main compounds that have potential as active ingredients in providing health benefits such as antioxidants (Purnami et al., 2018). Therefore, consuming kombucha tea can provide positive benefits for the health of the stomach, intestines, glands, and can help treat various problems such as aging, diabetes, rheumatic joints, and hemorrhoids (Goh et al., 2012).

Green tea (*Camellia sinensis*) can be used as an ingredient for making kombucha. Green tea contains secondary metabolite compounds such as saponins, tannins, alkaloids, flavonoids and glycosides (Nugraheni et al., 2022). Apart from green tea, lavender flowers (*Lavandula angustifolia*) are also known to be used for making kombucha. This flower is often used as an ingredient in kombucha tea because it has a pleasant aroma and a soft taste when drunk. Lavender also has antimicrobial properties that can help in the fermentation process and maintain the quality of kombucha (Tapias et al., 2022).

An organic compound is a compound composed of atoms of carbon (C), hydrogen (H), oxygen (O), and nitrogen (N), arranged in various unique conformations. These molecules form compounds with specific properties and functions. A functional group is the position of chemical reactivity in a molecule, which is a specific group of atoms that give the compound special properties (Toar et al., 2021). The content of compounds in green tea kombucha and lavender flower kombucha can be analyzed with various tools, one of which is by using a Fourier transformed infrared (FTIR) Spectrophotometer instrument.

FTIR is a method for compound identification through infrared spectroscopy, where infrared radiation will be passed through the sample. Some of the radiation will be absorbed by the sample and some will be passed (Satriawan & Illing, 2018). The working principle of FTIR is to recognize the functional group of a compound from the results of infrared absorbance carried out on a compound in the sample. The absorbance pattern absorbed by each compound will be different so that the content of the compounds in the sample can be distinguished (Sjahfirdi et al., 2015). The advantages of FTIR, which has an interferometer, are that information about the structure can be obtained precisely and accurately because of its high resolution; can be used to analyze samples in solid, liquid and gas phases; and is fast in the process of analyzing samples. In addition, FTIR can analyze samples qualitatively and quantitatively compared to dispersion IR which can only be used for qualitative analysis. Analysis of functional groups with FTIR spectroscopy is certainly the first step in predicting the structure of a compound in a sample through its functional groups. Functional group analysis is also expected to be the basis for identifying a product or material using existing functional group data (Marselia et al., 2021). The purpose of this study was to determine the difference in the content of compounds contained in green tea kombucha and lavender flower kombucha by analyzing their functional groups using FTIR (Fourier Transform Infra Red) instrument.

2 METHODS

Location

The practicum entitled Comparison of Function Groups of Green Tea Kombucha and Lavender Flower Kombucha Using FTIR (Fourier Transform Infrared) Spectroscopy was conducted on Saturday, May 13, 2024 at the Instrumentation Laboratory of Sunan Ampel State Islamic University Surabaya, Kec. Gunung Anyar, Surabaya.

Tools and Materials

The tools used in this practicum are drop pipettes and an FTIR Spectrophotometer connected via a computer. Meanwhile, the materials used were ethanol, tissue, green tea kombucha and lavender flower kombucha.

This research uses a qualitative analysis method. The subjects in this study used 2 samples, namely green tea kombucha samples and lavender flower kombucha samples. The tool used in this research is the FTIR (Fourier Transform Infrared) tool. Qualitative data processing and analysis methods are carried out by analyzing data through FTIR tests to detect the presence or absence of functional groups in the content of green tea kombucha samples and lavender flower kombucha samples.

Work Procedure

pH Level Test

The pH measurement was measured using a pH meter. Green tea kombucha and rosella flower kombucha were put in a beaker glass and then dipped in a pH meter.

Qualitative Test of Function Groups Using IR Spectrophotometer

The work method carried out is to turn on all equipment both FTIR instruments and computers, then when the computer is on, click the microlab menu on the computer, enter the password on the menu, then click start, method, new, click data collect only, after that click instrument (click full on spectral range), then click save as. The next step is to create a folder by clicking check and activate, then click start then the next step is to wet the instrument in the sample holder with alcohol and clean it with a tissue, then the green tea Kombucha sample is taken using a drop pipette and dripped on a sample holder that has been cleaned with alcohol, then click next on the computer and Spektra will appear on the computer screen, after that click data handling, then export, CPS and rename. The last step is to print the spectra data of green tea and lavender flower kombucha samples in the form of word or pdf, then save the file.

Repeat the same treatment on the Lavender flower kombucha sample.

