PHARMACOLOGICAL PROPERTIES OF *MORINGA OLIEFERA LAM. - A REVIEW*

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Summary

The present review describes the morphological, phytochemical and pharmacology aspects of *Moringa oleifera* (Moringaceae). Drumstick tree, also known as horseradish tree and ben tree in English, is a small to medium-sized, evergreen or deciduous tree native to northern India, Pakistan and Nepal. It is valued mainly for its edible fruits, leaves, flowers, roots, and seed oil, and is used extensively in traditional medicine throughout its native and introduced ranges. It is reported to contain anti-inflammatory, anti-oxidant, antihyperlipidemic, antiulcer activities. *Moringa oleifera* Lam. has many potential uses in managing health, especially among diabetic patients. Hyperglycaemia is one of the most important symptoms of diabetes. Thus the treatment of diabetic patients often must take into account the anti-hyperglycemic or hypoglycemic effects of treatments protocols. An overview of phytochemical and pharmacological profile are given in the present paper.

Keywords: *Moringa oleifera*; Pharmacognosy; Phytochemistry; Pharmacological profile.

Introduction

Drumstick tree, also known as horseradish tree and ben tree in English, is a small to medium-sized, evergreen or deciduous tree native to northern India, Pakistan and Nepal. It is cultivated and has become naturalized well beyond its native range, including throughout South Asia, and in many countries of Southeast Asia, the Arabian Peninsula, tropical Africa, Central America, the Caribbean and tropical South America. The tree usually grows to 10 or 12 m in height, with a spreading, open crown of drooping, brittle branches, feathery foliage of tripinnate leaves, and thick, corky, deeply fissured whitish bark. It is valued mainly for its edible fruits, leaves, flowers, roots, and seed oil, and is used extensively in traditional medicine throughout its native and introduced ranges.

Drumstick tree is indigenous to the Himalayan foothills of South Asia from northeastern Pakistan to northern West Bengal State in India and northeastern Bangladesh where it is commonly found from sea level to 1,400 m on recent alluvial land or near riverbeds and streams.

Moringa oleifera is a small, fast-growing evergreen or deciduous tree that usually grows up to 10 or 12 m in height. It has a spreading, open crown of drooping, fragile branches, feathery foliage of tripinnate leaves, and thick, corky, whitish bark.

This rapidly-growing tree (also known as the horseradish tree, drumstick tree, benzolive tree, kelor, marango, mlonge, moonga, mulangay, nébéday, saijhan, sajna or Ben oil tree), was utilized by the ancient Romans, Greeks and Egyptians; it is now widely cultivated and has become naturalized in many locations in the tropics. It is a perennial softwood tree with timber of low quality, but which for centuries has been advocated for traditional medicinal and industrial uses. It is already an important crop in India, Ethiopia, the Philippines and the Sudan, and is being grown in West, East and South Africa, tropical Asia, Latin America, the Caribbean, Florida and the Pacific Islands.

All parts of the Moringa tree are edible and have long been consumed by humans. The root is laxative, expectorant, diuretic, and good for inflammations, throat, bronchitis, piles, cures stomatitis, urinary discharges and obstinate asthma[1].

According to Fuglie[2] 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. In the West, one of the best known uses for Moringa is the use of powdered seeds to flocculate contaminants and purify drinking water, but the seeds are also eaten green, roasted, powdered and steeped for tea or used in curries. 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.

Morphology

Leaves and young shoots

The leaves are bipinnate or more commonly tripinnate, up to 45 cm long, and are alternate and spirally arranged on the twigs. Pinnae and pinnules are opposite; leaflets are 1.2 to 2.0 cm long and 0.6 to 1.0 cm wide, the lateral leaflets elliptic, the terminal ones obovate; petioles of lateral leaflets are 1.5 to 2.5 mm long, those of terminal ones 3 to 6 mm long. The leaflets are finely hairy, green and almost hairless on the upper surface, paler and hairless beneath, with red-tinged midveins, 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, becoming brown.

