

Phytochemical and Pharmacological Overview of Sahajan(*Moringa oleifera*)

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ABSTRACT

Moringa oleifera Lam. A truly miracle tree belongs to family Moringaceae, is a medium sized tree. The Moringa tree have spread to most part of Asia, nearly the whole of Africa, South America, southern part of North America and some pockets in Europe. The *M. oleifera* plant provides a rich and rare combination of zeatin, quercetin, β -sitosterol, and kaempferol. It is found to display a wide variety of pharmacological activities. The flowers of *M. oleifera* have stimulant, aphrodisiac, abortifacient, cholagogue property. Leaves are Purgative, applied as poultice to sores, used for piles, fevers, sore throat, bronchitis, scurvy and catarrh. Root contains laxative, abortifacient, vesicant, carminative, anti-inflammatory. Stem bark is Rubefacient, vesicant and used to cure eye diseases and for the treatment of delirious patients prevent. Traditionally, the plant is used as antispasmodic, stimulant, expectorant and diuretic. The present article describes various traditional and medicinal importance of the plant. Such herbal drug may provide potential effect as of compared to the conventional available synthetic drugs, with less or no side effects. The present review summarizes the referential information on this plant in order to provide current knowledge for future works. It also includes some of the pharmacological activities of *Moringa oleifera*

Keywords: *Moringa oleifera*, Moringaceae, Miracle tree, Pharmacological activities.

INTRODUCTION

India is the largest producer of medicinal herbs and approximately called the botanical garden of the world. In rural India, 70% of the population is dependent on the traditional system of medicine. In western world also the practitioner of herbal medicines is steadily growing and approximately 40% of the population is taking herbs to treat diseases.¹ The herbal products today symbolize safety in contrast to the synthetics that are regarded as unsafe to human and environment. Although herbs had been priced for their medicinal, flavouring and aromatic qualities for centuries, the synthetic products of the modern age surpassed their importance, for a while. However, the blind dependence on synthetics is over and people are returning to the naturals with hope of safety and security.²

According to WHO report, over 80% of the world population relies on the traditional medicine system largely plant, based for their primary health care needs.³ The use of plants for healing purposes predates human history and forms the origin of much modern medicine. In almost all the traditional medicines, the medicinal plants play a major role and constitute the backbone of the

traditional medicines. India has a rich heritage of traditional medicines and the traditional health care system have been flourishing for many centuries. It mainly consist of three major systems namely Ayurveda, Siddha and Unani system of Medicine.^{4,5}

Moringa oleifera Lam (Moringaceae) commonly known as drumstick or horseradish, has an important position in Ayurveda- an Indian indigenous system of medicine. It is a small, fast, growing, evergreen tree that usually grows up to 10 or 12 m in height, native to the Sub-Himalaya tracts of India, Pakistan, Bangladesh, Central America, Afghanistan, and Africa. Moringa, which is rich in vegetable oil and high in nutritional values, is used in Asia as a vegetable and medicinal plant. This is attributed to the presence of proteins, vitamins, and various phenolic compounds in the oil.⁶ The diverse range of medicinal uses for *Moringa oleifera*, include its use as an antioxidant,⁷ anti-carcinogenic⁸ anti-inflammatory, antispasmodic, diuretic⁹ antiulcer, antibacterial, antifungal¹⁰ and its antinociceptive properties, as well as its wound healing ability has been demonstrated. Additionally, the root bark has been used as an

analgesic, alexeteric, anthelmintic, and treatment for heart complaints, as well as for eye diseases, inflammation and dyspepsia.¹¹

It is a perennial softwood tree with timber of low quality. *Moringa oleifera* is an important food commodity which has had enormous attention as the 'natural nutrition of the tropics'.¹² The leaves, fruit, flowers and immature pods of this tree are used as a highly nutritive vegetable in many countries, particularly in India, Pakistan, Philippines, Hawaii and many parts of Africa^{13,14}

Almost all the parts of this plant: root, bark, gum, leaf, fruit (pods), flowers, seed and seed oil have been used for various ailments in the indigenous medicine of South Asia. All parts of the *Moringa* tree are edible and have long been consumed by humans.

