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EFFECT OF TOTAL PHENOLIC AND TOTAL FLAVONOID LEVELS ON THE ANTIOXIDANT POWER OF WATER EXTRACT, ETHANOL AND CHLOROFORM OF GREEN TEA LEAVES (*Camellia sinensis* L)

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ABSTRACT

Tea (Camellia sinensis L.) was originally used as a refresh drink. Tea has many benefits, especially for health and beauty. The most widely used tea in the market is green tea, because its properties can be used as a daily drink to improve the quality of life in carrying out daily activities. The aim of this study was to determine the effect of the relationship between total phenolic and total flavonoid levels in water extract (EA), ethanol (EE), and chlorophorom (EK) of green tea leaves on antioxidant power. This experimental study used the extraction method, qualitative analysis, quantitative analysis using the colorimetric method, and antioxidant power using the DPPH method. The data obtained were statistically analyzed using SPPS and Microsoft Excel. The results obtained in The extraction process yielded extracts: EA (21.44%), EE (11.20 %), and EK (3.58 %). Qualitative analysis of flavonoid and phenolic compounds in all the extracts revealed the presence of these compounds. In the total phenolic test, the levels were: 229.07 ± 0.99 (EA); 573.70 ± 3.93 (EE); 45.27 ± 0.73 mg/g (EK) GAE (Galic Acid Equivalent). Meanwhile, the flavonoid content was 13.10 ± 0.31 (EA); 40.49 ± 0.67 (EE); 20.94 ± 0.50 mg/g (EK) QE (Quercetin Equivalent). The antioxidant results have an IC50 (Inhibitory Concentration) value of 34.64 ± 0.74 (EA); 7.02 ± 0.15 (EE); 99.11 ± 1.23; positive control 5.94 ± 0.07 µg/mL (vitamin C). Results The highest phenolic, total flavonoid and antioxidant content was found in the ethanol extract, while total phenolic compounds had a high influence on antioxidant activity with a correlation value (R2: 0.9972) compared to flavonoid compounds (R2: 0.2631).

***Keywords**: Antioxidants; Extract; Phenolic; Flavonoids; Correlation*

INTRODUCTION

Tea (*Camelia sinensis L*) was originally obtained from China (Somantri, 2014). In Indonesia, the tea that is widely used is the Camelia sinensis L variety because this species is a variety that is suitable for growing in tropical climates (Somantri, 2013). Indonesia is the fifth largest tea producer and exporter in the world. In 2021, Vietnam and Kenya will import the most tea from Indonesia. Turkey consumes the most tea in the world (3.16/kg/year) (Badan Pusat Statistika, 2021). Indonesian people's highest consumption of tea bags is 2.79 grams/week and this trend continues to increase every year (Badan Pusat Statistika, 2021).

The use of tea itself can provide benefits to the body, including antioxidant, anticancer, antidiabetic, antibacterial, antiviral, neuroprotective, immunostimulant, antiosteoporotic, diuretic, and antiprotozoal effects (Zhao et al., 2022). In its use in society, one of the effects

provided is that antioxidants from green tea leaves are very high, so they can prevent free radical processes (Hsu et al., 2014). Free radicals themselves can be formed because there are molecules that have free electrons, so they can bond with other electrons in their environment (oxidation process), and new radical molecules are formed, which occur continuously, resulting in thousands of other molecules being damaged. Examples of free radical processes include air pollution, UV radiation, X-rays, pesticides, and smoke (Fitria et al., 2013). In normal amounts, free radical compounds prevent inflammation and antibacterial activity and maintain vascular muscle tonicity, and excessive amounts of these compounds can cause oxidative stress (accelerating the aging process and the emergence of degenerative diseases) (Yuslianti, 2018).

Antioxidants in traditional medicine are used as preventive therapies in the treatment of inflammation, diabetes mellitus, cancer, and bacteria. In cosmetic preparations, it is used as an anti-aging agent, while in food and beverages, it is used as a preservative and to maintain the stability of the preparation (Zhao et al., 2022). Tea has high antioxidant power, one of which is green tea, this tea is the one that is mostly used and utilized by the community (Anjarsari, 2016). Tea contains secondary metabolites, such as tea polyphenolic compounds (catechins, flavonoids, anthocyanins, and phenolic acids), alkaloids (caffeine), amino acids (theanine), and polysaccharides (glucose, fructose, sucrose, and galactose) (Zhao et al., 2022).

