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The Effect of Different Methods of Maceration and Microwave Assisted Extraction (MAE) on Determining Flavonoid Contents of Total Figs (*Ficus racemosa* L)

Pengaruh Perbedaan Metode Ekstraksi Maceration *dan Microwave Assisted Extraction* (MAE) Terhadap Penetapan Kadar Flavonoid Total Buah Ara (*Ficus racemosa* L.)

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Abstract

Figs (*Ficus racemosa* L.) are an essential source of bioactive components such as phenols, terpenoids, flavonoids, and alkaloids with antioxidant properties. Two extraction methods are used to extract flavonoids from figs: conventional and non-conventional. This study aimed to determine the effect of different extraction methods—maceration and Microwave Assisted Extraction (MAE)—on the total flavonoid content in figs (*Ficus racemosa* L.). The research was conducted using a laboratory experimental method. The procedures included collecting and preparing plant materials, producing simplicia, evaluating simplicia characteristics, conducting phytochemical screening, preparing extracts, and determining total flavonoid content. The results showed that the maximum wavelength of quercetin was 438 nm, with a regression equation of Y = 0.0669x + 0.0084. The average absorbance values of fig extract using the maceration method were 0.216 with methanol, while the MAE method was 0.280 with methanol. The average percentage of flavonoid content using the maceration method was 0.1245% with methanol, while with the MAE method, it was 0.1623% with methanol. The total flavonoid content of fig extract using the maceration method was 1.2451 mgQE/g extract with methanol, while with the MAE method, it was 1.6238 mgQE/g extract with methanol. The study concluded that the highest total flavonoid content was found in the methanol extract obtained through MAE. This extract had a value of 1.6238 mgQE/g extract.

***Keywords*: Maceration, Microwave Assisted Extraction (MAE), Figs (Ficus racemosa L.).**

Abstrak

Buah ara (*Ficus racemosa* L.) merupakan sumber penting komponen bioaktif, seperti fenol, terpenoid, flavonoid, dan alkaloid, dengan sifat antioksidan. Tujuan penelitian ini adalah untuk mengetahui pengaruh perbedaan metode ekstraksi, yaitu maserasi dan *Microwave Assisted Extraction* (MAE), terhadap penetapan kadar flavonoid total buah ara (*Ficus racemosa* L.). Metode penelitian bersifat eksperimental laboratorium. Prosedur penelitian meliputi pengumpulan dan penyiapan bahan tumbuhan, pembuatan simplisia, pemeriksaan karakteristik simplisia, skrining fitokimia, pembuatan ekstrak, dan penetapan kadar flavonoid total. Hasil penelitian menunjukkan panjang gelombang maksimum quercetin yaitu 438 nm, dengan persamaan regresi Y = 0,0669x + 0,0084. Rata-rata absorbansi kadar flavonoid ekstrak buah ara dengan metode maserasi menggunakan metanol adalah 0,216, sedangkan dengan metode MAE adalah 0,280. Rata-rata persentase kadar flavonoid dengan metode maserasi menggunakan metanol adalah 0,1245%, sedangkan dengan metode MAE adalah 0,1623%. Kadar flavonoid total ekstrak buah ara dengan metode maserasi menggunakan metanol adalah 1,2451 mgQE/g ekstrak, sedangkan dengan metode MAE adalah 1,6238 mgQE/g ekstrak. Penelitian ini menyimpulkan bahwa kandungan total flavonoid tertinggi ditemukan pada ekstrak metanol hasil MAE, dengan nilai sebesar 1,6238 mgQE/g ekstrak.

Kata Kunci: Maceration, Microwave Assisted Extraction (MAE), Buah Ara (Ficus racemosa L.).

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Introduction

Indonesia is a maritime country with various plants and natural resources that are national assets. Some plants are used for different purposes, such as preventing and treating various diseases, food ingredients, dyes, household equipment, and building materials. Many by-products and medicinal plants, such as steroids, alkaloids, flavonoids, phenols, and coumarins, have been isolated in modern times. [1].