According to Fuglie the many uses for *Moringa* include: alley cropping (biomass production), animal forage (leaves and treated seed-cake), biogas (from leaves), domestic cleaning agent (crushed leaves), blue dye (wood), fencing (living trees), fertilizer (seed-cake), foliar nutrient (juice expressed from the leaves), green manure (from leaves), gum (from tree trunks), honey- and sugar cane juice-clarifier (powdered seeds) honey (flower nectar), medicine (all plant parts), ornamental plantings, biopesticide (soil incorporation of leaves to prevent seedling damping off), pulp (wood), rope (bark), tannin for tanning hides (bark and gum), water purification (powdered seeds). *Moringa* seed oil (yield 30-40% by weight), also known as Ben oil, is a sweet non-sticking, non-drying oil that resists rancidity. It has been used in salads for fine machine lubrication and in the manufacture of perfume and hair care products. This tree has in recent times been advocated as an outstanding indigenous source of highly digestible protein, Ca, Fe, Vitamin C and carotenoids suitable for utilization in many of the so-called "developing" regions of the world where undernourishment is a major concern. The *moringa* tree, *Moringa oleifera* has probably been the most popular plant in ECHO's seed bank of underutilized tropical crops¹⁵

Taxonomic Classification

Kingdom -	Plantae
Sub kingdom -	Tracheobionta
Super Division -	Spermatophyta
Division -	Magnoliophyta
Class -	Magnoliopsida
Subclass -	Dilleniidae
Order -	Capparales
Family -	Moringaceae

Genus -	<i>Moringa</i>
Species -	<i>Oleifera</i>

Botanical Description

Synonyms

Latin -	<i>Moringa oleifera</i>
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

Morphology

Moringa oleifera is a small, fast-growing evergreen or deciduous tree that usually grows as high as 9 m. with a soft and white wood and with corky and gummy bark. Leaves are longitudinally cracked. Leaves have long main axis (30-75 cm) and jointed branch. The leaflets are finely hairy, green and almost hairless on the upper surface, paler and hairless beneath, with red-tinged mid-veins, with entire (not toothed) margins and are rounded or blunt-pointed at the apex and short-pointed at the base. The twigs are finely hairy and green. Flowers are white, scented in large auxiliary down panicles, pods are pendulous, ribbed, and seeds are 3-angled.

Geographical Source

The tree is wild in the Sub-Himalayan tracts from Chenab to Oudh. It grows at elevations from sea level to 1400 m. It is very commonly cultivated near houses in Assam, Bengal and peninsular India. It is a prolific coppice¹⁶ It is also cultivated in north-eastern Pakistan, north-eastern Bangladesh, Sri Lanka, West Asia, the Arabian peninsula, East and West Africa, throughout the West Indies and southern Florida, in Central and South America from Mexico to Peru, as well as in Brazil and Paraguay.¹⁷

Traditional Uses

Traditionally, the plant is used as antispasmodic, stimulant, expectorant and diuretic. Internally it is used as stimulant, diuretic and antilithic. Seeds

are stimulant. Bark is emmenagogue, antifungal, antibacterial. Flowers are cholagogue, stimulant, tonic and diuretic and useful to increase the flow of bile. The plant is also a cardiac circulatory tonic and antiseptic. Pods are antipyretic, anthelmintic; fried pods are used in diabetes. Root juice is employed in cardiac tonic, antiepileptic, in nervous debility, asthma, enlarged liver and spleen, deep seated inflammation and as diuretic in calculus

affection. Decoction is used as a gargle in hoarseness and sore throat. Root and fruit are antiparalytic. Leaf juice is used in hiccough (emetic in high doses), cooked leaves are given in influenza and catarrhal affections. Root-bark is used as antiviral, anti-inflammatory, analgesic. Stem-bark and flowers are hypoglycemic. Infusion of seed is anti-inflammatory, antispasmodic and diuretic, also given in venereal diseases.¹⁸

