

Review Article**An overview of *Moringa oleifera*: Bioactive phytoconstituents and their therapeutic potentials****S. S. Satkar, Sukanya Kamane*, Manisha Kasar, Varsha Ghotkule, M. V. Gurav**

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Abstract

The use of medicinal plants for healing is as old as humanity. Man and his quest for substances in nature have been linked since ancient times. In India, a wide variety of medicinal plants with multiple therapeutic uses are cultivated, and the pharmaceutical industry uses these to make a range of products. The use of medicinal plants increasingly shifted away from the empirical framework and towards explicatory facts as the rationale behind the use of particular plants to cure particular ailments was being uncovered. The *Moringa oleifera* is one of "miracle tree," It was discovered that every part of the plant has bioactive components. More than a hundred chemicals, including alkaloids, flavonoids, anthraquinones, vitamins, glycosides, and terpenes, have been identified thus far from various sections of *Moringa oleifera*. The herb has long been used to treat inflammation, cancer, liver and heart disease, ulcers, wounds, and discomfort.

Keywords: *Moringa oleifera*, Moringaceae, antioxidant, isocyanates, inflammation

Introduction

The most commonly grown variety of *Moringa oleifera* is a pan-tropical plant known by several names, including Drumstick in English, Saragvo in Gujarati, Soanjna in Hindi, Sajna in Bengali, Nugge in Kannada, Sigru in Malyalam, Shevga in Marathi, Shobhanjana in Sanskrit, Munaga in Telgu, and Murungai in Tamil (Somali, 1984). Mostly used for food and medicine, the drumstick tree (*Moringa oleifera* Lam.), a member of the Moringaceae family, is extensively distributed from India to Africa and many other tropical and dry nations. It is extensively grown for both its leaves and immature seed pods, which are used as vegetables and in traditional herbal medicine. Water cleansing is another application for it (Kalibbala, 2009). The deciduous tree *M. oleifera* grows quickly, reaching a height of 10–12 m (33–39 ft) with a trunk diameter of 45 cm (18 in) (Parrotta and John, 1993). Because all portions of *Moringa oleifera* may be used for food, medicine, and other industrial and domestic purposes, it is considered a very valuable plant (Padayachee and Baijnath, 2020).

They are well known for lowering the likelihood of developing chronic illnesses like cancer, heart disease, and neurological disorders as well as for acting as a helpful mediator in their treatment. (Shahidi F. and Ambigaipalan P., 2015) Because of its exceptional nutritional, environmental, and health benefits, *Moringa oleifera* is also known as the "Miracle Tree" or the "Tree of Life." In India, moringa leaves have long been used as medicine to treat conjunctivitis and kill intestinal worms in the belly (Anwar et al, 2008). Fresh moringa leaves are also used to cure anemia and increase the amount of milk produced by expectant and nursing moms. Therapeutic phytochemicals, which can promote the development of new medications, are the reason why medicinal plant research and uses are growing daily. Carotenoids, phenolic acids, flavonoids, tannins, saponins, alkaloids, and glucosinolates are among the majority of plant-based phytochemicals that have positive impacts on health and cancer prevention. Plants contain a large number of secondary aromatic metabolites called phytochemicals, which help to prevent disease. Numerous pharmacological characteristics are also displayed by this plant, such as antioxidant, antimicrobial, anticancerous, antidiabetic, antiarthritic, antinociceptive, anti-lipogenic, anti-obesity, immunomodulatory, and hypertensive (Adedapo et al., 2015).

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E-mail: sukanyakamane@gmail.comDOI: <https://doi.org/10.31024/ajpp.2024.10.5.1>2455-2674/Copyright © 2024, N.S. Memorial Scientific Research and Education Society. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

Plant Taxonomy

Synonym: Drumstick, Saragvo, Soanjna, Sajna, Nugge, Sigru, Shevga, Shobhanjana, Munaga, Murungai

Taxonomic classification

Kingdom	:	Plantae
Subkingdom	:	Tracheobionta
Superdivision	:	Spermatophyta
Division	:	Magnoliophyta
Class	:	Dilleniidae
Subclass	:	Capparales
Order	:	Capparales
Family	:	Moringaceae
Genus	:	Moringa Adans.
Species	:	Moringa oleifera Lam

