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COMPARISON OF TOTAL FLAVONOID CONTENT AND ANTIOXIDANT ACTIVITY OF PURPLE LEAF EXTRACT (*Graptophyllum pictum* (L.) Griff.) USING MACERATION AND SOXHLETATION EXTRACTION METHODS

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ABSTRACT

Purple leaves in Indonesia can be used as an anti-inflammatory medication and laxative to treat hemorrhoids, rheumatism, boils, and skin diseases. Purple leaves are also used as free-radical antidotes. This was due to the presence of secondary metabolite compounds in purple leaves. The right extraction method determines the amount of flavonoids that can be extracted and achieves a high flavonoid content. This study aimed to determine the total flavonoid content and antioxidant activity of purple leaves using different extraction methods, namely maceration and Soxhletation. This study employed an experimental method of testing total flavonoid levels using UV-Vis spectrophotometry and antioxidant activity using the DPPH method. The results showed that the maceration method yielded a total flavonoid level of 4,422 ± 0,047 ppm, which was higher than that obtained using the Soxhletation method (1,547 ± 0,027 ppm). In the antioxidant activity test, vitamin C was used as a comparator, with an IC_{50} of 2.263 ppm (very strong). The IC_{50} of purple leaf extract using the maceration method was 123,32 ppm (medium), while the soxhletation method yielded an IC_{50} of 104,42 ppm (medium). This shows that vitamin C has more potent antioxidant activity in counteracting free radicals than purple leaf extract, using maceration and Soxhletation methods. The results showed a significant difference in total flavonoid levels using different extraction methods, while there was no significant difference in the antioxidant activity of purple leaf extract using maceration and Soxhletation methods.

Keywords: antioxidant, extraction, flavonoid, maceration, purple leaf, soxhletation

INTRODUCTION

In Indonesia, purple leaves can be used as herbal medicines because of their secondary metabolites, which are beneficial for health. (Puspita *et al.*, 2014; Kumontoy, Deeng and Mulianti, 2023). The purple leaf plant has various pharmacological activities, including antioxidant, anti-inflammatory, anti-diabetic, analgesic, photoprotective, immunomodulatory, nephroprotective, anti-hemorrhoidal, and antibacterial effects (Umami, Mutiah, and Annisa, 2020; Goswami, Ojha and Mehra, 2021; Sartika and Indradi, 2021). Purple leaves were used as a countermeasure against free radicals. Free radicals can damage cells in the body and trigger degenerative diseases (Filbert *et al.*, 2014; Sekti, Gadis, and Nurfitria, 2022).

Purple leaves contain secondary metabolites, including phenolic compounds, glycosides, alkaloids, sitosterol, saponins, steroids, tannins, anthocyanin flavonoids, and leucoanthocyanin flavonoids (Aulia, Khamid and Aninjaya, 2019). Purple leaves exhibit potent antioxidant activity because of their high content of polyphenol compounds, specifically flavonoids (Rustini and Ariati, 2017). Flavonoids have antioxidant activity and act as free radical scavengers, enzyme inhibitors, and anti-inflammatory agents (Supriningrum, Fatimah, and Wahyuni, 2018). Antioxidants are substances that inhibit

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oxidation by reacting with reactive free radicals and converting them into non-reactive and relatively stable compounds (Ibroham, Siti, and Ika, 2022).

An appropriate extraction process must be performed to obtain flavonoids and antioxidants from the purple leaves. Extraction is the initial step in the isolation of secondary metabolites following sample preparation. Simplisia extraction can be performed using either cold or hot extraction methods. The extraction of flavonoids from purple leaves employs two different extraction methods: maceration using the cold method and Soxhletation extraction using the hot method (Mukhtarini, 2014; Abubakar and Haque, 2020). Both the methods have distinct advantages. Maceration is widely used because it is relatively safe for heat-sensitive chemical compounds, involves simple processes and equipment, and is relatively inexpensive. In contrast, Soxhletation extraction uses a smaller amount of solvent than maceration (Abubakar and Haque, 2020). Therefore, both maceration and soxhlet extraction are classical methods used for the extraction of bioactive compounds from natural materials, particularly medicinal plants. Additionally, the solvent used in the extraction process can affect the flavonoid yield and antioxidant activity. Ethanol can be used for extraction and is effective in extracting phenolic compounds and flavonoids (Hakim and Saputri, 2020).

