vera ladeska-Antioxidants, Total Phenolic And Flavonoid Content And Toxicity Assay Of Ampelas (Tetracera Macrophylla Wall.Ex Hook.F.& Thoms) From Kalimantan-Indonesia

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ABSTRACT

Background: High Reactive Oxygen Species (ROS) contribute to disease pathogenesis. Phenolic compounds and flavonoids are effective as antioxidants. **Objective**: The objective of this study was to evaluate *Tetracera macrophylla* leaf toxicity, total phenolic and flavonoid content, and antioxidant activity. The Folin-Ciocalteu method was used to measure total phenolic content, total flavonoid content with AlCl3, and toxicity with the MTT assay against RAW 264.7 cells. **Methods** :The antioxidants were determined using DPPH and FRAP. **Results**: Methanol extract exhibits antioxidant activity with IC50 values of 81.582 μg/mL (DPPH) and 11840 mol/g (FRAP), 353.781 mg GAE/g dry weight of total phenolic content, and 279.2 mg QE/g dry weight of total flavonoid content. The antioxidant activity of the methanol extracts was stronger than that of the ethyl acetate and n-hexane extracts. In the toxicity assay, the extracts of methanol and ethyl acetate produced IC50 values of 288.792 and 541.472 μg/mL, respectively. **Conclusion**: *Tetracera macrophylla's* methanol extract exhibited the highest yield, total phenolic and flavonoid content, and antioxidant activity. Methanol extract has low toxicity to RAW 264.7 cells.

Keywords: Antioxidants, Total phenolic, Total flavonoid, Toxicity, *Tetracera macrophylla*

INTRODUCTION

Balancing the level of free radicals with antioxidants in the body is a critical physiological function. A rise in the level of free radicals will trigger oxidative stress. Free radicals will injure cells or tissues, stimulating organ damage. Organ damage can subsequently induce chronic diseases such as diabetes, heart disease and gout. The administration of antioxidants will reduce the negative effects of free radicals on body tissues. Flavonoids and phenolic compounds are natural antioxidants contained in plants. Both are secondary metabolites with the ability to scavenge free radicals and inhibit lipid oxidation.

Indonesia has the second highest volume of natural resources in the world. One such resource with the potential to be developed is *Tetracera macrophylla*, which grows widely in Barito Utara, Kalimantan.[1] It belongs to the Dilleniaceae family and has synonyms in Indonesia of akar tembara and ampelas. In an ethnomedicinal method in Malaysia, a decocta of the stems of the plant was used to treat fatigue, while stembark was used to treat TB symptoms.[2] decocta from the roots has also been used to treat diarrhoea and dysentery.[3] In West Nigeria, an infusion of fresh leaves was used to treat chronic diabetes. In previous research, *Tetracera macrophylla* with DPPH and ABTS methods has been shown to display the highest antioxidant activity.[4]

An ethyl acetate fraction of the ethanolic extract of *Tetracera macrophylla* leaves was found to contain 5, 7-dihydroxy-8-methoxy flavone (wogonin), betulinic acid, kaempferol, quercetin and norwogonin compounds.[4] Ethanol extract from the leaves of *Tetracera macrophylla* contains phenolic and flavonoid compounds. Based on traditional usage and its chemical content, this plant has the potential to be used as an antioxidant.[5] However, since no research has reported on the toxicity of this plant, it is important to determine its safety. The purpose of this study was therefore to determine the antioxidant potential of *Tetracera macrophylla* and analyse the total phenolic content (TPC) and total flavonoid content (TFC).

MATERIALS AND METHODS

Plant Materials

Tetracera macrophylla leaf was the part of the plant used, which was obtained from the protected forest of Teweh Baru District, North Barito Regency, Central Kalimantan. This plant was determined at the National Research and Innovation Agency (BRIN) with collection number B-4/V/DI.05.07/11/2021.

Extraction

300 grams of *Tetracera macrophylla* leaves were extracted via the 3-times maceration method using n-hexane (3 litres), which was then stirred and stored 24 hours in the dark. The solution was filtered and ethyl acetate and methanol were added to the residue, respectively. All extracts were evaporated with a rotary vacuum evaporator at 50°C and dried over a water bath to obtain n-hexane extract (HE), ethyl acetate extract (EE) and methanol extract (ME). The dry extract was stored at 2–8^{0}C before use.