3 RESULTS and DISCUSSIONS

The results of qualitative tests of compounds contained in green tea kombucha samples using Infrared spectrophotometer (FTIR) are presented in Figure 1. This wave number data is then matched with literature frequency data. The functional groups obtained from the matching results for each wave number are presented in Table 1.

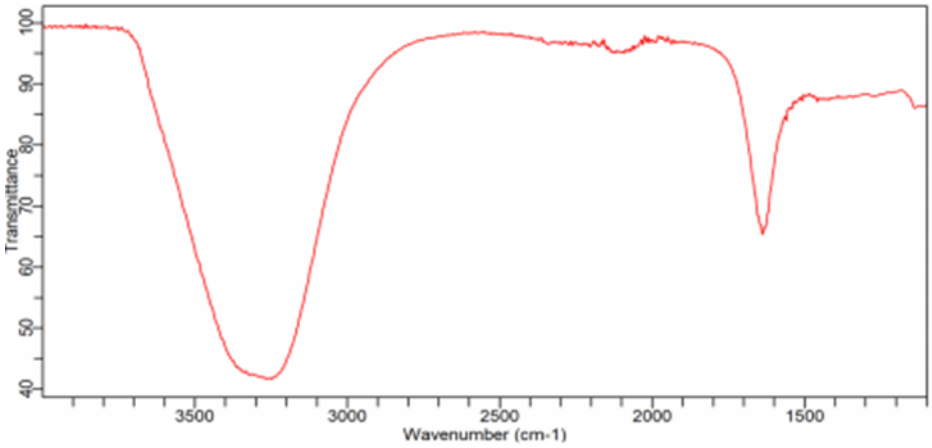

Figure 1: FTIR Spectrum of Green Tea Kombucha

Table 1: FTIR Data of Green Tea Kombucha

Wave number value obtained (cm)-1	Literature	Bond type
1136,83804	1050-1300	C-O (Alcohol, ethers, carboxylic acids, esters)
1638,16498	1610-1680	C=C (alkenes)
2118,99156	2100-2260	C≡C (Alkynes)
3267,01161	3200-3600	O-H (Hydrogen-bonded, alcohols, phenols)

Based on the data analysis of the FTIR spectrum results on the green tea kombucha sample, there are four functional groups detected, namely, there is a wide absorption at a wavelength of 3267.01161 cm-1 which indicates the stretching vibrations of the O-H (hydroxyl) group, also detected the C = C group at a wave of 1610.31 cm1. C-O group at wave number 1136.83 cm-1 and the presence of C-O group stretching vibrations at a wavelength of 1136 cm-1.

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

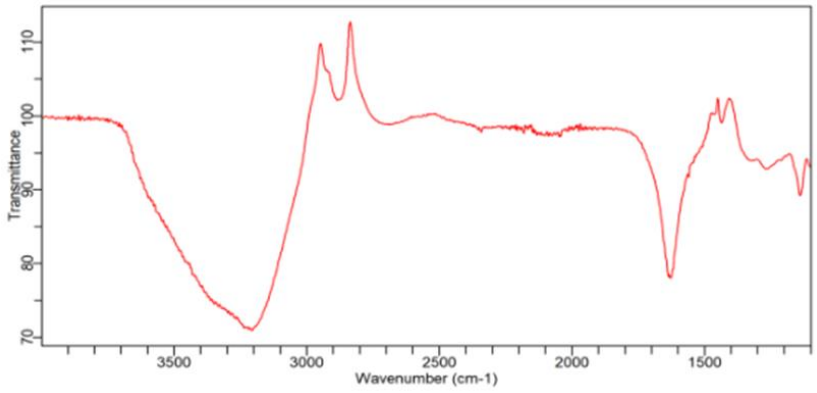

Figure 2: FTIR spectrum of Lavender Flower kombucha

Table 2: FTIR Data of Lavender Flower Kombucha

Wave number value obtained (cm)-1	Literature	Bond type
1628,84663	1610-1680	C=C (alkenes)
2569,99944	2500-2700	O-H (Hydrogen-bonded, carboxylic acids)
2689,27425	2500-2700	O-H (Hydrogen-bonded, carboxylic acids)
2879,36848	2850-2970	C-H (Alkanes)
3207,37421	3200-3600	O-H (Hydrogen-bonded, alcohols, phenols)

FTIR spectrum analysis of lavender kombucha showed several wave numbers associated with various types of bonds. At a wave number of 1628.84663 cm-1, C=C bonds were detected, stretching vibrations of hydrogen-bonded O-H groups at wave numbers 2569.99944 cm-1 and 2689.27425 cm, stretching vibrations of C-H bonds at a wavelength of 2879.36848 cm-1, and absorption indicating the stretching vibrations of O-H groups at a wave number of 3207.37421 cm-1. The results of FTIR analysis on lavender kombucha tea have almost the same functional group content as green tea.

