

Moringa oleifera: A Comprehensive Review of Its Historical Significance, Phytochemistry, Pharmacology, and Therapeutic Potential

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Abstract :-Moringa oleifera, commonly known as the drumstick tree or "miracle tree," is a highly valued plant with a long history of traditional use for its diverse nutritional and medicinal properties. Recent scientific research has highlighted the pharmacological potential of various parts of the plant, including its leaves, seeds, pods, and roots, as sources of bioactive compounds with antioxidant, anti-inflammatory, antidiabetic, and antimicrobial activities. Moringa is particularly rich in essential vitamins, minerals, amino acids, and unique phytonutrients such as glucosinolates and isothiocyanates, which are linked to its therapeutic effects. This review provides a comprehensive overview of the phytochemical composition, biological activities, and potential applications of Moringa oleifera in health promotion, with an emphasis on its antidiabetic, hepatoprotective, and immune-modulatory properties. Furthermore, the role of Moringa in addressing global nutritional challenges, particularly in malnutrition and food security, is discussed.

traditional medicine for centuries, especially in South Asia, Africa, and the Caribbean.

In terms of nutritional value, Moringa leaves are particularly rich in vitamins (A, C, and E), minerals (calcium, potassium, and iron), and essential amino acids, making it a powerful dietary supplement, particularly in regions facing malnutrition. The leaves are also packed with polyphenols, flavonoids, and other potent antioxidants that contribute to their wide range of therapeutic effects. From a pharmacological perspective, Moringa has garnered attention for its ability to modulate various biological pathways, offering promising applications in the treatment and prevention of chronic diseases such as diabetes, cardiovascular disorders, and inflammation-related conditions. One of the key bioactive compounds found in Moringa is moringinine, along with various isothiocyanates, which have been shown to exhibit potent anti-inflammatory and antidiabetic properties. Additionally, Moringa seeds are rich in antimicrobial peptides and exhibit excellent water purification properties, further enhancing its relevance in public health.

Given its potential to address both nutritional deficiencies and disease prevention, Moringa oleifera is increasingly being studied as a functional food and nutraceutical. This introduction to Moringa's chemical, nutritional, and medicinal profile provides the foundation for deeper exploration into its potential benefits for human health and its role in global food security.

INTRODUCTION

Moringa oleifera, a member of the Moringaceae family, is a fast-growing, drought-resistant tree native to the Indian subcontinent but now widely cultivated in tropical and subtropical regions worldwide. Known for its exceptional nutritional and medicinal qualities, Moringa has earned the title of "miracle tree" due to its remarkable capacity to grow in challenging environments while providing substantial health benefits. Nearly every part of the tree—leaves, seeds, pods, roots, bark, and flowers—has been utilized in

Plant Profile :-

Taxonomic Classification -

Kingdom	Plantae
Sub kingdom	Tracheobionta

Super Division	Spermatophyta
Division	Magnoliophyta
Class	Magnoliopsida
Subclass	Dilleniidae
Order	Capparales
Family	Moringaceae
Genus	Moringa
Species	Oleifera

Table :- 1

Botanical Description :-

Synonyms -

Latin	Moringa oleifera
Marathi	Shevaga
Sanskrit	Subhanjana
Hindi	Saguna, Sainjna
Gujarati	Suragavo
Tamil	Morigkai
Telugu	Mulaga, Munaga
Malayalam	Murinna, Sigru
Punjabi	Sainjna, Soanjna
Unani	Sahajan
Ayurvedic	Akshiva, Haritashaaka, Raktaka, Tikshnagandhaa
Arabian	Rawag
French	Moringe à graine ailée, Morungue
Spanish	Ángela, Ben, Moringa
Portuguese	Moringa, Moringueiro
Chinese	La ken
English	Drumstick tree, Horseradish tree, Ben tree

Table :- 2

Geographical Source :-

The tree thrives in tropical and subtropical regions, primarily in the Sub-Himalayan tracts from the Chenab River to Oudh, growing at elevations ranging from sea level to 1400 meters. It is widely cultivated in northeastern Pakistan, northeastern Bangladesh, and Sri Lanka. In India, it is commonly found in Assam, Bengal, and Peninsular regions, often near homes. Its range extends to the Arabian Peninsula, West Asia, and various parts of Africa, particularly East and West Africa. The tree is also found across the West Indies, southern Florida, Central and South America, including countries like Mexico, Peru, Brazil, and Paraguay. It is known for its resilience and ability to

regrow quickly after being cut, making it suitable for reforestation and cultivation in diverse climates.