Flowers, fruits and seeds

The fragrant, bisexual, yellowish white flowers are borne on slender, hairy stalks in spreading or drooping axillary clusters (panicles) 10–25 cm long. Individual flowers, set in a basal cup (hypanthium) ca. 3 mm long, are approximately 0.7 to 1 cm long and 2 cm broad, with five unequal yellowish-white, thinly veined, spathulate petals, five stamens with five smaller sterile stamens (staminodes), and a pistil composed of a 1-celled ovary and slender style [27, 30, 51]. The fruits are pendulous, linear, three-sided pods with nine longitudinal ridges, usually 20 to 50 cm long, but occasionally up to 1 m or longer, and 2.0 to 2.5 cm broad. The pods, each usually containing up to 26 seeds, are dark green during their development, and take approximately 3 months to mature after flowering [45]. They turn brown on maturity, and split open longitudinally along the three angles, releasing the dark brown, trigonous seeds. Seeds measure about 1 cm in diameter, with three whitish papery wings on the angles. Seed weights differ among varieties, ranging from 3,000 to 9,000 seeds per kilogram.

Bark and wood

The bark is whitish-gray, thick, soft, fissured and warty or corky, becoming rough. When wounded, the bark exudes a gum which is initially white in color but changes to reddish brown or brownish black on exposure. The wood is soft and light, with a density of 0.5 to 0.7 g/cm.

Root

Seedlings develop a swollen, tuberous, white taproot which has a characteristic pungent odor, and very sparse lateral roots. Trees grown from seeds develop a deep, stout taproot with a wide-spreading system of thick, tuberous lateral roots. Taproots do not develop on trees propagated from cuttings.

Phytochemistry

An examination of the phytochemicals of Moringa species affords the opportunity to examine a range of fairly unique compounds. In particular, this plant family is rich in compounds containing the simple sugar, rhamnose, and it is rich in a fairly unique group of compounds called glucosinolates and isothiocyanates (10,38). For example, specific components of Moringa preparations that have been reported to have hypotensive, anticancer, and antibacterial activity include 4-(4'-*O*-acetyl-a-L-rhamnopyranosyloxy)benzyl isothiocyanate **[1],** 4-(a-L-rhamnopyranosyloxy)benzyl isothiocyanate **[2],** niazimicin **[3]**, pterygospermin **[4],** benzyl isothiocyanate **[5],** and 4-(a-L-rhamnopyranosyloxy)benzyl glucosinolate **[6].** While these compounds are relatively unique to the Moringa family, it is also rich in a number of vitamins and minerals as well as other more commonly recognized phytochemicals such as the carotenoids (including b-carotene or pro-vitamin A). These attributes are all discussed extensively by Lowell Fuglie (47) and others, and will be the subject of a future review in this series.

Structures of selected phytochemicals from Moringa spp.: 4-(4'-0-acetyl-a-L-rhamnopyranosyloxy)benzyl isothiocyanate**(1)**, 4-(-L- rhamnopyranosyloxy) benzyl isothiocyanate **(2)**, niazimicin **(3)**, pterygospermin **(4)**, benzyl isothiocyanate **(5)** and (a-L- rhamnopyranosyloxy)benzyl glucosinolate **(6).**

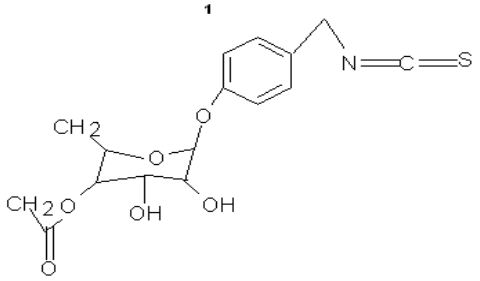
Roots of *M. oliefera* contain have high concentration of both 4-(α-L-rhamnopyranosyloxy)-benzylglucosinolate and benzylglucosinolate[12].The stem of plant contains: 4-hydroxymellein, vanillin, β- sitosterone, octacosanic acid and β-sitosterol and bark contain 4-(α-L-rhamnopyranosyloxy) – benzylglucosinolate[5].