Research (Candra, Andayani, and Wirasisya, 2021) indicates that soxhletation extraction results in a higher flavonoid content (0.72 mg QE/g) than maceration, reflux, and sonication methods. Another study (Prasetyo, Imawati, and Sumadji, 2022) reported that the total flavonoid content in basil leaves obtained through soxhlet extraction is 9.3106%, which is higher than the 6.2756% obtained through maceration (Fadlilaturrahmah *et al.*, 2020). The highest antioxidant activity was achieved through Soxhlet extraction (IC_{50} = 20.85 ppm) compared with the maceration and percolation methods. This indicates that the choice of extraction method can influence both the flavonoid content and antioxidant activity.

Based on the description above, to determine whether there is a difference in total flavonoid content and antioxidant activity between the hot and cold extraction methods, the researchers quantified the total flavonoid content in purple leaves using UV-Vis spectrophotometry and an antioxidant activity test using the DPPH method. This study aimed to identify the optimal extraction method to preserve flavonoid content in purple leaves. The optimal flavonoid content is crucial to support the pharmacological activity of purple leaves; therefore, the flavonoid content must be maintained (Sari and Listiani, 2022).

RESEARCH METHODS

Equipment and Materials

The equipment used includes an analytical balance (Kern), a maserator, a soxhlet extractor, an oven (Memmert type UN10), a desiccator, an evaporating dish (Shagufta Laboratory), water bath (Memmert), glassware (Pyrex), UV-Vis spectrophotometer (Optizen), and a set of rotary evaporator. The materials used are concentrated extract of purple betel leaf (*Graptophyllum pictum* (L.) Griff), 70% ethanol (p.a, Merck KGaA), $AlCl_3$ (p.a, Merck KGaA), potassium acetate (p.a, Merck KGaA), quercetin (p.a, Sigma-Aldrich), DPPH (2,2-diphenyl-1-picryl-hydrazyl) (Sigma-Aldrich), concentrated HCl (p.a, Merck KGaA), magnesium (Merck KGaA), and vitamin C (Merck KGaA). All chemicals used were of pro-analysis grade.

Research Procedure

1. **Raw material collection**

   Purple leaves were collected from a garden located in Nanjung Village, Bandung. The leaves collected were young because the total flavonoid content and antioxidant activity were higher in extracts from fresh young leaves (Umboro *et al.*, 2022).

2. **Making simplisia**

   Purple leaves that were collected were weighed, wet sorted, thoroughly washed with running water, and dried in indirect sunlight. Once dry, they were weighed again to determine the weight of the simplisia before being ground into powder.

3. Extraction

a. Maceration

Purple leaf powder (150 g) was weighed and macerated using 70% ethanol (1.5 L). Maceration was carried out for 3 days (3x24 hours), occasionally stirred, and then filtered. The filtrate was then concentrated with a rotary evaporator at 50°C, and the solvent was evaporated using a water bath at the same temperature until a thick extract was obtained (Hikmawati *et al.*, 2021).

b. Soxhletation

Purple leaf powder (150 g) was wrapped in filter paper and subjected to Soxhlet extraction using 70% ethanol (1.5 L). Extraction was performed for 8 hours at 70°C. The results were obtained when in a rotary evaporator at 50°C until a concentrated extract was obtained (Nurhasnawati, Sukarmi, and Handayani Fitri, 2017). A water bath at 50 °C was then used until a thick extract was obtained.

4. Identification of flavonoid compounds

The flavonoid compounds were identified by reacting 1 mL of purple leaf extract (*Graptophyllum Pictum* (L.) Griff) with 0.2 grams of magnesium powder and 2 mL of concentrated hydrochloric acid. The presence of flavonoid compounds in the extract is indicated by a color change to red, orange, or green (Umboro *et al.*, 2022).

5. Organoleptic test of purple leaf extract

Organoleptic testing was performed on the purple leaf extract to assess its form, odor, and taste using the five senses.

