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ARTICLE

EFFECT OF SOLVENT TYPE ON THE PHYTOCHEMICAL CONTENT AND THE SPECIFIC AND NON-SPECIFIC PARAMETERS OF JOMBANG (*Taraxacum officinale*) LEAF EXTRACTS

[*Pengaruh Jenis Pelarut terhadap Kandungan Fitokimia serta Parameter Spesifik dan Non-Spesifik Ekstrak Daun Jombang* (*Taraxacum officinale*)]

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ABSTRACT

Jombang (*Taraxacum officinale*) is a wild plant commonly used by the Javanese as a traditional medicine. This study aimed to perform phytochemical screening and analyze both specific and non-specific characteristics of Jombang leaf extracts obtained using four different solvents: ethyl acetate, 80% ethanol, 50% ethanol, and aqueous. Specific parameters included sample identity and organoleptic properties, while non-specific parameters covered drying loss, specific gravity, ash content, and water content. All tests refer to the Indonesian Materia Medika and the Indonesian Herbal Pharmacopeia as standards for medicinal plants. The phytochemical content of each extract varied, with tannins present in all four extracts. Flavonoids were not found in the 80% ethanol extract. Steroids were detected in both the ethyl acetate and aqueous extracts, while triterpenoids and alkaloids were present only in the ethanol extracts. Saponins were found in the 50% ethanol and aqueous extracts. Non-specific characteristics showed that the organic solvent extracts met the drying loss requirement of no more than 11%, whereas the aqueous extract exceeded this limit with a value of 13.72%. The specific gravity of the four extracts ranged between 0.04 and 0.10 g/mL, and the water content of all extracts met the standards, not exceeding 10%. Meanwhile, the ash content of the 80% ethanol extract did not meet the requirement as it exceeded 8.5%, while the other three extracts fulfilled the standards.

Keywords: aqueous, ethanol, ethyl acetate, non-specific parameters, specific parameters

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ABSTRAK

Jombang (Taraxacum officinale) merupakan tanaman liar yang biasa digunakan oleh masyarakat Jawa sebagai obat tradisional. Penelitian ini bertujuan untuk melakukan penapisan fitokimia dan menganalisis karakteristik spesifik dan non-spesifik dari ekstrak daun Jombang yang diperoleh dengan menggunakan empat pelarut yang berbeda: etil asetat, etanol 80%, etanol 50%, dan air. Parameter spesifik meliputi identitas sampel dan sifat organoleptik, sementara parameter non-spesifik mencakup susut pengeringan, bobot jenis, kadar abu, dan kadar air. Semua pengujian mengacu pada Materia Medika Indonesia dan Farmakope Herbal Indonesia sebagai standar tanaman obat. Kandungan fitokimia dari masing-masing ekstrak bervariasi, yaitu tanin ditemukan pada keempat ekstrak. Flavonoid tidak ditemukan pada ekstrak etanol 80%. Steroid terdeteksi pada ekstrak etil asetat dan air, sedangkan triterpenoid dan alkaloid hanya ditemukan pada ekstrak etanol. Saponin ditemukan pada ekstrak etanol 50% dan air. Karakteristik non-spesifik menunjukkan bahwa ekstrak dengan pelarut organik memenuhi persyaratan susut pengeringan, yaitu tidak lebih dari 11%, sedangkan ekstrak air melebihi batas dengan nilai 13,72%. Bobot jenis keempat ekstrak berkisar antara 0,04 hingga 0,10 g/mL, dan kandungan air pada semua ekstrak memenuhi standar, tidak melebihi 10%. Sementara itu, kadar abu pada ekstrak etanol 80% tidak memenuhi persyaratan karena melebihi 8,5%, sedangkan ketiga ekstrak lainnya memenuhi standar.

