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Review of Secondary Metabolites From Melandean Bark Extract (Bridellia Micrantha): Bioactive Potential and Applications in Health

Faizul Bayani[1], Depi Yuliana[2], Muhali[3], Hulyadi[3], Gargazi[4]

[1] Qamarul Huda Badaruddin University, Central Lombok, Indonesia, 83371
[2] Qamarul Huda Badaruddin University, Central Lombok, Indonesia, 83371
[3] Department of Chemistry Education, Faculty of Applied Science and Engineering, Mandalika University of Education, Jl. Pemuda No. 59A, Mataram, Indonesia
[4] Department of Infomation Tecnology Education, Faculty of Applied Science and Engineering, Mandalika University of Education, Jl. Pemuda No. 59A, Mataram, Indonesia
[*] Corresponding Author e-mail: muhali@undikma.ac.id

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Abstract

The emergence of various diseases affecting the immune system, such as COVID-19 and Hand, Foot, and Mouth Disease, demands serious attention. Current climate changes occurring in almost all parts of the world can lead to the emergence of various viruses and bacteria that cause multiple diseases. Exploring medicinal plants that can enhance the immune system is crucial to be continued. This study aims to identify secondary metabolite compounds contained in *Bridellia Micrantha* plants using chemical reagents and gas chromatography-mass spectrometry (GC-MS) instruments. This research is an experimental laboratory study. The variable studied is the content of secondary metabolite compounds. Data were collected using chemical reagents and instruments. The obtained data are described in informative tables and graphs. Based on the identification results using instruments, positive results were found for organic compound groups such as flavonoids, alkaloids, and tannins. GC-MS test results showed that the organic compounds contained in *Bridellia Micrantha* extract are 43.05% hexadecanoic acid, 21.46% oleic acid, 16% docos-13-enoic acid, 3.89% octadecanal, 1.85% propanediol, and 0.91% trans-phytol. Literature reviews indicate that the organic acids in Bridellia micrantha extract have clinical activities as antioxidants and anti-inflammatory agents, while organic compounds containing hydroxyl groups have clinical activities as anti-cancer agents. Based on these findings, Bridellia micrantha extract has the potential as a medicine that can enhance the body's immunity.

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INTRODUCTION

Secondary metabolism refers to the metabolic processes in organisms that use pre-existing organic energy sources as fuel. This contrasts with primary metabolism, where organisms use newly synthesized energy sources (Akula & Ravishankar, 2011; Guerriero et al., 2018). Organisms undergoing secondary metabolism utilize existing organic compounds, such as carbohydrates, fats, or proteins that have already been formed, rather than synthesizing them from scratch. Secondary metabolism generally occurs in heterotrophic organisms, which rely on other organisms for energy and fuel. Examples of organisms undergoing secondary metabolism include animals, fungi, and many bacteria. Secondary metabolism in plants is utilized to protect themselves from various environmental stresses (Ashraf et al., 2018; Guerriero et al., 2018; Li et al., 2020; Qaderi et al., 2023). The role of secondary metabolism in living organisms is to defend against pathogens, insects, or herbivores (Zaynab et al., 2018). Secondary metabolic compounds such as alkaloids, terpenoids, and phenolics can have antimicrobial, antifungal, or insecticidal properties that help organisms combat pathogen or pest attacks. Compounds like pheromones, phytohormones, and volatile compounds can play roles in communication between individuals, attracting pollinating insects, or even attracting natural predators to combat pests.

Organisms often produce secondary metabolites in response to environmental stress. Plants growing in harsh environments or experiencing high pest attacks may produce secondary metabolites as an adaptive mechanism for survival (Akula & Ravishankar, 2011; Ashraf et al., 2018). Environmental stress factors can alter plant metabolism, leading to the inhibition or promotion of secondary metabolites (Ashraf et al., 2018; Pant et al., 2021; Qaderi et al., 2023). While the critical role of these compounds in plant acclimatization and defense is well known, their response to climate change is still not well understood. As the impacts of climate change increase, understanding the regulation of secondary metabolism in plants becomes increasingly important. The effects of individual climate change components, including high temperatures, elevated carbon dioxide, drought stress, increased ultraviolet-B radiation, and their interactions on secondary metabolites such as phenolics, terpenes, and alkaloids, continue to be researched as evidence accumulates. It is crucial to understand the aspects of secondary metabolites that shape the future success of specific plants (Khare et al., 2020). The potential of plants containing high secondary metabolites should be continually explored, given the many diseases that attack the body's immunity. COVID-19 and hand, foot, and mouth disease highlight the massive impact of these diseases. Optimal immunity is one of the defenses against disease attacks.