Secondary metabolite compounds in tea determine the quality or grade of tea, namely the tea polyphenol compound catechin, which is a colorless compound produced by the biosynthesis process in certain taxonomic cells, thus producing a distinctive taste, color, and aroma (Anjarsari, 2016). According to research by Hung, et al., the content of these compounds is catechin gallate (KG), gallate catechin (GC), epigallocatechin (EGC), epicatechin gallate (ECG), epicatechin (EC) and epigallocatechin gallate (EGCG) in the four tea leaf extracts which are the highest. ethanol extract (Hung et al., 2021). Ethanol 95 % extract of tea leaves has very strong antioxidant power using the DPPH method (16.97 ± 0.52%) and FRAP method (4.15 ± 0.32 mmol) and a total phenolic content of 457.89 ± 28.94 g GAE k^{-1} (Gadkari et al., 2014). The total phenolic content of green tea is 334.69 ± 0.89 mg GAE/100g, the total flavonoid content is 0.34 ± 0.01 mgGAE/100g and has an IC_{50} (Inhibitory Concentration) value of 21.44 µg/mL (Kusmiyati et al., 2015). Research conducted by Theafelicia et.al ABTS and DPPH methods are two alternative methods for testing the antioxidants of black tea leaves with antioxidant values that are not significantly different. The antioxidant results in black tea using the DPPH method were 208.83 mgTE/g, ABTS 217.83 mgTE/g and FRAP 42.15 mgTE/g (Theafelicia and Wulan, 2023).

The total phenolic and flavonoid contents of water, ethanol, and chloroform extracts of green tea leaves were measured using the colorimetric method. Selection of extraction solvents with different levels of polarity to determine the profile of total phenolic compounds and flavonoids, which are responsible as antioxidants. To test antioxidant activity, the DPPH (2,2 Dipenyl-1-Picrylhidrazyl) method was used in comparison with the positive control (vitamin C). Indonesian people consume large amounts of tea because the phenolic and flavonoid compounds in tea contain high levels of antioxidants, which can prevent degenerative diseases. Total phenolic and total flavonoid content tests were carried out to determine the amount of these compounds and their effect on the antioxidant activity of each extract of water, ethanol, and chloroform of green tea leaves, which can be used as raw materials for traditional medicines, cosmetics, food supplements, and ingredients. Additional food and drinks. To determine the effect of the content of these compounds in the tea leaf extract, it is necessary to test the total phenolic content, total flavonoids, and antioxidant activity using the DPPH method, where the data obtained can be used as a reference to determine whether the total phenolic and flavonoid content is correlated with antioxidant activity. Each green tea leaf extract had different polarity properties.

RESEARCH METHODS

Equipment and Materials

Simplicia dried green tea leaves (*Camellia sinensis L.*) which have SNI: 3945:2016, aqua distillata (technical), ethanol 96% (technical), chloroform (Merck), FeCl3 (Merck), Folin Ciocalteu (Merck), Gallic Acid (Sigma-aldrich), Na2CO3 (Merck), DPPH (2,2 Dipenyl-1-Picrylhydrazyl) (Sigma-aldrich), wash benzene (technical), methanol (Merck), ethyl acetate (technical), boric acid (technical) , oxalic acid (technical), ether (technical), acetone (Merck), Quercetin (Sigma-aldrich), vitamin C (Merck), Aluminum Chloride 10 % (Merck), Sodium Acetate 1M (Merck), H2SO4 (Merck), absolute ethanol (Merck), and filter paper (Local). The tools used included analytical scales (AND), macerators (local), rotary evaporators (Biobase), a set of glassware (Pyrex), a UV-Vis spectrophotometer (Gynesis), and a water batch (Memmert).

Research Methods

1. Collection of Dried Simplicia Green Tea Leaves

   Simplicia green tea leaves (SNI 3945:2016) are obtained on the market with SNI (Indonesian National Standard) quality.

2. Extraction of Green Tea Leaves

   A total of five hundred (500) gram of green tea leaf simplicia passed the sorting process and were macerated using 96% ethanol and chloroform (1:5) in a macerator and stirred every 1 hour, then left for 24 hours and filtered. This process is repeated 3 times (remaceration). The maserate obtained was evaporated using a rotary evaporator until it was thick. Meanwhile, for the water extract, the infusion process was carried out by adding 500 gram of simplicia into the infusion pot, then adding water filter fluid (1:5) and heating at 90 ^{0}C (15 minutes) several times (Abdul, 2020).

