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ETHNOMEDICINAL AND PHYTOCHEMICAL ANALYSIS OF *MORINGA OLEIFERA*

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ABSTRACT

Moringa oleifera (Lam.), commonly known as the drumstick tree or horseradish tree, is a multipurpose plant revered for its nutritional and medicinal properties. This paper provides a comprehensive review of *M. oleifera's* ethnomedicinal uses across diverse cultures and its phytochemical profile, emphasizing the science behind its traditional applications. Ethnomedicinal data from South Asia, Africa, and Southeast Asia reveal its use in treating diabetes, inflammation, infections, and digestive disorders. Phytochemical analysis identifies flavonoids, glucosinolates, polyphenols, and alkaloids as key bioactive compounds, many of which exhibit antioxidant, anti-inflammatory, and antimicrobial activities. By correlating traditional uses with scientific findings, this study underscores *M. oleifera's* potential in modern pharmacology and nutraceuticals while highlighting gaps in clinical validation and standardization. Future research directions include systematic clinical trials and sustainable cultivation practices to harness its full potential.

1. INTRODUCTION

Moringa oleifera, a deciduous tree native to South Asia, is cultivated globally for its nutritional and therapeutic applications. Known as the "tree of life" due to its diverse benefits, *M. oleifera* has been a cornerstone of traditional medicine systems such as Ayurveda and African herbal practices. Its leaves, seeds, roots, and flowers are utilized to address conditions ranging from diabetes to parasitic infections. Modern scientific interest in *M. oleifera* has surged due to its phytochemical richness, which aligns with its traditional ethnomedicinal uses. This paper aims to synthesize existing knowledge on *M. oleifera's*

ethnomedicinal relevance and phytochemical composition, offering insights into its pharmacological potential and future research opportunities.

2. Ethnomedicinal Uses of *M. oleifera*

South Asian Traditions

In India, *M. oleifera* is deeply embedded in Ayurvedic medicine. Its leaves are consumed as a vegetable to manage diabetes and inflammation [1], while the bark is used for leprosy [2]. Roots, which contain Moringa-specific compounds, are employed as a stimulant and digestive aid [3]. The seeds are traditionally used as a purgative and to treat skin infections [4].

In sub-Saharan Africa, *M. oleifera* is valued for its nutritional and medicinal properties. The leaves are consumed as a dietary supplement to combat malnutrition, particularly in children [5]. Infusions of the bark are used to treat malaria and stomach ailments [6], while the gum is applied topically to wounds [7].

In Southeast Asia, *M. oleifera* flowers are used to treat coughs and colds [8], while the seeds are processed into water-purifying agents [9]. In the Philippines, the root is used as an anthelmintic [10]. These diverse applications highlight *M. oleifera's* adaptability to regional health needs.

Phytochemical Analysis of *M. oleifera*

Methods of Phytochemical Profiling

Advanced analytical techniques such as HPLC, GC-MS, and Spectrophotometry have been employed to isolate and quantify *M. oleifera's* bioactive compounds [11]. These methods enable precise identification of phytochemical classes and their concentrations across different plant parts.

Major Bioactive Compounds

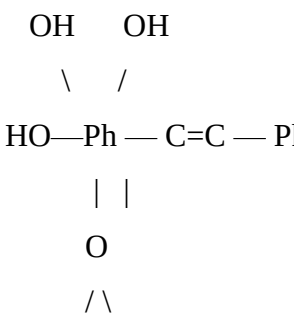
Flavonoids: Quercetin, kaempferol, and isorhamnetin are prevalent in leaves, exhibiting antioxidant properties [12].

Glucosinolates: Found in roots and seeds, these sulfur-containing compounds are implicated in anti-cancer activity [13].

Polyphenols: Phenolic acids like 4-(α-L-rhamnosyloxy) benzoic acid contribute to anti-inflammatory effects [14].

Quercetin (Aglycone)

Structure (2D):

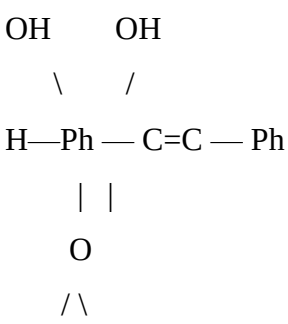


IUPAC:3,5,7,3′,4′-pentahydroxyflavone

Flavonol core with five hydroxy groups.Found in leaves and pods; occurs also as glycosides (e.g., quercetin-3-O-glucoside).

