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(RESEARCH ARTICLE)

Phytochemical Profile and Bioactivity of Memaye (*Leea indica* (Burm.f.) Merr) Leaves: A Medicinal Plant of the Besemah Tribe in Lahat, South Sumatra, Indonesia

Nina Tanzerina [1], Silvina Puji Ardiyanti [2], Juswardi [1,*], Harmida [1] and Salni [1]

[1] *Department of Biology, Faculty of Mathematics and Natural Sciences, University of Sriwijaya, South Sumatra, Indonesia.*
[2] *Program Study of Biology, Fac. of Mathematics and Natural Sciences, University of Sriwijaya, South Sumatra, Indonesia.*

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Abstract

The Memaye plant or Bandicoot berry (*Leea indica* (Burm.f.) Merr) is traditionally used by the Besemah tribe in Lahat, South Sumatra, Indonesia, to treat various ailments. The leaves of Memaye are rich in metabolites that have potential applications in treating infections and degenerative diseases. This study aims to determine the phytochemical profile and assess the bioactivity of the ethanol extract of Memaye leaves. Phytochemical profiling was performed using Gas Chromatography-Mass Spectrometry (GC-MS), while the exploration of bioactivity and biosynthesis pathways was based on various online resources. The phytochemical profile identified several dominant compounds, including *Formamide, N,N-dimethyl*; *Mesitylene*; *Benzenedicarboxylic acid, bis(2-ethylhexyl) ester*; *Supraene* or *Squalene*; *16-Heptadecenal*; *Imidazole-2-hydrazide-1-carboxylic acid, methyl ester*; *Phenethylamine, 3,4,5-trimethoxy-.α.-methyl*; and *Acetic acid, [(aminocarbonyl)amino] oxo*. These compounds exhibit potential antimicrobial, antibacterial, anti-inflammatory, anticancer, and antioxidant properties. Further investigation highlighted certain compounds with anti-infective activity, such as *Acetic acid* and *Mesitylene*, as well as compounds with anti-degenerative properties, including *Supraene*. The compounds noted for their anti-infective and anti-degenerative activities include *Formamide, N,N-dimethyl*; *16-Heptadecenal*; *Phenethylamine, 3,4,5-trimethoxy-.α-methyl*; *Imidazole-2-hydrazide-1-carboxylic acid*; and *1,2-Benzenedicarboxylic acid, bis(2-ethylhexyl) ester*. The phytochemical analysis reveals the significant potential of Memaye leaves as a source of bioactive compounds that could be developed into therapies for anti-infective and anti-degenerative treatments.

Keywords: Anti-infective; anti-degenerative; bioactivity; *Leea indica* (Burm.f.) Merr; GC-MS; Besemah tribe

1 Introduction

The Besemah people have long used various local medicinal plants in traditional medicine. This knowledge has been passed down through generations, utilizing various available plant species to treat illnesses. Research [1] found that 94 plant species from 47 families can be used to treat 29 infectious diseases. One of the plants used medicinally is Memaye or Bandicoot berry (*Leea indica* (Burm.f.) Merr).

The Besemah people utilize the roots of Memaye to treat infectious diseases such as hepatitis and degenerative diseases [2]. In several regions, the leaves have been used medicinally, including in India for diarrheoa and dysentery [3], in Malaysia for diabetes [4], and in Bangladesh for joint pain [5].

The phytochemicals of Memaye leaves include alkaloids, glycosides, terpenoids, flavonoids, and steroids. The flavonoid content in Memaye leaves plays a role in treating infections caused by viruses and bacteria [6]. Tests of the Memaye leaf extract on mice infected with bacteria showed an anti-inflammatory effect, indicated by a decrease in leukocyte counts [7]. Furthermore, Memaye leaves contain *methyl gallate*, a compound with antidegenerative properties due to its antioxidant activity, which can protect cells from free radical damage [8].

* Corresponding author: Juswardi

Several studies on the phytochemicals of Memaye leaves include metabolite analysis using HPLC, which identified 31 compounds, including *gallic acid* and *methyl gallate* [9]. Research using the GC-MS method identified 19 compounds [10]. Based on the potential of Memaye leaves used by the Basemah tribe as a lower-risk alternative treatment, a phytochemical profile approach and exploration of the specific bioactivity of the ethanol extract of Memaye leaves as an anti-infective and anti-degenerative agent were conducted.

2 Materials and Methods

2.1 Sampling ofthe plant

Memaye (*Leea indica* (Burm.f.) Merr) samples were collected in Sukaraja Hamlet, Sukamerindu District, Lahat Regency, South Sumatra Province, Indonesia, at coordinates 2°58'19"S 104°45'21"E.