(*Ficus racemosa* L.) It is a fruit-bearing plant that produces edible fruits and originates from Western Asia. The name "ara" is derived from Arabic. (*Ficus racemosa* L.) commonly known as fig, it is indigenous to India and Southeast Asia and grows in regions of Western Asia, from the Balkan coast to Afghanistan. It is now cultivated in Australia, Chile, Argentina, and the United States. The type of fig that grows naturally in Indonesia is (*Ficus racemosa* L.). The utilization of this type in Indonesia is still minimal and is generally only used as bonsai seedlings. [2]Siti Fatimah's research shows that the fig plant's leaves contain total flavonoids, which yield 5.956 ± 0.000 g QE/100g extract. The fig plant (*Ficus racemosa* L.) [3].

The fig fruit (*Ficus racemosa* L.) is an essential source of bioactive components such as phenols, terpenoids, flavonoids, and alkaloids with antioxidant properties. Research on flavonoid compounds is fundamental to discovering new compounds with strong potential as antibacterial, antiviral, antioxidant, antidiabetic, anti-inflammatory, anticancer, and antihyperlipidemic agents. [4].

Research by Shirajum Munira et al. (2018) states that figs have been proven to contain chemical compounds such as alkaloids, flavonoids, steroids, saponins, tannins, and alkaloids/triterpenoids, and they contain flavonoids in very high amounts. [5].

Flavonoids are the most diverse group of phenolic compounds found in almost all plants, generally in the epidermal tissues of leaves and fruit skins. Phenolic compounds are secondary metabolites found in plants with an aromatic ring containing one or two hydroxyl (OH) groups. In plants, this group of compounds has several functions, namely: Cell wall builders (lignin), Flower pigments (anthocyanins), Growth regulators (flavonols), Defense (flavonoids), Inhibitors and promoters of germination (simple phenols), Fragrances (vanillin, methyl salicylate) [6].

This study employs two extraction methods to isolate flavonoids from figs: a conventional method (maceration) and a non-conventional method (Microwave Assisted Extraction, MAE). These methods were chosen based on their ability to extract bioactive compounds efficiently, offering distinct advantages in terms of extraction time, solvent usage, and the preservation of thermolabile compounds. [7].

Methanol was selected as the extraction solvent in this study due to its polarity and proven efficiency in extracting a broad spectrum of flavonoid compounds. Methanol is widely used in phytochemical studies because it can penetrate plant tissues effectively and dissolve both low- and high-molecular-weight polyphenols. Moreover, methanol has demonstrated a higher capacity to yield flavonoids than other solvents such as ethanol or water, particularly when dealing with dry plant materials. Its relatively low boiling point makes it suitable for subsequent solvent removal without degrading heat-sensitive components. These advantages make methanol an ideal solvent for reliably quantifying total flavonoid content in fig fruit extracts. [8].

The maceration method, a conventional extraction technique, involves soaking the simplicia powder in an extracting liquid. The liquid penetrates the cell walls of the plant material and enters the cavities containing active compounds. Due to the concentration gradient between the inside and outside of the cells, the active compounds are drawn out and dissolved in the extracting liquid. This method is advantageous due to its simplicity, relatively low operational costs, and the minimal risk of damaging heat-sensitive compounds. However, one limitation of the maceration method, especially at room temperature, is that the extraction process may be incomplete, leading to suboptimal dissolution of the compounds. Temperature modifications are often necessary to optimize the process to improve extraction efficiency. [9]

The MAE method, a non-conventional technique, uses microwave energy to enhance the extraction process. The sample is irradiated with microwave energy, causing rapid heating and promoting the dissolution of compounds into the solvent. The MAE method offers several advantages, including reduced extraction time, increased selectivity, and higher yields. It also minimizes solvent usage, making it more environmentally friendly than conventional methods. However, one potential drawback is that excessive microwave power can lead to the degradation of thermolabile components, thereby reducing extraction efficiency. Despite this, MAE has been shown to provide higher recovery and better quality extracts, particularly for phenolic compounds like flavonoids, compared to traditional methods like Soxhlet extraction or maceration. [10].

