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Review Article

Moringa oleifera : A review of the medical evidence for its nutritional and pharmacological properties

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ABSTRACT

The *Moringa* plant provides a rich and rare combination of zeatin, quercetin, sitosterol, caffeoylquinic acid and kaempferol. In addition to its compelling water purifying powers and high nutritional value, *M. oleifera* is very important for its medicinal value. Various parts of this plant such as the leaves, roots, seed, bark, fruit, flowers and immature pods act as cardiac and circulatory stimulants, antipyretic, antitumor, anti-inflammatory, antiepileptic, diuretic, antiulcer, antispasmodic antihypertensive, cholesterol lowering, antidiabetic, antioxidant, antibacterial, hepatoprotective, and antifungal activities, and are being employed for the treatment of different ailments in the indigenous system of medicine, particularly in South Asia.

Key words: Sitosterol, Caffeoylquinic acid, Antidiabetic, Antioxidant, Antibacterial.

INTRODUCTION

The plant kingdom represents a rich storehouse of organic compounds, many of which have been used for medicinal purposes and could serve as lead for the development of novel agents having good efficacy in various pathological disorders in the coming years. *Moringa oleifera* is the most widely cultivated species of a monogeneric family, the Moringaceae, that is native to the sub-Himalayan tracts of India, Pakistan, Bangladesh and Afghanistan. ***M. oleifera*** is known as 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 Telegu and *Murungai* in Tamil. 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. *Moringa oleifera* is an important food commodity which has had enormous attention as the 'natural nutrition of the tropics'. *Moringa* leaves have been reported to be a rich source of β-carotene, protein, vitamin C, calcium and potassium and act as a good source of natural antioxidants; and thus enhance the shelf-life of fat containing foods due to the presence of various types of antioxidant compounds such as ascorbic acid, flavonoids, phenolics and carotenoids. 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, including the treatment of inflammation and infectious diseases along with cardiovascular, gastrointestinal, hematological and hepato-renal disorders. The seeds of *Moringa* are considered to be antipyretic, acrid, bitter[1].

Table 1 : Classifiaction of *Moringa oleifera*

Kingdom	Plantae
Division	Magnoliophyta
Class	Magnoliopsida
Subclass	Dilleniidae
Order	Capparales
Family	Moringaceae
Genus	*Moringa* Adans
Species	*Moringa oleifera* Lam.

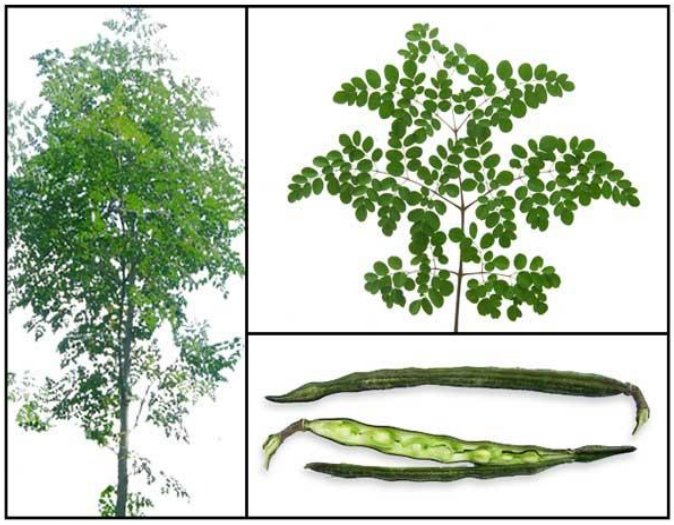

Figure 1: *Moringa oleifera Plant Parts*

Morphological features:

M. oleifera is a small or middle-sized tree, ranges in height from 5 to 10 m. It is found wild and cultivated throughout the plains, especially in hedges and in house yards, thrives best under the tropical insular climate, and is plentiful near the sandy beds of rivers and streams[2]. It can grow well in the humid tropics or hot dry lands, can survive destitute soils, and is little affected by drought. It tolerates a wide range of rainfall with minimum annual rainfall requirements estimated at 250 mm and maximum at over 3000 mm and a pH of 5.0–9.0[3].

Phytochemistry:

Moringa oleifera is rich in compounds containing the simple sugar, rhamnose called glucosinolates and isothiocyanates[4,5]. The stem contains: 4-hydroxymellein, vanillin, β-sitosterone, octacosanic acid and β-sitosterol[6] and bark, 4-(α-L-rhamnopyranosyloxy)–benzyl glucosinolate[5]. The purified, whole-gum exudates from the drumstick plant contains: Larabinose, D-galactose, D-glucuronic acid, L-rhamnose, D-mannose and D-xylose. The leaves contain quercetin-3-O-glucoside and quercetin-3-O-(6''-malonyl-glucoside), and lower amounts of kaempferol-3-Oglucoside and kaempferol-3-O-(6''-malonyl-glucoside). They also contained 3-caffeoylquinic and 5-caffeoylquinic acid. The whole pods are reported to contain nitriles, an isothiocyanate and thicarbamates[7,8] and O-[2'-hydroxy-3'- (2″-heptenyloxy)]-propylundecanoate and O-ethyl-4-[(α-l-rhamnosyloxy)- benzyl] carbamate, methyl-*p*hydroxybenzoate and β-sitosterol[9]. The mucilage from the pods designated as drumstick polysaccharide, the investigation of which revealed the presence of galactose, dextrose, xylose and sodium, potassium, magnesium, calcium salts of glucuronic acid. Contrary to the definition of mucilages, the presence of dextrose was an exception[10].