***Kata kunci**: air, etanol, etil asetat, parameter non-spesifik, parameter spesifik*

INTRODUCTION

Traditional medicine has long been used as an alternative treatment in health care before the widespread adoption of modern pharmaceuticals. Despite the limited scientific data available on the use of medicinal plants, these natural remedies are widely believed to be beneficial, safe, and non-harmful to health (Abdel-Aziz *et al.,* 2016; Sumarni *et al.,* 2019; Amaliana *et al.,* 2021). Indonesia, which harbors over 80% of the world's medicinal plants, offers abundant natural resources for therapeutic purposes. The practice of traditional medicine, passed down through generations, remains a vibrant aspect of Indonesia's cultural heritage, offering benefits such as low maintenance, affordability, and effective pain relief (Jennifer and Saptutyningsih, 2015; Sumarni *et al.,* 2019; Yunitarini and Widiaswanti, 2024). One of the medicinal plants traditionally used in Java is Jombang (*Taraxacum officinale*) (Adia *et al.,* 2024), a species also found across Europe, Asia, and North America. It grows in various environments, such as highlands, mountain slopes, and grasslands at altitudes of 1,200-1,500 m above sea level (Khan *et al.,* 2019; Nowak *et al.,* 2019). Numerous studies have identified its medicinal properties, including liver and blood detoxification, antibacterial and anti-inflammatory effects, as well as diuretic and choleretic (bile-stimulating) (Azhari and Apriliana, 2016; Khan *et al.,* 2019). The plant's roots are traditionally used to treat gastrointestinal and liver issues, while its leaves and flowers aid digestion and promote diuresis (Indriyanti *et al.,* 2015; Ricky and Silitonga, 2019).

Phytochemical investigations of various plant parts have revealed the presence of secondary metabolites such as alkaloids, flavonoids, tannins, saponins, phenols, and steroid/triterpenoids (Jassim *et al.,* 2012; Amin *et al.,* 2013; Ghaima *et al.,* 2013; Akhtar *et al.,* 2022). These compounds are widely known for their pharmacological effects, including antimicrobial activity, antioxidant properties, and regulation of the central nervous system (Khan *et al.,* 2019; Kania-Dobrowlska and Baraniak, 2022). However, despite the wide range of bioactive compounds reported, a critical gap remains in the literature regarding the comparative influence of different solvents on the extraction efficiency and phytochemical profile of Jombang leaves. Previous studies have either employed a single solvent or focused on narrow analytical parameters. While some research has utilized solvents like ethanol or methanol independently (Jassim *et al.,* 2012; Ghaima *et al.,* 2013; Dedic *et al.,* 2022; Adia *et al.,* 2024), other studies involving multiple solvents have primarily concentrated on antioxidant activity without conducting broader phytochemical assessments (Nowak *et al.,* 2019; Akhtar *et al.,* 2022). These limitations highlight the absence of comprehensive analysis addressing how variations in solvent polarity affect the types of secondary metabolites extracted, along with both specific and non-specific extract parameters.

The extraction method and choice of solvent are fundamental to determining the success of phytochemical analysis, as they influence the solubility, stability, and recovery of active compounds

(Tambun *et al.*, 2020; Goti and Dasgupta, 2023). In this study, maceration was selected as the extraction method due to its simplicity, cost-effectiveness, and suitability for preserving thermolabile compounds, although it generally requires longer extraction times and greater solvent volumes (Zhang *et al.*, 2018; Tambun *et al.*, 2020; Verep *et al.*, 2023). Four solvents of varying polarity, ethyl acetate, 80% ethanol, 50% ethanol, and water, were chosen for a comprehensive comparative analysis. Ethanol was selected due to its low toxicity, wide solubility range, and volatility, enabling the extraction of both polar and non-polar compounds (Zhang *et al*., 2018; Lee *et al.*, 2024). Water, a highly polar and widely available solvent, is effective at dissolving polar functional groups such as sugars, alcohols, aldehydes, and ketones (Khotimah *et al*., 2017; Plaskova and Mlcek, 2023). Ethyl acetate, a semi-polar solvent, was selected for its ability to extract glycosides and aglycones while being easily evaporated and relatively non-toxic (Joshi and Adhikari, 2019; Plaskova and Mlcek, 2023).