Phytochemical Screening

According to the Thin Layer Chromatography method, phytochemical screening was done using silica gel GF 254 as a stationary phase and n-hexane-ethyl acetate-methanol (5:2:1) as a mobile phase for flavonoids with AlCl3 10% spray reagent.A mobile phase was also used for phenolic: n-hexane-ethyl acetate (7:3) with $FeCl_3$ 5% spray reagent; and terpenoids/steroids: n-hexane-ethyl acetate (8:2) with spray reagent: Liebermann Burchard.[6]

Total Phenolic Content (TPC) Assay

In a 96-well microplate, 20 μL of sample was added to 100 μL of Folin-Ciocalteau (1:10) solution, and the mixture was agitated for 60 seconds. This was then incubated for 4 minutes at room temperature. 80 μL of a 7.5 % Na2CO3 solution were added, and the mixture was stirred before being left to incubate for two hours in the dark. The sample solution's absorbance was determined at a maximum wavelength of 750 nm using a microplate reader. The gallic acid regression equation was used to calculate the phenol content.

Total Flavonoid Content (TFC) Assay

96-well microplate was filled with 20 μL of sample, 20 μL of aluminium chloride solution, 20 μL of 1 M potassium acetate, and 180 μL of distilled water. 30 minutes of incubation followed by a 60-second shake of the mixture. Using microplate reader, an absorbance measurement of the solution's color intensity was made at a wavelength of 415 nm. Based on the quercetin regression equation, total flavonoid concentrations were calculated.[8]

Antioxidant Assay with DPPH Method

Based on a modified Molyneux methodology, the examined extracts DPPH free radical scavenging abilities were assessed.[9] There was a total of 0.1 mM of DPPH solution in pure methanol. 1000 μg/mL of methanol was used to get the sample concentration. From stock solution, concentration series of 40, 60, 80, 100, and 120 μg/mL were produced, and the assay was sonicated for two minutes. 3 mL of standard DPPH solution were pipetted into 1 mL for each concentration. It was then homogenized after being shaken, and it was incubated for 30 minutes in the dark. With a UV-Vis spectrophotometer, the absorption was measured at a wavelength of 516 nm. The positive control was quercetin. IC_{50} values were calculated based

on the presentation of the inhibition of DPPH radicals from each concentration of the sample solution with the formula:

% inhibition = (Absorbance sample/Absorbance control) x 100%

The value of IC_{50} was the concentration at which the sample reduced DPPH by 50%, using the linear regression equation y = a + bx.

Antioxidant Assay with FRAP Method

The FRAP radical method [10,11] was modified slightly to estimate the antioxidant effect of the samples. The sample concentration was prepared at 1000 g/mL in methanol, then diluted to 500 g/mL. 30 μl of sample solution was pipetted and added to 270 μl of FRAP reagent. This was homogenised for ± 60 seconds and incubated for 30 minutes at 37°C in a dark condition. The absorbance was read at a wavelength of 595 nm. Tests were carried out in triplo. The blanks were prepared in the same way, with the same volume of sample replaced with methanol absolute. Plate blanks were made with 300 μl methanol. Quercetin was used as the positive control. Antioxidant activity was calculated based on the ferric iron equivalent antioxidant activity (FeEAC) with the following formula:

$$FeEAC = \frac{\triangle A}{GRAD} x \frac{Av}{Spv} x\ D\ x\ \frac{1}{Cext}\ x\ 10^5$$

Toxicity Assay on RAW 264.7 Cells

At a density of 5 x 10^3 cells/well, RAW 264.7 cells were placed to a 96-well microplate and left to adhere for 24 hours at 37°C in a 5 % CO2 incubator. The culture medium was changed for new medium after 24 hours of incubation. The sample was then administered to the cells at doses of 15.625 μg/mL, 31.25 μg/mL, 62.5 μg/mL, 125 μg/mL, 250 μg/mL, and 1000 μg/mL. For 24 hours at 37°C, cells were incubated in an incubator with 5 % CO2. After 24 hours, the medium was removed, and the cells were washed in PBS. The plate underwent a 4-hour CO2 incubator incubation at 37°C and received a total of 10 μL of MTT working solution (5 mg/mL in phosphate buffer solution) for each well. At a wavelength of 570 nm, absorption was measured using a microplate reader.[12,13]

RESULTS

Phytochemical Screening

The content of the secondary metabolites in the extract was further identified; this included flavonoids, polyphenol, triterpenoids and steroids. The three extracts of HE, EE, and ME contained phenolic and flavonoid compounds (Table 1, Figure 1).