3. Preliminary Analysis

   a. Phenolic Test

   Ethanol, ethyl acetate, and chloroform extracts (100 mg) of green tea leaves were dissolved in 10 mL of water and heated for 10 minutes in a water bath. The heated samples were filtered and left to cool. These results were added with 3 drops of $FeCl_3$ reagent was added to the results. If a bluish-green color forms, the extract contains polyphenolic compounds (Rahma et al., 2023).

   a. Flavonoid Test

   The test solution was prepared by weighing 100 mg of a thick extract of ethanol, ethyl acetate, and chloroform from green tea leaves dissolved in 10 mL of methanol and heated for 10 minutes in a water batch. The obtained results were then filtered, and the filtrate was diluted with 10 mL of water. The filtrate obtained was added to 5 mL of washed benzene and allowed to stand until two layers were formed. The top layer (methanol) was then removed and evaporated. The residue obtained was dissolved in 5 mL of ethyl acetate and filtered. Next, the Taubeek test was carried out by evaporating 1 mL of the test solution, moistening the residue with acetone, and adding small amounts of boric acid powder and oxalic acid powder. This was followed by evaporation until the film became thick. The obtained residue was mixed with 2 mL of ether. The results were observed under UV light at 366 nm. If it fluoresces, the extract contains flavonoids (Abdul and Qonitah, 2020).

4. Total Phenolic Content Test

   Determination of total phenolic compound content using the visible spectrophotometric method. The total phenolic content was expressed as gallic acid equivalents (%) using the linear regression equation for the gallic acid standard solution. Gallic acid was weighed as much as 50 mg and dissolved in 95% ethanol. The standard solution was prepared in a concentration series by adding 1.5 mL of Folin-Ciocalteu solution (1:10), after which the solution was shaken and allowed to stand for 3 minutes. 1.2 mL of 7.5% Na_2CO3 solution was added, and the mixture was shaken again until homogeneous. The solution was left for the operating time (OT). After OT, the absorbance

value of the solution was recorded using a UV-Vis spectrophotometer at the maximum absorbance wavelength. Measurements were carried out 3 times (KeMenKes RI, 2017).

5. Total Flavonoid Content Test

   The total flavonoid content was measured using the colorimetric method. The total flavonoid content was expressed as quercetin equivalents (%) from the linear regression equation of the standard quercetin solution. The quercetin compound was weighed as much as 10 mg and dissolved in 80% ethanol. The solutions were prepared in a concentration series of 2, 3, 4, 5, and 6 µg/mL. The solution concentration series was added with 95% ethanol to 1 mL and 0.1 mL of 10% aluminum chloride and 0.1 mL of 1 M potassium acetate were added. Aquestilata was then added to a final volume of 5 mL. The solution was then left for OT (25 minutes). Absorbance was measured at a wavelength of 437 nm. Measurements: Sample measurements were carried out 3 times and the content was calculated using the standard curve equation (Departemen Kesehatan RI, 2010).

6. Antioxidant test using the DPPH method

   Extract and vitamin C with a series concentration range of 1-200 µg/mL were added to 1.0 mL of 0.4 mM DPPH solution and then diluted with ethanol p.a to 5.0 mL. The solution was vortexed until homogeneous, measured at the maximum wavelength, and allowed to stand for the operating time. Absorbance was measured against a blank (ethanol p.a). Control abrasiveness measurements were carried out (Sreenivasan et al., 2007), calculated using the formula:

$$(\%)inhibition = \left(\frac{A\ control - A\ sampel)}{A\ control}\right) x\ 100\ \%$$

   IC50 is the concentration of water, ethanol, and chloroform extracts of green tea leaves that can capture 50% of radical compounds by comparing controls through a linear regression equation between levels and percent radical capture (Fidrianny et al., 2014).

7. Data analysis

   The data obtained were tested using SPSS with a homogeneity test (Levene Test), normal distribution (Shapiro Wilk), one-way ANOVA, and Microsoft Excel by calculating linearity.

RESULTS AND DISCUSSION

Extraction

Extraction of green tea leaves with SNI standards in a simplified form is carried out using two extraction methods: infusion (water extract) and maceration (ethanol and chloroform extract). The solvents used have different levels of polarity, including water (polar), ethanol (semipolar), and chloroform (non-polar). The solvent ratio was 1:5 by recrystallization. The data on the yield of thick green tea leaf extract from the green tea leaf extraction process are shown in **Table I** below.