Many secondary metabolite compounds have been used in the development of modern medicine. Compounds such as alkaloids, flavonoids, and terpenoids have been shown to have beneficial pharmacological activities, such as antibacterial, anticancer, or anti-inflammatory agents (Cardarelli et al., 2017; Kumar et al., 2021; Leicach & Chludil, 2014; Michalak, 2022; Poiroux-Gonord et al., 2010). Antioxidants are substances that can inhibit or neutralize the damaging effects of reactive oxygen species (ROS) or free radicals in the body. ROS are highly reactive molecules that can cause oxidative stress, leading to cell damage and contributing to the development of various diseases (Mattosinhos et al., 2022). Antioxidants work by donating electrons or hydrogen atoms to stabilize and neutralize free radicals, preventing them from causing damage to cells, proteins, DNA, and other cellular components (Asumang et al., 2021; Shahidi & Zhong, 2015). They help maintain the balance between oxidative stress and the body's antioxidant defense mechanisms (Balasaheb Nimse & Pal, 2015; Gulcin, 2020).

Today, there is significant interest in antioxidants, especially in preventing the known adverse effects of free radicals in human metabolism and their damage during the processing and storage of fatty foods (Shahidi & Zhong, 2015). In both cases, natural-source antioxidants are preferred over synthetic ones. Antioxidants can be categorized into two types: endogenous antioxidants, which are produced naturally within the body, and exogenous antioxidants, which are obtained from external sources such as food and supplements (Korczowska-Łącka et al., 2023; Supruniuk et al., 2023). Antioxidants are found in almost all parts of plants but have varying concentrations in different parts. Vitamin C, obtained from fruits and vegetables, is a powerful antioxidant that helps protect against oxidative damage and supports the immune system (Gaafar et al., 2020; Gęgotek & Skrzydlewska, 2022). Besides fruits, antioxidants are also found in seeds, such as vitamin E in nuts, seeds, and vegetable oils, which is a fat-soluble antioxidant protecting cell membranes from oxidative stress. In addition to organic compounds, antioxidants are also found in organic minerals. One such mineral functioning as an antioxidant in the body is selenium. Selenium is a component of antioxidant enzymes that help protect cells from oxidative damage. This mineral is found in nuts, seafood, and grains.

It is important to note that while antioxidants have been studied for their potential health benefits, their effects on the body can be complex and vary depending on factors such as dosage, interactions with other compounds, and individual variability. It is generally recommended to obtain antioxidants from a balanced diet rich in fruits, vegetables, whole grains, and other nutrient-dense foods rather than relying solely on supplements. To harness the potential of secondary metabolites, research continues to identify, understand, and develop new applications of these compounds in health, industry, and the environment (Kumar et al., 2021; Michalak, 2022; Sen & Chakraborty, 2011). Several groups of secondary metabolite compounds have been extensively extracted as natural antioxidants, such as alkaloids, terpenoids, and flavonoids. Well-known examples of alkaloids include morphine, codeine, and quinine. Morphine and codeine are used as analgesics (pain relievers) and antitussives (cough suppressants), while quinine is used for the treatment of malaria. Terpenoid compounds such as artemisinin, found in the plant Artemisia annua, are used as antimalarial agents. Additionally, paclitaxel, found in the bark of the Taxus tree, is used as a chemotherapy agent for cancer treatment. Examples of flavonoids used in the pharmaceutical industry include quercetin and kaempferol. Both have antioxidant and anti-inflammatory activities and have been investigated for their potential in treating various conditions, including cardiovascular diseases, cancer, and diabetes (Huang et al., 2022; Kandar, 2022; Mandal et al., 2021; Milugo et al., 2013; Mondal & Syed, 2020).