The comparison between these two methods provides valuable insights into their respective efficiencies and their potential applications for flavonoid extraction from figs. By analyzing the differences in extraction time, solvent consumption, and the preservation of active compounds, this study aims to determine the optimal extraction method for flavonoid recovery.

Experimental Section

The method used in the research is the experimental method. The study includes the collection and preparation of plant materials, the creation of simplicia, the examination of simplicia characteristics, phytochemical screening, the preparation of extracts, and the determination of total flavonoid content. The duration of this research was from July to September 2023. This research was conducted at the Research Laboratory of the Faculty of Pharmacy, UMN Al-Washliyah Medan, the Scholar Laboratory, and the Biology Laboratory of FMIPA Universitas Sumatra Utara. The test material was the fig fruit extract (*Ficus racemosa* L.) from Gg. Sudomuyo, Sei Kambing Village, Medan Helvetia District, Medan City, North Sumatra Province.

Materials and Apparatus

The tools used in this research include laboratory glassware, a maceration vessel, a blender, dropper pipettes, volumetric pipettes, an analytical balance, a rotary evaporator, a measuring cylinder, an Erlenmeyer flask, a test tube, a volumetric flask, scissors, a sieve, labeling paper, Whatman No. 1 filter paper, a UV-Vis spectrophotometer, and Microwave Assisted Extraction (MAE). The material used in this study is the fig fruit (*Ficus racemosa* L.). Aquadest chemical reagents, quercetin, sulfuric acid, hydrochloric acid, iron (III) chloride, H2SO4, ethyl acetate, chloroform, magnesium powder, HCl, amyl alcohol, Mayer's reagent, Bouchardat, and Dragendorff, n-hexane, 2% AlCl3, 120 mM potassium acetate, aquades, FeCl3, methanol.

Statistical Analysis

The data obtained from determining total flavonoid content were analyzed statistically using descriptive statistics to calculate the mean and standard deviation. To evaluate the significance of differences between extraction methods (Maceration and Microwave Assisted Extraction) and solvents (methanol), one-way analysis of variance (ANOVA) was performed, with a significance level set at $p < 0.05$. ANOVA was used

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to test for significant differences between the groups generated from different extraction methods and solvent types. If the ANOVA results indicated significant differences, post-hoc tests were conducted to determine which group pairs differed significantly. All statistical analyses were performed using SPSS software version 25.0 to ensure the reliability and validity of the research results. [11].

Results and Discussion

Methanol Extraction by Maceration

50 g of fig fruit simplicia powder (*Ficus racemosa* L.) was extracted using methanol as a solvent, then filtered, and subsequently evaporated using a rotary evaporator at a temperature of 50 °C and evaporated over a water bath until a thick extract was obtained, to evaporate the methanol solvent, resulting in a thick extract of fig fruit (*Ficus racemosa* L.) weighing g. In previous research by Ely Setiawan et al. (2017) titled "The Potential of Methanol Extract from Bacang Mango Leaves (*Mangifera foetida* L.) as an Antibiotic Against Enterobacter aerogenes and Identification of Its Active Compound Groups," the maceration process yielded a concentrated methanol extract with a dark greenish-black color, amounting to 10.61%.

Methanol Extraction by Microwave Assisted Extraction (MAE)

50 g of fig fruit simplicia powder (*Ficus racemosa* L.) was extracted using a Microwave Assisted Extraction (MAE) device with methanol as the solvent. The extraction mixture was filtered through Whatman No. 1 filter paper to remove solid residues. After filtration, the extract was evaporated using a rotary evaporator at 50 °C and further evaporated over a water bath until a thick extract was obtained. This process helped to remove the methanol solvent, leaving behind a concentrated fig fruit extract (*Ficus racemosa* L.), with the final weight of the extract being recorded.