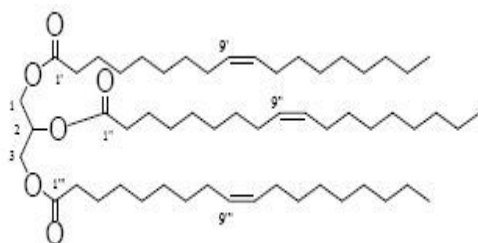
Table 1: Medicinal uses of different plant parts

S No.	Plant parts	Medicinal uses
1	Root	Antilithic, rubefacient, laxative, abortifacient, vesicant, carminative, anti-inflammatory, stimulant in paralytic affections; a Cardiac/circulatory tonic used in treating Rheumatism, articular pains, lower back or kidney pain and constipation.(Fig :1a)
2	Leaves	Purgative, applied as poultice to sores, rubbed on the temples for Headaches; used for piles, fevers, sore throat, bronchitis, eye and Ear infections, scurvy and catarrh; leaf juice is believed to control Glucose levels, applied to reduce glandular swelling (Fig:1b)
3	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, used to destroy tumors and to heal ulcers. (Fig: 1c)
4	Root bark	The juice from the root bark is put into ears to relieve earaches and also placed in a tooth cavity as a pain killer, and has anti-tubercular activity
5	Gum	Used for dental caries, and as astringent and rubefacient; Gum, mixed with sesame oil is used to relieve headaches, fevers, intestinal complaints, dysentery, asthma and sometimes used as an abortifacient, and to treat syphilis and rheumatism
6	Flower	stimulant, aphrodisiac, abortifacient, cholagogue; used to cure inflammations, muscle diseases, hysteria, tumors, and enlargement of the spleen; lower the serum cholesterol, phospholipid, triglyceride, VLDL, LDL cholesterol to phospholipid ratio and atherogenic index; decrease lipid profile of liver, heart and aorta in hypercholesterolaemic rabbits (Fig:1d)
7	Seed	Seed extract exerts its protective effect by decreasing liver lipid peroxides ¹⁹

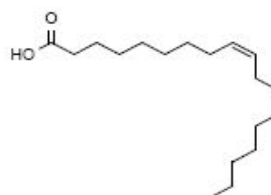
Table 2: Phytochemicals isolated from different parts of plant

Phytochemical content	Isolated from
Benzylamine ²⁰	Root bark
Aurantiamide acetate (a rare dipeptide) and 1,3 dibenzyl urea ²¹	Root
Vanillin, β -sitosterol, β -sitostenone, 4-hydroxymellein and octacosanoic acid ²²	Stem
β -Sitosterol, Alkaloids- moringine, moringinine ²³	Stem bark
4-Hydroxymellein, Vanillin, Octacosanoic acid, β -Sitostenone ²⁴	Stem
L-arabinose, D-galactose, D-glucuronic acid, L-rhamnose, D-mannose and D-xylose ²⁵	Gum
Gossypetin ²⁶ niazirin and niazirin ²⁷ , three mustard oil glycosides, 4-[(4'-O-acetyl- α -L-rhamnosyloxy)benzyl] isothiocyanate, niaziminin A and niaziminin B. ²⁸ Growth promoters, Phenolic acids-gallic ²⁹ , chlorogenic, ellagic and ferulic acid.	Leaves
Quercetagenin, kaempferol, quercetin and rutin; Ascorbic acid, carotenoids (mainly lutein and β -carotene) ³⁰	Pods
Glycosides- thiocarbamate and isothiocyanate. Two new compounds, O-[2'-hydroxy-3'-(2"-heptenyloxy)]-propyl undecanoate and O-ethyl-4-[(α -L-rhamnosyloxy)-benzyl] carbamate. Methyl p-hydroxybenzoate and β -sitosterol have also been isolated. A water-soluble polysaccharide was isolated from the aqueous extract of pods of <i>Moringa oleifera</i> . The polysaccharide contains d-galactose, 6-O-Me-d-galactose, d-galacturonic acid, l-arabinose and l-rhamnose. Plant hormones- auxins and cytokinins ³¹	
Glycosides-carbamate, thiocarbamate, and isothiocyanate Ascorbic acid, oestrogenic substances, β -sitosterol, iron, calcium, phosphorus, copper, Vitamin A, B, C, α -tocopherol, riboflavin, nicotinic acid, folic acid, pyridoxine, β -carotene, proteins, essential amino acids – methionine, cystine, tryptophan and lysine. Novel bioactive nitrile glycosides- Niaziridin and niazirin ³²	Leaves and pods
Rhamnetin, Amino acids, sucrose, d-glucose, traces of alkaloids, wax Flavonoids -quercetin, kaempferol, isoquercitrin, rhamnetin, kaempferitrin Minerals- potassium, calcium	Flowers