Given the importance of secondary metabolite compounds in enhancing the body's resistance to free radicals and pathogens, exploring these compounds is crucial since each plant contains different compositions of secondary metabolites depending on factors such as climate, soil, temperature, and organisms that may affect their growth. Differences in external and internal conditions cause the concentration and composition of secondary metabolites to vary among plants (Qaderi et al., 2023; Srivastava et al., 2021; Yang et al., 2018). Climate change encompasses rapid and instantaneous changes in various important environmental parameters that regulate ecosystem dynamics. These rapid changes can cause direct and secondary physiological effects on plants, including changes in plant secondary metabolism. Plant secondary metabolites generally refer to compounds essential for plant interaction with their environment and are also used for therapeutic purposes. These compounds play a crucial role in defense mechanisms, acting as important signaling molecules under various environmental stresses and thus playing a significant role in plant adaptation to extreme environments. Various environmental factors such as temperature, light, ultraviolet-B radiation, tropospheric O3, salinity, and soil water content can affect the biosynthesis and accumulation of secondary metabolites in plants. This chapter will summarize the effects of various environmental factors on secondary metabolism and pave the way for obtaining important bioactive compounds from plants (Li et al., 2020; Olivoto et al., 2017; Wang et al., 2016; Yang et al., 2018). Based on the above review, exploring the contents of each plant species is important to add to public literacy about the benefits of various medicinal plants. One plant in Indonesia that has rarely been explored for its secondary metabolite compounds is melandean (Bridelia micrantha).

Bridelia micrantha (commonly known as Coastal Golden Leaf) is a species of flowering plant in the Phyllanthaceae family. The plant is native to various regions in Africa, including East, West, and South Africa. It is known for its diverse medicinal properties and use in traditional medicine (Adika et al., 2012; Bayani et al., 2023; Kevin et al., 2023). Bridelia micrantha has a rich history of use in African traditional medicine. Various parts of the plant, including the bark, leaves, roots, and fruit, are used to treat various ailments. Extracts from the bark and leaves have been used to treat bacterial and fungal infections. The plant is used to reduce inflammation and treat conditions such as arthritis and rheumatism. It is also used to treat diarrhea, dysentery, and other digestive disorders. In some areas, the plant is used as a traditional remedy for malaria (Adika et al., 2012; Asumang et al., 2021; Bayani et al., 2023; Omeh et al., 2014).

Bridelia micrantha is known to produce various secondary metabolites, which are compounds that play a vital role in the plant's defense mechanisms and its interactions with the environment (Mborbe et al., 2023; Mburu et al., 2016; Okeleye et al., 2011). Some of these compounds have been identified as having significant pharmacological activities such as flavonoids, tannins, and alkaloids. Herbal flavonoids act as free radical scavengers due to the presence of hydroxyl groups that prevent oxidative damage (Irfan et al., 2021; Kandar, 2022; Shen et al., 2022; Wang et al., 2016). There are six main groups of flavonoids: flavonol, flavan-3-ol, flavone, isoflavone, flavanone, and anthocyanidin. Commonly used herbal flavonoids include chamomile, dandelion, ginkgo, green tea, hawthorn, licorice, passionflower, milk thistle, onion, rosemary, sage, thyme, and yarrow. Herbal flavonoids have broad biological properties that promote human health and help prevent the risk of various diseases, including cancer, cardiovascular disorders, CNS disorders, diabetes, inflammation, and boosting the human immune system. The main objective of this chapter is to highlight the description of herbal medicines, sources of herbal flavonoids, classification of herbal flavonoids, their chemical structures, and their applications in healthcare systems (Kandar, 2022; Mondal & Syed, 2020). Abiotic stresses such as drought, salinity, extreme temperatures, and heavy metals can significantly affect plants, triggering various physiological and biochemical responses, including changes in the production of secondary metabolites. Different environmental stresses can lead to different compositions of secondary metabolites in plants. Bridelia micrantha, originating from Africa, would certainly have a different composition of secondary metabolites if it grows and develops in Lombok due to the different environmental conditions. Therefore, exploring the secondary metabolites of Bridelia micrantha in Lombok is essential to enhance medicinal plant literacy and identify the environmental stresses in Lombok affecting its secondary metabolite composition.

