



SOLVENTS ON PHYTOCHEMICAL AND ORGANOLEPTIC PROPERTIES OF BASELLA ALBA: POTENTIAL FOR DEVELOPMENT OF DIABETES DRUGS

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ABSTRACT

The content of basella alba shows that phenolic compounds can also act as inhibitors of the α -amylase and α -glucosidase enzymes, thus providing an anti-hyperglycemic effect. However, the influence of different solvents on its phytochemical composition, organoleptic characteristics, and bioactive compound content remains underexplored. Leaves of *B. alba* collected from Central Java, Indonesia, were shade-dried, powdered, and extracted separately using ethanol (EEBA), methanol (MEBA), and water (AEBA) via maceration for 3×24 hours. Extracts were filtered, concentrated using a rotary evaporator, and evaluated for organoleptic traits, phytochemical profiles, total flavonoid content (TFC), total phenolic content (TPC), antioxidant activity (DPPH assay, IC_{50}), and pH. The aqueous extract (AEBA) produced the highest yield (7.95%) but contained fewer bioactive metabolites compared to organic solvents. Phytochemical screening revealed that MEBA contained alkaloids, flavonoids, triterpenoids, saponins, steroids, tannins, and phenolics; EEBA showed similar profiles except for alkaloids; while AEBA lacked alkaloids and flavonoids. Quantitative analysis indicated that MEBA had the highest flavonoid content (35.20 mg QE/g), whereas EEBA had the highest phenolic content (25.28 mg GAE/g). Antioxidant activity analysis showed MEBA exhibited the strongest effect ($IC_{50} = 284.43 \mu\text{g/mL}$), followed by EEBA (436.84 $\mu\text{g/mL}$) and AEBA (1129.37 $\mu\text{g/mL}$). The pH values of all extracts were comparable (6.54–6.62). While water produced the highest yield, methanol proved most effective in extracting phenolics, flavonoids, and alkaloids, thereby yielding superior antioxidant potential. Ethanol also extracted substantial flavonoid content, though without alkaloids. These results highlight methanol as the most effective solvent for isolating antioxidant-related compounds from *B. alba* leaves.

Keywords: antioxidant; basella alba; organoleptic; phytochemical

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INTRODUCTION

Traditional medicine is widely recognized as a health system that combines the use of plants, animals, and minerals, as well as spiritual therapies, manual techniques, and physical exercises. This approach has been applied to maintain health, prevent, diagnose, and treat illness in communities around the world (Farias et al., 2023). Traditional medicine is a holistic health system that utilizes natural resources and spiritual/manual therapies, playing a vital role in the prevention, diagnosis, treatment, and maintenance of health across cultures. Integration with modern medicine continues to grow, but further research is needed to ensure its safety and effectiveness (Farias et al., 2023). Herbal medicines remain relevant and effective as affordable and accessible health solutions, especially in urban areas. Innovations in manufacturing methods and standardization are increasingly improving the efficiency and safety of herbal medicines in modern healthcare (El-Saadony et al., 2025). Natural bioactive compounds continue to be a major focus of research due to their broad therapeutic potential. Technological innovations and interdisciplinary approaches are

accelerating their exploration and clinical application, although challenges related to isolation, bioavailability, and standardization still need to be overcome for their optimal use in healthcare (Vaou et al., 2025).

Preliminary research is very important to identify bioactive compounds such as flavonoids, alkaloids, saponins, and tannins in *Basella alba*, which play a role in antidiabetic activity. *Basella alba* has been shown to contain various bioactive compounds, including flavonoids, alkaloids, saponins, tannins, triterpenoids, and phytosterols. Flavonoids have been specifically identified through TLC, IR, and GC-MS analyses, with the highest concentrations in the stems and seeds. Additionally, compounds such as naringin, apigenin, and luteolin have also been found in leaf extracts. Compounds in herbal plants that play a role in their pharmacological effects (Reddy et al., 2023). Further in vitro, in vivo, and especially clinical trials are essential to demonstrate the therapeutic benefits of *Basella alba* in diabetes. Studies support its antidiabetic potential, but validation in humans is still needed (Dedvisitsakul & Watla-iad, 2022). Damage to pancreatic beta cells results in insulin deficiency and consequently hyperglycemia (Sheik et al., 2023). Circulating levels of proinflammatory cytokines are typically increased in DM, as a result of hyperglycemia, which is increased through oxidative mechanisms (Dedvisitsakul & Watla-iad, 2022). Chronic hyperglycemia in diabetes triggers a series of biochemical processes that lead to complications in the eyes, kidneys, nerves, and blood vessels through oxidative stress, AGE formation, and endothelial dysfunction. Prevention and management of these complications require strict glycemic control and multifactorial interventions (Caturano et al., 2023). Chronic hyperglycemia causes tissue damage through several pathways, including the formation of advanced glycation end products (AGEs), oxidative stress, mitochondrial dysfunction, and activation of the polyol and hexosamine pathways (Caturano et al., 2023).