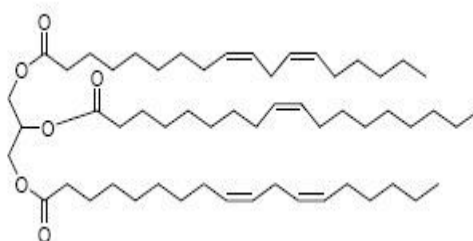
α and gamma tocopherols ³³	Leaves, flowers and fresh beans
Indole acetic acid, Indole acetonitrile, Proanthocyanidins ³⁴	Fruit
Moringyne, Monopalmiticdioleicdioleic triglyceride, 4-Hydroxyphenyl acetamide, 4-Hydroxyphenylacetic acid, O-ethyl-4-(α -L-rhamnosyloxy) benzyl carbamate, 4(α -L-rhamnosyloxy) benzyl isothiocyanate, 4(α -L-rhamnosyloxy)benzyl nitrile, 4(α -L rhamnosyloxy)benzylglucosinolate, niazimicin, 3 -O-(6'-O-oleoyl-beta-D-glucopyranosyl)- β -sitosterol, β -sitosterol-3-O- β -D-glucopyranoside, niazirin, β -sitosterol, glycerol-1-(9-octadecanoate), isothiocyanates, thiocarbamates and flavonoids Presence of a hemagglutinin is also reported ³⁵	Seeds
Campesterol (up to 15.13 %), stigmasterol (up to 17.27%), β -sitosterol (up to 50.07 %), delta5-avenasterol, delta7-avenasterol, clerosterol, 24-methylenecholesterol, delta7-campestanol, stigmastanol, 28-isoavenasterol, unsaturated fatty acids - (especially oleic acid up to 75.39 %) Saturated fatty acids- behenic (up to 6.73%) and palmitic (upto 6.04 %) monoterpenoid compounds (81.8%) dominate the oil of <i>Moringa oleifera</i> with an abundance of α -phellandrene (25.2%) and p-cymene (24.9%) ³⁶	Seed oil