6. Determination of total flavonoid content

a. Determination of quercetin maximum wavelength (λ max)

The maximum wavelength (λmax) of quercetin was identified by analyzing a quercetin solution in the 400-500 nm wavelength range (Sari and Listiani, 2022).

b. Preparation of quercetin comparator test solution

2,5 mg of quercetin was dissolved in 25 mL of 70% ethanol to obtain a concentration of 100 ppm, followed by several concentrations [2, 4, 6, 8, and 10 ppm]. For each concentration, 1 mL of 5% $AlCl_3$ solution and 1 mL of 120 mM potassium acetate were added. The samples were then incubated at room temperature for 30 minutes. The absorbance was measured using UV-Vis spectrophotometry (Sari and Listiani, 2022).

c. Determination of total flavonoid content of purple leaf extract

Purple leaf extract (10 mg) was dissolved in 10 mL of 70% ethanol, and then, 1 mL of 5% $AlCl_3$ solution and 1 mL of 120 mM potassium acetate were added. The samples were then incubated at room temperature for one hour. The absorbance was measured using the UV-Vis spectrophotometric method (Sari and Listiani, 2022).

Formula for determining the total flavonoid content (%)

$$F = \frac{C \times V \times Fp}{m} \times 100\%$$

Description:

C = Sample Concentration
V = Total volume of extract
Fp = Dilution factor
m = Sample weight

7. Antioxidant activity test

a. Preparation of DPPH solution

To obtain a concentration of 40 ppm, 40 mg DPPH was dissolved in 1000 mL 70% ethanol. Then, 4 mL of this solution was pipetted into a test tube, and 1 mL of 70%

ethanol was added and incubated for 30 minutes. Subsequently, measure the wavelength in the range of 400-800 nm (Indrawati, Baharuddin, and Kahar, 2022).

b. Antioxidant activity testing of purple leaf extract
Purple leaf extract (25 mg) was dissolved in 50 mL 70% ethanol to obtain a concentration of 500 ppm. A series of concentrations of 50, 75, 100, 125, and 150 ppm were prepared. Next, the sample solutions from various concentrations were pipetted, and 4 mL of 40 ppm DPPH solution was added. The solution was incubated for 30 minutes, and the absorbance was measured using UV-Vis spectrophotometry (Indrawati, Baharuddin, and Kahar, 2022).

c. Preparation of vitamin C comparison solution
Vitamin C (100 mg of vitamin C was dissolved in 70% ethanol up to 100 mL. Serial dilutions of 2, 4, 6, 8, and 10 ppm were prepared. Pipette 1 mL of each solution into a test tube and add 4 mL of 40 ppm DPPH solution. The solution was incubated in the dark for 30 minutes, and the absorbance was calculated using UV-Vis spectrophotometry (Indrawati, Baharuddin, and Kahar, 2022).

Data Analysis

The study results of total flavonoid content and antioxidant activity (Inhibition concentration 50%) with soxhletation and maceration extraction methods were analyzed quantitatively using SPSS. The data were analyzed by ANOVA test with a 95% confidence level.

RESULTS AND DISCUSSION

Purple leaf extraction

The extraction methods used in this study were cold and hot extraction, with cold extraction using maceration and hot extraction using soxhletation. The two extraction methods have different advantages. The main advantage of the maceration method is that the procedure and equipment used are simple and do not require heating, thereby preventing the degradation of natural materials. Additionally, cold extraction allows a greater amount of compounds to be extracted (Asworo and Widwiastuti, 2023). On the other hand, the soxhletation extraction method, which uses heat, can produce a larger volume of extract, requires less solvent, the time used is faster, and ensures that the sample is thoroughly extracted because of the repeated process (Puspitasari and Proyogo, 2016).

In the maceration and soxhletation extraction processes, 70% ethanol was used as the solvent. The use of 70% ethanol as a solvent is due to the fact that flavonoid compounds are in the form of glycosides, which are polar, so they must be dissolved with a polar solvent. Ethanol (70%) is a solvent with a polarity higher than that of 96% ethanol (Hasanah and Novian, 2020).