2.2 Location research

The research was conducted in the Physiology and Development Laboratory, Genetics and Biotechnology Laboratory, Department of Biology, Faculty of Mathematics and Natural Sciences, Sriwijaya University, and in the Chemical Analysis Division, Central Laboratory, Padjajaran University.

2.3 Instruments and Chemicals

The Instruments employed in this study included the Agilent 5977B GC-MSD and a rotary evaporator. The materials were used Memaye (*Leea indica* (Burm.f.) Merr) leaves and 96% ethanol

2.4 Preparation and Extraction

Memaye leaf samples were collected, sorted, and cleaned to remove any dirt. The leaves were then dried in indirect sunlight for three days. Once dry, they were ground and sieved to obtain a fine powder. The powder was extracted using a maceration method with 96% ethanol at a ratio of 1:5 over three 24-hour periods. The mixture was subsequently filtered to obtain the filtrate, which was then evaporated using a rotary evaporator. The resulting extract was analyzed for its phytochemical content.

2.5 Analysis of phytochemical with GC-MS instruments

A phytochemical profile was conducted using GC-MS analysis which was performed following the Agilent 5977B GC-MSD instrument protocol.

2.6 Identification of phytochemicals and search bioactivity

GC-MS data were analyzed quantitatively using Agilent Technology. This analysis produced a chromatogram displaying peaks representing the detected chemical components, their retention times, abundances, and chemical structures. Metabolite compounds, compound classes, and biosynthetic pathways were then identified using websites such as *PubChem*, *KEGG, ChEBI*, *PlantCyc*, and *SpectraBase*. Search for Anti-Infective and Anti-Degenerative Compounds. The exploration of anti-infective and anti-degenerative compounds was conducted by collecting secondary data through phytochemical identification results from websites such as *DrugBank*, *PubChem*, *KEGG*, *ChEBI*, and *NCBI*.

3 Results and Discussion

3.1 Phytochemical Profile of Memaye Leaves (*Leea indica* (Burm.f) Merr)

The peaks observed in the chromatogram illustrate the variety of metabolites present in the ethanol extract of Memaye leaves. A total of eight compounds were identified, with five of them being dominant, comprising 95.96% of the total. The identified compounds include: *Formamide (N,N-dimethyl)* at 47.69%, *Mesitylene* at 23.86%, *1,2-Benzenedicarboxylic acid, bis(2-ethylhexyl) ester* at 14.63%, *Supraene* or *squalene* at 5.91%, and *16-Heptadecenal* at 3.87%.

3.2. Bioactivity of Memaye Leaves (*Leea indica* (Burm.f) Merr) Compounds

The phytochemicals detected in the ethanol extract of Memaye leaves were further researched using the *KEGG* and *ChEBI* databases and categorized based on their compound classes. Table 1 presents the names of the metabolites, their classification, and their bioactivity.

Table 1 Phytochemicals of Memaye Leaf Ethanol Extract , in Retention time, Compound name, Class classification, and Bioactivity.

Retention Time (minutes)	Compound Name	Relative Abundance (%)	Class Compound	Bioactivity	References
3.128	*Acetic acid, [(aminocarbonyl)amino]oxo*	1.24	Carboxylic acid	Anti-infective	[11]
3.641	*Formamide, N,N-dimethyl*	47.69	Amine	Antimicrobial, Antiosteoporosis	[12] [13]
8.216	*Mesitylene*	23.86	Aromatic	Antibacterial	[14]
35.611	*16-Heptadecenal*	3.87	Aldehydes	Antimicrobial, Anticancer	[15]
36.236	*Phenethylamine, 3,4,5-trimethoxy-.alpha.- methyl*	1.44	Alkaloids	Anticancer, Antibacterial, Antifungal, Antidepressant	[16]
36.688	*Imidazole-2-hydrazide-1-carboxylic acid, methyl ester*	1.46	Alkaloids	Anticancer, Antinflammatory, Antibacterial	[17]
51.047	*1,2-Benzenedicarboxylic acid, bis(2-ethylhexyl) ester*	14.63	Aromatic	Antidermatophyte, Anticancer	[18] [19], [20]
56.206	*Supraene* or *squalene*	5.91	Triterpenoids	Antioxidant, Anticancer	[21] [22]

Table 1 illustrates the bioactivity of the phytochemical compounds found in the ethanol extract of Memaye leaves, which exhibit properties such as antioxidant, anti-infective, antibacterial, antimicrobial, anticancer, antidepressant, and anti-inflammatory agents. These properties can help combat infections and inflammation, as well as protect body cells from oxidative damage caused by free radicals. The most prominent bioactivity is attributed to the anticancer properties, particularly in the compounds *Mesitylene*, *16-Heptadecenal*, *Phenethylamine, 3,4,5-trimethoxy-α-methyl*, *Imidazole-2-hydrazide-1-carboxylic acid methyl ester*, *1,2-Benzenedicarboxylic acid bis(2-ethylhexyl) ester*, and *Supraene*. Research conducted [23] indicates that Memaye leaf extract demonstrates bioactivity as an antioxidant by scavenging free radicals in the body and as an anticancer agent that can inhibit the growth of cancer cells.