This study aims to evaluate the phytochemical profile of Jombang leaf extracts using these four solvents by analyzing both specific and non-specific parameters. Through this approach, the study seeks to determine the optimal solvent system for extracting bioactive compounds from Jombang (*Taraxacum officinale*), contributing to the standardization and scientific validation of traditional herbal medicines for potential pharmaceutical development. To date, no study has comprehensively examined the effects of solvent polarity on the phytochemical profile of Jombang leaf extracts, nor compared the extraction efficiency based on both specific and non-specific parameters. Therefore, this study offers new insights into optimizing solvent systems for traditional herbal use.

MATERIALS AND METHODS

Materials and Instruments

Jombang leaf *(Taraxacum officinale)* powder was obtained from plantations in the Yogyakarta area. Aqueous, 80% ethanol, 50% ethanol, and ethyl acetate were used as solvents and the reagents used were Dragendorff, Wagner, Mayer, and Liebermann-Burchard reagents. Other chemicals used were hydrochloric acid (HCl) 2N, magnesium powder, ferric chloride ($FeCl_3$), gelatin, and petroleum ether. We also used several glassware in this study, such as Beaker glass (Borossil), Erlenmeyer (Pyrex), test tube (Iwaki), glass jar, and pycnometer (Iwaki). The main instrument used in this research was a *vacuum rotary evaporator* (Eyela).

Preparation and Characterization of Jombang (*Taraxacum officinale*) Leaf Extract

The plant material utilized was dried leaf powdered prepared at PT. Palapa Muda Perkasa (Depok, West Java, Indonesia) and identified as *Taraxacum officinale* (Jombang) with Letter Number: 996/IPH.1.01/If.08/I/2022. Approximately 950 g of fresh leaves were washed under running water and dried in an oven at 40^0C for three days. The dried leaves then sorted, blended, and sieved using a 60-mesh sieve.

The extraction method employed was maceration. A total of 250 g of samples was weighed and placed in a 10 L jar. The solvent was added in a 1:10 ratio, which amounted to 2.5 L. Samples were steeped with each solvent separately for 24 hours and mixed every 6 hours. After 24 hours samples were filtered using filter paper. This procedure was repeated three times to maximize the extraction process. After the maceration was completed, a vacuum rotary evaporator was used to generate a thick extract (Kemenkes RI, 2017; Akhtar *et al.*, 2022; Verep *et al.*, 2023).

To ensure the quality of medicinal plant extracts, efforts must be taken to establish quality test standards that can be measured using both non-specific and specific parameters. If standardization is achieved, it is envisaged that the standardized extracts can be utilized as a pharmaceutical with consistent and measured levels of active compounds (Saifudin, 2011; Pandey and Tripathi, 2014).

Phytochemical Screening

Alkaloid Detection

A 0.5 g sample was placed in three test tubes, followed by 1 mL of 2N HCl and 5 mL of distilled water, which were heated for 5 minutes before being filtered. In test tube 1, two drops of Dragendorff's reagent were added. Test tube 2 was added with Mayer's and tube 3 with Wagner's. If the results were positive for alkaloids, the Dragendorff reagent will form a reddish-brown precipitate, the Mayer reagent will form a creamy white or yellow precipitate, and the Wagner will form a light brown or reddish precipitate (Shaik and Patil, 2020).

Flavonoid Detection

A 0.5 g of sample was put into a test tube followed by 0.5 g of Mg powder, 1 mL of concentrated HCl and 1 mL of amyl alcohol. This mixture was shaken slowly. If the flavonoid test is positive, the amyl alcohol layer will turn red, yellow, or orange (Supriyanto *et al.,* 2021; Tampang *et al.,* 2024).

