

Review Article

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Drumstick (*Moringa oleifera*): A Miracle Tree for its Nutritional and Pharmaceutical Properties

Diksha Manaware*

Department of Horticulture (Vegetable Science), Jawaharlal Nehru Krishi Vishwavidyalaya, Jabalpur (M.P.), India

*Corresponding author

ABSTRACT

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Moringa oleifera (*M. oleifera*) which is commonly known as Drumstick tree belongs to family Moringaceae. It is also called as the horseradish tree, benzolive tree, kelor, marango, mlonge, moonga, mulangay, saijhan, sajna or Ben oil tree. It is called as “Miracle Tree” because of its high nutritional value and medicinal uses. All parts of this plant are renewable sources of tocopherols (γ and α), phenolic compounds, β -carotene, vitamin C and total proteins, including the essential sulfur amino acids, methionine and cysteine. It is the richest plant source of Vitamins A, B, C, D, E and K. Minerals present in this tree include K, Mg, Ca, Mn, Zn, Cu, and Fe. Various parts of Moringa tree possess antitumor, antibacterial, hepatoprotective, circulatory stimulants, antispasmodic, anti-hypertensive, diuretic, antioxidant, anti-diabetic, cholesterol lowering, antifungal, antiepileptic, antipyretic, antiulcer and anti-inflammatory activities. This review article provides a brief overview about the nutritional importance and medicinal properties of drumstick.

Introduction

Moringa oleifera (*M. oleifera*) which is commonly known as Drumstick tree (from the long, slender, triangular seed-pods) is an angiospermic, fast-growing, drought-resistant tree which belongs to family Moringaceae.^[21] It is also called as the horseradish tree (from the taste of the roots, which resembles horseradish), benzolive tree (from the oil which is derived from the seeds), kelor, marango, mlonge, moonga, mulangay, saijhan, sajna or Ben oil tree.^[14,47] All parts of the Moringa tree can be consumed. This

plant typically belongs to sub-Himalayan Northern India, Pakistan, Bangladesh and Afghanistan.^[48] The Tropical and subtropical area of the world is suitable for the growth of this plant. It is called as “Miracle Tree” because of its high nutritional value and medicinal uses.^[47] The genus *Moringa* includes 13 species distributed in sub-Himalayan, ranges of India, Sri Lanka, North Eastern and South Western Africa, Madagascar and Arabia.^[45] The best known and most widely distributed species is *Moringa pterygosperma* Gaerthn (syn. *Moringa oleifera* Lam).

M. oleifera is a deciduous tree that can reach a height of 10–12 m (32–40 ft) and trunk diameter of 45 cm (1.5 ft). They have corky gray bark, branching and fern like leaves. The flowers are fragrant and hermaphroditic, surrounded by five unequal, thinly veined, yellowish-white petals. The fruit is a hanging, three-sided brown capsule of 20–45 cm size which holds dark brown, globular seeds with a diameter around 1 cm. The seeds have three whitish papery wings. The drumstick tree is a mixed mating species adapted to outcrossing, although selfing is also possible. It is insect-pollinated, with large numbers of insects required for pollination. Fruit set via open pollination is typically 11-15%, while hand pollination yields 62-100%.^[62] The moringa tree is grown mainly in semiarid, tropical, and subtropical areas. It tolerates a wide range of soil conditions, but prefers a neutral to slightly acidic (pH 6.3 to 7.0), well-drained sandy or loamy soil. It is called as “Miracle Tree” because of its high nutritional value and medicinal uses. All parts of this plant are renewable sources of tocopherols (γ and α), phenolic compounds, β -carotene, vitamin C and total proteins, including the essential sulfur amino acids, methionine and cysteine.^[1, 17] It is the richest plant source of Vitamins A, B, C, D, E and K. Minerals present in this tree include K, Mg, Ca, Mn, Zn, Cu, and Fe.^[52] The leaves, pods, seeds, gums, barks and flowers of *Moringa* are used to relieve mineral and vitamin deficiencies, support a healthy cardiovascular system, promote normal blood-glucose levels, neutralize free radicals (thereby reducing malignancy), provide excellent support of the body's anti-inflammatory mechanisms, enrich anaemic blood and support immune system. *Moringa* leaves are good food sources for those suffering from malnutrition due to the high protein and fiber content.^[18] Leaves treat with fevers, bronchitis, eye and ear infections, and inflammation of the mucus membrane.^[1] *Moringa* seed cake, obtained as a byproduct