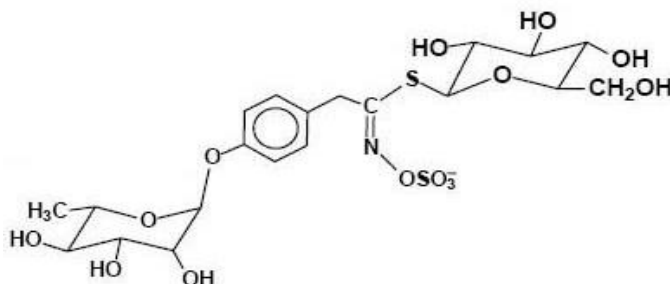
1, 2, 3 – triolein

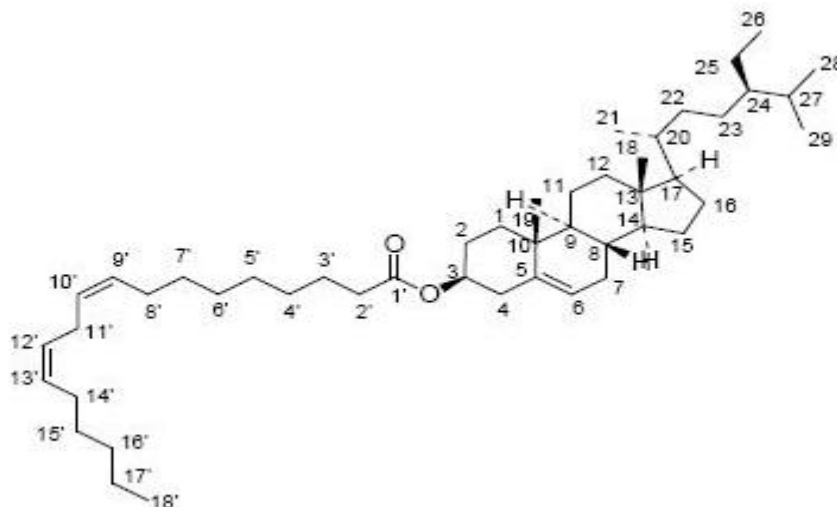


Linoleic acid

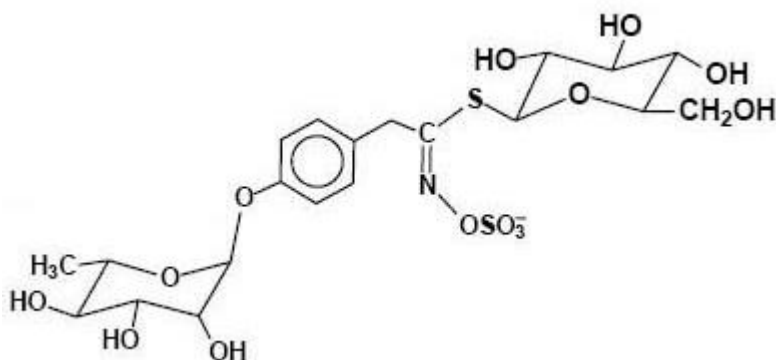


1,3 – dilinoeoyl-2-olein

4-(α -L-rhamnopyranosyloxy) benzyl glucosinolate



Linoleic sitosterate

4-(α -L-rhamnopyranosyloxy) benzyl glucosinolate

Pharmacological Properties

Moringa oleifera also has numerous medicinal uses, which have long been recognized in the Ayurvedic and Unani systems of medicine. The medicinal attributes and pharmacological activities ascribed to various parts of *Moringa* are detailed below.

Antioxidant activity

Hydro-alcoholic extract of *Moringa oleifera* at doses of 125 mg/kg bodyweight and 250 mg/kg body weight for 7 and 14 days, respectively produced antioxidant property.³⁷

CNS Activity

Ethanol extract from the leaves of *Moringa oleifera* at dose of 2000mg/kg protected mice against pentylenetetrazol induced convulsion and also possess CNS depressant activity.³⁸

Ethanol extract of *Moringa oleifera* leaves in alteration of brain monoamines (norepinephrine, dopamine and serotonin) & EEG wave pattern in Alzheimer's disease in rats. Treatment with *Moringa oleifera* leaf extract restores the monoamine levels of brain regions to near control levels.³⁹

Antimicrobial activity

Moringa oleifera root bark extract was investigated against *Staphylococcus aureus*, *Escherichia coli*, *Salmonella gallinarum* and *Pseudomonas aeruginosa* in vitro. Both the gram-positive and gram-negative organisms showed variable sensitivity to different extracts of *M.oleifera* root bark in organic solvents like methanol, acetone, ethyl acetate and chloroform and in inorganic solvent, water. Ethyl acetate and acetone extracts showed maximum antibacterial activity.⁴⁰

Protease Inhibitor

Among the different parts of *M. oleifera* tested, the crude extract isolated from the mature leaves and seeds showed the highest level of inhibition against trypsin. Various extraction media evaluated, the crude extract prepared in phosphate buffer showed maximum recovery of the protease inhibitor. The protease inhibitor recorded high inhibitory activity toward the serine proteases thrombin, elastase, chymotrypsin and the cysteine.⁴¹

Analgesic, Antipyretic & Wound Healing Activity

Aqueous extract of bark of *Moringa oleifera* for normal wound healing and dexamethasone suppressed wound healing using incision, excision and dead space, *Moringa oleifera* significantly increased the wound breaking strength in incision wound mode wound models in Wistar rats.⁴²