METHOD

The research employed in this study is descriptive quantitative, where each observation involves recording the necessary objects using qualitative methods, such as color testing with reagents, and quantitative methods, using GC-MS (Gas Chromatography-Mass Spectroscopy). The research was conducted at the Advanced Biology Laboratory and the Analytical Chemistry Laboratory of the Faculty of Mathematics and Natural Sciences, University of Mataram. This study utilized a single variable, analyzing the active compounds such as alkaloids, flavonoids, terpenoids/steroids, tannins, saponins, phenols, glycosides/quinones using chemical reagents. The sample in this study is the bark of Melandean (Bridelia Micrantha). The samples were directly collected from rice fields near residential areas in Rakam Village, Selong District, East Lombok Regency. The tools used in this study included a blender, Erlenmeyer flask, stirring rod, a set of Pyrex beakers, analytical balance (Kern), rotary evaporator (NESCO), water bath (Memmert), GC-MS Shimadzu (Gas Chromatography-Mass Spectroscopy). The materials used in this study were Melandean bark extract, methanol, Mayer's reagent, sulfuric acid, FeCl3, NaOH, acetic acid, chloroform, Molisch's reagent. The determination of Melandean (Bridelia Micrantha) bark was conducted by bringing the fresh or undried bark to be identified and verified as the correct plant material. This determination was carried out in the Advanced Biology Laboratory of the University of Mataram. To explore the composition of secondary metabolites in Melandean (Bridelia Micrantha), several scientific activities were conducted as follows:

A. Sample Preparation

1. Melandean (Bridelia Micrantha) bark was collected independently.
2. It was cleaned of any adhering dirt.
3. It was then washed with running water, drained, sorted, and weighed for wet weight, totaling 1.5 kg.
4. The bark was dried by air-drying in an open room protected from direct sunlight, covered with a thin cloth.
5. The bark was considered dry when it became brittle upon breaking.
6. The dry weight was then measured, totaling 1.1 kg.
7. The bark was ground into powder using a blender.
8. The finely ground bark was stored in a tightly sealed container, protected from sunlight.

B. Preparation of Melandean (Bridelia Micrantha) Bark Extract

a. 200 grams of Melandean (Bridelia Micrantha) bark powder was weighed and placed in a glass jar.
b. 1 liter of 80% methanol solvent was added and stirred constantly for 10 minutes, then the glass jar was covered with aluminum foil and wrapped in plastic wrap.
c. After 4 x 24 hours, the jar was opened and stirred constantly with a stirring rod for 15 minutes. After stirring, it was filtered using cheesecloth and an Erlenmeyer flask.
d. The filtrate was transferred to a different Erlenmeyer flask, sealed tightly with aluminum foil, and wrapped in plastic wrap. The Erlenmeyer flask was then stored in a place protected from sunlight.
e. After macerating for 4 x 24 hours, the entire filtrate was combined, and the total volume was measured.
f. The filtrate was concentrated using a rotary evaporator at 40°C to evaporate the solvent, resulting in a remaining filtrate volume of about 100-200 ml for easier removal from the evaporator flask.
g. The remaining filtrate was then further concentrated using a water bath at 54°C until a thick and dense extract was obtained (Adrianta, 2020).

C. Phytochemical Screening

Phytochemical screening is the process of identifying and analyzing the chemical compounds (phytochemicals) present in plants. This process is crucial for determining the medicinal potential of the plant. Phytochemicals, such as alkaloids, flavonoids, phenolics, tannins, saponins, steroids, glycosides, and terpenoids, have various biological activities that can be beneficial for treating different diseases. Phytochemical screening was conducted to identify the composition of secondary metabolites contained in the organic sample. This is a qualitative analysis of secondary metabolite compounds.