of pressing seeds to obtain oil, is used to filter water using flocculation to produce potable water for animal or human consumption.

Pharmaceutic properties of drumstick (*M. oleifera*)

Moringa oleifera is often referred as a panacea and can be used to cure more than 300 diseases.^[2] *Moringa* has long been used in herbal medicine by Indians. Various parts of *Moringa* tree possess antitumor, antibacterial, hepatoprotective, circulatory stimulants, antispasmodic, anti-hypertensive, diuretic, antioxidant, anti-diabetic, cholesterol lowering, antifungal, antiepileptic, antipyretic, antiulcer and anti-inflammatory activities.^[45] A number of natural compounds have been isolated from *M. oleifera* leaves including fully acetylated glycosides bearing thiocarbamates, carbamates or nitriles.^[16, 35] Plant glycosides can be used to cure cancer or chronic conditions such as high cholesterol and atherosclerosis.^[8,20] *Moringa* tree have been proved to contain several phytochemicals having beneficial pharmacological properties with potential medicinal applications. They comprise cholesterol lowering compounds, antiulcer, hypoglycemic, with infectious skin curing, anti-hypertensive, antispasmodic, and anticancer properties.^[4] *Moringa* is used for malnourished children and for improvement of the immune system, against AIDS and HIV linked illnesses. It also contains flavonoids which have anti-carcinogenic, anti-viral and anti-estrogenic activities.^[22, 30, 31]

Antimicrobial Activity

Moringa oleifera leaf ethanolic extract had the broadest spectrum of activity on the test bacteria.^[7] Antimicrobial activity from the ethanolic extract of leaves, seeds and flowers of *Moringa oleifera* against microorganisms like *Escherichia coli*, *Klebsiella pneumoniae*,

Enterobacter spp, *Proteus mirabilis*, *Pseudomonas aeruginosa*, *Salmonella typhi* A, *Staphylococcus aureus*, *Streptococcus* and *Candida albicans*.^[43] Antibacterial activity from the aqueous, acetone and ethanolic extracts of the leaves of *Moringa oleifera*. Of the three solvents used, ethanolic extract of the plant demonstrated the highest activity, while the aqueous extract showed the least activity at 100 mg/ml. The activities of the plant extracts were comparable to those of antibiotics, ciprofloxacin, cotrimoxazole and chloramphenicol.^[13] The seed extracts of *Moringa oleifera* were multocida, *Escherichia coli*, *Bacillus subtilis* and *Staphylococcus aureus*) and fungal (*Fusarium solani* and *Rhizopus solani*) strains. The zones of growth inhibition showed greater sensitivity against the bacterial strains as compared to the fungal strains.^[12, 24, 37]

Antiinflammatory Activity

Aqueous extracts of *Moringa oleifera* leaves possess anti-inflammatory activity.^[33] The phytochemicals like phenolic acids and flavanols present in *Moringa* are associated with its anti-inflammatory effect.^[30, 42]

