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Comparison of Metabolite Content between Water Extract and Ethanol Extract of Moringa Leaves (*Moringa oleifera*): A Systematic Literature Review

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A B S T R A C T

Extraction with water and ethanol are two common methods used to isolate secondary metabolites from *Moringa oleifera*. Extraction with water usually produces extracts rich in polar compounds, while extraction with ethanol tends to be better at isolating non-polar compounds. This study aimed to carry out a systematic review related to the comparative study of metabolite content between aqueous extracts and ethanol extracts of *Moringa oleifera*. The literature search process was carried out on various databases (PubMed, Web of Sciences, EMBASE, Cochrane Libraries, and Google Scholar) regarding the comparison of the secondary metabolite content of aqueous and ethanol extracts of *Moringa oleifera*. This study follows the preferred reporting items for systematic reviews and meta-analysis (PRISMA) recommendations. Moringa leaf water extract has higher flavonoid and phenolic content than the ethanol extract of Moringa leaves. Meanwhile, the ethanol extract of Moringa leaves contains higher alkaloids and triterpenoids than the aqueous extract of Moringa leaves.

1. Introduction

Moringa oleifera, also known as moringa, is a plant that has a long history of use in traditional medicine and nutrition. One of the main reasons for interest in *Moringa oleifera* is the high content of secondary metabolites in this plant. Secondary metabolites are chemical compounds produced by plants in response to the environment and play an important role in the pharmacological properties and efficacy of these plants.[1-3]

Extraction with water and ethanol are two common methods used to isolate secondary metabolites from *Moringa oleifera*. Extraction with water usually produces extracts rich in polar compounds, while extraction with ethanol tends to be better at isolating non-polar compounds. Comparison of the content of secondary metabolites between the aqueous extract and the ethanol extract of *Moringa oleifera* can provide a better understanding of the chemical profile and potential biological activity of this plant.[4,5]

Various studies have been conducted to compare the content of secondary metabolites between the aqueous extract and the ethanol extract of *Moringa oleifera*. Analytical methods such as high-performance liquid chromatography (HPLC), mass spectroscopy (MS), and nuclear magnetic spectroscopy (NMR) have been used to identify and characterize these compounds. The results of this study demonstrated differences in secondary metabolite content between the aqueous extract and the ethanol extract of *Moringa*

oleifera. Some of the compounds commonly found in aqueous extracts include flavonoids, polyphenols, vitamins, and minerals. On the other hand, ethanol extract usually contains compounds such as alkaloids, glucosinolates, and triterpenoids.[6-8] This study aimed to carry out a systematic review related to the comparative study of metabolite content between aqueous extracts and ethanol extracts of *Moringa oleifera*.

2. Methods

The literature search process was carried out on various databases (PubMed, Web of Sciences, EMBASE, Cochrane Libraries, and Google Scholar) regarding the comparison of the secondary metabolite content of aqueous and ethanol extracts of *Moringa oleifera*. The search was performed using the terms: (1) "aqueous extracts" OR "ethanol extracts" OR" active compound" OR" secondary metabolite" AND (2) " *Moringa oleifera*". The literature is limited to preclinical studies and published in English. The literature selection criteria are articles published in the form of original articles, an experimental study about the comparison of secondary metabolite content of aqueous and ethanol extracts of *Moringa oleifera*, the control group only received liquid without therapeutic effect or no treatment, studies were conducted in a timeframe from 2013-2023, and the main outcome was the comparison of secondary metabolite content of aqueous and ethanol extracts of *Moringa oleifera*. Meanwhile, the exclusion criteria were animal models that were not related to the comparison of secondary metabolite content of aqueous and ethanol extracts of *Moringa oleifera*, the absence of a control group, and duplication of publications. This study follows the preferred reporting items for systematic reviews and meta-analysis (PRISMA) recommendations.