In previous research by Karami (2015) titled *"Optimization of Microwave-Assisted Extraction (MAE) and Soxhlet Extraction of Phenolic Compounds from Licorice Root,"* the yield obtained from the extraction using the Microwave Assisted Extraction (MAE) method was 16.38% [12].

Table 1. Yield of *Ficus racemosa* L. Fruit Extract by Maceration Extraction Method Extract Weight Yield Value (%)

Maceration	**Metanol**	**7,9 gram**	**15,8%**
Microwave Assisted Extraction (MAE)	Metanol	7,6 gram	15,2%

PhytochemicalScreening

Table 2. Results of Phytochemical Screening of Fig Fruit (*Ficus racemosa* L.)

Screening Test	Results of Fig Screening (*Ficus racemosa* L.)
Alkaloid	Positif (+)
Flavonoide	Positif (+)
Terpenoide	Positif (+)
Steroid	Positif (+)
Saponin	Negatif (-)
Tanin	Positif(+)

Explanation:
(+) : contains the tested compound
(-) : does not contain the tested compound

In the phytochemical screening test, the compounds detected in the fig fruit (*Ficus racemosa* L.) are flavonoids, alkaloids, tannins, and steroids/terpenoids. Meanwhile, the group of compounds that were not detected is the saponin compounds.

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Determination of Total Flavonoid Content in Fig Fruit (*Ficus racemosa* L.) Determination of the Maximum Wavelength of Quercetin

The maximum wavelength of quercetin was determined by running a quercetin solution at 400 – 800 nm. The running results show that the maximum wavelength of quercetin is 438 nm.

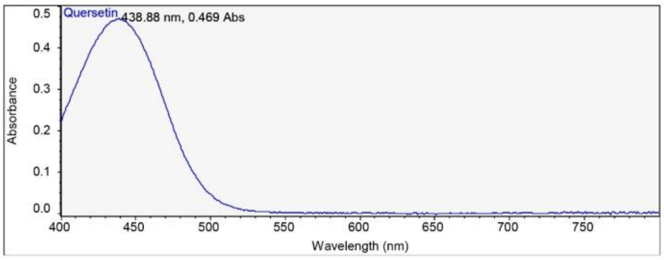

Figure 1. Maximum Wavelength of Quercetin

In determining total flavonoid content in fig fruit (*Ficus racemosa* L.), the first step involved identifying the maximum wavelength of quercetin, which is used as the standard for the analysis. This was achieved by running a quercetin solution from 400 nm to 800 nm across various wavelengths. The results indicated that the maximum absorption for quercetin occurs at 438 nm. This wavelength was chosen because flavonoids, including quercetin, exhibit a conjugated aromatic system that strongly absorbs ultraviolet and visible light at this specific wavelength. The absorption at 438 nm is optimal for quantifying flavonoid content in the fig fruit extract using UV-Vis spectrophotometry.

Determination of the Quercetin Standard Calibration Curve

The calibration curve of the quercetin standard solution was created by measuring five series of quercetin standard solutions with concentrations of 4 ppm, 6 ppm, eight ppm, 10 ppm, and 12 ppm at a wavelength of 438 nm.

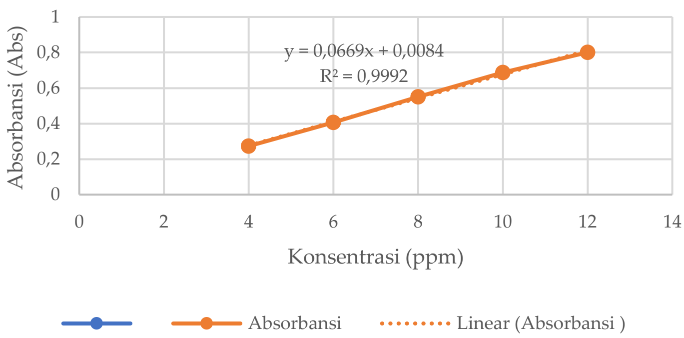

Figure 2. Quercetin Standard Calibration Curve

The next step in determining the total flavonoid content involved creating a calibration curve using a quercetin standard solution. To construct this curve, five different concentrations of quercetin standard solutions (4 ppm, 6 ppm, eight ppm, 10 ppm, and 12 ppm) were prepared and measured at a wavelength of 438 nm, which was previously identified as the optimal wavelength for flavonoid analysis. The absorbance values obtained at these concentrations were used to generate a calibration curve, which helps establish a relationship between concentration and absorbance. This calibration curve is a reference for determining the flavonoid content in the fig fruit extracts by comparing their absorbance values to the known concentrations in the curve.