Morphological characteristics

Moringa oleifera is short, slender, deciduous, perennial tree, to about 10 m tall; rather slender with drooping branches; branches and stems brittle, with corky bark; leaves feathery, pale green, compound, tripinnate, 30–60 cm long, with many small leaflets, 1.3–2 cm long, 0.6–0.3 cm wide, lateral ones somewhat elliptic, terminal one obovate and slightly larger than the lateral ones; flowers fragrant, white or creamy-white, 2.5 cm in diameter, borne in sprays, with 5 at the top of the flower; stamens yellow; pods pendulous, brown, triangular, splitting lengthwise into 3 parts when dry, 30–120 cm long, 1.8 cm wide, containing about

20 seeds embedded in the pith, pod tapering at both ends, 9-ribbed; seeds dark brown, with 3 papery wings. Main root is thick. Fruit production occurs in March and April (Sabale et al., 2008). The table 1 describes some common medicinal uses of different parts of *Moringa oleifera*.

Chemical constituents

Moringa oleifera is reported to contain alkaloids, flavonoids, anthocyanins, proanthocyanidins, and cinnamate (Nath et al., 1992). All parts of the tree are considered to possess medicinal properties and are used in the treatment of ascites, rheumatism, and venomous bites and as cardiac and circulatory stimulants. The root is laxative, expectorant, diuretic, and good for inflammations, throat, bronchitis, piles, curing stomatitis, urinary discharges, and obstinate asthma (Kirtikar and Basu, 1935). The table 2 explains phytochemical constituents and their therapeutic activity.

Therapeutic applications

Hypolipidemic Effects

Lipid homeostasis may be impacted by a number of the bioactive substances included in MO leaves. Flavonoids and phenolic chemicals play significant roles in lipid control (Siasos et al., 2013). One significant source of possible treatment agents for diabetes and hyperlipidemia are medicinal plants. Adisakwattana and Chanathong, (2011) studied to examine how *Moringa oleifera* leaf

Table 1: Some common medicinal uses of different parts of *Moringa oleifera*

Plant part	Medicinal Uses
Root	Laxative, abortifacient, antilithic, rubefacient, vesicant, carminative, antifertility, anti-inflammatory, and stimulating in paralytic conditions; also acts as a cardiac/circulatory tonic and treats rheumatism, inflammation, articular aches, lower back or kidney discomfort, and constipation.
Leave	Leaf juice is used to minimize glandular swelling and is thought to regulate glucose levels. It is also used as a purgative, used as a poultice to sores, rubbed on the temples for migraines, and used for piles, fevers, sore throats, bronchitis, eye and ear infections, scurvy, and catarrh.
Stem bark	Rubefacient, vesicant and used to cure eye diseases and for the treatment of delirious patients, prevent enlargement of the spleen and formation of tuberculous glands of the neck, bark is put into ears to relieve earaches and also placed in tooth cavity as a pain killer, and has anti-tubercular activity
Gum	In addition to being astringent and rubefacient, gum is used to treat tooth cavities. When combined with sesame oil, it can also be used to treat fevers, headaches, intestinal issues, dysentery, and asthma.
Flower	High medicinal value as a cholagogue, aphrodisiac, abortifacient, and stimulant; used to treat tumors, inflammation, muscle diseases, and splenic enlargement; increases the excretion of fecal cholesterol and decreases the lipid profile of the liver, heart, and aorta in hypercholesterolemia rabbits; and lowers the serum cholesterol, phospholipid, triglyceride, VLDL, and LDL cholesterol to phospholipid ratio and atherogenic index.
Seed	The antihypertensive substances thiocarbamate and isothiocyanate glycosides have been separated from the acetate phase of the ethanolic extract of Moringa pods and the seed extract reduces liver lipid peroxides to provide its protective effect