The purified drumstick plant contains: L-arabinose, D-galactose, D-glucuronic acid, L-rhamnose, D-mannose and D-xylose in the molar ratios of approxi 14.5 : 11.3 : 3.2 : 1.1[6]. A leucoanthocyanin characterized as leucodelphinidin-3-O- B-D- galactopuranosy)-O-B-D- glucopyranoside is also present in gum.

Bioassay-guided analysis of an ethanolic extract of leaves showed the presence of two nitrile glycosides, niazirin and niazirinin and three mustard oil glycosides, 4-[(4'-O-acetyl- a-L- rhamnosyloxy)benzyl] isothiocyanate, niaziminin A and B[7,8].

Whole pods are reported to contain nitriles, an isothiocyanate and thicarbamates and O-[2'-hyrdoxy-3'-(2-heptenyloxy)]-propylundecanoate and O-ethyl-4-[(a-1-rhamnosyloxy-benzyl] carbamate.

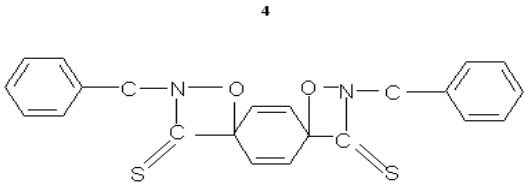
1

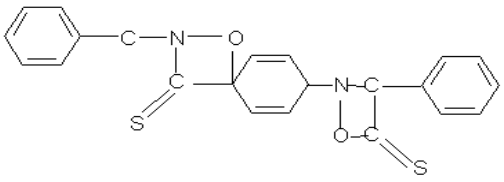


4-(4'-O-acetyl-a-L-rhamnopyranosyloxy) benzyl isothiocyanate

OR

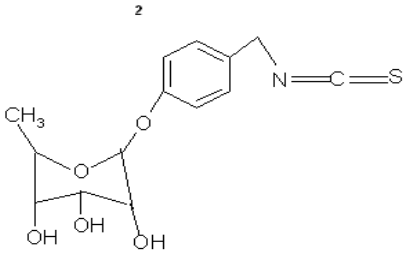
4





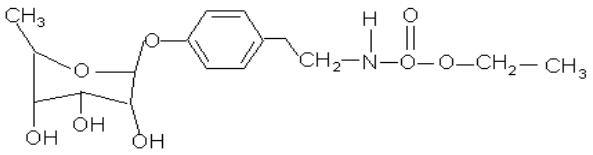
pterygospermin

2



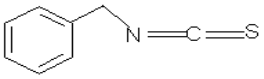
4-(a-L-rhamnopyranosyloxy) benzyl isothiocyanate

3



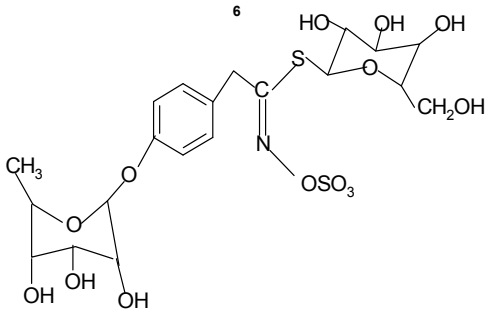
niazimicin

5



benzyl isothiocyanate

6



4-(a-L-rhamnopyranosyloxy)benzyl glucosinolate

Pharmacological activities

Anti-inflammatory

The crude ethanolic extract of dried seeds was tested for anti- inflammatory activity using carrageenan induced inflammation in the hind paw of mice by various workers and found to inhibit 85% of inflammation at a dose of 3mg/kg body weight, while the mature green seeds inhibited edema by 77% at the same dose[9]. Hot water infusions of flowers, leaves, roots, seeds and bark alsoshowed anti-inflammatory activity agains carrageenan-induced hind paw edema. A crude methanol extract of the root was also screened for anti- inflammatory effect using the rat paw edema and the rat 6-days air pouch inflammatory models.