The development of *Basella alba* as a potential therapeutic agent for gestational diabetes requires preliminary investigations. Such preliminary studies are essential for identifying the bioactive compounds, including flavonoids, alkaloids, saponins, tannins, and others, which are often responsible for the pharmacological effects of herbal medicine (Ahmed, 2022). According to Omotoso (2023), *B. alba* contains substantial amounts of vitamins, particularly vitamins A, C, and B9, and is also rich in essential minerals such as calcium, magnesium, iron, and phosphorus. In addition, this plant provides various essential amino acids, including arginine, leucine, isoleucine, lysine, threonine, and tryptophan (Omotoso et al., 2024). Based on evidence from in vitro, preclinical, and clinical studies, the fruit of *B. alba* (commonly known as Malabar spinach) has been reported to contain flavonoids and betalains, which exhibit antibacterial, antihyperglycemic, antioxidant, anti-inflammatory, cytotoxic, and antiproliferative activities (Nur et al., 2023). In this study, the authors aim to investigate the differences in organoleptic properties, phytochemical activities, and compound content of *Basella alba* leaf extracts obtained using various solvents.

METHOD

1. Plant Material

Basella alba plants were obtained from the Central Java region, Indonesia, and were taxonomically authenticated at the Laboratory of the Traditional Health Services Unit, Dr. Sardjito Hospital, Tawangmangu, Central Java, with the result: Family: Basellaceae; Genus: *Basella*. Species: *Basella alba* L. Local Name: Brazilian Spinach / Malabar Spinach. Morphological Characteristics: Stem: Climbing, succulent, green to pinkish in color, smooth surface. Leaves: Heart-shaped, smooth surface, entire margin, dark green color. Flowers: Small, whitish-green, arranged in clusters. Fruits: Berry-shaped, round, dark purple when mature.

2. Preparation of extract

The aerial parts of *Basella alba* were collected and subsequently shade-dried at room temperature. The dried plant material was ground into a fine powder and separately macerated with ethanol,

methanol, and distilled water for 3 × 24 hours. This process yielded three types of extracts: EEBA (Ethanol Extract of *B. alba*), MEBA (Methanol Extract of *B. alba*), and AEBA (Aqueous Extract of *B. alba*). Extracts are usually concentrated using a rotary vacuum evaporator under low pressure. This method is very common in research and industry to efficiently remove solvents without damaging heat-sensitive active compounds (Santoso et al., 2021). The color, consistency, and percentage yield of each extract were recorded, as presented in Table 1. All extracts were stored in a desiccator until further analysis.

3. phytochemical screening

Phytochemical screening of the prepared plant extracts was carried out using several methods, including chemical tests, Thin Layer Chromatography (TLC), and UV-Vis spectrophotometric analysis to determine the total flavonoid content, total phenolic content, and IC50 values. The phytochemical examination of both methanolic and aqueous extracts was performed following standard procedures (Rao et al., 2023). The results revealed the presence of various phytoconstituents, which are summarized in Tables 2 and 3. The phytochemical tests included the detection of alkaloids, flavonoids, triterpenoids, saponins, steroids, tannins, and phenolics (Nur et al., 2023).

RESULT

Table 1.
Organoleptic characteristics and extraction yield of *Basella alba* leaf extracts using different solvents

Extract	Form	Color	Odor	Taste	% Yield
EEBA (<i>Ethanol Extract of B. alba</i>)	Paste	Black	Characteristic extract odor	Bitter	5.48
MEBA (<i>Methanolic Extract of B. alba</i>)	Paste	Black	Characteristic extract odor	Bitter	5.94
AEBA (<i>Aqueous Extract of B. alba</i>)	Solid paste	Black	Strong, pungent	Slightly sour, bitter	7.95

The extraction process revealed that all three types of *Basella alba* extracts (EEBA, MEBA, and AEBA) exhibited relatively similar organoleptic characteristics, namely a paste-like form with a black coloration. The ethanolic extract (EEBA) and methanolic extract (MEBA) were obtained as black pastes with a characteristic extract odor and a bitter taste, yielding 5.48% and 5.94%, respectively. In contrast, the aqueous extract (AEBA) was obtained as a solid paste with a black coloration, a more pungent odor, and a slightly sour-bitter taste, showing the highest yield of 7.95%. These findings indicate that water as a solvent produces a greater amount of extract compared to ethanol or methanol, although the resulting odor and taste tend to be stronger.