The highest yield was obtained in the water extract (21.44%), followed by the ethanol extract (11.20%), and the chloroform extract (3.58%). The large yield in the water extract was because more compounds that were soluble in water (polar compounds) were extracted compared with compounds in the ethanol and chloroform extracts. Polar compounds include mineral salts, vitamins B and C, and phenol compounds (OH groups). In addition, other factors influence the yield of an extract, namely harvest time, place of growth, simplicia particle size, remaceration time, and evaporation during the extraction process. Research from Riyani et al., obtained a water extract yield of 7.95%, this result was smaller than this research for water extract of 21.44% (Riyani et al., 2022). For an ethanol extract of 11.20%, the requirements in the Indonesian Herbal Pharmacopoeia Edition II are above 7.8%; this extract meets the requirements (KeMenKes RI, 2017).Click or tap here to enter text. For the chloroform extract, because it is rarely used, there is no standard yield.

Table I. Yield Results of Green Tea Leaf Extract (*Camellia Sinensis L*)

No.	Extract Name	Powder Weight (kg)	Extract Weight (kg)	Yield (%w/w)
1	Water Extract	0.5000	0.1072	21.44
2	Ethanol Extract	0.5000	0.0563	11.20
3	Chloroform Extract	0.5000	0.0179	3.58

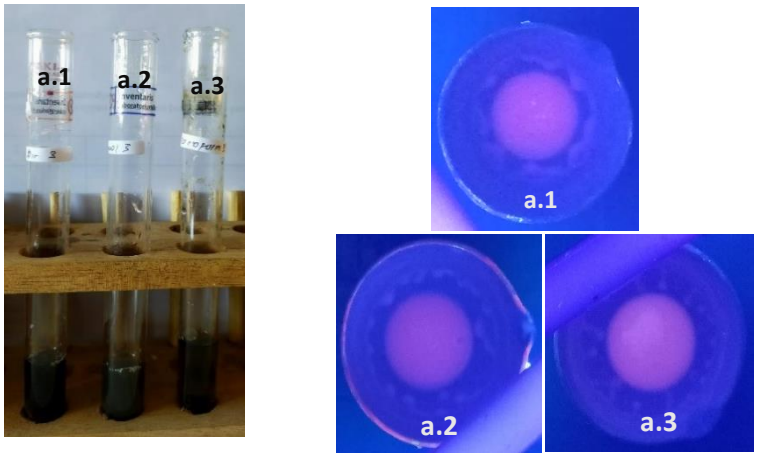
Preliminary Analysis of Polyphenols and Flavonoids

A preliminary qualitative analysis of the thick extracts of green tea leaves was carried out. Results of qualitative analysis using the tube test method for polyphenol tests ($FeCl_3$ test) and flavonoids (Taubeck test). The results of the polyphenol test showed that the solution turned bluish green, and in the taubeck test, it was found that the extract gave a fluorescent color under a 366 nm UV lamp. In the taubeck test, the addition of boric acid and oxalate can form a colored complex characterized by intense yellow fluorescence under UV 366 light. In addition, this addition can extend the bathochromic shift to a wavelength of 366 nm. This type of flavonoid contains an orthohydroxy group (Susilowati and Estiningrum, 2016). The results are shown in **Figure 1.**

Table II. Results of Preliminary Analysis of Polyphenols and Flavonoids of Green Tea Leaf Extract (*Camellia sinensis L.)*

No.	Extract Name	Polyphenols	Flavonoids
1	Water Extract	++	+
2	Ethanol Extract	++	+
3	Chloroform Extract	+	+

As shown in **Table II**, there were water, ethanol, and chloroform extracts, but the polyphenol content was the highest in the water and ethanol extracts compared to the ethanol extract based on the changing color intensity of the solution. The flavonoid compounds in each extract had almost the same fluorescence intensity.



a. Polyphenol Test **b. Flavonid Test**

Figure 1. Polyphenol and Flavonoid Test of Green Tea Leaf Extract, a.1. Water Extract; a.2: Ethanol Extract and a.3: Chloroform Extract