Streoid/Trierponoid Detection

The Liebermann-Burchard reaction was used to investigate triterpenoid and steroid compounds. Two mL of the test fluid was evaporated in a porcelain cup. The residue was dissolved in 0.5 mL chloroform, followed by 0.5 mL of anhydrous acetic acid. Two mL of strong H_2SO_4 was then injected through the tube wall. A brownish or violet ring grows along the border. The solution indicates the presence of triterpenoids, while the greenish-blue ring suggests the presence of steroids (Puspitasari *et al.,* 2023).

Saponin Detection

A 0.5 g sample was placed in a test tube and heated with 5 mL of water in a water bath. The filtrate was then forcefully shaken for 10 seconds before being allowed to rest for 10 minutes. If the saponin test is positive, foam will occur (Supriyanto *et al.,* 2021; Tampang *et al.,* 2024).

Tannin Detection

A test tube was filled with 0.5 g of sample, and 5 mL of water and heated in a water bath. The sample was then chilled, with 2-3 drops of 1% $FeCl_3$ and 1% gelatin added. If the tannin test results are positive the color will be green, dark blue or greenish black (Supriyanto *et al.,* 2021; Tampang *et al.,* 2024).

Specific and Non-specific Parameters

Organoleptic Properties

The organoleptic examination including shape, odor, taste, and color are all analyzed as samples. The odor character was assessed using observations made after 15 minutes of exposure to air, which can be classified as odorless, distinctive odor, or other features (Depkes RI, 2000; Depkes RI, 2008; Yuslianti *et al.,* 2016).

Drying Loss

A total of 1-2 g of extract was weighed in an evaporizer cup, and then the surface of the extract was levelled before being placed in the oven at 105^0C for 30 minutes. Then we place it in a desiccator until cool, then weighed. The procedure was repeated two times (Depkes RI, 2000).

Water Content

The water content was evaluated through the distillation of toluene. The toluene was first saturated with water and then 5 g of extract was weighed and placed in a round bottom flask before adding the saturated toluene. The flask was heated for 15 minutes and after the toluene began to boil, the distillation rate was set to drops/second, then 4 drops/second. After all of the water has been

distilled the heating process was maintained for 5 minutes. The recipient tube was allowed to cool until room temperature (Depkes RI, 2000).

Ash Content

The total ash content was estimated by weighing roughly 2-3 g of extract and depositing it in a crucible that has been burned and tared. The crucible containing the extract was gently fired until charcoal formed, and it eventually burned out at 600^0C for 3 hours in a furnace. After that, we chilled and weighed. Ash content was estimated for air-dried materials (Depkes RI, 2000; Tampang *et al.,* 2024).

Specific Gravity

This test employed thick extract and distilled water, with a pycnometer as the primary instrument. The empty pycnometer was cleaned and dried before weighing as W0. The pycnometer was then filled with boiled water at 25^0C and weighed as W1. The extract was diluted by 5% with water. The liquid extract was placed in a pycnometer, the excess extract was removed, and the weight was recorded as W2. A liquid extract's specific gravity was calculated by dividing its density by that of water in a pycnometer at a temperature of 25^0C (Depkes RI, 1995).

RESULTS

Extract of the Samples

The yield of the extracts obtained using four different solvents is shown in **Table 1**.

Table 1. Yield of Jombang leaf extracts using aqueous, 50% ethanol, 80% ethanol, and ethyl acetate as solvents (*Rendemen ekstrak daun Jombang menggunakan pelarut air, etanol 50%, etanol 80%, dan etil asetat*).

Solvent (*Pelarut*)	**Sample Weight** (*Berat Sample*) **(g)**	**Extract Weight** (*Berat Ekstrak*) **(g)**	**Yield** (*Rendemen*) **(%)**
Ethyl Acetate	250	21.2	8.48
Ethanol 80%	250	79.9	31.90
Ethanol 50%	250	93.9	37.56
Aqueous	250	71.5	28.60

Phytochemical Screening

Phytochemical screening was conducted to detect the presence of alkaloids, flavonoids, saponins, tannins, and steroids/triterpenoids. The results are presented in **Table 2**.