DPPH Assay

The DPPH assay was determined using quercetin as the standard (Figure 2). *Tetracera macrophylla* leaf n-hexane extract was found to be a weak antioxidant, while the ethyl and methanol extracts had strong antioxidant properties (Table 2).

FRAP Assay

The FRAP assay was carried out using a microplate reader with a standard solution of AFS (ammonium ferrous sulfate) and positive control of quercetin. Figure 3 displays the AFS standard curve and Table 3 shows the ability to reduce Fe^{3+} to Fe^{2+} from the *Tetracera macrophylla* extract. The slope of the linear regression obtained from the AFS standard, 0.0015, was used as the gradient to measure the antioxidant reduction capacity.

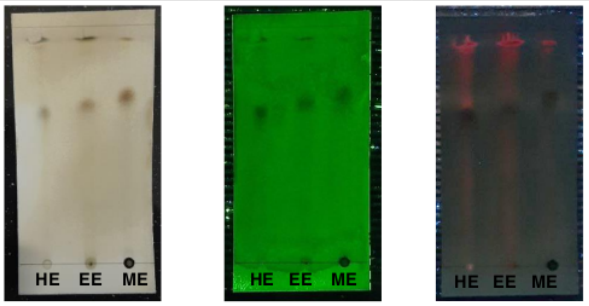
Total Phenolic Content (TPC) and Total Flavonoid Content (TFC)

TPC was determined using the Folin–Ciocalteu method at a wavelength of 750 nm with gallic acid as the standard (Figure 4). TFC was determined via a colorimetric method using $AlCl_3$ and quercetin as the standard (Figure 5). Table 4 contains the TPC and TFC results. The TPC and TFC for HE was not detected due to low absorbance.

Toxicity Assay on RAW 264.7 Cells

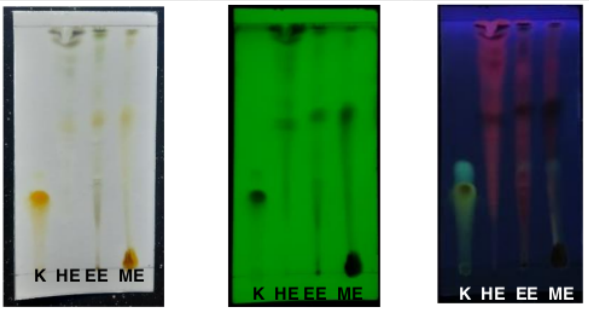
The toxicity assay was determined in triplo with six variations of concentration: 15.625; 31.25; 62.5; 125; 125; 250 and 1000 μg/ml. The sample IC_{50} value for RAW 264.7 cells can be seen in Table 5. The concentration curve for the extracts and inhibition of RAW 264.7 cell proliferation are shown in Figures 6 and 7. Dimethyl sulfoxide (DMSO) can be used to dissolve the formazan crystals to produce a purple color with a recognizable absorbance at 570 nm. Since the intensity of the purple color is inversely correlated with the number of cells, it indicates the vitality of the cells (Figure 8).

Phenol chromatogram



Visually UV 254 UV 366

Flavonoids chromatogram



Visually UV 254 UV 366

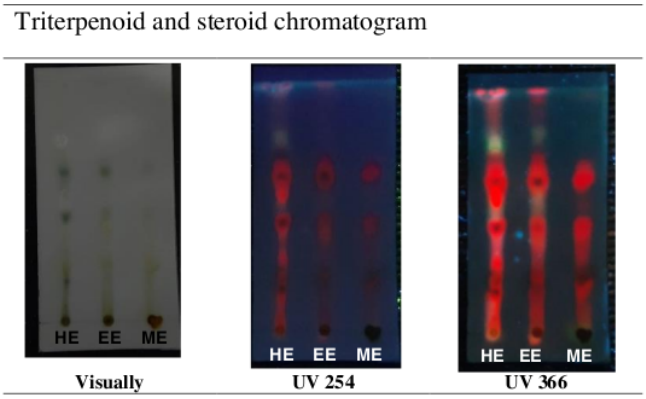


Figure 1. TLC results of n-hexane extract: ethyl acetate extract: methanol extract