1. **Alkaloid Test**
   - ✓ 0.5 grams of the extract was added to a beaker with 2 ml of chloroform. Then, 7 ml of 10% ammonia, 1 ml of 2N hydrochloric acid, and 9 ml of distilled water were added. The mixture was heated in a water bath for 2 minutes, cooled, and filtered using filter paper. The obtained filtrate was tested for alkaloids. Three test tubes were taken, and 0.5 ml of the filtrate was added to each tube.
   - ✓ 2 drops of Mayer's reagent were added to one tube, producing a red precipitate.
   - ✓ 2 drops of Wagner's reagent were added to the second tube, producing a black-brown precipitate.
   - ✓ 2 drops of Dragendorff's reagent were added to the third tube, producing a brick-red precipitate. Alkaloids were considered present if precipitation or turbidity occurred in at least two out of the three tests (Banu & Dr. L. Cathrine, 2015; Egbuna et al., 2018).
2. **Flavonoid Test**
   - ✓ 1 ml of the sample was added to three test tubes, followed by magnesium powder and 1 ml of HCl.
   - ✓ Tube 1 was used as a control.
   - ✓ 1 ml of 10% lead acetate solution was added to tube 2.
   - ✓ A few drops of 20% NaOH were added to tube 3. The presence of a yellow precipitate indicated the presence of flavonoids (Agie Novilda et al., 2022; Nortjie et al., 2022)
3. **Saponin Test**
   1 ml of methanol extract of Melandean bark was added to hydrochloric acid and shaken vigorously until foam appeared. Stable foam for 10 minutes indicated the presence of saponins (Agie Novilda et al., 2022).
4. **Tannin Test**
   1 ml of methanol extract of Melandean bark was added to 1 ml of 10% FeCl3. The appearance of a dark blue or blackish-green color indicated the presence of tannins (Agie Novilda et al., 2022).
5. **Steroid/Terpenoid Test**
   1 gram of the extract was added to 2 ml of chloroform and shaken. The filtrate was then added to acetic anhydride and concentrated sulfuric acid, each 2 drops. A blue or green color indicated steroids, while a red or purple color indicated terpenoids (Farah et al., 2019).
6. **Phenol Test**
   1 gram of the extract was added to 10 ml of hot water. A few drops of FeCl3 were then added. The presence of phenols in the sample was indicated by a dark green color (Apt. Belinda Arbitya Dewi et al., 2022).

7. **Glycoside/Quinone Test**
   1 gram of the extract was added to Molisch's reagent and then sulfuric acid. The presence of glycosides in the sample was indicated by the formation of a purple ring (Pandey & Tripathi, 2014; Safriana et al., 2021; Shaikh & Patil, 2020; Sivanandham, 2015).

D. Identification of Organic Compounds in Bridelia Micrantha Using GC-MS

The selection of the GC-MS instrument is based on the physicochemical properties of secondary metabolites that are volatile. GC-MS is known for its high sensitivity in detecting each component in an analyte (Egbuna et al., 2018; Nortjie et al., 2022; Pandey & Tripathi, 2014). The choice of quantitative analysis method depends on factors such as the nature of the phytochemicals, available instruments, and the desired level of accuracy and sensitivity. Often, a combination of these techniques is used to provide a comprehensive analysis of the phytochemical composition of plant samples. In this study, the GC-MS instrument was used to identify the composition of secondary metabolite compounds contained in Melandean (Bridelia Micrantha) bark. The selection of this instrument is based on the volatility of several groups of secondary metabolite compounds and its high sensitivity in reading organic compound structures. The following outlines the process of identifying Melandean extract using GC-MS.

- The sample was dissolved with a solvent.
- 1 ml of the sample was injected into the GC instrument's inlet, which transports the sample with the mobile phase or carrier gas to the column.
- The mobile phase used was helium gas, while the stationary phase was an Rtx-5M5 column (5% diphenyl, 95% dimethyl polysiloxane).
- In the column, the compounds were separated due to the difference in interaction with the mobile and stationary phases.
- The sample carried by the mobile phase interacted with the stationary phase at different speeds.
- Compounds with the highest speed exited first, while those with the lowest speed exited last.
- The separated compounds were then carried to the detector.
- The detector provided signals displayed on the software or computer as a chromatogram.
- In the final mass spectrometry, the compounds underwent ionization
- The results were observed through a spectrum interpreted based on molecular weight and retention time (Rt) from the Melandean bark extract (Bridelia Micrantha), showing the types and quantities of compounds in each peak (Agie Novilda et al., 2022).

E. Data Analysis and Presentation

The methanol extract of Melandean (Bridelia Micrantha) bark underwent qualitative phytochemical screening to determine the chemical content of the plant. The data obtained from the chemical tests of secondary metabolite compounds in the 80% methanol extract of Melandean (Bridelia Micrantha) bark were presented in tables and analyzed descriptively based on the observed color changes. The GC-MS (Gas Chromatography-Mass Spectroscopy) results were presented in the form of GC and MS chromatograms and discussed descriptively based on retention time, area percentage, molecular structure, and molecular weight.