Table 3 presents the absorbance values of the standard quercetin solution at a wavelength of 438 nm. The absorbance was measured at five different concentrations: 4 ppm, 6 ppm, eight ppm, 10 ppm, and 12 ppm. The corresponding absorbance values were 0.273, 0.406, 0.550, 0.688, and 0.801, respectively. These measurements were used to generate the standard calibration curve for quercetin, essential for determining the total flavonoid content in the fig fruit extracts. The regression equation derived from the calibration curve

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is given by the formula y = 0.0669x + 0.0084, where 'y represents the absorbance and 'x' represents the concentration. The equation provides a strong linear relationship between the concentration of quercetin and its absorbance at 438 nm.

Table 3. Absorbance Values of Standard Quercetin Solution at a Wavelength of 438 nm

Concentration	Absorbance (Abs)	Regression Equation
4	0,273	Y = 0,0669x + 0,0084
6	0,406	
8	0,550	
10	0,688	
12	0,801	

Results of Total Flavonoid Content Determination of Methanol Extract from Fig Fruit (*Ficus racemosa* L.) by Maceration

Table 4. Absorbance Values of Methanol Extract of Fig Fruit by Maceration

Maceration Method	Replication	Absorbance (Abs)	Average Absorbance (Abs)
Methanol	1	0,213	0,216
	2	0,218	
	3	0,219	

Table 4 presents the absorbance values for the methanol extract of fig fruit (*Ficus racemosa* L.) obtained through the maceration method. The absorbance was measured across three replications, with the recorded absorbance values being 0.213, 0.218, and 0.219, respectively. The average absorbance for the three replications was calculated to be 0.216. These absorbance values are critical in determining the total flavonoid content of the methanol extract, as they provide the necessary data for calculating flavonoid concentration using the established calibration curve of quercetin. The slight variations in absorbance between the replications are typical and reflect the consistency of the extraction and measurement process.

Table 5. Absorbance Values of Methanol Extract from Fig Fruit Microwave Assisted Extraction (MAE)

Microwave Assisted Extraction Method (MAE)	Replication	Absorbance (Abs)	Average Absorbance (Abs)
Metanol	1	0,280	0,280
	2	0,280	
	3	0,280	

Table 5 presents the absorbance values for the methanol extract of fig fruit (*Ficus racemosa* L.) obtained using the Microwave Assisted Extraction (MAE) method. The absorbance values for all three replications were consistent, each measuring 0.280. As a result, the average absorbance for the three replications was also 0.280. These absorbance values are essential for calculating the flavonoid concentration in the methanol extract, based on the previously established quercetin calibration curve. The consistent absorbance values across replications indicate high precision in the MAE method for extracting flavonoids from the fig fruit.

Results of the Measurement of Total Flavonoid Content Percentage in Methanol Extract of Fig Fruit

Table 6 shows the measurement results of the total flavonoid content percentage for the methanol extract of fig fruit (*Ficus racemosa* L.) using the maceration method. The table presents the absorbance values for each replication, which were measured as 0.213, 0.218, and 0.219, respectively. The average absorbance for the three replications was calculated to be 0.216. These absorbance values were used to determine the total flavonoid content using the quercetin calibration curve. The flavonoid content percentage for each replication was found to be 0.1223%, 0.1253%, and 0.1259%. The average rate of total flavonoid content was 0.1245%, indicating a relatively consistent yield of flavonoids from the methanol extract through the maceration method. This data demonstrates the efficiency of the maceration method for extracting flavonoids from fig fruit and allows for comparison with other extraction methods, such as MAE, which may yield different flavonoid content percentages.