Anticancer Activity

Moringa can be used as an anticancer agent as it is natural, reliable and safe, at established concentrations. It can be used as an antiproliferative agent, thereby inhibiting the growth of cancer cells. Soluble and solvent extracts of leaves have been proven effective as anticancer agents. Furthermore, research papers suggest that the anti-proliferative effect of cancer may be due to its ability to induce reactive oxygen species in the cancer cells. The reactive oxygen species induced in the cells leads to apoptosis. This is further proved by the up regulation of caspase 3 and caspase 9, which are part of the apoptotic pathway.^{26–28} Moreover, the ROS

production by *moringa* is specific and targets only cancer cells, making it an ideal anticancer agent. The compounds of the leaves that are held responsible for the anticancer activities are glucosinolates, niazimicin and benzyl isothiocyanates.^[23, 25, 28, 48, 53]

Antiulcer activity

Moringa oleifera has also been investigated for its antiulcer activity. There are studies that show that the extract of leaves and fruits of *Moringa oleifera* has ability to heal chronic gastric ulcers induced via acetic acid.^[10, 11]

Antioxidant Activity

The antioxidants are popular due to the fact as they fight against free radicals that cause oxidative stress, cell damage, and inflammation. In addition to this, *Moringa* contains antioxidants called flavonoids, polyphenols, and ascorbic acid in the leaves, flowers, and seeds which are beneficial in many ways.^[51] Aqueous, methanolic (70%), ethanolic extract (80%) of leaves of *Moringa oleifera* exhibit strong antioxidant and radical scavenging activity.^[31] This antioxidant activity of *Moringa oleifera* leaves is due to presence of Kaemferol.^[17, 31]

Antiuroliathatic Activity

The root bark of *Moringa oleifera* Lam. (Moringaceae) acts as an antiuroliathatic agent. This was investigated using an experimentally induced urolithiatic rat model. Hyperoxaluria was induced in rats using 0.75% ethylene glycol in water. Aqueous (AqE) (200 mg kg⁻¹ body weight) and alcoholic extracts (AlcE) (200 mg kg⁻¹ body weight) of the root bark of *M. oleifera* were given orally in curative and preventive regimens over a period of 28 days. Both the extracts significantly (P < 0.001) lowered the

urinary excretion and kidney retention levels of oxalate, calcium and phosphate. [27]

Wound healing Activity

Moringa has blood-clotting properties in its leaves, roots, and seeds that benefit wound healing and can reduce clotting time, which means it reduces the time it takes for scratches, cuts, or wounds to stop bleeding. The ethanolic and ethyl acetate extracts of seeds defines significant antipyretic activity in rats, where ethyl acetate extract of dried leaves presents wound healing activity (10% extracts in the form of ointment) on excision, incision and dead space (granuloma) wound models in rats. [51]

Antifertility activity

Zade and dabhadkar, 2015 studied the antifertility effect of the alcoholic extract of *Moringa oleifera* stem bark in female albino rats. Rats were laprotomised on 10th day of pregnancy and live fetuses were observed in both the horns of the uterus. Rats in group 1 (control) were orally administered, with 0.5 ml of distilled water once daily while those in

group 2 to 4 (experimental groups) were administered 25, 50 and 100 mg/kg body weight doses of alcoholic extract of *M. oleifera* stem bark respectively. The alcoholic extract of *M. oleifera* stem bark exhibited significant antifertility activity (26.26 to 100%). [55]

Anti-asthmatic Activity

It has been reported a long time ago that Moringa plant can be used for the treatment of asthma. [40] The seed kernels of *Moringa oleifera* also showed prominent effect in the treatment of bronchial asthma. Also a study showed significant decrease in the severity of asthma symptoms and also concurrent respiratory functions improvement in various human models. [36]

Hepatoprotective activity

Ethanolic extract of leaves and alcoholic extract of seeds of *Moringa oleifera* showed hepatoprotective effect in Isoniazid, Rifampicin, Pyrazinamide induced liver damage and diclofenac induced hepatic toxicity in rat, respectively. [32]