Test of Total Phenolic Content of Green Tea Leaf Extract

The total phenolic content of water, ethanol, and chloroform extracts of green tea leaves was determined using the colorimetric method with a UV-Vis spectrophotometer. The total phenolic content in the water, ethanol, and chloroform extracts of green tea leaves is shown in **Table III**. From the results of **Table III**, the total phenolic content for the water extract was 229.07 ± 0.99 mg/g GAE, ethanol extract: 573.70 ± 3.93 mg/g GAE and chloroform extract: 45.27 ± 0, 73 mg/g GAE. From these data, the ethanol extract had the highest total phenolic content, followed by the water and chloroform extracts. From the statistical tests carried out to test the differences with SPSS using the Kruskal Wallis test, the three extracts had a p-value <0.05 (0.027), so they had a significant difference.

The high level of ethanol extract of green tea leaves compared to water and chloroform extracts is because phenolic compounds tend to be attracted to the universal solvent, namely ethanol, because of its extraction power which can attract polar, semipolar and non-polar compounds. Polar and semipolar compounds are phenolic compounds and some flavonoid compounds that have free OH groups, such as flavanols, isoflavanols, flavandiols, and flavonoid glycosides (Dwicahyani et al., 2018).

Table III. Total Phenolic Content of Green Tea Leaf Extract (*Camellia sinensis L.*). (EA: Water Extract; EE: Ethanol Extract; EK: Green Tea Leaf Chloroform Extract; GAE: Galic Acids Equivalent. * There is a significant difference (p < 0.05))

Total Phenolic Content			
Sampel	**Concentration (mg/g) GAE**	**Mean levels ± SD**	**Kruskal Wallis Test**
EA 1	229.64	229.07 ± 0.99	0.027
EA 2	227.93		
EA 3	229.64		
EE 1	569.16	573.70 ± 3.93	
EE 2	575.98		
EE 3	575.97		
EK 1	44.48	45.27 ± 0.73	
EK 2	45.42		
EK 3	45.92		

Test of Total Flavonoid Content of Green Tea Leaf Extract

In **Table IV**, the total flavonoid levels of the water extract, ethanol, and chloroform of green tea leaves were obtained using the visible spectrophotometry method. The results obtained were that the average water extract content was 13.10 ± 0.31 mg/g Quercetin Equivalent (QE); ethanol extract was 40.49 ± 0.67 mg/g QE and chloroform extract was 20.94 ± 0.50 mg/g QE. The highest total flavonoid content in green tea leaves was found in the ethanol extract, followed by the chloroform and water extracts.

Table IV. Total Flavonoid Content of Green Tea Leaf Extract (EA: Water Extract; EE: Ethanol Extract; EK: Green Tea Leaf Chloroform Extract; QE: Quercetin Equivalent. * There is a significant difference (p < 0.05))

Total Flavonoid Content			
Sampel	**Concentration (mg/g) QE**	**Rate mean ± SD**	**Anova Test**
EA 1	12.85	13.10 ± 0.31	0.00
EA 2	13.45		

EA 3	13.00	
EE 1	41.10	
EE 2	39.78	40.49 ± 0.67
EE 3	40.59	
EK 1	20.36	
EK 2	21.25	20.94 ± 0.50
EK 3	21.21	

Total flavonoid levels are found in ethanol extracts because ethanol extracts use a solvent that has a universal polarity level, so it can attract all flavonoid compounds that are polar, semi-polar, and non-polar (Marcelinda et al., 2016). This results in the perfect and optimal extraction of flavonoid compounds in the form of aglycones and glycones. Flavonoids, especially those with free OH groups, have good activity. In addition to their strong antioxidant properties, flavonoids also exhibit anti-inflammatory, anti-diabetic, anti-cancer, and other activities (Fidrianny et al., 2014).

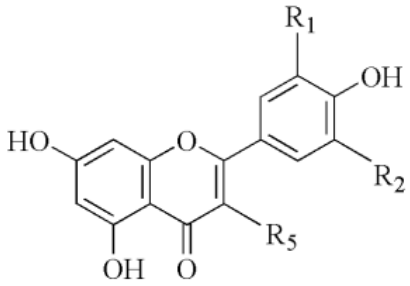


Figure 2. Chemical Structures Of Flavonoids From Green Tea (Zhao et al., 2022)

Antioxidant Activity of Green Tea Leaves

The antioxidant activity of water, ethanol, and chlorophorom extracts of green leaves using the DPPH method was tested using a UV-Vis spectrophotometer. Four treatments were tested for their antioxidant activity: water, ethanol, chloroform extract, and vitamin C. The results obtained for antioxidant activity can be seen in **Table V.** The highest antioxidant is indicated by the lowest IC_{50} value found in the ethanol extract (7.02 ± 0.15 µg/mL) compared to water extract (34.64 ± 0.74 µg/mL) and chloroform (99.11 ± 1.23 µg/mL). The positive control, vitamin C, had an IC_{50} value of 5.94 ± 0.07 µg/mL.