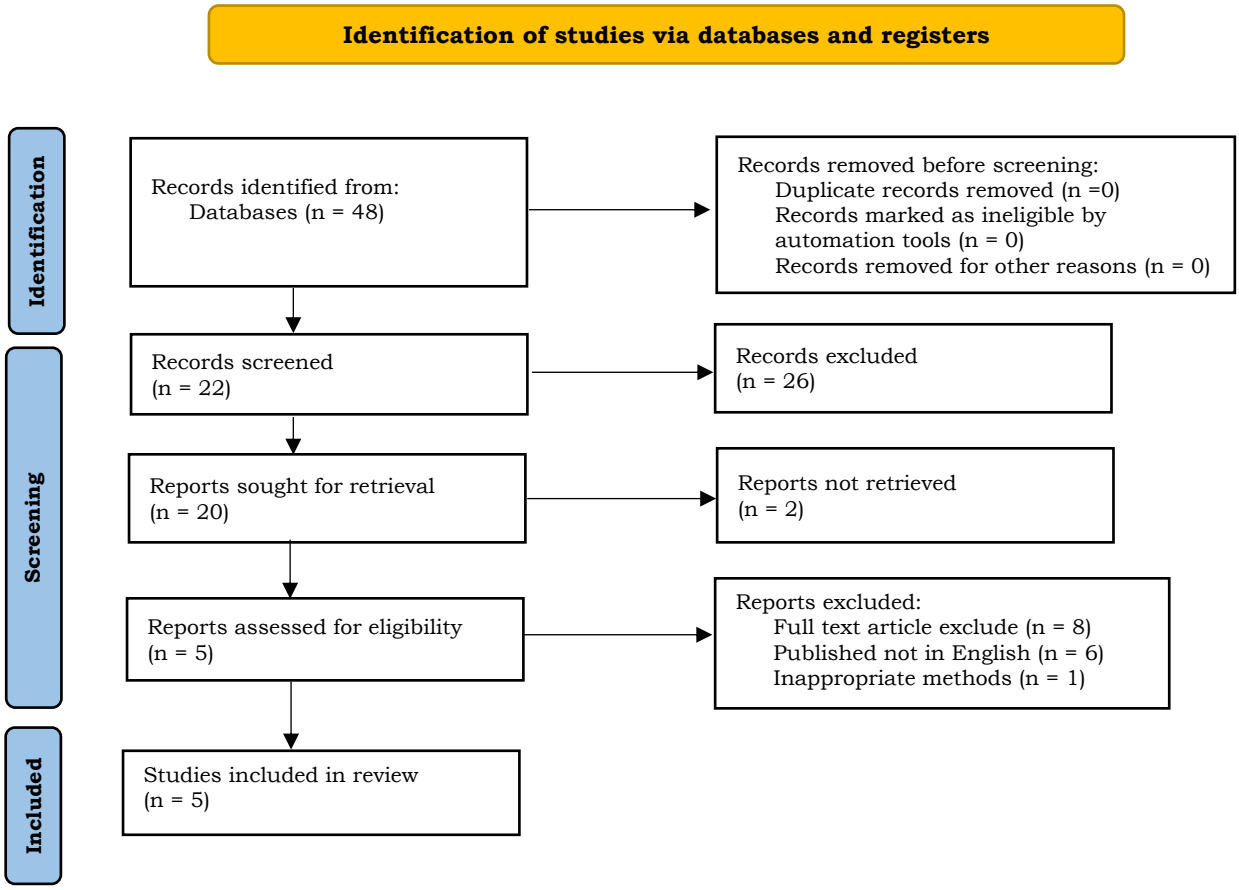

Figure 1. Research PRISMA diagram.