Table 6 Measurement Results of Total Flavonoid Content % of Macerated Fig Fruit Extract

Maceration Method	Replication	Absorbance (Abs)	Average Absorbance (Abs)	Percentage (%) Rate	Average Percentage (%) Content
Metanol	1	0,213	0,216	0,1223	0,1245
	2	0,218		0,1253	
	3	0,219		0,1259	

Table 7. Measurement Results of % Total Flavonoid Content of Fig Fruit Extract by Microwave Assisted Extraction (MAE)

Microwave Assisted Extraction Method (MAE)	Replication	Absorbance (Abs)	Average Absorbance (Abs)	Percentage (%) Rate	Average Percentage (%) Content
Metanol	1	0,280	0,280	0,1623	0,1623
	2	0,280		0,1623	
	3	0,280		0,1623	

Table 7 presents the results of the percentage measurement of total flavonoid content in fig fruit (*Ficus racemosa* L.) extracted with methanol using the Microwave Assisted Extraction (MAE) method. The absorbance values obtained from all three replications were consistently recorded at 0.280, with an average absorbance of 0.280. Applying the quercetin standard calibration curve, the corresponding percentage of total flavonoid content for each replication was calculated to be 0.1623%. The uniform absorbance and percentage values across all replications indicate high reproducibility and precision in the MAE technique. The average total flavonoid content percentage was 0.1623%, higher than that obtained through the maceration method. This suggests that MAE may be more effective in enhancing the extraction efficiency of flavonoid compounds, possibly due to improved solvent penetration and compound release facilitated by microwave energy.

Results of Total Flavonoid Content Measurement of Methanol Extract of Ficus carica Fruit by Maceration

Table 8. Results of Total Flavonoid Content Measurement of Methanol Extract from Macerated Fig Fruit

Maceration Method	Replication	Absorbance (Abs)	Total flavonoid content (mgQE/g extract)	Percentage (%) of Total Flavonoid Content
Metanol	1	0, 213	1.2232	1.2451
	2	0,218	1.2532	
	3	0,219	1.2591	

Table 8 shows the measurement results of the total flavonoid content in fig fruit (Ficus carica) extracted using the maceration method with methanol as the solvent. The absorbance values obtained from three replications were 0.213, 0.218, and 0.219, respectively. These absorbance values correspond to flavonoid contents of 1.2232 mgQE/g, 1.2532 mgQE/g, and 1.2591 mgQE/g extract. The slight variation among the replicates indicates good consistency and reproducibility of the maceration method. The total flavonoid content was calculated to be 1.2451 mgQE/g extract, with a corresponding average percentage of 1.2451%. Although this value is lower than that obtained by the Microwave Assisted Extraction (MAE) method, the maceration process remains a viable and simple extraction technique, particularly when advanced equipment is unavailable. However, the lower yield may be attributed to the limited cell wall disruption and slower mass transfer in the maceration process compared to MAE.

Table 9 Results of Total Flavonoid Content Measurement of Methanol Extract of Fig Fruit Microwave Assisted Extraction (MAE)

Microwave Assisted Extraction Method (MAE)	Replication	Absorbance (Abs)	Total flavonoid content (mgQE/g extract)	Percentage (%) of Total Flavonoid Content
Metanol	1	0,280	1,6238	
	2	0,280	1,6238	1,6238
	3	0,280	1,6238	

Table 9 displays the results of the total flavonoid content measurement in fig fruit (*Ficus racemosa* L.) extracted with methanol using the Microwave Assisted Extraction (MAE) technique. The absorbance was consistently measured at 0.280 in all three replications, corresponding to a total flavonoid content of 1.6238 mgQE/g extract for each replicate. The consistency of the absorbance and calculated flavonoid content across all trials indicates excellent reproducibility of the MAE method. The average total flavonoid content was 1.6238 mgQE/g extract, suggesting that the MAE technique is highly effective in extracting flavonoid compounds. Compared to traditional methods such as maceration, this higher yield is likely due to the enhanced solvent penetration and rapid heating provided by microwave energy, which accelerates the release of bioactive compounds from plant matrices.