Table.1 Comparison of nutritional value of *M. oleifera* with other common foods

Nutrients	Comparison with other foods
Vitamin A	Four times of carrots (4X) and thirteen times of spinach (13X)
Vitamin B	Four times of pork meat (4X)
Vitamin B₃	Fifty times (50X) of peanut
Vitamin C	Seven times (7X) of oranges
Vitamin E	Six times (6X) times of Rapeseed oil
Calcium	Four times (4X)times of milk
Magnesium	Thirty six (36) times of egg
Potassium	Sixty three times (63X) of milk and three times (3X) of banana
Iron	Twenty five times(25X) of spinach
Protein	Two times (2X) of yogurt
Amino acid	Two times (2X) of black vinegar

Table.2 Nutritional value and phytochemical constituents of different parts of Drumstick (*M. oleifera*)

Plant part	Plant part Picture	Nutritional value	Phytochemical constituents	Reference
Leaves		Contains proteins, fiber and various minerals like Mg, Ca, S, K, and Fe, Vitamins like vitamin-A (Beta-carotene), vitamin B-choline, vitamin B1-thiamine, riboflavin, nicotinic acid and ascorbic acid, Various amino acids like Arg, His, Lys, Trp, Phe, Thr, Leu, Met, Ile, Val, Phytochemicals like tannins, sterols, saponins, terpenoids, phenolics, alkaloids, Flavanoids like quercetin, isoquercetin, kaempfericetin, isothiocyanates and Phenolic compounds such as quercetin, kaempferol.	Glycoside niazirin, niazirin, three mustard oil glycosides, 4-[4'-O-acetyl-a-L-rhamnosyloxy)benzyl] isothiocyanate, niaziminin A and B.	Faizi <i>et al.</i> , (1994), Faizi <i>et al.</i> , (1995), Tiloke <i>et al.</i> , (2013), Rockwood <i>et al.</i> , (2013), Mbikay <i>et al.</i> , (2012), Barminas <i>et al.</i> , (1998)
Root bark		Contains Alkaloids like morphine, moriginine, minerals like calcium, magnesium and sodium.	4-(a-L-rhamnopyranosyloxy)-benzylglucosinolate	Bennett <i>et al.</i> , (2003), Monera and Maoponga (2012)
Flowers		Contains Ca, K, amino acids and nectar.	D- mannose, D- glucose, protein, ascorbic acid, polysaccharide	Pramanik <i>et al.</i> , (1998), Barminas <i>et al.</i> , (1998), Sotalangka <i>et al.</i> , (2013)
Pods		Contains lipids, non-structural carbohydrates, protein, fiber, ash and various fatty acids like linoleic acid etc.	Nitriles, isothiocyanate, thiocarbamates, 0-ethyl-4-[(a-1 rhamnosyloxy)-benzyl] carbamate, methyl-p-hydroxybenzoate and β sitosterol	Faizi <i>et al.</i> , (1994), Faizi <i>et al.</i> , (1995), Fuglie <i>et al.</i> , (2005), Barminas <i>et al.</i> , (1998)
Seeds		Contains oleic acid (Ben oil), an antibiotic called pterygospermin, Phytochemicals like tannins, saponin, phenolics, quercetin, phytate, flavanoids, terpenoids, lectins, kaempferol, Antioxidants such as vitamin C, β -carotene, α and γ -tocopherol, β -sitosterol, vitamin A, alkaloids, glucosinolates, and isothiocyanates, Fatty acids like Linoleic acid, linolenic acid, behenic acid.	Crude protein, crude fat, carbohydrate, methionine, cysteine, 4-(a-L-rhamnopyranosyloxy)-benzylglucosinolate, benzylglucosinolate, moringyne, mono-palmitic and di-oleic triglyceride, Vitamin A, beta carotene (precursor of Vitamin A)	Bennett <i>et al.</i> , (2003), Rockwood <i>et al.</i> , (2013), Fahey <i>et al.</i> , (2005), Thurber and Fahey (2010)