Table V. Antioxidant Activity of Green Tea Leaf Extracts using the DPPH Method (EA: Water Extract; EE: Ethanol Extract; EK: Chloroform Extract & Control (+): Vitamin C. * There is a significant difference (p < 0.05); 1 normally distributed data (p>0.05); 2 Data are not homogeneous (p<0.05)).

Sampel	IC_{50} value (µg/mL)			Mean IC_{50} values (µg/mL) ± SD	Normality test	Homogeneity Test	Anova test
	I	II	III				
EA	34.57	35.41	33.93	34.64 ± 0.74	0.684[1]	0.026[2]	0.00*
EE	7.16	7.02	6.87	7.02 ± 0.15			
EK	99.96	97.70	99.66	99.11 ± 1.23			
Control (+)	6.00	5.95	5.86	5.94 ± 0.07			

The antioxidant activity of water, ethanol, and chloroform extracts of green tea leaves is indicated by the change in the purple color of the DPPH radical compound, which becomes a stable color, namely yellow, because it binds to the antioxidant compound. Antioxidants were measured using the DPPH method, where free radical compounds receive free electrons from antioxidant compounds, thereby causing the reduction of free radicals. This process is due to the provision of hydrogen, which forms stable DPPH (Ratnayani et al., 2012). The antioxidant activity of an extract was determined from the IC_{50} (inhibitory concentration) value using a linear regression equation, where the IC_{50} value is the concentration of an extract solution that can ward off free radicals by 50 % (Murwanto and Santosa, 2012).

Antioxidant activity is expressed in the form of an IC_{50} value, which is used as an indication of the antioxidant activity of the extract, which was obtained using a linear regression equation (Ratnayani et al., 2012). Vitamin C was used as a positive control because vitamin C is a strong and good antioxidant; therefore, it can be compared with water, ethanol, and chloroform extract samples of green tea leaves using the DPPH method. The average IC_{50} values are shown in **Table V**. The results showed that the ethanol extract had high antioxidant power with a small IC_{50} value, which was close to that of vitamin C. This is because the content of phenolic and flavonoid compounds in the ethanol extract was higher than that in the extract. Water and chloroform in green tea leaves. Research conducted by Noviardi et al. stated that all plants that have secondary metabolite compounds in the form of phenolics, flavonoids, tannins and alkaloids have the potential to have antioxidant activity (Noviardi et al., 2020).

Correlation Test (linearity)

The total phenolic content in water, ethanol, and chloroform extracts of green tea leaves in reducing free radicals using the DPPH method has a correlation relationship by calculating the correlation coefficient (R^2), where the correlation coefficient value obtained is 0.9972 (**Figure 2**), which indicates that 99.72% of the antioxidant activity in water, ethanol, and chloroform extracts was influenced by the phenolic or polyphenol content. Meanwhile, the antioxidant activity of 0.28 % %was influenced by other compounds.

In **Figure 3**, the results show a correlation between the total flavonoid content and antioxidant activity of water, ethanol, and chloroform extracts of green tea leaves. The results obtained had a correlation coefficient (R^2) of 0.2631, where it can be concluded that 26.31% of the antioxidant activity of the water, ethanol, and chloroform extracts of green leaf tea was influenced by flavonoid compounds. Meanwhile, the antioxidant activity of 73.69 % %was influenced by other compounds.