Maceration Method

The powder of fig fruit simplicia (*Ficus racemosa* L.) was extracted using the maceration method with methanol as the solvent. The maceration process was carried out for 5 days, after which the liquid extract was separated from the residue by filtration using Whatman No. 1 filter paper. A second maceration was then performed on the remaining residue for another 2 days, followed by another filtration using the same filter paper. Both filtrates were combined and concentrated using a rotary evaporator at 50 °C until a thick extract was obtained. The extract was further concentrated using a water bath to ensure maximum solvent removal. The resulting extract was a dense, reddish-brown substance with the characteristic aroma of figs. The percentage yield of the extract was subsequently calculated. [13]

Microwave Assisted Extraction (MAE)

The result of extracting fig fruit simplicia powder (*Ficus racemosa* L.) using the Microwave Assisted Extraction (MAE) method was filtered using Whatman No. 1 filter paper to separate the liquid extract from the residue. The filtrate was then evaporated using a rotary evaporator at 50 °C and further concentrated over a water bath until a thick fig fruit extract (*Ficus racemosa* L.) was obtained.

Interpretation of Results

The results from both extraction methods (maceration and MAE) indicate a noticeable difference in flavonoid content. Specifically, the flavonoid content in the fig fruit extract obtained from the MAE method was higher (1.6238 mgQE/g extract) compared to the maceration method (1.2451 mgQE/g extract). This significant difference prompts a closer examination of why the MAE method yielded better results. One of the key reasons for the better flavonoid content in the MAE method could be attributed to the microwave energy's ability to enhance solvent penetration and increase the temperature of the solvent more efficiently. The microwave radiation may cause rapid heating and vibration of the solvent molecules, thereby facilitating the extraction of flavonoids from the plant cells. Additionally, the non-thermal effects of microwaves, such as polarization and cavitation, might further contribute to the breakdown of plant cell walls, releasing more bioactive compounds compared to the maceration process, which is a slower, more passive method. [7].

On the other hand, the maceration method, being a traditional extraction technique, relies on passive diffusion and prolonged soaking time, which can result in less efficient solvent penetration and extractive

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yield. While it still extracts flavonoids, the slower process may not be as effective in releasing compounds that are sensitive to heat or those trapped inside the plant cell matrix [14].

Furthermore, the solvent interactions play a significant role in the extraction efficiency. Both methods used methanol as the solvent, effectively extracting flavonoids due to its polarity. However, during the MAE process, the increased energy may alter the solvent's interaction with plant components, leading to a more efficient release of flavonoids. In contrast, the maceration method operates at ambient temperature, which might not be sufficient to fully break the bonds between flavonoids and other cellular components, limiting the extraction efficiency. [15].

Another factor that could contribute to the observed differences is the heat sensitivity of flavonoids. Some flavonoids may be sensitive to high temperatures, which could lead to degradation or alteration of their chemical structure when subjected to prolonged heating. In the MAE method, the quick heating of the solvent may reduce the exposure time to high temperatures, thereby preventing the degradation of heat-sensitive compounds. On the contrary, the longer extraction time in maceration may increase the risk of flavonoid degradation due to prolonged exposure to heat. [16].

Phytochemical Screening

The results of the phytochemical screening research were conducted using a qualitative method through color reactions with a specific pre-reaction. In this study, the screening results of fig fruit (*Ficus racemosa* L.) were found to be positive for secondary metabolites, namely alkaloids, flavonoids, steroids/triterpenoids, and tannins. In contrast, saponins in fig fruit were found to be negative for secondary metabolites.

Determination of Total Flavonoid Content in Fig Fruit (*Ficus racemosa* L.)