Morphology :-

Moringa oleifera is a fast-growing tree that typically reaches 9–10 meters in height. It has a slender trunk with drooping branches and corky, gummy bark. The leaves are pale green, compound with many small, feather-like leaflets that are 1.3–2 cm long, with smooth edges and reddish mid-veins. The tree produces fragrant white or creamy-white flowers in large clusters, each about 2.5 cm wide. The pods are long, pendulous, ribbed, and triangular, measuring 30–120 cm in length. When dry, the pods split open to reveal about 20 dark brown seeds with thin, papery wings.



Fig 1 :- Plant Of Moringa Oleifera

Table 3. Some common medicinal uses of different parts of Moringa oleifera

Plant Part	Medicinal Uses
Root	Antilithic, Rubefacient, Vesicant, Carminative, Antifertility, Anti-inflammatory, Stimulant in paralytic afflictions, Cardiac/circulatory tonic, Laxative, Abortifacient, Treats rheumatism, Inflammations, Articular pains, Lower back or kidney pain, Constipation
Leaf	Purgative, Applied as poultice for sores, Headaches, Piles, Fevers, Sore throat, Bronchitis, Eye/ear infections, Scurvy, and Catarrh; Controls glucose levels, Reduces glandular swelling
Stem Bark	Rubefacient, Vesicant, Cures eye diseases, Treats delirious patients, Tuberculous glands, Spleen enlargement, Heals ulcers, Destroys tumors, Relieves earaches, Tooth painkiller, Anti-tubercular
Gum	Used for dental caries, Rubefacient, Relieves headaches, Fevers, Intestinal complaints, Dysentery, Asthma, Abortifacient, Treats syphilis and rheumatism
Flower	Stimulant, Aphrodisiac, Abortifacient, Cholagogue; Treats inflammations, Muscle diseases, Tumors, Spleen enlargement; Lowers cholesterol, Phospholipid, Triglycerides, VLDL, LDL; Decreases liver and aortic lipid profiles
Seed	Protects by decreasing liver lipid peroxides, Contains antihypertensive compounds, Reduces cholesterol and blood lipids; Thiocarbamate and isothiocyanate glycosides extracted from pods

Phytochemistry of Moringa oleifera :-

Phytochemicals are plant-derived chemicals that can affect health, flavor, texture, smell, or color, though they are not essential nutrients for humans. Moringa oleifera contains a variety of unique phytochemicals. Notably, it is rich in compounds with simple sugar rhamnose and a distinctive group called glucosinolates and isothiocyanates. Important components include 4-(4'-O-acetyl-a-L-rhamnopyranosyloxy)benzyl

isothiocyanate, 4-(a-L-rhamnopyranosyloxy)benzyl isothiocyanate, niazimicin, pterygospermin, benzyl isothiocyanate, and 4-(a-L-rhamnopyranosyloxy)benzyl glucosinolate, which are known for their hypotensive, anticancer, and antibacterial properties. Additionally, Moringa is also high in vitamins, minerals, and common phytochemicals like carotenoids, including β-carotene.

