

Phytochemistry and Pharmacology of *Moringa oleifera* Lam

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Key Words

antipyretic, *Moringa oleifera*, niazimicin, pharmacological activity

Abstract

Moringa oleifera Lam. or *munga* is one of the most important plant widely cultivated in India. It belongs to family Moringaceae. This plant is widely used as nutritional herb and contains valuable pharmacological action like anti-asthmatic, anti-diabetic, hepatoprotective, anti-inflammatory, anti-fertility, anti-cancer, antimicrobial, anti-oxidant, cardiovascular, anti-ulcer, CNS activity, anti-allergic, wound healing, analgesic, and antipyretic activity, *Moringa oleifera* Lam. The plant is also known as Horse - radish tree, Drumstick tree. Every part of this plant contains a valuable medicinal feature. It contains rich source of the vitamin A, vitamin C and milk protein. Different types of active phytoconstituents like alkaloids, protein, quinine, saponins, flavonoids, tannin, steroids, glycosides, fixed oil and fats are present. This plant is also found in the tropical regions. Some other constituents are niazinin A, niazinin B and niazimicin A, niaziminin B. The present review discusses the phytochemical composition, medicinal uses & pharmacological activity of this plant.

1. Introduction

In the last few decades due to exponential improvement in the herbal medicine field *Moringa oleifera* is popular in develop countries because it is obtained

from the natural source and shows less adverse effects. Herbal drugs and their constituents play an important role in different medicinal system like unani, siddha, yoga, homeopathy, naturopathy and ayurveda. More than 70% population uses this non-allopathic system of medicine. *Moringa oleifera* is also known as horse radish tree and drum stick tree. Fig. 1 show the plant *Moringa oleifera* Lam. *Moringa oleifera* (munga) plant belonging to family moringaceae and it is native to sub - himalayan tracts of India, Pakistan, Bangladesh and Afghanistan. It is a small, fast growing, evergreen or deciduous tree. It usually grows up to 10 to 12 m in height [1]. Munga plants provide large and rare combination of zeatin, quercetin, beta - sitosterol, kaempferol, and caffeoylguinic acid. Vital minerals present in the *Moringa oleifera* include iron, potassium, calcium, copper, zinc, magnesium, manganese etc. Other most important and valuable species of plant *Moringa* are *M.oleifera*, *M.arborea*, *M.drouhardii*, *M.ovalifolia*, *M.longituba*, *M.rivae*, *M.borziana*, *M.corcanensis*, *M.hildebrandtii*, *M.ruspoliana*, *M.stenopetala*, *M.peregrina*, *M.pygmaea*. Different parts of the plant such as bark, leaves, seeds, flowers, roots, and immature pods, contains large number of important phytoconstituents such as terpenoids, alkaloids, tannins, steroidal aglycones and reducing sugars. Plant leaves contains essential amino acids to build strong healthy bodies. *Moringa oleifera* leaves have been used in traditional medicine system for centuries, in the ayurvedic system of medicine associated with the cure or prevention of the diseases because of its water compelling, water purification capacity and high nutritional importance. Plant leaves are tiny and difficult to harvest and use a rich nutritional profile of leaves which contains vitamins, minerals and essential amino acids. One hundred grams of dry *Moringa oleifera* leaf contains 9

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Figure 1 Plant of *Moringa oleifera* Lam.

times the vitamin A of carrots, 15 times the potassium of bananas, 17 times the calcium of milk, 12 times the vitamin C of oranges and 25 times the iron of spinach. Antioxidants galore and plant leaves of munga contains rich source of antioxidants, including beta carotene, vitamin c, quercetin and chlorogenic acid. Chlorogenic acid has been found to lower blood sugar levels [2]. The leaves and seeds of *Moringa oleifera* Lam. may protect against some effects of the arsenic toxicity which is especially important light of news. Contamination of ground water by arsenic has also become a cause of global public health concern. *Moringa oleifera* seeds have even been found to work better for water purification function [3]. From a digestive point of view the plant *Moringa oleifera* Lam. is highly rich in fibers that as the epoch times put it works like a mop in your intestines, to clean up any of that extra grunge left over from a greasy diet and also noteworthy are its isothiocyanates, which have anti- bacterial activity that may help to rid your body of H. pylori, bacteria implicated in gastritis ulcers, and gastric cancer.