Kaempferol (Aglycone)

Structure (2D):



IUPAC:3,5,7,4′-tetrahydroxyflavone

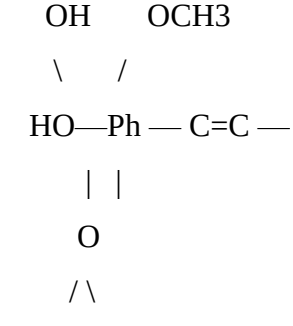
Features:

Flavonol with four hydroxy groups.

Present in leaves often as glycosides (kaempferol-3-O-hexosides).

3. Isorhamnetin

Structure (2D):

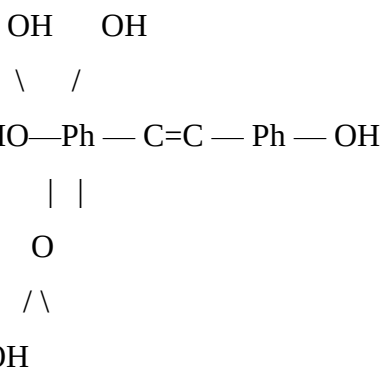


IUPAC:3,5,7-trihydroxy-4′-methoxyflavone

Methylated derivative of quercetin; major flavonol in leaf extracts.

Myricetin

Structure (2D):



IUPAC: 3,5,7,3′,4′,5′-hexahydroxyflavone

Highly-oxygenated flavonol; found in leaves sometimes as glycosides.

Rutin (Quercetin-3-O-rutinoside)

Structure (2D):

Quercetin core — O — Sugar (rutinose)

Quercetin aglycone **linked** to a disaccharide (rutinose) at the 3-OH.

A flavonoid glycoside commonly identified in *Moringa* leaves.

Flavonoid	**Class**	**Common Form in *M. oleifera***
Quercetin	Flavonol	Aglycone + glycosides
Kaempferol	Flavonol	Aglycone + glycosides
Isorhamnetin	Flavonol	Methylated aglycone
Myricetin	Flavonol	Aglycone
Rutin	Flavonoid glycoside	Quercetin-3-O-rutinoside

Alkaloids: Benzyl isothiocyanate from seeds displays antimicrobial properties [15].

Comparative Analysis by Plant Part

Leaves: Rich in vitamins (C, A) and iron; used to address anemia and oxidative stress [16].

Seeds: High in isothiocyanates; employed in water purification and as a laxative [17].

Roots: Contain moringinine, a compound linked to anti-epileptic effects [18].

Correlation of Ethnomedicinal Uses and Phytochemistry

Diabetes and Antioxidant Activity

In vitro studies validate the anti-hyperglycemic potential of *M. oleifera* leaf extracts, attributed to quercetin-mediated insulin sensitization [19]. Its polyphenols combat oxidative stress, a key factor in diabetes progression [20].

Anti-inflammatory and Antimicrobial Properties

The presence of glucosinolates and alkaloids supports its traditional use in treating inflammatory and infectious diseases [21]. For example, benzyl isothiocyanate demonstrates potent activity against Staphylococcus aureus [22].

Nutritional and Immune-

High vitamin C and carotenoid content in leaves align with their use as dietary supplements to enhance immunity [23].

CHALLENGES AND FUTURE DIRECTIONS

Standardization: Variability in phytochemical content due to environmental factors necessitates standardized cultivation and extraction protocols .Most studies are in vitro or animal-based; human trials are needed to substantiate ethnomedicinal claims .Promoting *M. oleifera* as a climate-resilient crop could address food and health insecurity

CONCLUSION

Moringa oleifera exemplifies the synergy between traditional wisdom and scientific research. Its phytochemical profile offers a rationale for many ethnomedicinal applications, particularly in metabolic and infectious diseases. Further interdisciplinary research is essential to bridge the gap between folklore and modern pharmacology, ensuring *M. oleifera's* equitable global utilization.

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