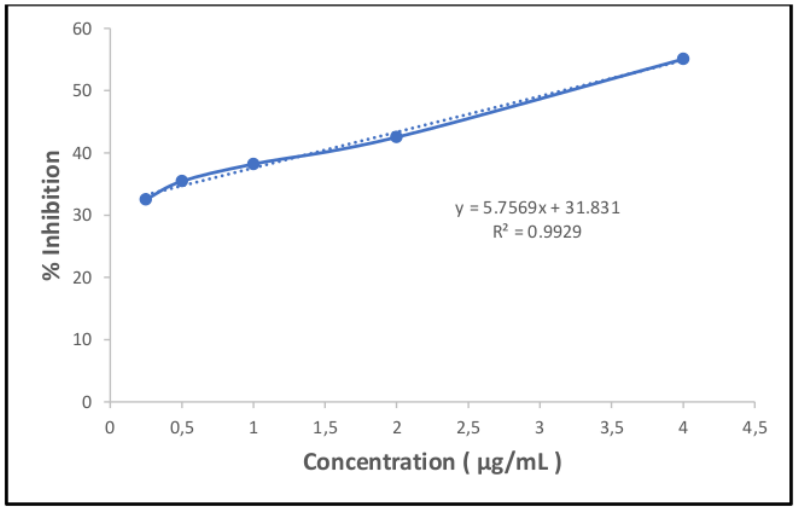


Figure 2: Curve of % inhibition and quercetin concentration

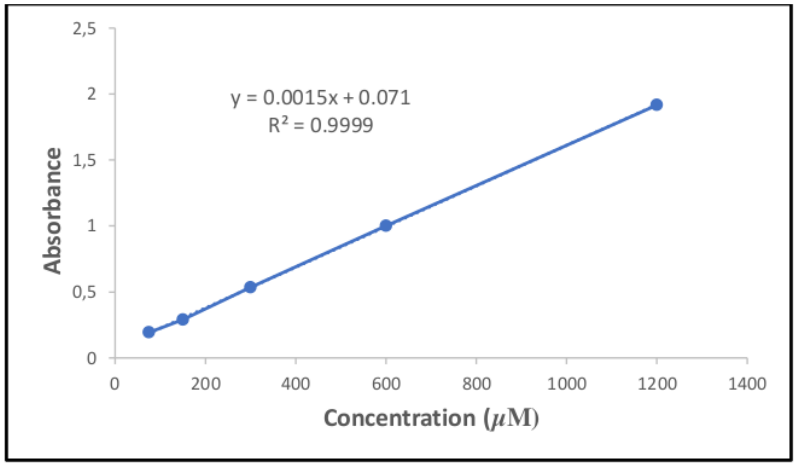


Figure 3: Calibration curve of AFS

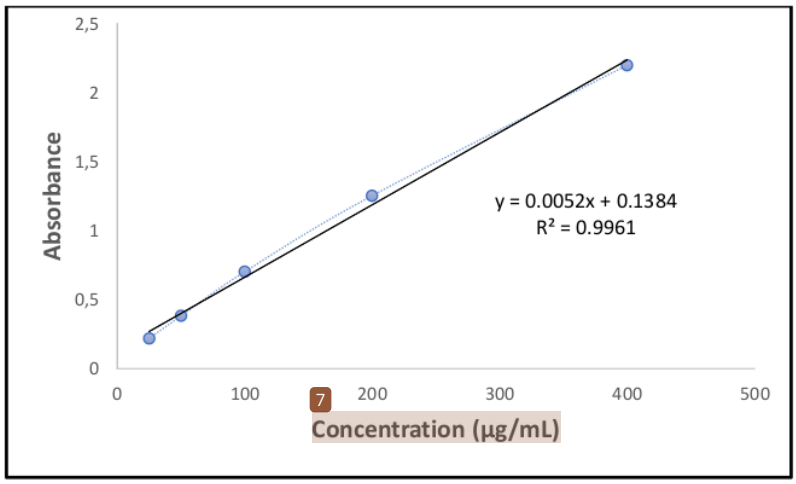


Figure 4: Calibration curve of gallic acid

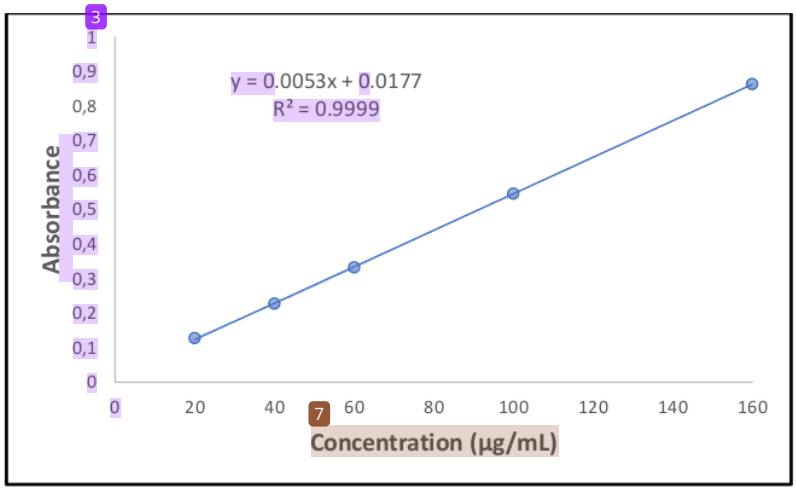