Quantitative analysis of methanol extracts from fig fruits was performed using UV-Vis spectrophotometry, as flavonoids exhibit a conjugated aromatic system that absorbs strongly in the ultraviolet and visible light spectrum. The initial step was determining the maximum wavelength for quercetin, which is commonly used as a reference flavonoid in such analyses. A solution of quercetin was run at wavelengths ranging from 400–800 nm, and the maximum wavelength of 438 nm was found, consistent with the typical absorption maximum for flavonoids. The absorbance values at various concentrations of quercetin (4 ppm, 6 ppm, eight ppm, 10 ppm, and 12 ppm) were recorded at the identified maximum wavelength of 438 nm. The recorded absorbances were as follows: 4 ppm: 0.273, 6 ppm: 0.406, 8 ppm: 0.550, 10 ppm: 0.688, and 12 ppm: 0.801. These values were used to construct a calibration curve, following the Lambert-Beer law, which relates absorbance to concentration. The regression equation derived from the data was: $y = 0.0669x + 0.0084$, with a correlation coefficient (r) of 0.999, indicating a powerful linear relationship between absorbance and concentration. This linearity is expected and typical for flavonoid compounds at this wavelength range. Similar measurements were made for the flavonoid content determination in the fig fruit extracts for both maceration and Microwave Assisted Extraction (MAE) methods. The absorbance values for both methods were as follows: Maceration method: Average absorbance: 0.216 nm, MAE method: Average absorbance: 0.280 nm. Per the Lambert-Beer law, the absorbance values of 0.216 and 0.280 are within the acceptable range (0.2–0.8) for UV-Vis spectrophotometry. However, the absorbance for the MAE extract was slightly higher, which may indicate a higher concentration of flavonoids in the MAE extract compared to the macerated extract. Flavonoids, being conjugated compounds, are expected to have strong absorbance in the UV-Vis range, with typical absorbance peaks in the range of 350–400 nm for many flavonoids, and in the 420–450 nm range for those with extended conjugation.

The absorbance values observed in this study fall within the expected range for flavonoids, confirming the reliability of the UV-Vis analysis method for this purpose. The flavonoid content in the methanol extract obtained by maceration was 1.2451 mgQE/g extract; by MAE, it was 1.6238 mgQE/g extract. The percentage of flavonoid content in the maceration method was 0.1245%, while the MAE method yielded 0.2163%. These values are consistent with previous research. For instance, [17] reported a much higher flavonoid content of 17.18% using maceration, possibly due to differences in extraction methods, solvent use, or the plant material. The higher flavonoid content observed in the MAE method in this study may be attributed to the more efficient extraction conditions facilitated by microwave energy, which enhances the extraction of flavonoids by promoting higher molecular movement and more effective solvent interaction. In conclusion, while the absorbance data for both extraction methods fall within expected ranges for flavonoid analysis, the differences

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in results between the maceration and MAE methods should be explored further. The MAE method, yielding higher flavonoid content, likely benefits from a more efficient extraction process, possibly due to heat-assisted solubilization of flavonoids and better solvent interaction [18].

This study demonstrates that the Microwave Assisted Extraction (MAE) methanol method yields a higher total flavonoid content than the maceration method. Based on the results, the total flavonoid content in the extract obtained through MAE was 1.6238 mgQE/g extract, while the extract obtained via the maceration method contained 1.2451 mgQE/g extract. This difference was analyzed using an ANOVA test, which indicated a significant difference between the two extraction methods, with a p-value < 0.05. This suggests that the MAE method is more effective in extracting flavonoids from fig fruit (*Ficus racemosa* L.) than the maceration method. Therefore, MAE can be considered a more efficient method for extracting flavonoids from fig fruit, which has potential as a bioactive source with various health benefits.

Conclusions

This study concluded that the highest total flavonoid content was found in the extract obtained through Microwave Assisted Extraction (MAE) using methanol, with a value of 1.6238 mgQE/g of extract. Compared to the maceration method, which yielded an extract with a total flavonoid content of 1.2451 mgQE/g of extract, the MAE method provided a higher result.

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