Antioxidant

The oil from the dried seeds showed higher antioxidant activity than butylated hydroxyl toluene and alpha-tocopherol[10]. Aqueous, methanol (80%) and ethanol (70%) extracts of freeze-dried leaves showed radical scavenging and antioxidant activities. All the extracts were capable of scavenging peroxyl and superoxyl radicals. The major bioactive compounds of phenolics were found to be flavonoid groups such as quercetin and kaempferol[11].

CNS depressant

The methanolic extract of the root exhibited significant CNS depressant activity in mice. The extract potentiated significantly the sleeping time induced by pentobarbitone sodium, diazepam and meprobamate, showed analgesic properties and also potentiated analgesia induced by Morphine and Pethidine. Effect of chronic treatment of standardized aqueous extract of root (100, 200, 300, 350, 400, 450 mg/kg; p.o.) on penicillin induced convulsion, locomotor behaviour, brain serotonin (5-HT), dopamine, norepinephrine(NE) level was studied in Holtzman strain adult albino rats. The extract showed central inhibitory effect and improvement in the disturbed balance between 5-HT, DA and NE[12].

Antihyperlipidaemic

The leaves possess hypocholesterolemic activity; administration of the crude leaf extract along with high-fat diet decreased the high- fat diet-induced increase in serum, liver and kidney cholesterol levels by 14.35%(115-103.2mg/100ml of serum), 6.40% (9.4-8.8mg/g wet wt) and 11.09% (1.09- 0.97mg/g wet wt), respectively[13].

They were found to lower the serum cholesterol, phospholipid, triglyceride, VLDL, LDL cholesterol to phospholipid ratio and atherogenic index in hypercholesterolaemic rabbits.

Antihepatotoxic

Aqueous and alcoholic extracts of root and flower of this plant were screened for antihepatotoxic activity in paracetamol treated albino rats. Liver function was assessed based on liver to body weight ratio, serum levels of transaminase (SGPT, SGOT), alkaline phosphatase (SLAP) and bilirubin. All extracts were found to have antihepatotoxic activity. The LD value of ethanolic (90%) extracts of roots and flowers were calculated to be 1.23 and1.47g/kg i.p. in mice, respectively.

The corresponding values for aqueous extract were 1.78 and 1.92mg/kg, respectively[14]. The extract was found to enhance the recovery from hepatic damage induced by antitubercular drugs[15, 16].

Antiulcer

The methanolic extract ofdrumstick leaves inhibited gastric lesion formation induced by aspirin, serotonin or indomethacin in rats[16]. The methanolic extract of flower buds showed antiulcerogenic activity against aspirin induced gastric ulcer at a dosage of 4g/kg body weight.

Anticancer

Paste of drumstick leaves has been screened for its influence on the carcinogen detoxifying glutathione-S- transferase (GST) in Swiss mice. It increased GST activity by more than 78% in the stomach, liver and oesophagus and show protective activity against carcinogenesis. The crude ethanolic extract of seeds exhibited anti-tumour activity against Epstein-Barr virus-early antigen (EBV-EA)[9].

Miscellaneous

Hot water infusions of flowers, leaves, roots, seeds and stalks of bark of drumstick tree possess antispasmodic activity[17]. The seeds infusion showed a significant inhibition of acetylcholine- induced contraction of rat ileum with an ED_{50} of 65.6mg/ml bath concentration and diuretic activity at 1g/kg[17]. One of the studies carried out at Saudi Arabia showed that ***M. oleifera*** increased the blood glucose by 15% in alloxanized mice. While in another study ethanolic extract showed significant blood glucose lowering effect within 2 weeks in alloxan induced diabetic albino rats[18].

The blood glucose levels and the corresponding insulin levels in response to drumstick leaves in southern India were compared to the levels achieved in response to 75g of glucose in non-insulin dependent diabetes mellitus patients. The blood glucose response was 56% compared to 75g of glucose. It was concluded that the reduced blood glucose response to drumstick leaves is not due to insulin secretion[19].

Conclusion

The multiple benefits of *Moringa olifera* made it a true miracle of nature. Numerous studies have been conducted on different parts of *Moringa olifera*, but this plant has not yet developed as a drug by pharmaceutical industries. In view of the nature of the plant, more research work can be done on humans so that a drug with multifarious effects will be available in the future market.

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