Table 2. Phytochemical screening of Jombang leaf extracts using aqueous, 50% ethanol, 80% ethanol, and ethyl acetate as solvents (*Penapisan fitokimia ekstrak daun Jombang menggunakan pelarut air, etanol 50%, etanol 80%, dan etil asetat*).

Phytochemical compounds (*Komponen Fitokimia*)		**Results Test** (*Hasil Uji*)			
		Ethyl acetate Extract (*Ekstrak Etil asetat*)	**Ethanol 80% Extract** (*Ekstrak Ethanol 80%*)	**Ethanol 50% Extract** (*Ekstrak Ethanol 50%*)	**Aqueous Extract** (*Ekstrak Air*)
Alkaloid	Dragendorff	(-)	(+)	(+)	(+)
	Mayer	(-)	(-)	(+)	(-)
	Wagner	(-)	(+)	(+)	(-)
Flavonoid		(+)	(-)	(+)	(+)
Tannin		(+)	(+)	(+)	(+)
Saponin		(-)	(-)	(+)	(+)
Steroid		(+)	(-)	(-)	(+)
Triterpenoid		(-)	(+)	(+)	(-)

Ket.: (+): compound detected; (-): compound not detected (*Notes: (+): senyawa terdeteksi; (-): senyawa tidak terdeteksi*)

Organoleptic

Organoleptic test results are presented in **Table 3**.

Table 3. Organoleptic observations of Jombang leaf extracts using aqueous, 50% ethanol, 80% ethanol, and ethyl acetate as solvents (*Uji organoleptik ekstrak daun Jombang menggunakan pelarut air, etanol 50%, etanol 80%, dan etil asetat*).

Solvent (*Pelarut*)	**Color** (*Warna*)	**Odor** (*Bau*)	**Form** (*Bentuk*)	**Taste** (*Rasa*)
Ethyl acetate	Blackish green (*Hijau kehitaman*)	Distinctive (*Khas*)	Liquid (*Cairan*)	Bitter (*Pahit*)
80% ethanol	Brown (*Coklat*)	Distinctive	Thick (*Kental*)	Bitter
50% ethanol	Brown	Distinctive	Thick	Bitter
Aqueous	Blackish green	Distinctive	Liquid	Bitter

Drying Loss, Water Content, Ash Content, and Specific Gravity

The results for drying loss, water content, ash content, and specific gravity are summarized in **Table 4**.

Table 4. Drying loss, water content, ash content, and specific gravity of Jombang leaf extracts using aqueous, 50% ethanol, 80% ethanol, and ethyl acetate as solvents (*Susut pengeringan, kandungan air, kadar abu, dan bobot jenis ekstrak daun Jombang menggunakan pelarut air, etanol 50%, etanol 80%, dan etil asetat*).

Sample (*Sampel*)	**Drying Loss** (*Susut Pengeringan*) **(%)**	**Water Content** (*Kandungan Air*) **(%)**	**Ash Content** (*Kadar Abu*) **(%)**	**Specific Gravity** (*Bobot Jenis*) **(g/mL)**
Ethyl acetate	11.00	9.5	8.42	0.04
80% ethanol	2.94	12.5	9.40	0.06
50% ethanol	2.00	10.5	7.41	0.05
Aqueous	13.72	14	8.91	0.10