Figure 5: Calibration curve of quercetin

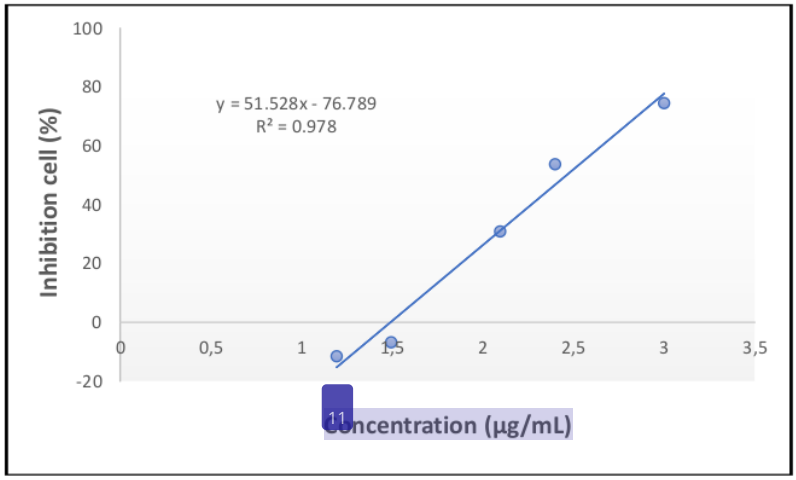


Figure 6. Curve of concentration of ethyl acetate extract and inhibition of RAW 264.7 cell proliferation

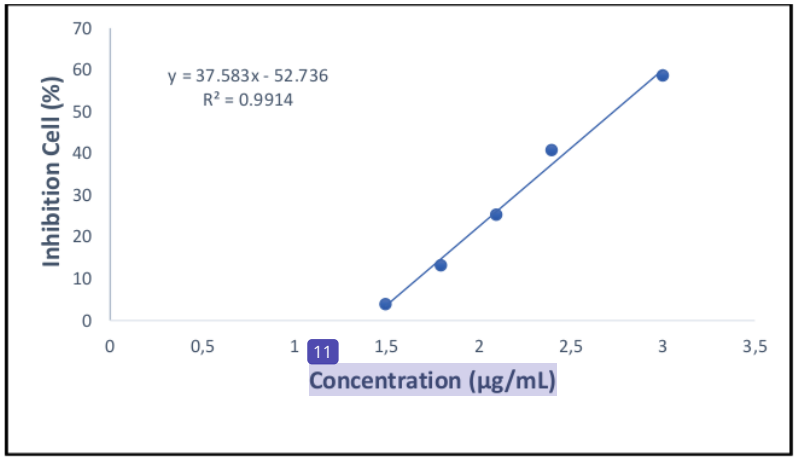


Figure 7. Curve of concentration of methanol extract and inhibition of RAW 264.7 cell proliferation