Table 2: Phytochemical constituents and their therapeutic activity

Parts	Phytochemical Constituents	Therapeutic Activity
Roots	4(α -L-rhamnosyloxy)-benzyl isothiocyanate	Carminative, antifertility, anti-inflammatory, stimulant in paralytic afflictions,
Stem	4-hydroxymellein, vanillin, sitosterone, octacosanic acid and sitosterol	Protect skin keratinocytes against oxidative stress injury by enhancement of antioxidant defense systems
Bark	4(α -L-rhamnosyloxy)-benzyl isothiocyanate	Antihypertensive, anti-anxiety, anti-diarrheal, and as a diuretic
Whole gum exudates	L-arabinose, D-galactose, D-glucuronic acid, L-rhamnose, D-mannose, D-xylose and Leucoanthocyanidin	Used in emulsifying, thickening and stabilizing agent
Leaves	Glycoside: niazirin, niazirin and three mustard oil glycosides, 4-(4'-O-Acetyl- α -L-rhamnosyloxy)benzyl isothiocyanate, niaziminin A and B	Fevers, sore throat, bronchitis, eye and ear infections
Mature flowers	D-mannose, D-glucose, protein, ascorbic acid, polysaccharide	Strengthen bones, vitamin C to reduce inflammation, and some potassium, iron, and amino acids.
Whole pods	Nitriles, isothiocyanate, thiocarbamates, 0-[2'-hydroxy-3'-(2''heptenyloxy)]propylundecanoate 0-ethyl- 4-[(α -1-rhamnosyloxy)-benzyl] carbamate	Protecting and nourishing skin and hair, treating edema. Protecting the liver, Preventing and treating cancer, treating stomach upset, fighting foodborne bacterial infections, Preventing rheumatoid arthritis.
Mature seeds	Crude protein, Crude fat, carbohydrate, methionine, cysteine, 4-(α -L-rhamnopyranosyloxy)-benzylglucosinolate, benzyl glucosinolate, moringyne, mono-palmitic and di-oleic triglyceride	Asthma, diabetes, breast-feeding,
Seed oil	Vitamin A, beta carotene, precursor of Vitamin A	Helps to strengthen hair, retain moisture, and prevent dandruff and dry scalp due to its antibacterial properties.

extract affected the inhibition of pancreatic α -amylase and α -glucosidase linked to diabetes mellitus. Additionally, in vitro bile acid binding capability and inhibition of pancreatic lipase, cholesterol esterase, and cholesterol micellization were examined. During this study they were observe that *Moringa oleifera* leaf extract could be used to prevent hyperlipidemia and regulate lipid concentration (Adisakwattana and Chanathong, 2011). Because MO extracts block both lipase and cholesterol esterase, they exhibit hypolipidemic action, suggesting that they may be used to prevent and cure hyperlipidemia.

Antioxidant Effects

Because *Moringa oleifera* leaves contain high levels of antioxidants. The leaves, which are abundant in vitamins, carotenoids, polyphenols, phenolic acids, flavonoids, alkaloids, glucosinolates, isothiocyanates, tannins, and saponins, are the most utilized portions of the plant. The pharmacological characteristics of MO leaves may be explained by the large amount of bioactive chemicals. These pharmacological characteristics have been validated by numerous in vitro and in vivo investigations. Because MO leaves are high in antioxidants

and other nutrients that people in developing nations frequently lack, they are primarily employed for both medical and nutritional purposes. It has been demonstrated that the β -carotene in *Moringa oleifera* leaves has antioxidant properties.

Only when consumed in combination the antioxidants have the greatest impact on the harm that free radicals produce. It has been demonstrated that the combination of antioxidants present in *Moringa oleifera* leaves is more potent than a single antioxidant, presumably as a result of enhanced antioxidant cascade mechanisms and synergistic mechanisms. According to a recent study, *Moringa oleifera* leaves may be a significant source of vitamin A. (Anwar et al, 2008).

Anti-Inflammatory and Immunomodulatory Effect

The extract of *Moringa oleifera* leaves prevented the generation of human macrophage cytokines tumor necrosis factor alpha (TNF- α), interleukin-6 (IL-6), and IL-8), which were brought on by lipopolysaccharide (LPS) and cigarette smoke (Kooltheat et al., 2014). Four moringa

glucosinolates were converted into moringa isothiocyanates using naturally occurring myrosinase in a moringa concentrate (MC), which is created by extracting fresh leaves with water. 4-((α -L-rhamnosyloxy)benzyl) isothiocyanate, 4-((4'-O-acetyl- α -L-rhamnosyloxy)benzyl) isothiocyanate concentration, and optimal conditions for optimizing MC production were determined (Waterman et al., 2014). Additionally, it was shown that both MO concentration and isothiocyanates reduced RAW macrophages' gene expression and inflammatory marker generation. Through increases in white blood cells, neutrophil percentage, and serum immunoglobulins, MO leaf extracts boosted humoral and cellular immune responses in cyclophosphamide-induced immunodeficient mice. (Sudha et al., 2010).