DISCUSSION

Yield Extracts

Yield extract calculations are used to evaluate the ratio of the amount of extract recovered from a material to the original weight of the simplicial material, as well as the number of bioactive compounds included in the extracted material (Maryam *et al.*, 2020). **Table 1** demonstrated that the yield of ethyl acetate extract was the lowest (8.48%) when compared to polar solvents such 50% ethanol (37.56%), 80% ethanol (31.9%), and aqueous extract (28.6%). Ethanol solvent is a molecule with a hydroxyl group that adds to hydrophilic qualities, allowing ethanol to attract polar chemicals in Jombang leaves (Widyawati *et al*., 2014; Anggestia *et al*., 2024; Nawangsih *et al*. 2024). This indicates that Jombang leaves contain more dissolved polar components than semi-polar ones (Truong *et al.,* 2019). These results were similar to our previous study on grape seed extraction, which showed that the ethanol solvent yielded a higher extract than ethyl acetate (Syafriana *et al.,* 2020; Hamida *et al.,* 2021).

The superior extraction yield observed with 50% ethanol compared to 80% ethanol can be attributed to the role of water in enhancing extraction efficiency. In ethanol-water mixtures, water increases the permeability of plant cell walls and promotes tissue swelling, thereby facilitating the release and diffusion of bioactive compounds, particularly phenolics. Aqueous ethanol also possesses lower viscosity than absolute ethanol, enabling better solvent penetration and more efficient mass transfer. While ethanol alone can dissolve certain semi-polar molecules, its reduced polarity at higher concentrations limits its ability to extract more polar compounds, such as flavonoid glycosides and tannins. These compounds are more soluble in solvents with intermediate polarity, as provided by 50% ethanol. Thus, the combination of improved tissue accessibility, optimal solvent polarity, and an expanded solubility range for both polar and semi-polar compounds likely contribute to the higher yield obtained with 50% ethanol (Plaskova and Mlcek, 2023).

Phytochemical Screening

Phytochemical screening was conducted to assess the presence of secondary metabolites in the samples. This examination is essential for determining the bioactive compounds that may contribute to the plants' known pharmacological activities and potential therapeutic applications. Moreover, it provides a scientific basis for the targeted isolation of active compounds and facilitates further in-depth studies (Shaikh and Patil, 2020).

As shown in **Table 2**, alkaloids were detected in the ethanol extract of *Jombang* leaves using all three reagents (Mayer, Dragendorff, and Wagner), whereas the ethyl acetate extract tested negative. This finding aligns with previous studies indicating that ethanol, a polar solvent, is more effective in extracting alkaloids compared to semi-polar solvents like ethyl acetate (Widayanti and Supriyati, 2009; Putri and Lubis, 2020; Syafriana *et al*., 2020; Adia *et al*., 2024). The weaker hydrogen bonding ability of ethyl acetate limits its capacity to solubilize alkaloids. Additionally, the aqueous extract only yielded a positive result with Dragendorff reagent, which, based on the criteria by Surbakti *et al*. (2018), is insufficient to confirm the presence of alkaloids. Therefore, alkaloids were considered absent in both ethyl acetate and aqueous extracts.

The flavonoid test revealed that extracts with ethyl acetate, 50% ethanol, and aqueous solvents were positive, while extracts with 80% ethanol solvent were negative. This result contradicts the general theory that ethanol is the most effective solvent for extracting polyphenolic compounds like flavonoids (Thouri *et al.,* 2017; Hamida *et al.,* 2021). Flavonoids are amphipathic molecules, containing both polar and non-polar functional groups, which makes them more soluble in characteristics within their molecular structure, which makes them more soluble in solvents with intermediate polarity (Yusof *et al.*, 2020).

The solubility of flavonoids depends greatly on their chemical structure and the polarity of the solvent used. According to Panche *et al.* (2016) and Plaskova and Mlcek (2023), flavonoids with hydroxylated groups (more polar) tend to dissolve better in water or polar solvents, while alkylated aglycones are more effectively extracted in less polar solvents like ethyl acetate (Doloking *et al*., 2022; Dias *et al*., 2021). Therefore, the successful extraction of flavonoids using ethyl acetate, 50%

ethanol, and water suggests that the Jombang leaves may contain both glycosidic (polar) and aglycone (less polar) flavonoids. This dual solubility profile may explain the negative result with 80% ethanol, which is less polar than 50% ethanol and water, and therefore less effective at extracting polar flavonoid glycosides.