The results showed that the highest yield was obtained with the maceration method, at 17.83%, whereas the yield for the soxhletation extraction method was 14.80%. According to Indonesian Herbal Pharmacopeia literature, these yields are within the acceptable range, which specifies a minimum yield of 9.3%. Determination of the yield serves to assess the concentration of secondary metabolites carried by the solvent (Egra *et al.*, 2019).

Purple leaf extract characteristics

The results of the characteristic test of purple leaf extract showed that the characteristics of purple leaf extract obtained using maceration and soxheltation extraction methods were thick extracts, brownish-green color, and a distinctive purple leaf odor. These characteristics are consistent with the Indonesian Herbal Pharmacopoeia literature.

Table I provides data on the characteristics of purple leaf extracts obtained using the maceration and soxhletation methods.

Table I. Results of Characteristics of Purple Leaf Extract

Organoleptic	Extraction Methods

Test	Maceration	Soxhletation
Color	Brownish-Green	Brownish-Green
Form	Thick	Thick
Odor	Typical purple leaf	Typical purple leaf

Flavonoid compound identification

Flavonoid identification aims to determine the secondary metabolite content in purple leaf extracts using maceration and soxhletation extraction methods. Qualitative test data for the flavonoid compounds are shown in **Table II**.

Table II. Results of Flavonoid Compound Identification

Extraction Methods	Reagents	Color	Result
Maceration	0,2 gram Mg + 2 mL concentrated HCl	Red	+
Soxhletation	0,2 gram Mg + 2 mL concentrated HCl	Red	+

Note: (+) Contains Flavonoid compounds

Based on **Table II**, the test results using Wilstater's reagent yielded a positive result. The phytochemical screening of the purple leaf extract was conducted by adding Mg and concentrated HCl. In the flavonoid test using the Wilstater method, the addition of concentrated HCl hydrolyzed flavonoids into their aglycones by breaking down O-glycosides. The H+ ions from the acid replace the glycoside because of their electrophilic properties. The reduction of Mg and concentrated HCl can produce a complex with a red or orange color (Candra, Andayani, and Wirasisya, 2021; Bachtiar, Handayani, and Ahmad, 2023).

Determination of total flavonoid content of purple leaf extract

Determination of the total flavonoid content of the purple leaf extract was performed using UV-Vis spectrophotometry to quantify the total flavonoid content in samples extracted using maceration and soxhletation methods. In this study, quercetin was used as a standard solution because it is a type of flavonoid commonly used to determine flavonoid levels (Hasanah *et al.*, 2019; Nofita, Sari, and Mardiah, 2020; Nurlinda, Handayani and Rasyid, 2021; Blezensky and Sudjarwo, 2022). Quercetin is a flavonoid of the flavonol group, with a ketone group at C-4 and a hydroxyl group at C-3 or C-5 atoms that are neighbors of flavones and flavonols. (Azizah, Kumolowati and Faramayuda, 2014). In the study conducted by (Blezensky and Sudjarwo, 2022), quercetin was used as a standard solution, where the total flavonoid content of the mangrove root extract was 792 ± 0.28 (mg QE/g). Another study that also used quercetin as a standard solution reported that the flavonoid content of the ethanol extract of Bilajang Bulu leaves was 163.4 mg/L (Hasanah *et al.*, 2019). Quercetin is a class of flavonols that has a keto group at C-4 and a hydroxyl group at either C-3 or C-5 atoms, which can form complexes with $AlCl_3$ (Nurlinda, Handayani, and Rasyid, 2021; Blezensky and Sudjarwo, 2022).

The total flavonoid content of the samples was determined using quercetin as a standard at concentrations of 2, 4, 6, 8, and 10 ppm. The concentration series was used to obtain a linear regression equation that can be used to calculate the percentage content. Triplicate regression data were used in this study.