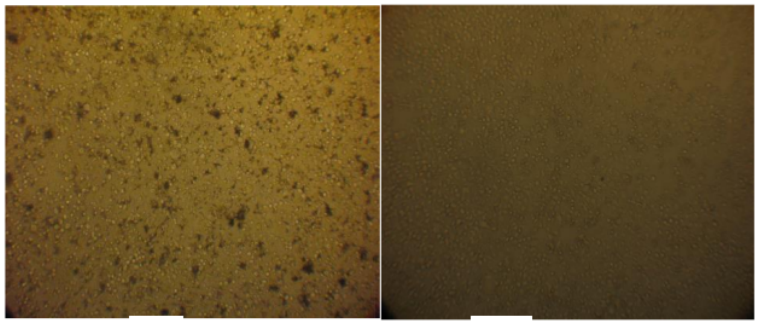


Figure 8. Appearance of raw cells after exposure to MTT.

Table 1. Phytochemical Screening of the Extracts

Phytochemical constituents	HE	EE	ME
Flavonoid	+	+	+
Polyphenol	+	+	+
Triterpenoids	+	-	-
Steroid	+	-	-

Note: Absent = -
Present = +

Table 2. Antioxidant Activity of *T. Macrophylla* Leaves by DPPH Method

Sample	Equation	R^2	IC_{50} (μg/mL)
n-Hexane Extract (HE)	Y= 0.1523x – 0.624	0.9799	**332.39**
Ethyl Acetate Extract (EE)	y = 0.3639x + 10.186	0.9907	109.409
Methanol Extract (ME)	y = 0.4189x + 15.825	0.9976	81.582
Quercetin	y = 5.7569x + 31.831	0.9929	3.15

Table 3. Antioxidant Activity of *T. Macrophylla* Leaves by FRAP Method

Sample	FeEAC (mol/gram)
n-Hexane Extract (HE)	457.12 ± 0.019
Ethyl Acetate Extract (EE)	3823.33 ± 0.085
Methanol Extract (ME)	11840 ± 0.117
Quercetin	28200 ± 0.014

Table 4. Total Phenolic Content (TPC) and Total Flavonoid Content (TFC) of *T. Macrophylla* Extracts

Sample	TPC (mg GAE/g Dry Weight) ± SD	TFC (mg QE/g Dry Weight) ± SD
Ethyl Acetate Extract (EE)	148.33 ± 17.474	104.98 ± 7.525
Methanol Extract (ME)	353.781 ± 5.796	279.2 ± 6.814

Table 5. IC_{50} Value Against RAW 264.7 cell

y = bx ± c					
Sample	**b**	**c**	**y**	**x/IC_{50}**	**IC_{50}**
Ethyl Acetate Extract (EE)	51.528	-76.789	50	2.460585	288.792 μg/mL
Methanol Extract (ME)	37.583	-52.736	50	2.733576	541.472 μg/mL

DISCUSSION

Phytochemical screening showed that all of the extracts – HE, EE and ME – of *Tetracera macrophylla* contained flavonoid and polyphenol. Flavonoids and polyphenol can donate hydrogen and act as antioxidants. The determination of phenolic content in n-hexane extract did not produce absorbance data that met the standard curve. This was due to the presence of only minor amounts of phenolic compounds in the n-hexane extract so that they were not detected on the microplate reader. The high phenolic content resulted from a more polar solvent, namely methanol.

The determination of total flavonoid levels resulted in the formation of a stable complex between aluminium chloride and a keto group at the C-4 atom and a hydroxy group at the C-3 or C-5 atom in flavonols and flavones.[14] The formation of the complex was accompanied by a shift in the wavelength towards the visible, which was marked by a yellow solution. Potassium acetate was added to ionise the 3 and 4´-OH groups that were not complexed with the Al^{3+} and 7-hydroxyl groups so that they could maintain wavelengths in the visible region.[15]