Aside from flavonoids, tannins were the other polyphenolic compounds studied. The tannin test confirmed that the extracts from the four solvents contained tannin (**Table 2**). Tannins are polyphenolic compounds that generally be extracted using either a single solvent or a solvent mixture, depending on the desired yield and specificity. Commonly used solvents for tannin extraction include methanol, ethanol, acetone, and ethyl acetate (Yusof *et al.,* 2020; Kusuma *et al.,* 2022). This general information provides a background for interpreting the results of this study. According to Lis and Olas (2019), tannins may be identified in both ethanol and aqueous extracts of Jombang leaves. The present findings further show that ethyl acetate can also attract tannin compounds found in Jombang leaves, which may be due to interactions between the hydroxyl groups in tannins and the methoxyl or hydroxyl groups of the solvent. Tannins are amphipathic, possessing both polar (hydrophilic) and non-polar (hydrophobic) structural features. The hydroxyl group confer polarity, whereas the aromatic phenolic structure contributes to non-polar characteristics (Putri and Lubis, 2020).

Saponin is an active chemical with an easily detectable surface due to its capacity to produce foam. Compounds in the saponin group include polar glycosyl groups and non-polar steroid and triterpenoid groups. The affirmative saponin test produced foam only in 50% ethanol extract and aqueous solvents. Foaming suggests glycosides, which can create foam in water and then be digested into glucose and other chemicals (Rai *et al*., 2021; Elu *et al.*, 2023). However, these results are not consistent with the results of Ghaima *et al.* (2013) which revealed that the ethyl acetate extract of Jombang leaves contained saponin.

The results of the steroids and triterpenoids revealed the opposite patterns: steroids tested positive in aqueous and ethyl acetate, whereas triterpenoids tested positive in both ethanol solvents (50% and 80%). Triterpenoids are known as non-polar compounds, yet test results showed that it can be detected in universal solvents such as ethanol (Firdiyani *et al.,* 2015; Fadhila *et al.,* 2023). These results are in accordance with Puspitasari *et al.* (2023) which showed that ethanol extract of *Moringa* leaves containing triterpenoid compounds and negative for steroids, while ethyl acetate extracts of *Moringa* leaves showed positive for steroids and negative in triterpenoids.

Steroids are non-polar bioactive chemicals that are typically attracted to non-polar solvents. The steroids appear positive in ethyl acetate (semi-polar) and aqueous (polar) solutions. The dipole moment of polar and semi-polar compounds affects this, causing non-polar molecules without dipoles to form an electrostatic force between the two. Non-polar substances may be partially soluble in both polar and non-polar solvents due to this force (Firdiyani *et al.,* 2015; Khafid *et al.,* 2023).

Organoleptic

Organoleptic extract observation aimed to provide an initial introduction using the five senses by characterizing their shape, color, odor, and taste (Depkes RI, 2000). The organoleptic results of Jombang leaf extracts showed that the extracts derived from ethanol solvents were thick, whilst those obtained from ethyl acetate and aqueous solvents were liquid. These forms were aligned with the observed colors, which were brown for ethanol extracts and blackish green for ethyl acetate and aqueous extracts. These organoleptic characteristics were the first to be reported. It is intended that these data can serve as a reference for other researchers and future research on Jombang leaves.