Green tea kombucha and lavender kombucha were detected to have some of the same groups, namely O-H groups and C=C groups. The widened bands in these two samples are caused by the presence of intermolecular hydrogen bonds. The hydroxyl group band can come from phenol (Ar-OH) groups, and is corroborated by the presence of C=C groups in the sample. Based on the presence of these two groups, it can be analyzed that green tea kombucha and lavender kombucha contain phenolic or polyphenolic compounds (Mahardika et al., 2020). In green tea kombucha, C-O groups and C≡C groups were indicated which were not detected in the lavender kombucha sample. Both groups can strengthen that green tea contains polar compounds (Sunardi, 2023). One of the flavonoid compounds found in green tea is catechin.

Green tea is known to have high antioxidant activity. This antioxidant activity is caused by the compounds contained therein, including catechin compounds. Catechins are secondary metabolite compounds from the flavonoid group that have a flavon-3-ol structural framework (Fadhilah et al., 2021). Catechin has the chemical formula C15H14O6, which has 15 carbon atoms arranged in the C6-C3-C6 configuration and its carbon skeleton consists of two C6 groups (substituted benzene rings) and is connected to three aliphatic carbon atoms (Figure 3) (Katja et al., 2021).

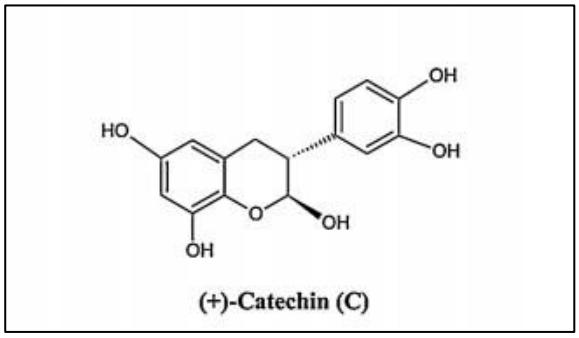

Figure 3: Catechin compounds (Katja et al., 2021).

Catechins have two aromatic rings and several hydroxyl groups, because they have more than one hydroxyl group this compound is referred to as a polyphenolic compound or a compound that acts as an antioxidant, apart from antioxidants catechins also have greater antibacterial activity against gram positive than gram negative bacteria. The main sources of catechins are found in fruits such as grapes, apples, pears, cherries, green tea and gambier (Fadhilah et al., 2021). While the kombucha sample indicated the stretching vibrations of the hydrogen-bonded O-H group at wave numbers 2569.99944 cm-1 and 2689.27425 cm-1 which indicated the presence of carboxylic acids in the sample, as well as at wave number 2879.36848 cm-1 there were stretching vibrations of C-H alkanes bonds which were not detected in the green tea kombucha sample. These functional groups indicate the presence of nonpolar compounds such as terpenoids and steroids contained in lavender kombucha samples (Susanti and Nurman, 2022).

The results of this FTIR spectrum analysis show that lavender tea kombucha contains compounds with various functional groups, reflecting its complex and rich chemical composition. However, this instrument only functions to determine molecular vibrations which are used to predict the structure of chemical compounds contained in the sample (Sulistiyani & Huda, 2018). This instrument cannot directly determine what compounds are contained in the sample, but only predicts compounds by looking at the results of the functional groups produced.

In addition to the differences in functional groups analyzed using FTIR, the two kombucha samples also have different PH levels. The pH of green tea kombucha is 3.32 while the pH of lavender flower kombucha is 2.90. pH is one of the important parameters affecting kombucha fermentation due to the formation of several acids formed such as acetic and gluconic acids. It is also closely related to microbial growth and changes in the structure of phytochemical compounds that can affect antioxidant activity (Hafsari and Farida, 2021).

4 CONCLUSIONS

The conclusion of this study shows that green tea kombucha and lavender flower kombucha have differences in chemical composition that are reflected in the pattern of functional groups detected in FTIR analysis. Although both contain phenolic compounds, green tea kombucha contains polar compounds such as catechins that act as antioxidants, while lavender kombucha contains nonpolar compounds such as terpenoids and steroids. In addition, differences in pH levels can also affect the fermentation process and antioxidant activity of both types of kombucha.

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