Flowers



Seeds



Fruits



Leaves

Figure 2 Parts of *Moringa oleifera* Lam.

Table 1 Phytoconstituents of plant *Moringa oleifera* Lam [4, 5]

Sr. No	Plant part	Extract	Phytoconstituents
1	Leaves	Aqueous and alcoholic	Niazirin and Niazirin - nitrile glycosides, 4-[(4'-O- acetylalpha- L-rhamnosyloxy) benzyl isothiocyanate, Niaziminin A, and Niaziminin B, three mustard oil glycosides, niaziminin, a thiocarbamate, 4-(alpha-1- rhamnopyranosyloxy)-benzylglucosinolate, quercetin-3-O-glucoside and quercetin-3-O-(6"- Malonyl- glucoside), Niazimicin. Pyrrole alkaloid (pyrrolemarumine 400-O-a-L-rhamnopyranoside) and 40- hydroxyphenylethanamide(marumoside A and B) 4.alpha and gamma-tocopherol.2
2	Seeds	Aqueous and Hydro-alcoholic	Methionine, cysteine, 4-(alpha-L- rhamnopyranosyloxy) benzylglucosinolate, Moringine, benzylglucosinolate, niazimicin niazirin.
3	Pods	Hydro-alcoholic	Isothiocyanate, nitrites, thiocarbamates, O-(1heptenyloxy) propyl undecanoate, O-ethyl-4-(alpha-L-rhamnosyloxy) benzyl carbamate, methyl- p-hydroxybenzoate, beta- sitosterol .
4	Bark	Alcoholic	4-(alpha-L- rhamnopyranosyloxy) benzylglucosinolate.
5	Flowers	Hydro-alcoholic	D-glucose, quercetin, isoquercetin, kaempferol, kaempferitin and ascorbic acid, protein, D-mannose.
6	Root	Alcoholic	Moringine, moringinine, spirachin, 1,3-dibenzyl urea, alpha- phellandrene, p-cymene, Deoxy-niazimicine, 4-(alpha-L-rhamnopyranosyloxy)benzylglucosinolate.
7	Stem	Aqueous and Hydro-alcoholic	4-hydroxyl mellein, vanillin, octacosonoic acid, beta- sitosterone and beta- sitosterol.

Taxonomical Classification:

- Kingdom – Plantae
- Sub kingdom – Tracheobionta
- Super Division – Spermatophyta
- Division – Magnoliophyta
- Class – Magnoliopsida
- Sub class – Dilleniidae
- Order – Capparales
- Family – Moringaceae
- Genus – Moringa
- Species – oleifera

Synonyms: The plant *Moringa oleifera* is known by several names throughout the world. The synonyms are given below.

- Latin – Moringa oleifera
- Sanskrit – Subhanjana,
- Hindi – Saguna, Sainjna
- Gujarati – Suragavo
- Tamil – Mulaga , Munaga
- Malayalam – Murinna, Sigr
- Punjabi – Sainjna, Soanjna
- Unani – Sahajan
- Ayurvedic – Haritashaaka, Raktaka, Akshiva

- Arabian – Rawag,
- French – Morungue
- Spanish – Angela, Ben, Moringa
- Chinese – La ken
- English - Drumstick tree, Horseradish tree

2. Morphology

Moringa oleifera is a small fast – growing evergreen or deciduous tree usually grows up to 10 or 12 m in height. It has spreading, fragile branches, feathery foliage of tripinnate leaves, and whitish gray bark [4].