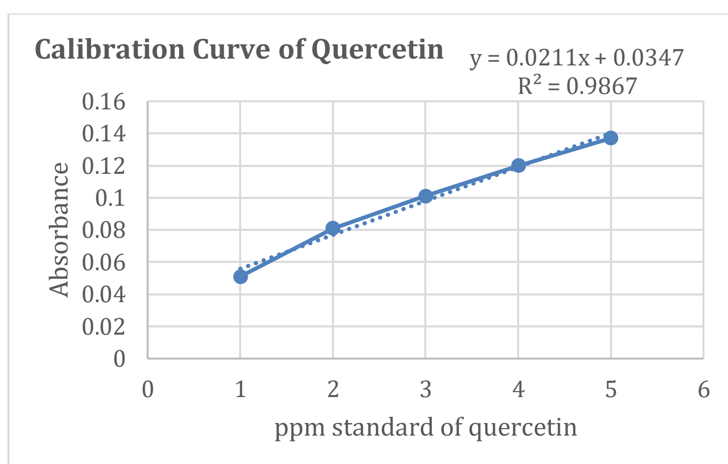

Figure 1. Calibration Curve of Quercetin

The absorption measurement at the maximum wavelength in the 400-500 nm range showed that the wavelength of quercetin was 462 nm. The standard quercetin measurement provided a regression equation of y = 0,0211x + 0,0347, with an R^2 value of 0.9867 (**Figure 1**). This correlation coefficient indicates that the linear quercetin standard curve is related to the concentration of quercetin solution and the absorption value; therefore, it can be used to determine the total flavonoid content in the extract. The calculated total flavonoid content as quercetin in the purple leaf extract obtained through maceration and soxhletation extraction methods is shown in **Table III**.

Table III. Total Flavonoid Content of Purple Leaf Extract

Sample	Replication	Absorbance (y)	Content (ppm)
Purple leaf extract by maceration method	Rep 1	0,128	4,422
	Rep 2	0,129	4,469
	Rep 3	0,127	4,422
Average		**0,128**	**4,422 ±0,047a**
Purple leaf extract by soxhletation method	Rep 1	0,067	1,531
	Rep 2	0,068	1,578
	Rep 3	0,067	1,531
Average		**0,067**	**1,547 ±0,027b**

Note: Numbers followed by different letters in the table indicate significantly different results at $p < 0.05$.

The results of the calculation of the total flavonoid content in purple leaf extract samples extracted by maceration and soxhletation methods showed that the total flavonoid content extracted by maceration and soxhletation methods was statistically significant (sig < 0.05). The total flavonoid content of the purple leaf extract obtained using the maceration method was 4.422 ± 0.047 ppm, which was higher than that obtained using the soxhletation method (1.547 ± 0.027 ppm).

One of the factors that can affect the difference in flavonoid content is extraction temperature (Ulfah *et al.*, 2024). Temperature can affect the solubility of compounds owing to density effects. Flavonoids are compounds that are easily oxidized at high temperatures and cannot withstand heat. Increasing temperature can cause a decrease in flavonoid levels or damage. (Maryam *et al.*, 2023). The optimum temperature for flavonoid compounds is 30-60°C (Supriningrum, Sundu, and Setyawati, 2018). The use of high temperatures in the extraction process using the soxhletation method can cause damage to compounds or decomposition of compounds contained in purple leaf extracts (Ulfah *et al.*, 2024). According to Mokoginta, Runtuwene, and Wehantaouw (2013), the extraction of simplisia using the soxhletation method produces lower flavonoid levels than the maceration method, which is thought to have a significant effect on the extraction process.

The maceration method is a method that uses room temperature and without high-temperature heating so as not to damage flavonoid compounds (Kemit, Widarta, and Nocianitri, 2016). The maceration method uses ethanol solvent at room temperature. During the soaking process, plasmolysis occurs, which causes the rupture of the cell wall due to the pressure difference inside and outside the cell, and then the compounds in the cytoplasm are dissolved in the organic solvent so that the extraction process is perfect. This can produce more flavonoid compounds (Rahma, Taufiqurrahman, and Edyson, 2017).

Antioxidant Activity of Purple Leaf Extract

Testing the antioxidant activity of a plant is crucial for assessing whether the plant has antioxidant activity. Antioxidant activity was assessed using the DPPH (2,2-diphenyl-1-picryl-hydrazyl) method and a UV-Vis spectrophotometer. The maximum wavelength of DPPH was 519 nm. DPPH is a free radical that is highly stable at room temperature and is used to evaluate the antioxidant activity of chemical components or natural substances. DPPH free radicals have a complementary purple color and show maximum absorption at wavelengths of 515-520 nm (Hasan *et al.*, 2022; Indrawati, Baharuddin, and Kahar, 2022).