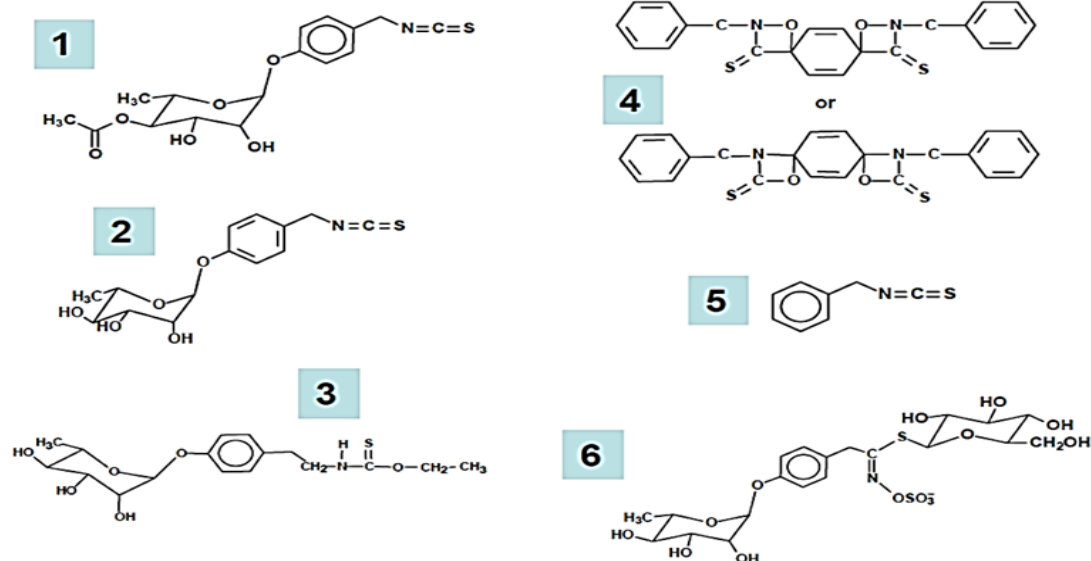


Figure 2. Structures of phytochemicals present from *Moringa* spp. : 4-(4'-O-acetyl-a-L rhamnopyranosyloxy) benzyl isothiocyanate [1], 4-(L-rhamnopyranosyloxy) benzyl isothiocyanate [2], niazimicin [3], pterygospermin [4], benzyl isothiocyanate [5], and 4-(a-L-rhamnopyranosyloxy) benzyl glucosinolate [6].

Pharmacological properties of *Moringa oleifera*:

1. Antibacterial and Antifungal Activity :-

Moringa oleifera demonstrates significant antibacterial activity against pathogens like *Escherichia coli*, *Staphylococcus aureus*, and *Pseudomonas aeruginosa*. The presence of bioactive compounds, including isothiocyanates and flavonoids, contributes to this effect. The plant extracts also exhibit antifungal properties, showing efficacy against fungi like *Aspergillus niger* and *Candida albicans*. These activities make *Moringa oleifera* useful for treating infections and preventing microbial growth. Additionally, its extracts can be used in natural antimicrobial formulations. This broad-spectrum antimicrobial action underscores its traditional use in wound care and infection management.

2. Antioxidant activity :-

Moringa oleifera exhibits strong antioxidant properties, primarily due to its rich content of phenolic compounds, including glucosinolates, isothiocyanates, thiocarbamates, and flavonoids. These compounds help neutralize reactive oxygen species (ROS), chelate metal ions, and regenerate antioxidants within cell membranes. Key components like β -carotene, vitamin A, and vitamin C contribute to its antioxidant effects. The plant's hydro-ethanolic leaf extract has been shown to effectively scavenge free radicals, prevent lipid peroxidation, and protect against oxidative

damage, thereby potentially aiding in the prevention of various diseases associated with oxidative stress.

3. Gastric ulcer protective activity :-

Moringa oleifera shows significant protective effects against gastric ulcers in animal models. Extracts from its leaves, when administered at doses of 200 and 400 mg/kg, have been shown to reduce ulcer severity in both pyloric ligation and ibuprofen-induced ulcer models. These extracts effectively lower the ulcer index and reduce the free and total acidity of gastric juice, comparable to the standard anti-ulcer drug famotidine. The presence of tannins and flavonoids in the extract may contribute to its protective effects by forming a protective barrier and enhancing capillary resistance, thus preventing ulcer development.