The antioxidant assay with DPPH was faster and simpler. The DPPH molecule was more stable due to the delocalisation of the spare electrons along the entire molecule so that this molecule did not undergo dimerisation. In this process, the antioxidant compounds donated one electron to DPPH to produce a reduction in DPPH free radicals. The antioxidant power was expressed in IC_{50}, which was the concentration of the test compound that captured 50% of free radicals.[16] The antioxidant assay with DPPH showed that the antioxidant activity in methanol extract had the highest results, with IC_{50} 81.582 μg/mL, while hexane extract showed no antioxidant activity (the highest level of antioxidant activity was $IC_{50} < 10\mu$g/mL, the lower antioxidant activity was $IC_{50} < 100 - 250\ \mu$g/mL, and no antioxidant activity was $IC_{50} > 250\ \mu$g/mL).[17] The principle of the FRAP method was electron transfer from antioxidant compounds to reduce the yellow Fe (III)-tripyrydyltriazine (TPTZ) complex to a blue Fe (II)-TPTZ complex. The more concentrated the blue colour produced, the more Fe2+ ions were formed, thus indicating a higher antioxidant potential.[18,19] Based on the table, methanol extract reduced ferrous ions more than hexane extract and ethyl acetate extract. This was presumably because the methanol extract of *Tetracera macrophylla* contained higher amounts of quercetin than the other two extracts. This was in line with the results of antioxidant activity under the DPPH method, where the methanol extract had an 11840 FeEAC mol/gram (FRAP method).

The MTT assay significantly helped to determine whether any compounds displayed cell toxicity or proliferative activity. Doses that produced a viability percentage of below 90% were categorised as toxic to cells. [20,21,22] The results of this study indicate that EE and ME have a lower ability to inhibit the proliferation of RAW 264.7 cells; therefore, ME and EE are not cytotoxic to RAW 264.7 cells. An HE toxicity test was not performed on RAW cells because it contained weak antioxidant compounds. The yellow tetrazolium salt (3-(4,5-dimethylthiazol-2-yl)-2,5-diphenyltetrazolium bromide) was converted by metabolically active cells into purple formazan crystals in the MTT experiment. In living cells, NADPH-dependent oxidoreductase enzymes can be employed to change MTT into formazan. The MTT assay is better suited to evaluate the preliminary anti-inflammatory and anti-cancer effects of test samples due to its efficiency and simplicity.

CONCLUSION

The concentrations of phenols, flavonoids, and antioxidants are impacted by variations in solvent polarity. Tetracera macrophylla's methanol extract had the highest yield, total phenolic content, total flavonoid content, and antioxidant activity. Methanol extract doesn't harm RAW 264.7 cells much.

REFERENCES

1. Indonesia KR, Hoogland RD. The genus Tetracera (Dilleniaceae) in the eastern old world. Published by Herbarium Bogoriense. 1953;2(2):185–224.
2. Mazlun MH, Sabran SF, Abdullah Z, Parumasivam T. A comparative study of antituberculosis activities of Tetracera macrophylla Wall. Ex Hook. f. &thoms. stem fractions using different chromatographic stationary phases. IOP Conf. Series: Earth and Environmental Science. 2021;736(012036):1–8. https://doi.org/https://doi.org/10.1088/1755-1315/736/1/012036.
3. Quattrocchi U. CRC world dictionary of medicinal and poisonous plants: common names, scientific names, eponyms, synonyms, and etymology. CRC Press; 2012.
4. Roheem FO, Ahmed QU, Mat So'ad SZ, Shah SAA, Latip J, Alhassan AM, Syed Mohammad SNA. Assessment of free radical scavenging and digestive enzyme inhibitory

activities of extract, fractions and isolated compounds from Tetracera macrophylla leaves. Journal of Herbal Medicine. 2020;22(August 2020):100351.