RESULTS AND DISCUSSION

Phytochemical screening is a multi-step process aimed at evaluating and identifying bioactive compounds in plants. This process is crucial in the discovery of new drug agents and the development of health products from natural sources. The main steps involved in phytochemical screening in this study include. This step involves collecting plant materials, which can include various parts such as leaves, stems, roots, flowers, or seeds (Mborbe et al., 2023; Mburu et al., 2016). The collected samples are then processed to prepare the extract. This typically involves drying and grinding the plant material, followed by extraction using an appropriate solvent such as water, ethanol, methanol, or chloroform. The choice of solvent can influence the type of compounds extracted (Yara-Varon et al., 2016). In this study, pro-analysis methanol 80% was used. Methanol was chosen due to its high ability to dissolve and penetrate plant cells (Asumang et al., 2021; Hashim et al., 2016; Omeh et al., 2014). Its small molecular size allows methanol to extract down to the cytoplasm of the cells. The ability of methanol to dissolve both polar and non-polar organic compounds is another reason for its selection as the solvent in the extraction process of Bridelia micrantha (Asumang et al., 2021; Hashim et al., 2016; Omeh et al., 2014).

Methanol is a polar solvent, meaning it can dissolve polar compounds such as alkaloids, flavonoids, and saponins. Its polarity also allows methanol to dissolve compounds with hydrogen bonds (Herschlag & Pinney, 2018; Pimentel & McClellan, 1971). Despite being polar, methanol also has the capability to dissolve non-polar compounds to a reasonably good extent. This makes it a flexible solvent for extracting various types of bioactive compounds (Milugo et al., 2013; Yara-Varon et al., 2016). The small molecular size of methanol enables it to easily penetrate the plant cell walls and membranes, reaching the cytoplasm where many bioactive compounds are located. This enhances the extraction efficiency as methanol can reach and dissolve compounds located inside the cells (Zhang et al., 2020). With its ability to penetrate cells, methanol can extract bioactive compounds more effectively than other solvents with larger molecules.

The extract was then subjected to various qualitative tests to detect the presence of different classes of phytochemicals, such as alkaloids, flavonoids, saponins, tannins, and terpenoids. These tests involve simple chemical reactions that result in color changes or precipitates indicating the presence of specific compounds. The results of the phytochemical screening of the Bridelia micrantha extract are presented in Table 1. Table 1 should be included here in the final document with the results of the phytochemical screening.

Table 1. Results of Qualitative Phytochemical Compound Tests

No	Type of Test Compound	Reagent	Results
1	Flavonoids	Dilute NaOH	+
			+
			+
			+
2	Alkaloids	CH3COOH	+
			+
			+
3	Saponin	Mg Powder	-
4	Tannin	H_2SO4	+
5	Terpenoids	Dragendroff	+
6	Polyphenols/Hydroquinones	Mayer	+
7	Steroids	Wagner	+

Phytochemical screening of Bridelia micrantha revealed positive results for several types of bioactive compounds, including flavonoids and alkaloids. Flavonoids are polyphenolic compounds known for their various health benefits, including antioxidant, anti-inflammatory, and cardioprotective activities (Mondal & Syed, 2020; Shen et al., 2022). All tests indicated positive (+) results, suggesting a strong presence of flavonoids in Bridelia micrantha samples. Flavonoids in Bridelia micrantha can neutralize free radicals and prevent cell damage (Irfan et al., 2021; Mattosinhos et al., 2022). This process reduces inflammation by inhibiting enzymes involved in inflammatory processes (Mondal & Syed, 2020). Additionally, some flavonoids are known to inhibit cancer cell proliferation and induce apoptosis.

Alkaloids are organic nitrogen compounds that often exhibit significant physiological activities, including analgesic, antimalarial, and anticancer properties. All tests showed positive (+) results, indicating the presence of alkaloids in Bridelia micrantha samples. Alkaloids are frequently used in pain management, with some being effective against malaria parasites. Certain alkaloids can induce cancer cell death and inhibit metastasis (Milugo et al., 2013). The phytochemical tests demonstrated that Bridelia micrantha is rich in various bioactive compounds, particularly flavonoids and alkaloids (Huang et al., 2022). The presence of these compounds suggests a significant potential for developing Bridelia micrantha as a source of natural ingredients for medicines and health supplements. Further research is needed to isolate and identify specific compounds and to test their biological activities in experimental and clinical models. For example, alkaloids like morphine bind to opioid receptors in the brain and spinal cord, reducing pain perception and providing analgesic effects. Antimalarial alkaloids inhibit the replication of malaria parasites in the human body. Anticancer alkaloids inhibit cell division and tumor growth by interfering with microtubules necessary for mitosis.