Table 2.
Phytochemical screening of *Basella alba* leaf extracts using different solvents

Phytochemical compounds	EEBA (<i>Ethanol extract</i>)	MEBA (<i>Methanolic extract</i>)	AEBA (<i>Aqueous extract</i>)
Alkaloids	–	+	–
Flavonoids	+	+	–
Triterpenoids	+	+	+
Saponins	+	+	+
Steroids	+	+	+
Tannins	+	+	+
Phenolics	+	+	+

Note: (+) indicates presence; (–) indicates absence of the compound.

Based on the results of the phytochemical screening, it was observed that the three *Basella alba* extracts (EEBA, MEBA, and AEBA) exhibited distinct secondary metabolite profiles depending on the solvent used. The ethanolic extract (EEBA) and methanolic extract (MEBA) contained a broader range of bioactive compounds compared to the aqueous extract (AEBA). Both EEBA and

MEBA were found to possess flavonoids, triterpenoids, saponins, steroids, tannins, and phenolics, with the difference that alkaloids were detected exclusively in the methanolic extract. In contrast, AEBA revealed the presence of triterpenoids, saponins, steroids, tannins, and phenolics, but lacked both flavonoids and alkaloids. These findings indicate that ethanol and methanol are more effective solvents for extracting secondary metabolites from *Basella alba* compared to water. This highlights the significant role of solvent polarity in determining the types of compounds that can be extracted, whereby organic solvents (ethanol and methanol) are capable of solubilizing a wider spectrum of active phytochemicals than water.

Table 3.

Comparative levels of flavonoids, phenolics, antioxidant activity (IC_{50}), and pH in *Basella alba* leaf extracts

Parameter	EEBA (<i>Ethanollic extract</i>)	MEBA (<i>Methanolic extract</i>)	AEBA (<i>Aqueous extract</i>)
Total Flavonoids* (mg QE/g)	2.81	35.20	2.09
Total Phenolics** (mg GAE/g)	25.29	22.66	5.66
Antioxidant Activity (IC_{50} , $\mu\text{g/mL}$)***	436.84	284.43	1129.37
pH	6.54	6.62	6.60

Notes:

QE = Quercetin equivalents

** GAE = Gallic acid equivalents

*** IC_{50} = half-maximal inhibitory concentration; lower IC_{50} indicates higher antioxidant activity

Based on the analysis of secondary metabolite content and antioxidant activity in *Basella alba* extracts, significant differences were observed among the solvents used. The methanolic extract (MEBA) exhibited the highest total flavonoid content (35.20 mg QE/g), compared to the ethanolic extract (EEBA, 2.81 mg QE/g) and the aqueous extract (AEBA, 2.09 mg QE/g). However, the highest total phenolic content was found in the ethanolic extract (25.29 mg GAE/g), followed by methanol (22.66 mg GAE/g) and water (5.66 mg GAE/g). Antioxidant activity, as measured by IC_{50} values, demonstrated that the methanolic extract possessed the strongest antioxidant potential (284.43 $\mu\text{g/mL}$), compared to the ethanolic extract (436.84 $\mu\text{g/mL}$) and the aqueous extract (1129.37 $\mu\text{g/mL}$), where a lower IC_{50} value indicates stronger antioxidant activity. The pH values of the three extracts were relatively similar, ranging from 6.54 to 6.62, suggesting no significant differences in acidity.

DISCUSSION

The extraction results of *Basella alba* demonstrated that the aqueous extract (AEBA) yielded the highest extract recovery compared to ethanol (EEBA) and methanol (MEBA), although the organoleptic properties of the aqueous extract were more pronounced, characterized by a solid paste form with a pungent odor and a slightly sour-bitter taste. Previous studies on *Basella alba* have also reported that aqueous extraction tends to produce higher yields. For instance, the study *Anti-Melanogenic Potential of Malabar Spinach* reported that the yield of the aqueous extract was approximately 6.20% w/w based on dry weight, while extraction with ethanol (50% and 95%) resulted in yields of ~13.05% and ~8.50%, respectively. (Ri et al., 2019).