Table.3 Nutrient values of leaves and pods of *Moringa oleifera*

Principle	Nutrient value-Leaves	Nutrient value-Pods
Vitamins		
Folates	40 µg (10%)	44 µg (11%)
Niacin	2.220 mg (14%)	0.680 mg (4%)
Pyridoxine	1.200 mg (92%)	0.120 mg (9%)
Riboflavin	0.660 mg (51%)	0.074 mg (6%)
Thiamin	0.257 mg (21.5%)	0.053 mg (4.5%)
Vitamin A	7564 IU (252%)	74 IU (2.5%)
Vitamin C	51.7 mg (86%)	141 mg (235%)
Electrolytes		
Sodium	9 mg (0.5%)	42 mg (3%)
Potassium	337 mg (7%)	461 mg (10%)
Minerals		
Calcium	185 mg (18.5%)	30 mg (3%)
Iron	4.00 mg (50%)	0.36 mg (4.5%)
Magnesium	147 mg (37%)	45 mg (11%)
Phosphorus	112 mg (20%)	50 mg (9%)
Selenium	0.9 µg (1.5%)	8.2 µg (15%)
Zinc	0.60 mg (5%)	0.45 mg (4%)
Energy	64 Kcal (3%)	37 Kcal (2%)
Carbohydrates	8.28% (6%)	8.53 g (6.5%)
Protein	9.40 g (17%)	2.10 g (4%)
Total Fat	1.40% (7%)	0.20 g (1%)
Cholesterol	0 mg (0%)	0 mg (0%)
Dietary Fiber	2.0 g (5%)	3.2 g (8%)

Table.4 Medicinal uses of different parts of *M. oleifera*

Plant Parts	Medicinal uses	Reference
Leaves	Treat asthma, hyperglycemia, Dyslipidemia, flu, heart burn, syphilis, malaria, pneumonia, diarrhea, headaches, scurvy, skin diseases, bronchitis, eye and ear infections Also reduces, blood pressure and cholesterol and acts as an anticancer, Antioxidant, antimicrobial, anti-atherosclerotic and ant diabetic agents, neuro protectant	Jung, (2014), Monera and Maponga,(2012)
Root bark	Act as a cardiac stimulant, antiulcer and anti-inflammatory agent	Monera and Maponga, (2012)
Flower	Act as hypocholesterolemic, anti-arthritic agents can cure urinary problems and cold	Sutalangka <i>et al.</i> , (2013)
Pod	Treat diarrhea, liver and spleen problems, and joint pain.	Fuglie, (2005)
Seed	Treat hyperthyroidism, Chronn's disease, antiherpes-simplex virus arthritis, rheumatism, gout, cramp, epilepsy and sexually transmitted diseases, can act as antimicrobial and anti-inflammatory agents	Thurber and Fahey, (2010)

Antiepileptic Activity

Methanolic extract of *Moringa oleifera* leaves were investigated its anti-convulsant activity using Pentylentetrazole (PTZ) and maximum electric shock (MES) on male albino mice.^[3]

Cardiovascular activity

Moringa leaf powder has heart-healthy benefits, particularly to control blood lipid, the prevention of plaque formation in the arteries, and reduced cholesterol levels. The great combination of diuretic along with lipid and blood pressure lowering components make this plant incredibly beneficial in cardiovascular disorders.^[51]

In conclusion the drumstick (*M. oleifera*) is highly valued for its indispensable medicinal properties and nutritional benefits. *Moringa oleifera* has enormous potential uses but it is very less explored. It has several medicinal properties like Anti Diabetic, Anti Asthmatic, Hepatoprotective, antiinflammatory, antipyretic, Analgesic activity, Hypocholesterolemic effect, Anti-Oxidant, Anti-Microbial, Anti-Cancer, Water Purification properties. It is also use as a good source of animal and bird feed and food forticant. The study revealed that almost all parts of drumstick such as leaves, root bark, flowers, pods, seeds are used extensively in traditional medicines. The above mentioned nutritional and pharmaceuticals properties of *M. oleifera*, made it a “Tree of Life”.

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