In addition to these uses, alkaloids can treat bacterial and fungal infections and prevent infections in wounds. Reserpine, an alkaloid, lowers blood pressure by reducing the activity of neurotransmitters like norepinephrine. Some alkaloids can lower blood sugar levels by enhancing insulin secretion or increasing insulin sensitivity. The results of the phytochemical tests were further clarified using gas chromatography-mass spectrometry (GC-MS). The GC-MS results are presented in Figure 1.

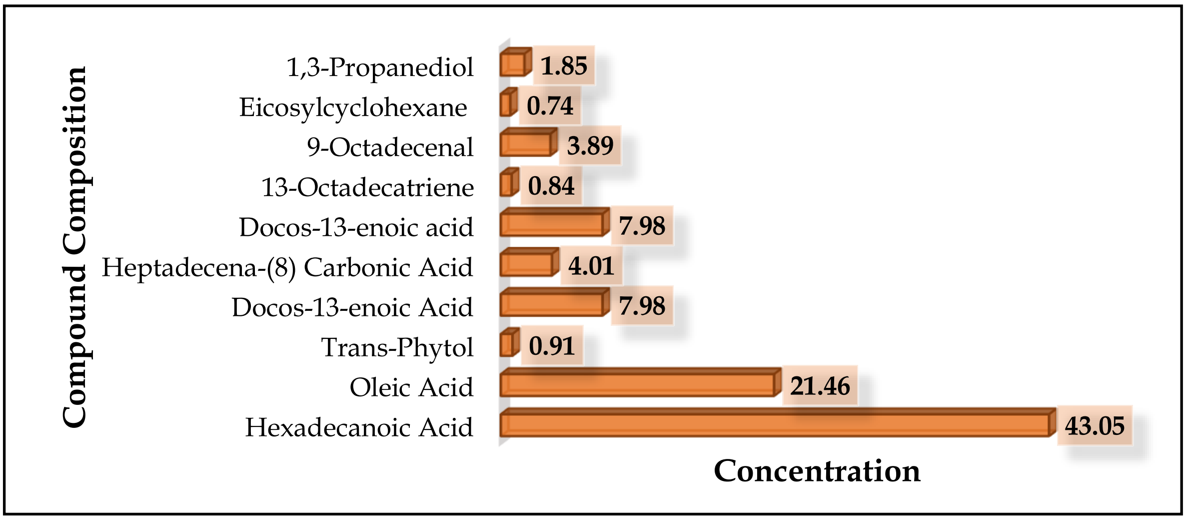

Figure 1. Results Fitochemical Bridellia Micrantha Use GC-MS Instrumen

(Egbuna et al., 2018; Sivanandham, 2015) describe phytochemical screening as a comprehensive and systematic approach to identify and evaluate bioactive compounds in plants. This process involves multiple steps from sample collection to advanced analytical techniques like GC-MS for confirmation. Figure 1 depicts the composition of organic compounds present in Bridelia Micrantha. Clinical studies of the organic compounds in Bridelia Micrantha are crucial for evaluation due to its use as a traditional medicine by Lombok healers. Essential tests are conducted as empirical evidence that can be scientifically accountable. Several clinical studies of the organic compounds in Bridelia Micrantha can be explained as follows.

Bredillia micrantha is known to possess various pharmacological capabilities, including antioxidant, anticancer, and anti-inflammatory properties (Kevin et al., 2023; Mburu et al., 2016; Okeleye et al., 2011). 1,3-Propanediol, a compound frequently used in industry as a solvent and raw material for polymer production, also has potential as a natural preservative and safe emulsifier in pharmacology. Another organic compound detected in Bridelia micrantha extract is eicosylcyclohexane. Eicosylcyclohexane is a long-chain hydrocarbon known for its antioxidant properties, although specific pharmacological research on eicosylcyclohexane may be limited. Long-chain aldehydes are known to possess antibacterial and antifungal activities, contributing to Bridelia micrantha's ability to inhibit the growth of pathogenic microorganisms.