Leaves: The leaves are bipinnate or commonly tripinnate up to 45 cm long the leaflets are hairy, green and almost hairless on the upper surface. The twigs are hairy and green, these are compound leaves with leaflets of 1 -2 cm long.

Flowers: The fragrant, bisexual, yellowish white flowers are hairy stalks in spreading or drooping axillary panicles 10 - 25 cm long. Individual flowers are approximately 0.7 to 1 cm long and 2 cm broad and five unequal yellowish – white, thinly veined, spatulate petals, five stamens with five smaller sterile stamens and pistil composed of a 1-celled ovary and slender style.

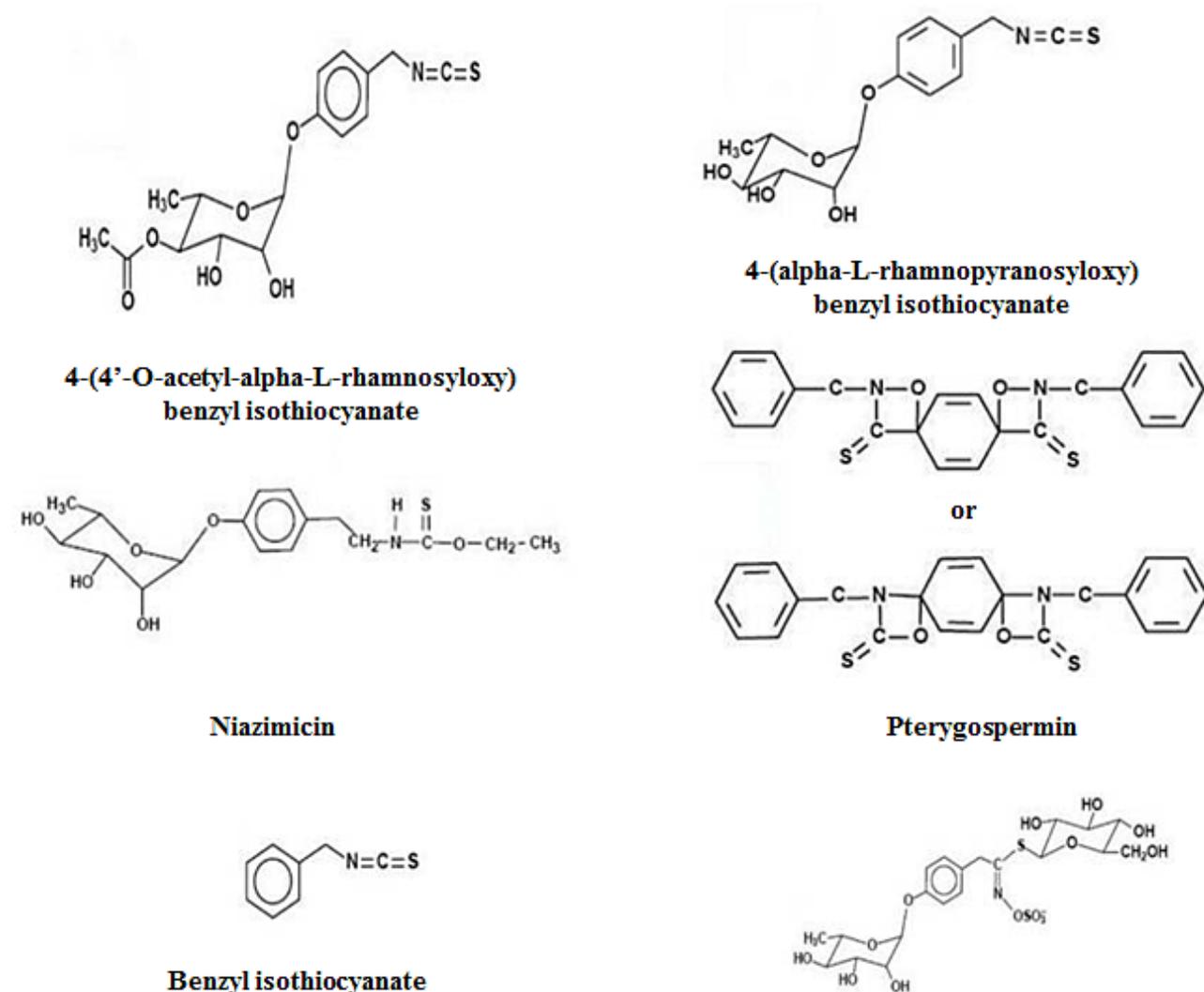


Figure 3 Structure of phytoconstituents.

Fruits: Fruits are tri-lobed capsules and are referred to pods it is pendulous, brown triangular, and splits into three parts lengthwise when dry 30 - 120 cm long, 1.8 cm wide fruits production mostly occurs in march and april. Fruit contain around 26 seeds during their development stage. Immature pods are green in color they turn brown on maturity.

Seeds: Seeds are round 1cm in diameter with brownish semi-permeable seed hull with 3 papery wings hulls of seed are brown to black but can be white if kernels are of low viability. Viable seed germinate within 2 weeks, each tree can produce around 15,000 to 25,000 seeds/year. Average weight is 0.3 gm/seed. The parts of plant *Moringa oleifera* is shown in Fig. 2.

Phytochemical constituents: Some phytochemical constituents of *Moringa oleifera* plant are found in various parts of the plant. According to the literature; these constituents are listed in tabular form in Table 1 and their chemical structures are shown in Fig. 3.

Pharmacological Activity: The plant *Moringa oleifera* poses broad pharmacological activities. Some of them are discussed below.

Antioxidant activity: Aqueous and alcoholic extracts (methanolic & ethanolic) of leaves and roots of *Moringa oleifera* exhibit strong *in-vitro* anti-oxidant and radical scavenging activity. Its leaves are rich source of antioxidant compounds; they could protect the animals against diseases induced by oxidative stress. Administration of *Moringa oleifera* leaves extract seems to prevent oxidative damage caused by high-fat diet [5].