5. Lima CC, Lemos RPL, Conserva LM. Dilleniaceae family : an overview of its ethnomedicinal uses, biological and phytochemical profile. Journal of Pharmacognosy and Phytochemistry. 2014;3(2):181–204.
6. Harborne JB. Phytochemical Methods, 2nd ed. Bandung: ITB Press; 1987.
7. Bobo-García G, Davidov-Pardo G, Arroqui C, Vírseda P, Marin-Arroyo MR, Navarro M. Intra-laboratory validation of microplate methods for total phenolic content and antioxidant activity on polyphenolic extracts, and comparison with conventional spectrophotometric methods. Journal of the Science of Food and Agriculture. 2014;95(May):204–209. https://doi.org/10.1002/jsfa.6706.
8. Farasat M, Khavari-nejad R, Namjooyan SMBNF. Antioxidant activity, total phenolics and flavonoid contents of some edible green seaweeds from northern coasts of the Persian Gulf. Iranian Journal of Pharmaceutical Research. 2014;13(December):163–170.
9. Molyneux P. The use of the stable free radical Diphenylpicryl-hydrazyl (DPPH) for estimating antioxidant activity. Songklanakarin Journal of Science and Technology. 2004;26:211–219.
10. Wong C, Cheung W, Lau Y, Bolanos de la Torre AAS, Owusu-Apenten RK. A FRAP assay at pH 7 unveils extra antioxidant activity from green, black, white and rooibos tea but not apple tea. Food and Nutrition Report. 2015;1(1):1–8.
11. Prastiwi R, Elya B, Hanafi M, Desmiaty Y, Sauriasari R, Prastiwi R, Elya B, Sauriasari R. The antioxidant activity of Sterculia stipulata Korth woods and leaves by FRAP method. Pharmacognosy Journal. 2020;12(2):236–239. https://doi.org/10.5530/pj.2020.12.36.
12. Zheng L, Wang M, Peng Y, Li X. Physicochemical characterization of polysaccharides with macrophage immunomodulatory activities isolated from red ginseng (Panax ginseng C. A. Meyer). Journal of Chemistry. 2017:1–8. https://doi.org/https://doi.org/10.1155/2017/3276430.
13. Riss T, Moravec R, Niles A, Benink H, Worzella T. Cell viability assays. Assay guidance manual. 2016. In: Markossian S, Grossman A, Brimacombe K, et al., editors. Assay Guidance Manual [Internet]. Bethesda (MD): Eli Lilly & Company and the National Center for Advancing Translational Sciences; 2004-. Available from: https://www.ncbi.nlm.nih.gov/books/NBK144065/
14. Azizah, D. N., Kumolowati, E., & Faramayuda, F. (2014). Determination of Flavonoid Levels AlCl3 Method in Methanol Extract of Cocoa Fruit Peel (Theobroma cacao L.). Kartika Scientific Journal of Pharmacy, 2(2). https://doi.org/10.26874/kjif.v2i2.14.
15. Chang C-C, Yang M-H, Wen H-M, Chern J-C. Estimation of total flavonoid content in propolis by two complementary colometric methods. Journal of Food and Drug Analysis. 2002; 10(3). https://doi.org/10.38212/2224-6614.2748.
16. Alam MN, Bristi NJ, Rafiquzzaman M. Review on in vivo and in vitro methods evaluation of antioxidant activity. Saudi Pharmaceutical Journal. 2013;21(2):143–152. https://doi.org/10.1016/j.jsps.2012.05.002.
17. Phongpaichit S, Nikom S, Rungjindamai N, Sakayaroj J, Hutadilok-Towatana N, Rukachaisirikul V, Kirtikara K. Biological activities of extracts from endophytic fungi

isolated from garcinia plants. FEMS Immunol Med Microbiol. 2007;51:517–525. https://doi.org/10.1111/j.1574-695X.2007.00331.x.

18. Jatmika C, Manggadani BP, Hayun H. Evaluasi Aktivitas Antioksidan Senyawa 4-[(E)-2-(4-okso-3-fenilkuinazolin-2-il)etenil]-benzensulfonamida dan Analognya. Pharmaceutical Sciences and Research. 2015;2(3):143–151. https://doi.org/https://doi.org/10.7454/psr.v2i3.3482.

19. Xiao F, Xu T, Lu B, Liu R. Guidelines for antioxidant assays for food components. Food Frontiers. 2020;1(1):60–69. https://doi.org/10.1002/fft2.10.

20. Muniandy K, Gothai S, Badran KMH, Kumar SS, Esa NM, Arulselvan P. Suppression of proinflammatory cytokines and mediators in LPS-induced RAW 264.7 macrophages by stem extract of Alternanthera sessilis via the inhibition of the NF-kB pathway. Journal of Immunology Research. 2018;4:1–12.

21. Wu J, Liu K, Shi X. The anti-inflammatory activity of several flavonoids isolated from Murraya paniculata on murine macrophage cell line and gastric epithelial. Pharm Biol. 2016;54(5):868–81.

22. Soonthornsit N, Pitaksutheepong C, Hemstapat W, Utaisincharoen P, Pitaksutheepong T. In vitro anti-inflammatory activity of Morus Alba l. stem extract in LPS-stimulated RAW 264.7 cells. Evidence-Based Complement Altern Med. 2017:1–8.

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