(Pravst, 2014; Sales-Campos et al., 2013) state that Oleic acid is a monounsaturated fatty acid commonly found in olive oil, known for its beneficial effects on cardiovascular health. Its presence in plant extracts suggests potential health benefits related to lipid metabolism (Yin, 2023). Oleic acid (OA) has anti-inflammatory effects and has been shown to have anticancer potential, especially in inhibiting cancer cell proliferation (Carrillo Pérez et al., 2012; Gęgotek & Skrzydlewska, 2022; Mattosinhos et al., 2022; Santa-María et al., 2023). (Santa-María et al., 2023) state that OA is an effective biomolecule, although the mechanisms by which OA mediates beneficial physiological effects are not fully understood. OA affects cell membrane fluidity, receptors, intracellular signaling pathways, and gene expression. OA can directly regulate both the synthesis and activity of antioxidant enzymes. (Santamarina et al., 2021) suggest that its anti-inflammatory effects may be related to the inhibition of pro-inflammatory cytokines and activation of anti-inflammatory cytokines. The most well-known mechanism highlights OA as a natural activator of sirtuin 1 (SIRT1). (Tutunchi et al., 2020) report that oleoylethanolamide (OEA), derived from OA, is an endogenous ligand of the peroxisome proliferator-activated receptor alpha (PPARα). OEA regulates food fat intake and energy homeostasis and is therefore proposed as a potential therapeutic agent for treating obesity. OEA has anti-inflammatory and antioxidant effects. The beneficial effects of olive oil may be related to OEA action. New evidence suggests that oleic acid may affect epigenetic mechanisms, opening new avenues in exploring therapies based on these mechanisms. OA may provide beneficial anti-inflammatory effects by regulating microRNA expression (Charlet et al., 2022). In addition to containing oleic acid, the most abundant organic acid in Bridelia Micrantha is hexadecanoic acid.

(Ganesan et al., 2022) state that Hexadecanoic acid, also known as palmitic acid, is a saturated fatty acid commonly found in plants and animals. It is known for its antimicrobial and antioxidant properties, making it an essential component in health products. Antibiotic resistance is considered one of the biggest threats to human health worldwide, and excessive antibiotic use accelerates this problem. Bacteria resistant to multiple drugs (MDR) are increasingly difficult to treat because the antibiotics used become less effective. Therefore, new methods need to be evaluated to control MDR bacteria. Clove alcohol extract (CAE) showed the highest inhibition activity against MDR bacteria. Gas chromatography-mass spectrometry analysis of CAE, partially purified at 0.9 Rf detected by thin-layer chromatography, showed the active compound called methyl hexadenoic acid ester with the highest antimicrobial effect against clinical pathogenic bacteria (Bharath et al., 2021; Ganesan et al., 2022).

Trans-phytol is a cyclic terpene alcohol, serving as a precursor for the synthesis of vitamins E and K1. It exhibits antioxidant and antimicrobial properties, showing potential for use in pharmaceutical formulations. Trans-phytol finds several applications in the health sector, particularly due to its role in the biosynthesis of essential vitamins and its therapeutic potential. Phytol serves as a precursor in the synthesis of vitamin E, an antioxidant that protects cells from damage caused by free radicals. It is also a component of vitamin K1, crucial for blood clotting and bone health. Phytol has been studied for its antimicrobial properties, demonstrating effectiveness against certain bacteria and fungi. As an antioxidant, phytol helps reduce oxidative stress, associated with various chronic diseases including cardiovascular diseases and cancer. Research indicates that phytol may have anti-inflammatory effects, which could be beneficial in treating conditions such as arthritis. Some studies suggest that phytol may have neuroprotective effects, making it a candidate for research in neurodegenerative diseases such as Alzheimer's.

CONCLUSION

The conclusion describes the answer to the hypothesis and/or the purpose of the study or scientific findings obtained. The conclusion does not contain a repetition of the results and discussion, but rather a summary of the findings as expected in the objectives or hypotheses.

RECOMMENDATIONS

Other solvents are needed to extract the bark of Bridellia micrantha to explore other bioactive compounds contained within it. Instruments such as IR and NMR should also be used to confirm the bioactive compounds that have clinical activities in the healthcare field.

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