Antiepileptic activity: Methanolic extract of *Moringa oleifera* leaves exhibit potent anti-convulsant activity against pentylenetetrazole and maximal electroshock induced convulsions at the dose levels of 200 mg/kg and 400 mg/kg administered intraperitoneally. Diazepam and phenytoin were used as reference standard. Methanolic extract significantly delayed the onset of seizures in Ptz induced convulsions and significantly reduced duration of hind limb

Table 2 Tabular representation of pharmacological activities of *Moringa oleifera* Lam

Sr. No	Part of plant	Extract	<i>In-vitro</i> / <i>In-vivo</i>	Activity	Standard used
1	Leaves and roots	Aqueous and alcoholic extracts	<i>In-vitro</i>	Anti-oxidant and radical scavenging activity	-
2	Leaves	Methanolic extract	<i>In-vivo</i>	Antiepileptic activity and anti-convulsant activity	Pentylentetrazole
3	Leaves	Aqueous extract	<i>In-vivo</i>	Anti-diabetic activity	Streptozotocin
4	Leaves	Ethanollic extract	<i>In-vivo</i>	Cardiovascular activity/anti-hypertensive	-
5	Roots	Aqueous extract	<i>In-vivo</i>	Anti-fertility activity	-
6	Bark	Aqueous and alcoholic extract	<i>In-vitro</i>	Anti-urolithiatic activity	Ethylene glycol
7	Seed kernel	Alcoholic extract	Human study	Anti-asthmatic activity	-
8	Leaves and seeds	Ethanollic extract	<i>In-vivo</i>	Hepatoprotective activity	-
9	Leaves and seeds	Ethanollic extracts	<i>In-vivo</i>	Anti-cancer activity	-
10	Root, Bark, leaves, flowers, seeds, stalks	Methanolic and aqueous	<i>In-vitro</i>	Anti-inflammatory activity	Carrageen
11	Leaves	Macerated and infused aqueous extract as well ethanollic extract	<i>In-vitro</i>	Anthelmintic activity	Piperazine citrate
12	Leaves	Aqueous extract	<i>In-vitro</i>	CNS activity	Penicillin

extension in MES test at both the dose levels. This may be because of the presence of alkaloids, flavonoids and tannins present in the extract [6].