Anti-Diabetic Activity

The aqueous extract of *M. oleifera* leaves as a potent antidiabetic were assessed histomorphometrically, ultrastructurally and biochemically. *M. oleifera* treatment significantly ameliorated the altered FPG (from 380% to 145%), reduced glutathione (from 22% to 73%) and malondialdehyde (from 385% to 186%) compared to control levels. *M. oleifera* significantly increased the areas of positive purple modified Gomori stained α -cells (from 60% to 91%) and decreased the area percentage of collagen fibers (from 199% to 120%) compared to control values.⁴³

Anti-diabetic effect of leaves of *Moringa oleifera* on glucose tolerance in Goto-Kakizaki and Wistar rats. *Moringa* significantly decreased the blood glucose in Wistar rats. The area under the curve of changes in the blood glucose was significantly higher in the Goto-Kakizaki rats. The action of MO was greater in Goto-Kakizaki rats than in Wistar rats.⁴⁴

Anti-Ulcer Activity

Ethanollic root-bark extract of *Moringa oleifera* at doses of 350 and 500 mg/kg decreased the ulcer index significantly as compared to the control group, ethanol-induced and pylorus ligation-induced gastric ulceration.⁴⁵

The leaf extracts of *Moringa oleifera*, (150 mg.kg⁻¹, p.o.) in rats offered significant protection against indomethacin-induced, ethanol-induced, and ischemic reperfusion-

induced ulcer models when compared to the control group.⁴⁶

Antimalarial

M. oleifera seeds were evaluated for the larvicidal and pupicidal potential of the methanolic extracts against malarial vector *Anopheles stephensi* mosquitoes at different concentrations (20, 40, 60, 80 and 100 ppm). Phytochemicals derived from *M. oleifera* seeds extracts are effective mosquito vector control agents.⁴⁷

Commercial and industrial application of *Moringa oleifera*

Water treatment

Significant cytotoxicity effects were observed when the powdered *M. oleifera* seeds concentration is from 1 to 50 mg/L. Through direct contact, ethanolic-water extraction and hexane extraction, the toxic effects of hydrophobic and hydrophilic components in *M. oleifera* seeds were distinguished. It suggested that the hydrophobic lipids contributed to the dominant cytotoxicity, consequently resulting in the dominant genotoxicity in the water-soluble fraction due to limited dissolution when the *M. oleifera* seeds granule concentration was from 10 to 1000 mg/L.⁴⁸

The highest removal efficiency of color, turbidity, and UV-254 nm occurred with 1M NaCl solution, with coagulant concentration between 100 and 300 mg L⁻¹.⁴⁹

Moringa oleifera seed utilizing electrophoresis, and compared the efficiency of different extracts obtained, using solutions of NaCl (0.01 M, 0.1 M and 1 M), distilled water, *Moringa oleifera* Lam seed, acting as a natural coagulant in order to obtain drinking water.⁵⁰

Poultry Diet

Moringa oleifera leaves in maize meal fed to poultry showed profound, statistically significant effect on their weight as well as intensity in coloration of the beaks and legs, combs and wattles, in contrast to a control (maize-meal only) feeding of broilers. Moreover, a significant level of the biochemical minerals of serum Calcium, Sodium, Potassium, Chloride, Albumen and Triglyceride were observed in broilers fed with the formulated *Moringa oleifera* leaves and maize meal as compared to the maize meal only (control).

Ben Oil

The Moringa seeds yield 38–40% edible oil (called ben oil from the high concentration of behenic acid contained in the oil). The refined oil is clear, odorless, and resists rancidity at least as well as any other botanical oil. The seed cake remaining after oil extraction may be used as a fertilizer or as a flocculent to purify water. Oil from the seed, called oil of Ben, is used for earache and in ointments for skin conditions. The oil rubbed on the skin is said to prevent mosquitoes from biting.

Bio-Gas

Methane gas can also produce out of the leaves. Experiments have established that it is possible to produce 4400 cubic meters of bio gas per hectare per year.⁵¹

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