The parameter used to determine the strength of antioxidant activity was the IC_{50} (Inhibition Concentration 50 value). IC_{50} is the concentration required to inhibit 50% of DPPH free radical activity (Hasan et al., 2022). Vitamin C was used as a comparator for the antioxidant activity test. Vitamin C is the most effective water-soluble antioxidant in neutralizing free radicals (Indrawati, Baharuddin, and Kahar, 2022). Based on the antioxidant activity test of the purple leaf extract, the IC_{50} values different between the maceration and soxhletation extraction methods (**Table IV**).

Table IV. The Level of Antioxidant Activity In Purple Leaf Extract Using The DPPH Method

Solution Type	IC_{50} Value (ppm)	Description
Vitamin C	2,263a	Very Strong
Purple Leaf Extract Maceration Method	123,32b	Medium
Purple Leaf Extract Soxhletation Method	104,42b	Medium

Note: Numbers followed by different letters in the table indicate significantly different results at $p < 0.05$.

The results showed that there was a significant difference (sig < 0.05) between antioxidant activity testing on vitamin C and antioxidant activity testing on purple leaf extract, whereas there was no significant difference in antioxidant activity testing on purple leaf extract using maceration or soxhletation methods. **Table IV** shows that Vitamin C has an antioxidant activity value of 2.263 ppm, which falls into the extreme category compared to the purple leaf extracts obtained using maceration and soxhletation extraction methods. The maceration method resulted in an IC_{50} value of 123,32 ppm (medium category), whereas the soxhletation method resulted in an IC_{50} value of 104,42 ppm (medium category). The higher the IC_{50} value, the lower is the antioxidant activity potential (Nasution, Batubara, and Surjanto, 2015; Hasan *et al.*, 2022).

This shows that the antioxidant power of purple leaf extract using maceration and soxhletation methods is weaker than Vitamin C. This can be caused because Vitamin C is a pure compound that has high antioxidant activity while purple leaf extract is a crude extract consisting of several other compounds (Tongkali, Yudistira, and Suoth, 2022). One of the compounds found in purple leaves is flavonoids. Flavonoid compounds can act as antioxidants by capturing free radicals through the provision of hydrogen atoms to stabilize fat peroxy radicals (Dewi *et al.*, 2014). In general, the ability of flavonoids to capture radicals depends on the substitution of hydroxyl groups and the stabilization of phenolic radicals through hydrogen bonding or electron delocalization. Furthermore, the flavonoid phenoxy radical was stabilized by the delocalization of unpaired electrons around the

aromatic ring. The stability of flavonoid phenoxy radicals (reactive oxygen) will reduce the speed of propagation of the autooxidation chain reaction (Amin, Wunas, and Anin, 2022). The antioxidant activity is closely related to flavonoid compounds (Fadlilaturrahmah *et al.*, 2020). The higher the flavonoid content in the extract, the greater the antioxidant activity (Hidayah and Anggarani, 2022). In this study, although the flavonoid content in purple leaves using the maceration method was higher than that of the soxhletation method, both had the same antioxidant activity.

CONCLUSION

Determination of the total flavonoid content in purple leaf extracts showed that the maceration method had 4,422 ± 0,047 ppm, while the soxhletation method had 1,547 ± 0,027 ppm. These results are statistically significant (sig < 0.05), indicating that the extraction method can affect flavonoid content. ppm for the maceration extract show an IC_{50} value; 123,32 ppm for the maceration method, categorized as medium, and 104,42 ppm for the soxhletation method, categorized as medium. This shows that there is no significant difference in the antioxidant activity of purple leaf extracts using maceration and soxhletation methods. Based on the research results, it can use the maceration method on purple leaves produces high levels of flavonoid compounds which can be utilized for further research in pharmaceutical technology to formulate purple leaf extract (*Graptophyllum pictum* (L.) Griff.) for medicinal and cosmetic preparations, respectively.

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