Drying Loss, Water Content, Ash Content, and Specific Gravity

The drying loss parameter test is intended to establish a maximum limit (range) for the amount of water and volatile compounds lost during the drying process. The drying process quality improves as the drying loss value decreases (Kamali *et al.,* 2020). Drying loss indicates an extract's ability to maintain quality and prevent fungal growth (Depkes RI, 2000; Safitri, 2008). According to the data, the drying loss with 50% and 80% ethanol solvents was 2% and 2.94%,

respectively. This result fulfils the Depkes RI (2008) requirements of no more than 11% (**Table 4**). Meanwhile, drying loss with aqueous and ethyl acetate as solvents was 13.72% and 11%, respectively. The results from the aqueous extract did not match the WHO (2007) guidelines, which were no more than 11%. However, the ethyl acetate extract still met the standards despite being on the borderline of the maximum limit. Non-compliant drying loss might impair the quality and lead to mold growth (Safitri, 2008; Hidayati *et al.,* 2018).

Water content is determined to provide a minimal limit or range for the quantity of water present in the material. A natural medicinal substance's water content has a significant impact on its quality. The higher the water content, the shorter the shelf life since it promotes microbial development. Besides that, the determination of water content is also linked to the purity of the extract. The water content test revealed that the extract using ethanol and aqueous produced results greater than 10%, which is the upper limit for good water content. If the water content is excessively high, or more than 10%, fungi can grow on the sample causing harm and affecting its quality (Najib *et al.*, 2017; Maryam *et al.*, 2020). The only water content that passes the requirements of Depkes RI (2008) is ethyl acetate extract at 9.5% (less than 10%) (**Table 4**).

The ash content of an extract is one of its quality characteristics. The purpose of measuring the ash content is to determine the mineral content included internally from the beginning of the process to the production of the extract, as well as to regulate the amount of pollution from inorganic objects (Prabowo *et al.*, 2019; Putra and Sandhika, 2024). According to the data, the ash content for 50% ethanol and ethyl acetate solvents was 7.41% and 8.42%, respectively. This result fulfils the criteria set by the Depkes RI (2008), which are no higher than 8.5%. However, the extracts employing aqueous solvent and 80% ethanol yielded 8.91% and 9.40%, respectively. This result surpasses the normal ash content threshold, indicating that the extract contains inorganic contaminants. The presence of high minerals or trace elements may enhance the potential of drug interactions with conventional medications that are sensitive to cations (Jassim *et al.*, 2012).

The data from the specific gravity test revealed that the solvents ethyl acetate, 80% ethanol, 50% ethanol, and aqueous were 0.04 g/mL, 0.06 g/mL, 0.05 g/mL, and 0.10 g/mL, respectively. Specific gravity is defined as the ratio of the extract's density to the density of water expressed in terms of mass per unit volume. The purpose of determining specific gravity is to provide a mass value per unit volume, which is a special parameter used to compare the ability of liquid extracts to concentrated (thick) extracts and to provide an overview of the chemical content (Depkes RI, 2000).

CONCLUSION

This study demonstrated that solvent polarity significantly influences the phytochemical composition and extract quality of Jombang (*Taraxacum officinale*) leaves. Flavonoids were selectively extracted by ethyl acetate, 50% ethanol, and aqueous solvents, whereas alkaloids were present only in ethanol-based extracts, highlighting the critical role of solvent selection in targeting specific metabolite groups. The distinct distribution of secondary metabolites such as steroids, triterpenoids, and saponins across solvents underscores the amphipathic nature of these compounds and their varied solubility profiles. In terms of extract quality, organic solvents, particularly ethyl acetate and ethanol, produced extracts that met standard parameters for drying loss, water content, and ash content, suggesting their suitability for further pharmaceutical or nutraceutical development.This study offers a novel contribution by integrating specific and non-specific parameter analysis with solvent-based phytochemical screening, providing a more comprehensive approach to determining optimal extraction conditions for Jombang leaves.

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AUTHOR CONTRIBUTIONS

VS and AFM: Creating research concepts and supporting the materials. VS: Collecting research data, analysis of the data, drafting the article, and final manuscript revision; HAA and ZIV: Collecting research data and drafting the article; S: Analysis of the data and revising the manuscript.

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