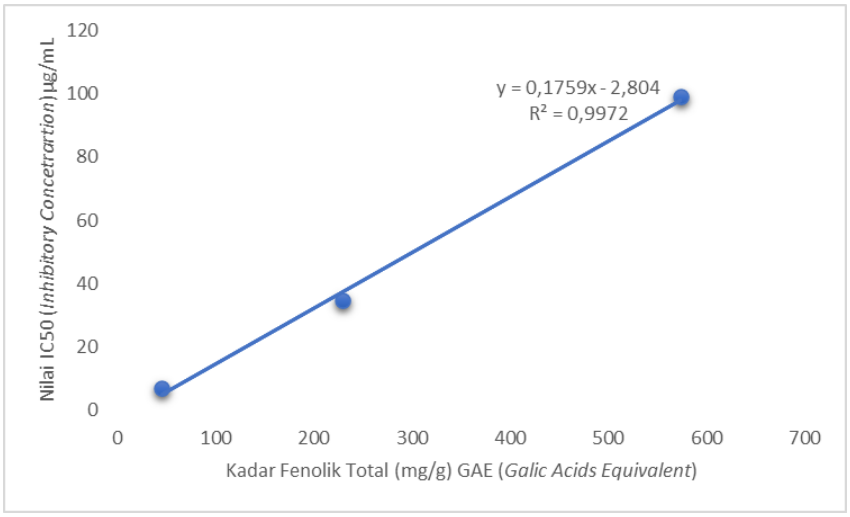


Figure 3. Graph of The Linearity Relationship Between Total Phenolics and Antioxidants

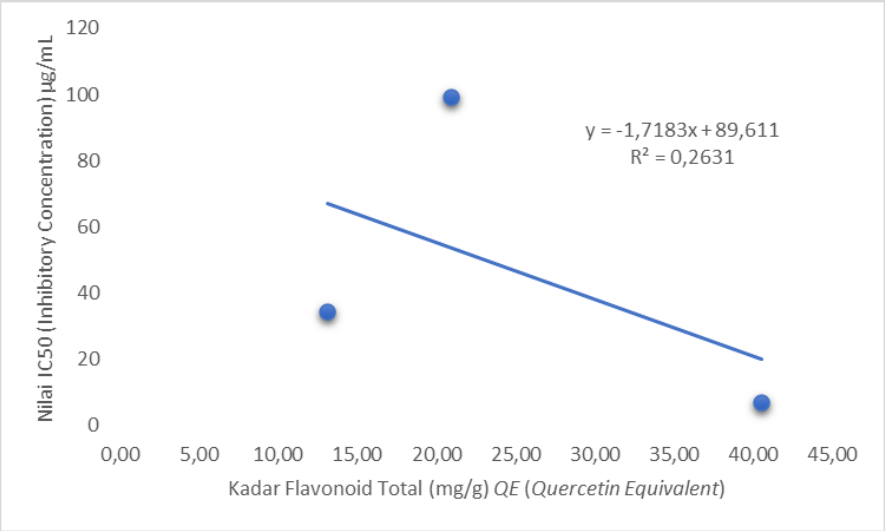


Figure 4. Graph of Linearity Relationship between Total Flavonoids and Antioxidants

Data obtained from the correlation relationship between total flavonoid and total phenolic content on the strength of activity to suppress free radicals using the DPPH method, which had the highest correlation, was the content of total phenolic compounds (99.72%) compared to total flavonoids (26.31%). These results indicate that the water, ethanol, and chloroform extracts of green tea leaves have the power or capacity to act as antioxidants using the DPPH method, namely the phenolic compounds.

According to Pawata (2016), phenolic compounds are the building blocks or the basis for the formation of flavonoid compounds. This phenolic compound plays a role in capturing free radical activity in the external environment because it contains a -OH (hydroxy) group (Parwata, 2016). This group can neutralize free radicals by donating electrons, and thus, it can capture free electrons in radical compounds. High phenolic levels result in increased antioxidant activity, as shown by low IC_{50} (inhibitory concentration) values (Dewi et al., 2018).

Flavonoids consist of aglycones and glycones, as well as flavans, flavanols, isofalvones and others (Puspitasari et al., 2016). These results indicate that the levels of flavonoids in water, ethanol, and chloroform extracts do not necessarily affect their antioxidant activity because not all flavonoids have free -OH groups (flavones, flavones, isoflavones, and flavanones); therefore, the capture of free electrons is not as strong and optimal as that of phenolic compounds such as flavonols, dihydroflavonols, flavandiols, and glycoside forms (Abdul and Qonitah, 2020).

CONCLUSION

From this research, it can be concluded that tea leaf extract with ethanol as a solvent has good effectiveness in removing phenolic and flavonoid compounds. Phenolic compounds are compounds that have a correlation with the antioxidant activity of tea leaf extracts compared to flavonoid compounds.

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