Among the identified compounds, those in the aromatic class made up 38.49% and included two compounds: *Mesitylene*, and *1,2-Benzenedicarboxylic acid bis(2-ethylhexyl) ester*. According to [14], *Mesitylene* possesses antibacterial, anti-inflammatory, and anticancer properties. Additionally, aromatic compounds also show antimicrobial bioactivity [24].

Based on the active compounds identified in the GC-MS analysis of the ethanol extract of Memaye leaves, we traced the biosynthetic pathways, which consist of *mevalonic acid*, *malonic acid*, and *shikimic acid*. Compounds synthesized through the malonic acid pathway include *Acetic acid, [(aminocarbonyl)amino]oxo*, *Formamide, N,N-dimethyl*, and 16-Heptadecenal. The shikimic acid pathway encompasses four compounds: Mesitylene, Phenethylamine, 3,4,*5-trimethoxy-α-methyl, Imidazole-2-hydrazide-1-carboxylic acid methyl ester,* and *1,2-Benzenedicarboxylic acid bis(2-ethylhexyl) ester*. The compound synthesized through the mevalonic acid pathway is *Supraene* (*squalene*).

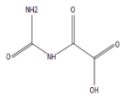
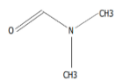
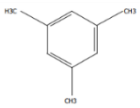
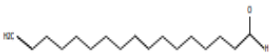
The exploration of the biosynthetic pathways revealed six classes of phytochemicals in the ethanol extract of Memaye leaves: carboxylic acids (1.24%), amides (47.69%), alkaloids (2.90%), aromatics (38.49%), and triterpenoids (5.91%). The amide class has the highest percentage area in the diagram, with the detected compounds being *Formamide, N,N-dimethyl*. According to [25], compounds in the amide class are known for their antifungal, insecticidal, diuretic, antiviral,

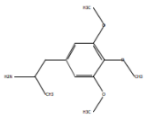
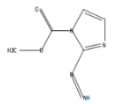
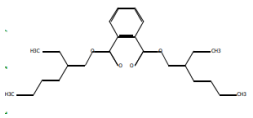
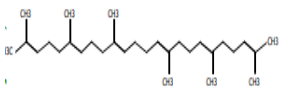
antiseptic, anti-inflammatory, analgesic, wound healing, antifeedant, and antibacterial properties. The carboxylic acid class exhibited the lowest abundance in the analysis.

3.3. Exploration of Anti-Infective and Anti-Degenerative Properties

Active compounds in the ethanol extract of Memaye leaves were found to exhibit various biological activities. Two compounds showed anti-infective effects, one had anti-degenerative properties, and five displayed both anti-infective and anti-degenerative effects. See Table 2 for details on these compounds and their pharmacological effects.

Table 2 Phytochemical from the ethanol extract of Memaye leaves with anti-infective and anti-degenerative bioactivity and their pharmacological effects.

Compounds	**Bioactivity (References)**	**Pharmacological effect**	**Chemical structure and abudance (%)**
Aceticacid, [(aminocarbonyl) amino]oxo	Antiinfection [11]	*Acetic acid* can damage microbial cell walls by lowering the pH of the microbe's environment. Its *aminocarbonyl* group inhibits important enzymes or microbial biosynthesis processes, thus preventing microbial proliferation. *Acetic acid* and *aminocarbonyl* groups have synergistic effectiveness against pathogens.	 (1.24)
Formamide, N,N-dimethyl	Antimicrobial [12] Antiosteoporosis [13]	The carbonyl group (C=O) in *Formamide, N,N-dimethyl* can interact with lipoprotein or phospholipid molecules present in microbial cell membranes, thereby disrupting membrane integrity. Furthermore, *Formamide, N,N-dimethyl* can attenuate high glucose-induced osteoclast differentiation by targeting the activation of mitogen-regulated protein kinases (MAPKs) and nuclear factor kappa B (NF-κB) in BMM.	 (47.69)
Mesitylene	Antibacterial [14]	The presence of a methyl group in *mesitylene's* structure imparts lipophilic properties, enabling it to interact with lipid-rich bacterial cell membranes. This interaction enhances *mesitylene's* penetration into bacterial cells, disrupting membrane function and increasing permeability.	 (23.86)
16-Heptadecenal	Antimicrobial, Anticancer [15]	This compound serves two primary functions: As an antimicrobial, it inactivates proteins by forming covalent cross-links with various functional groups, including –NH2, -OH, and -COOH. As an anticancer agent, it promotes apoptosis, inhibits the proliferation of cancer cells, and prevents the formation of new blood vessels in tumors.	 (3.87)