Studies were performed to determine the *in-vivo* anti-convulsant effect of ethanollic extract of *Moringa concanensis* leaves (200 mg/kg, i.p) on MES and PTZ-induced seizures in Swiss albino mice. Observation revealed MES seizures, suppression of tonic hind limb extension. In PTZ seizures, abolition of the convulsions was noted. The ethanollic extract of *Moringa concanensis* leaves may produce its anti-convulsant effects via multiple mechanisms since it abolished the hind limb extension induced by MES as well as abolished seizures produced by PTZ [7].

Anti-diabetic activity: Aqueous extract of *Moringa oleifera* leaves shows anti-diabetic activity and controls diabetes and thus exhibit glycemic control [8].

The investigation of *in-vitro* antioxidant and *in-vivo* antidiabetic effects of methanol extracts of *Moringa oleifera* pods in streptozotocin (STZ)-induced diabetic albino rats was performed. Diabetic rats were treated with 150 or 300 mg/kg of extract for 21 days and the antidiabetic effects were evaluated by measuring changes in biochemical parameters in serum and pancreatic tissue. The progression of diabetes was significantly reduced after treatment with

the extract. In treated rats, both doses of extract induced a significant reduction in serum glucose and nitric oxide, with concomitant increases in serum insulin and protein levels [9].

The antidiabetic activity of two doses of *Moringa* seed powder 50 and 100 mg/kg on STZ induced diabetes male rats was investigated. The diabetic positive control group showed increased IL-6, increased lipid peroxide, and decreased antioxidant enzyme in the serum and kidney tissue homogenate compared with that of the negative control group [10].

Cardiovascular activity: Ethanollic extract of *Moringa oleifera* leaves showed prominent anti-hypertensive or hypotensive activity. The *in-vivo* activity was done in animal's heart and it was found that thiocarbamate and isothiocyanate glycosides were responsible for this powerful hypotensive activity [11].

Anti-fertility activity: Aqueous extract of *Moringa oleifera* roots was found to be effective as anti-fertility in presence or absence of estradiol dipropionate and progesterone. The *in-vivo* antifertility activity and histopathology study was done using aqueous extract to investigate the effect on histoarchitecture of the uterus during pre and post-implantation stages [12].

Anti-urolithiatic activity: The *in-vitro* anti-urolithiatic activity was performed in aqueous and alcoholic extract of bark of *Moringa oleifera*. It showed reduction in weight of stone produced using ethylene glycol induced urolithiasis. It also possesses both preventive and curative property [13].

Anti-asthmatic activity: A study was carried out to investigate the usefulness of *Moringa oleifera* seed kernel in patients of bronchial asthma. The patients of either sex with mild-to-moderate asthma were treated with finely powdered dried seed kernels in dose of 3 g for 3 weeks. The clinical efficacy was assessed using a spirometer prior to and at the end of the treatment. The majority of patients showed increase in hemoglobin (Hb) values and reduction in Erythrocyte sedimentation rate (ESR). Improvement was also observed in symptom score and severity of asthmatic attacks. After 3 weeks treatment in asthmatic subjects the drug produced significant improvement in forced vital capacity, forced expiratory volume in one second, and peak expiratory flow rate values by $32.97 \pm 6.03\%$, $30.05 \pm 8.12\%$, and $32.09 \pm 11.75\%$ respectively [14].

Alcoholic extracts of *Moringa oleifera* seed kernels were found spasmolytic in acetylcholine, histamine, BaCl₂ and 5HT, induced bronchospasm [15].