3. Results and Discussion

Comparison of the flavonoid content of water extract and ethanol extract of Moringa leaves

A comparison of the levels of flavonoids in the aqueous extract and the ethanol extract of Moringa leaves (*Moringa oleifera*) can give an idea of the concentration of flavonoid compounds contained in each extract. Flavonoids are a group of bioactive compounds found in many plants and have a variety of biological activities, including antioxidant, anti-inflammatory and anticancer. Several studies have been conducted to compare the levels of flavonoids in aqueous extracts and ethanol extracts of Moringa leaves. The results of this study can provide information about the preference of the solvent used to extract flavonoids from Moringa leaves.[9]

In several studies, aqueous extract of Moringa leaves is known to contain flavonoids such as quercetin, kaempferol, and rutin. Quercetin and kaempferol are flavonoids that are commonly found in many plants and have a variety of purported health benefits. On the other hand, the ethanol extract of Moringa leaves also contains flavonoids, but the levels and types of flavonoids found are less than the aqueous extract. Extraction with ethanol tends to be more effective in extracting non-polar flavonoids, such as kempferol-3-O-glucoside.[10]

Comparison of the phenolic content of aqueous extracts and extracts of ethanol Moringa leaves

A comparison of the phenolic content between the water extract and the ethanol extract of Moringa leaves (*Moringa oleifera*) can give an idea of the number of phenolic compounds contained in each extract. Phenolic compounds are a group of compounds that have antioxidant activity and have the potential to provide health benefits. Several studies have been conducted to compare the phenolic content in aqueous extracts and ethanol extracts of Moringa leaves. The results of this study can provide information regarding the preference of the solvent used to extract phenolic compounds from Moringa leaves.[11]

In several studies, the aqueous extract of Moringa leaves is known to contain phenolic compounds such as gallic acid, caffeic acid, chlorogenic acid, and protocatechuic acid. These compounds are phenolic types that are commonly found in various plants and have significant antioxidant activity. On the other hand, the ethanol extract of Moringa leaves may also contain phenolic compounds, but the content and type of phenolic found in the extracted ethanol are lower than the aqueous extract. Extraction with ethanol tends to be more effective in extracting more non-polar phenolic compounds.[12]

Comparison of the alkaloid content of water extract and extract ethanol Moringa leaves

A comparison of the alkaloid content between the aqueous extract and the ethanol extract of Moringa leaves (*Moringa oleifera*) can give an idea of the amount of alkaloid compounds contained in each extract. Alkaloids are a group of compounds that generally have pharmacological activity and can be found in various plants. However, it is important to note that Moringa leaves are generally known to have a low alkaloid content. In general, alkaloids are concentrated higher in other plant parts, such as roots or bark. Therefore, moringa leaf extract may contain relatively small amounts of alkaloids compared to other plant parts. In terms of the comparison between the aqueous extract and the ethanol extract, the ethanol extract tends to be more effective in extracting alkaloid compounds. Alkaloids have relatively non-polar properties, so non-polar ethanol solvents can be more efficient in extracting these compounds.[13-15]

Comparison of triterpenoid content of aqueous extracts and extracts of ethanol Moringa leaves

A comparison of the triterpenoid content between the aqueous extract and the ethanol extract of Moringa leaves (*Moringa oleifera*) can give an idea of the number of triterpenoid compounds contained in each extract. Triterpenoids are a group of compounds that are commonly found in plants and have various potential health benefits, such as anti-inflammatory, antioxidant, and anticancer activities.[16-17]

Scientific studies show that ethanol extract tends to be more effective in extracting triterpenoid compounds from Moringa leaves compared to aqueous extracts. The main reason is that triterpenoids are generally non-polar compounds, so non-polar ethanol solvents can be more efficient in extracting these compounds. Several triterpenoids that have been identified in the ethanol extract of Moringa leaves include compounds such as lupeol, sitosterol, and stigmasterol. These compounds are examples of triterpenoids that have various pharmacological and nutraceutical potentials.[18-20]

4. Conclusion

Moringa leaf water extract has higher flavonoid and phenolic content than the extract of ethanol Moringa leaves. Meanwhile, extract ethanol Moringa leaves contain higher levels of alkaloids and triterpenoids than aqueous extracts of Moringa leaves.

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