Phenethylamine, 3,4,5-trimethoxy- .alpha.- methyl	Anticancer Antimicrobial [16]	*Phenethylamine* compounds and methoxy groups can influence cell receptors and signaling pathways, which helps to inhibit the proliferation of cancer cells. Additionally, methoxy groups can damage microbial cell membranes, resulting in the death of these microbes. This membrane damage disrupts essential cellular functions, including metabolism and the transport of molecules.	 (1.44)
Imidazole-2-hydrazide-1-carboxylic acid, *methyl ester*	Anticancer, Antiinflammatory, Antibacterial [17]	As an anticancer agent, this compound induces apoptosis of cancer cells, inhibits cancer cell proliferation, and prevents metastasis. As an anti-inflammatory agent, it reduces inflammation by inhibiting the NF-κB pathway and the COX-2 enzyme. Furthermore, this compound has antibacterial effects by damaging bacterial cell walls and interfering with bacterial protein synthesis.	 (1.46)
1,2-Benzenedicarboxylic acid, bis(2-ethylhexyl) ester	Antidermatophyte [18] Anticancer[19], [20]	This compound exhibits lipophilic properties and disrupts fungal metabolic activity, inhibiting their growth. Additionally, the compound's toxicity can induce apoptosis in cancer cells, leading to cell death.	 (14.63)
Supraene or *squalene*	Antioxydant [21] Anticancer [22]	It binds to and neutralizes free radicals by donating electrons or hydrogen atoms, stabilizing them and helping to reduce cell damage that can lead to cancer. Additionally, it can inhibit oxidative stress by slowing down the activity of enzymes involved in the formation of reactive oxygen species (ROS) through the formation of metal ion chelates.	 (5.91)

According to Table 2, all eight compounds identified in the Memaye leaf extract show promise as anti-infective and anti-degenerative agents. These compounds possess specific bioactive properties that could be utilized in the treatment of degenerative and infectious diseases. The anti-infective compounds found in the Memaye leaf extract include *Acetic acid, [(aminocarbonyl)amino],* and *Mesitylene*. Notably, the compound with significant anti-degenerative activity is *Supraene*. Additionally, five other compounds—*16-Heptadecenal*, *Phenethylamine, 3,4,5-trimethoxy-α-methyl, Imidazole-2-hydrazide-1-carboxylic acid methyl ester*, and *Supraene*—exhibit anti-inflammatory, antimicrobial, antioxidant, and anticancer properties.

The active compounds in the ethanol extract of Memaye leaves can be used as anti-infective and anti-degenerative agents. Compounds with anti-infective properties contain characteristic chemical groups that allow them to interact with the biological structure of microbes. *Acetic acid, [(aminocarbonyl)amino]oxo*, *16-Heptadecanal* has a hydroxyl group (-OH) and an amine group (-NH2). Meanwhile, *Mesitylene* has a methyl group, which makes it lipophilic. According to [26], compounds with anti-infective properties often contain chemical groups such as methyl, carbonyl, hydroxyl, or amine groups**.**

4 Conclusion

The phytochemical profile of the ethanol extract from Memaye leaves reveals five dominant compounds: *Formamide (N,N-dimethyl)*, *Mesitylene*, *16-Heptadecenal, 1,2-Benzenedicarboxylic acid) bis(2-ethylhexyl) ester*, and *Supraene*. These compounds demonstrate potential as antimicrobial, antibacterial, anti-inflammatory, anticancer, and antioxidant agents. Exploration of their bioactivity shows that *acetic acid [(aminocarbonyl)amino]* and *mesitylene* are active compounds with anti-infection properties. In contrast, the *supraene* compound can be utilized for its antidegenerative effects. Additionally, several compounds exhibit both anti-infection and antidegenerative properties, including *Formamide (N,N-dimethyl)*, *16-Heptadecenal*, *Phenethylamine, 3,4,5-trimethoxy-α-methyl*, *Imidazole-2-hydrazide-1-carboxylic acid, methyl ester*, and *1,2-Benzenedicarboxylic acid, bis(2-ethylhexyl) ester*

Overall, the phytochemical analysis of Memaye leaves highlights their significant potential as a source of bioactive compounds that could be developed for anti-infection and anti-degenerative therapies.

5 Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

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