Hepatoprotective activity: *In-vivo* hepatoprotective activity of ethanolic extract of leaves and alcoholic extract of seed of *Moringa oleifera* was estimated against isoniazid, rifampicin, and pyrizinamide induced liver damage. Haematological along with hepatorenal functions of methanolic extract of *Moringa oleifera* roots, doses of the crude extract (CE) on liver and kidney functions were also reported [16].

Anti-cancer activity: Ethanolic extracts of leaves and seeds of *Moringa oleifera* shows potent anti-tumor activity. Thiocarbamate and isothiocyanate related compounds were isolated and which act as inhibitor of tumor promoter. The *in-vivo* antitumor potential was due the presence of three known thiocarbamate and isothiocyanate related compounds which act as inhibitors of tumor promoter telocidin B-4-induced Epstein-barr virus, interestingly [17].

Anti-inflammatory activity: Methanolic and aqueous extract of root and bark, methanolic extract of leaves and flowers and ethanolic extract of seeds of *Moringa oleifera* posses anti-inflammatory activity. *In-vitro* anti-inflammatory activity from the hot water infusions of flowers, leaves, roots, seeds and stalks or bark of *Moringa oleifera* using carrageenan-induced and the extract was pharmacologically evaluated [18].

Anti-microbial activity: Leaves, roots, bark and seeds of *Moringa oleifera* show anti-microbial activity against bacteria and fungi. The plant shows *in vitro* activity against bacteria, yeast, dermatophytes and helminths by disc-diffusion method. The fresh leaves and aqueous extract from the seeds inhibit the growth of *Pseudomonas aeruginosa* and *staphylococcus aureus* [19].

Anthelmintic activity: *In-vitro* study assessed the efficacy of macerated and infused aqueous extract as well ethanolic extract of *Moringa oleifera* against fresh eggs, embryonated eggs, L₁ and L₂ larvae of *Haemonchus contortus*. Five different concentrations of extracts were prepared (0.625, 1.25, 2.5, 3.75 and 5 mg/mL). Fresh eggs were exposed to

these different concentrations for 48 hours, while embryonated eggs and larvae were exposed for 6 and 24 hours respectively. Distilled water and 1.5% DMSO were used as negative control. Results revealed that ethanolic leaf extract of *Moringa oleifera* was most efficient on eggs by inhibiting $60.3\% \pm 8.2\%$ and $92.8\% \pm 6.2\%$ eggs embryonation at 3.75 and 5 mg/mL respectively [20].

Different concentrations of ethanolic extracts of *Moringa oleifera* and *Vitex negundo* were assessed for antihelminthic activity against *Pheritima posthuma*. Piperazine citrate (10 mg/mL) was used as a reference standard and distilled water served as a control group. The results were expressed in were expressed in terms of time for paralysis and time for death of worms. *Moringa oleifera* shows more activity as compared to *Vitex negundo* in dose dependent manner [21].

CNS activity: *Moringa oleifera* leaves extract restores mono amine levels of brain, which may be useful in Alzheimer's disease. *In-vitro* anticonvulsant activity from the aqueous extract of *Moringa oleifera* roots and ethanolic extract of leaves was studied on penicillin induced convulsion, locomotor behaviour, brain serotonin (5-HT), dopamine and norepinephrine level and evaluated [22]. The pharmacological activity of *Moringa oleifera* is listed in tabular form in Table 2.

3. Conclusion

The plant *Moringa oleifera*; family Moringaceae posses broad spectrum of pharmacological activities. Also, most of the parts of plant like seeds, leaves, flowers and roots are used for treatment of various diseases. Literature reports that aqueous, ethanolic and methanolic extracts are widely used for investigation, identification, and estimation purpose. In future the active constituents can be isolated and formulated into suitable dosage form and delivery system. Also, in future *in-vivo* studies based on animal models can be done for better effect.

Conflict of interest

The authors declare that there are no conflicts of interest.

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