Previous studies have reported that methanol extracted the highest phenolic content from *B. alba* leaves, whereas ethanol was more effective in extracting flavonoids. This finding is consistent with the general understanding that alcohol-based solvents (ethanol or methanol) are more efficient in extracting bioactive compounds responsible for distinctive odor and taste characteristics compared to water. However, alcoholic solvents do not necessarily produce the highest overall yield. (Jayswal et al., 2023). The total flavonoid and phenolic contents fall within a certain range depending on the

solvent concentration and extraction technique employed. Additional techniques, such as ultrasonication, also influence both the yield and quality of the extract, primarily by reducing extraction time and enhancing efficiency in recovering bioactive compounds (Fitriansyah et al., 2018). The concentration of the solvent (ethanol), solvent volume, and extraction time have a significant influence on both the total phenolic content (TPC) and total flavonoid content (TFC) (Hiranpradith et al., 2025).

MEBA demonstrated the presence of alkaloids, flavonoids, triterpenoids, saponins, steroids, tannins, and phenolics. EEBA contained all of these metabolites except alkaloids, while AEBA revealed only triterpenoids, saponins, steroids, tannins, and phenolics, with no detectable flavonoids or alkaloids. These differences may be attributed to the varying polarity of the solvents and their ability to solubilize specific compounds. Methanol and ethanol, being polar solvents, are particularly effective in extracting flavonoids (including semi-polar flavonoids or their glycosides) as well as alkaloids. In contrast, distilled water, despite being highly polar, may be less efficient at extracting heavier or semi-polar compounds that require organic solvents to be released from the plant matrix or cell wall. Previous studies have indicated that the solubility of flavonoids is strongly influenced by both their structural characteristics and the type of organic solvent used, with solvents of medium to high polarity, such as methanol or ethanol, being more effective for solubilizing specific flavonoid structures (e.g., aglycones or glycosides) compared to aquadest (Chebil et al., 2007).

lycosylation of flavonoids enhances their solubility in aqueous solvents compared to their corresponding aglycones. For example, myricitrin (a flavonoid conjugated with a galactose moiety) exhibits significantly higher water solubility than its aglycone form, myricetin (Slámová et al., 2018). Glycosides generally exhibit lower lipophilicity and higher water solubility. In contrast, aglycones are more soluble in organic solvents (which are more lipophilic) than in aquadest (Chuang et al., 2017). The aqueous extract yielded the lowest content. This finding indicates that although water is highly polar, it may be less efficient in extracting certain flavonoids, particularly aglycone flavonoids or those with low hydrophilicity. (Ri et al., 2019). Water often produces a high extraction yield because it extracts numerous polar non-phenolic compounds such as carbohydrates, proteins, and salts. However, a high yield does not necessarily correlate with phenolic content or bioactive activity. (Nawaz et al., 2020). Ethanol and methanol, although sometimes producing a lower total yield, concentrate phenolic and flavonoid compounds that contribute to the tested antioxidant and antimicrobial activities. (Nawaz et al., 2020).

According to Jayswal et al., methanol extracted the maximum amount of phenols from *B. alba* leaves and exhibited the highest antioxidant activity compared to other solvents (Jayswal et al., 2023). Similar studies support that the higher the phenolic content and the lower the IC₅₀ value, the stronger the antioxidant effect (Aryal et al., 2019). Research on various herbal plants (Zingiberaceae) in Indonesia reported that total phenolic content (TPC) and total flavonoid content (TFC) significantly contributed to antioxidant activity (including DPPH assay), with a significant Pearson correlation observed between TPC/TFC and activity. This indicates that the higher the phenolic/flavonoid content, the greater the scavenging percentage, which generally corresponds to a lower IC₅₀ value (Muflihah et al., 2021).

CONCLUSION

This study demonstrates that the type of solvent has a significant effect on the organoleptic characteristics, phytochemical composition, and bioactive compound content of *Basella alba* leaf extracts. The aqueous extract (AEBA) yielded the highest extract recovery; however, the bioactive compounds obtained were relatively fewer compared to organic solvents. The methanolic extract (MEBA) was found to be the most effective in extracting phenolics, flavonoids, and alkaloids,

thereby showing greater potential to provide stronger antioxidant activity. The ethanolic extract (EEBA) was also able to extract a significant amount of flavonoids, although it did not contain alkaloids.

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