Hepatoprotective Effects

One possible explanation for the hepatoprotective action of MO leaf methanol extract is quercetin (Anwar et al., 2008). *Moringa oleifera* leaves have been demonstrated to improve drug-induced liver and kidney damage and lower plasma levels of ALT, AST, ALP, and creatinine. Similar results were seen in rats co-treated with NiSO₄ and *Moringa oleifera* leaves to cause nephrotoxicity (Sharifudin et al., 2013). In addition to lowering lipids and lipid peroxidation levels in the rats' liver, *Moringa oleifera* leaves also significantly impacted the levels of aspartate amino transferase (AST), alanine amino transferase (ALT), and alkaline phosphatase (ALP) (Halaby et al., 2013).

Anti-Hyperglycemic (Antidiabetic) Effect

Numerous substances included in *Moringa oleifera* leaves may have a role in maintaining glucose homeostasis. Isothiocyanates, for instance, have been shown to lower hepatic gluconeogenesis and insulin resistance (Waterman et al., 2014; Fabio et al., 2014). In peripheral tissues, phenolic acids and flavonoids influence β -cell mass and function, impact glucose homeostasis, and raise insulin sensitivity. Terpenoids, which are involved in the activation of β -cells and the subsequent production of insulin, may be the cause of the hypoglycemic and antihyperglycemic effects of *Moringa oleifera* leaves. Furthermore, it has been demonstrated that flavonoids contribute significantly to the hypoglycemic effect (Manohar et al., 2012).

Hypotensive Effects

Several bioactive substances found in *Moringa oleifera* leaves, including nitrile, mustard oil glycosides, and thiocarbamate glycosides, have been utilized to stabilize blood pressure. Rats' blood pressure was lowered by the four pure chemicals that were separated from the ethanol extract of *Moringa oleifera* leaves: niazinin A, niazinin B, niazimicin, and niazinin. This action may have been caused by a calcium antagonist effect (Dubey) According to a recent study, *Moringa oleifera* decreased vascular oxidation in rats with spontaneous hypertension (Randriamboavonjy et al., 2017).

Effects on Ocular Diseases

Vitamin A insufficiency is the main cause of blindness, which can range from night blindness to dropped dark adaptation. High situations of vitamin A set up in *Moringa oleifera* leaves, capsules, and splint cream can help night blindness and other eye conditions. also, eating leaves with canvases averted the onset of cataracts and enhanced vitamin A nutrition (Anwar et al., 2008).

Anticancer Effects

Moringa oleifera chemo preventive qualities have been investigated, and it has been demonstrated to stop the growth of a number of human cancer cells (Karim et al., 2016). Acute myeloid leukemia, acute lymphoblastic leukemia, and hepatocellular carcinoma cells were all decreased in their ability to survive by the extract of *Moringa oleifera* leaves. The anti-cancer benefits of MO may be due to a number of bioactive chemicals, such as niazimicin, 4-(α -L-rhamnosyloxy) benzyl isothiocyanate, and β -sitosterol-3-O- β -D-glucopyranoside (Abdull Razis). By blocking NF- θ B signaling and improving the drug's action in these cells, *Moringa oleifera* has been demonstrated to decrease the proliferation of pancreatic cancer cells in pancreatic cells and boost the effectiveness of chemotherapy (Berkovich et al., 2013). Numerous studies have documented *Moringa oleifera* leaves' ability to shield cells and organisms against oxidative DNA damage, which is linked to degenerative illnesses and cancer.

Protection against Alzheimer's Disease (AD) and Parkinson's Disease (PD)

The modulatory significance of the monoaminergic system in memory processing is conceded, and announcement disrupts this system. The processes that laboriously contribute to the reduction of announcement symptoms include acetylcholinesterase inhibition, monoamine revision, the antiamyloid aggregation impact, and antioxidant exertion (Obulesu and Rao, 2011). It has been shown that some shops, similar as *Moringa oleifera*, ameliorate memory through nootropic action and guard against the oxidative stress associated with announcement (Ganguly). Glucomoringin (GMG)(4-(α -L-rhamnopyranosyloxy) benzyl glucosinolate) bioactivated with the enzyme myrosinase to form the corresponding isothiocyanate(4-(α -L-rhamnopyranosyloxy) benzyl C; moringin) was the subject of the current study in order to estimate an implicit neuroprotective effect in the treatment or forestallment of Parkinson's complaint (PD) (Giacoppo et al., 2017).

Conclusion

This review concluded that more than a hundred chemicals,

including alkaloids, flavonoids, anthraquinones, vitamins, glycosides, and terpenes, have been identified thus far from various sections of *Moringa oleifera*. The herb has long been used to treat inflammation, cancer, liver and heart disease, ulcers, wounds and discomfort. It can be used as potent ingredient for the development of phytopharmaceutical for various disorders.

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