4. Analgesic and local anesthetic activity :-

Moringa oleifera demonstrates notable analgesic and local anesthetic properties. The alcoholic extract of its seeds exhibits potent analgesic effects comparable to aspirin at a dose of 25 mg/kg. Additionally, methanol extracts of the plant's root bark have shown significant local anesthetic activity in both frog and guinea pig models. This suggests that *Moringa oleifera* can be used for pain relief and local anesthesia, supporting its traditional use in managing pain and inflammation.

5. Anti-inflammatory and antinociceptive activity :-

Moringa oleifera has demonstrated significant anti-inflammatory and antinociceptive (pain-relieving)

effects in various animal models. The aqueous extract of the plant's roots effectively reduced edema in the carrageenan-induced inflammation model, comparable to the anti-inflammatory drug indomethacin. Additionally, the plant's leaf extract has shown dose-dependent antinociceptive activity in tests like writhing, hot-plate, and formalin assays. This suggests that *Moringa oleifera* can alleviate pain and inflammation through both peripheral and central mechanisms.

6. Cardioprotective activity :-

Moringa oleifera shows significant cardioprotective effects, particularly in the context of myocardial infarction induced by isoproterenol. Chronic treatment with its lyophilized hydroalcoholic extract improved hemodynamic parameters and modulated biochemical markers, reducing lipid peroxidation in myocardial tissue. It also mitigated histopathological and ultrastructural damage caused by the isoproterenol. These effects suggest that *Moringa oleifera* has protective properties for the heart, attributed to its antioxidant and myocardial-preserving actions.

6. Wound healing activity :-

Moringa oleifera exhibits significant wound healing properties. Its aqueous leaf extract, tested at doses of 300 mg/kg, promotes wound healing in rats through increased collagen deposition and improved alignment and maturation of tissue. This extract was effective in various wound models, including resutured incision, excision, and dead space wounds. These findings indicate that *Moringa oleifera* can accelerate the healing process and improve tissue repair.

7. Hypotensive and spasmolytic activity

Moringa oleifera has demonstrated hypotensive (blood pressure-lowering) effects through the isolation of active glycosides from its extracts. Notable compounds include niazirin and various isothiocyanates and thiocarbamates, which showed significant hypotensive activity. The plant also exhibits spasmolytic activity, which is beneficial for gastrointestinal motility disorders. These effects support its traditional use in managing blood pressure and digestive issues.

8. Anti-helminthic, hypolipidaemic, and antiatherosclerotic activity :-

Moringa oleifera shows strong anti-helminthic activity, effectively causing paralysis and death in worms, comparable to the drug piperazine citrate. It also demonstrates hypolipidaemic effects by

significantly lowering cholesterol levels and reducing atherosclerotic plaque formation in hypercholesterolemic rabbits. Additionally, the plant's methanolic extract has been shown to reduce serum cholesterol and triglyceride levels while increasing HDL, thus supporting its potential in managing lipid profiles and preventing atherosclerosis.

9. Antirolithiatic activity :-

Moringa oleifera exhibits antirolithiatic activity by effectively reducing calcium oxalate levels and kidney stone formation in rats. Both aqueous and alcoholic extracts of the plant's root-wood significantly lower urinary oxalate and stone-forming constituents, suggesting a regulatory effect on endogenous oxalate synthesis. These findings support the use of *Moringa oleifera* in preventing and managing kidney stones.

10. Anti-AIDS, antipyretic, and anti-asthmatic activity :-

Moringa oleifera shows potential as an anti-AIDS agent due to its immunostimulatory effects, enhancing immune response through both cellular and humoral immunity. The plant's ethanol extract exhibits antipyretic activity, effectively lowering body temperature and reducing fever in rats. Additionally, the ethanolic seed extract has been shown to alleviate asthma symptoms by reducing inflammatory markers in models of asthma, indicating its potential in managing respiratory conditions.

11. Hypocholesterolemic activity :-

Moringa oleifera demonstrates significant hypocholesterolemic activity by lowering cholesterol levels and reducing atherosclerotic plaque formation. In studies with hypercholesterolemic rabbits and rats, the plant's extracts significantly reduced serum cholesterol, triglycerides, LDL, and atherosclerotic indices, while increasing HDL levels. This indicates the plant's potential in managing cholesterol and preventing heart disease.

12. Anti-urolithiatic activity :-

Moringa oleifera exhibits notable anti-urolithiatic activity by reducing the formation of calcium oxalate stones in the kidneys. Both aqueous and alcoholic extracts of the plant significantly lower elevated urinary oxalate levels and reduce stone formation in rats. This suggests that *Moringa oleifera* may help in managing or preventing kidney stones through its effects on endogenous oxalate synthesis and deposition.

13. other activities of *Moringa oleifera* :-

Moringa oleifera shows potential in various other health applications. Its powder has been explored for anti-AIDS effects due to its immunostimulatory properties. The plant's extracts stimulate the immune system and may enhance cellular and humoral immunity. Additionally, *Moringa oleifera* has demonstrated antipyretic activity by reducing fever and anti-asthmatic effects by mitigating inflammation in asthma models. The plant's diverse biological activities highlight its broad therapeutic potential.

Traditional uses :-

Traditionally, *Moringa oleifera* has been widely used for its medicinal and practical benefits. It is known for its antispasmodic, stimulant, expectorant, and diuretic properties. The fresh root is acrid, with a taste similar to horseradish, and is used as a stimulant, diuretic, and

antilithic. The gum is mucilaginous, while the seeds are acrid and serve as stimulants. The bark is emmenagogue, abortifacient, antifungal, and antibacterial, and the flowers are cholagogue, diuretic, and helpful in increasing bile flow. The plant also functions as a cardiac tonic and antiseptic. The pods are antipyretic and anthelmintic, with fried pods being used for diabetes. Root juice acts as a cardiac tonic, antiepileptic, and is used for asthma, nervous debility, and liver or spleen enlargement. The leaves and pods are consumed as food, and the seeds yield Ben oil, which is used for lubrication, perfumes, and hair products. Various parts of the plant are employed in folk remedies, livestock feed, and even rituals against witchcraft.

Nutritional information :-

Aspect	Details
Nutritional Value	<ul style="list-style-type: none"> ➤ Vitamin A: More than carrots ➤ Calcium: More than milk ➤ Iron: More than spinach ➤ Vitamin C: More than oranges ➤ Potassium: More than bananas ➤ Protein: Comparable to milk and eggs
Food Source	<ul style="list-style-type: none"> ➤ Can be eaten fresh, cooked, or dried into powder. ➤ Dried powder can be stored for extended periods without refrigeration.
Health Benefits	<ul style="list-style-type: none"> ➤ Valuable during food scarcity ➤ Provides essential nutrients at the end of the dry season when other foods are limited.
Documented Impact	<ul style="list-style-type: none"> ➤ Highlighted by organizations such as Trees for Life. ➤ Documented to prevent malnutrition and support health in tropical regions.
Cultural Integration	<ul style="list-style-type: none"> ➤ Used both as food and medicine. ➤ Deeply ingrained in local diets and traditional practices.
Clinical Evidence	<ul style="list-style-type: none"> ➤ Anecdotal evidence supports benefits. ➤ Well-controlled clinical studies are needed for comprehensive validation.

CONCLUSION

Moringa (*Moringa oleifera*), known as the "miracle tree," is a highly versatile plant with numerous nutritional and medicinal benefits. Rich in vitamins, minerals, and antioxidants, its leaves, seeds, pods, and roots are widely used in traditional medicine to treat malnutrition, inflammation, and infections. *Moringa* has demonstrated significant pharmacological activities, including anti-inflammatory, antimicrobial, and antihyperglycemic properties. It shows potential in managing conditions like diabetes, hypertension, and supporting immune function. Widely cultivated in tropical regions, it is a valuable resource for food and medicine. However, caution is advised regarding the consumption of its roots and bark, which may contain

toxic compounds. Further research is needed to fully explore its therapeutic potential.

Overall, *moringa* holds great promise in the field of natural health and nutrition, offering significant potential as a source of dietary supplementation and herbal medicine. Further research is warranted to fully elucidate its pharmacological activities and optimize its applications in modern healthcare.

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