Nutritional analysis

Moringa leaves are extremely nutritious. In fact they contain larger amounts of several nutrients than the common foods often associated with these nutrients. These include vitamin C, which fights a host of illness including colds and flu; vitamins A, which acts as a shield against eye disease, skin disease, heart ailments, diarrhea, and many other diseases; Calcium which builds strongs bones and teeth and helps prevent osteoporosis.

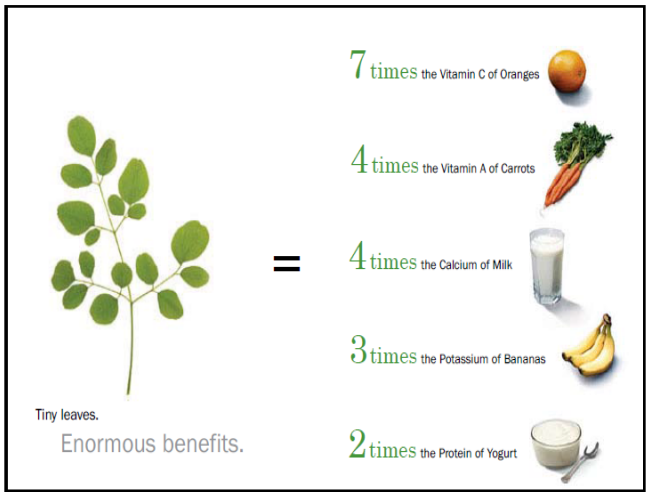

Figure 2: Gram-for-gram comparison of nutritional data of Moringa[11]

Pharmacological activity:

The benefits for the treatment or prevention of disease or infection that may accrue from either dietary or topical administration of Moringa preparations (e.g. extracts, decoctions, poultices, creams, oils, emollients, salves, powders, porridges) are not quite so well known[12]. *Moringa oleifera* also has numerous medicinal uses, which have long been recognized in the Ayurvedic and Unani systems of medicine[13].

Antihypertensive:

The widespread combination of diuretic along with lipid and blood pressure lowering constituents make this plant highly useful in cardiovascular disorders. *Moringa* leaf juice is known to have a stabilizing effect on blood

pressure (The Wealth of India, 1962; Dahot, 1988). Nitrile, mustard oil glycosides and thiocarbamate glycosides have been isolated from *Moringa* leaves, which were found to be responsible for the blood pressure lowering effect[7]. Most of these compounds, bearing thiocarbamate,carbamate or nitrile groups, are fully acetylated glycosides, which are very rare in nature[14]. Methyl phydroxybenzoate and β-sitosterol investigated in the pods of *M. oleifera* have also shown promising hypotensive activity[15].

Antiulcer and hepatoprotective activities:

The methanol fraction of *M. oleifera* leaf extract showed antiulcerogenic and hepatoprotective effects in rats. Aqueous leaf extracts also showed antiulcer effect[16] indicating that the antiulcer component is widely distributed in this plant. *Moringa* roots have also been reported to possess hepatoprotective activity. The aqueous and alcohol extracts from *Moringa* flowers were also found to have a significant hepatoprotective effect which may be due to the presence of quercetin, a well known flavonoid with hepatoprotective activity[17].

Antitumor and Anticancer Activities:

It has been found that niaziminin ,a thiocarbamate from the leaves of *M. oleifera*, exhibits inhibition of tumor-promoterinduced Epstein–Barr virus activation. On the other hand, among the isothiocyanates, naturally occurring 4-[[4′-*O*-acetyl- α-irhamnosyloxy] benzyl], significantly inhibited tumor-promoter induced Epstein–Barr virus activation, suggesting that the isothiocyano group is a critical structural factor for activity[18]. Makonnen *et al.* [1997] found *Moringa* leaves to be a potential source for antitumor activity. *O*Ethyl- 4-[α-L-rhamnosyloxy]benzyl carbamate together with 4[α-L rhamnosyloxy]-benzyl isothiocyanate, niazimicin and 3-*O*-[6′-*O*-oleoyl- α-D glucopyranosyl]-β-sitosterol have been tested for their potential antitumor promoting activity using an *in vitro* assay which showed significant inhibitory effects on Epstein–Barr virus-early antigen. Niazimicin has been proposed to be a potent chemo preventive agent in chemical carcinogenesis[19].

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[20, 21]. Hot water infusions of flowers, leaves, roots, seeds and bark also showed anti-inflammatory activity against carrageenan-induced hind paw edema. The seed infusion showed anti-inflammatory and diuretic activity at 1000 mg/kg[22].

Antibacterial and antifungal activities:

Defatted and shell free seeds contain about 8-10% of 4-α-L-rhamnosyloxy-benzyl isothiocyanate, but this amount is produced when ascorbic acid is added during water extraction. The compound acts on several bacteria and fungi. The minimal bactericidal concentration *in vitro* is 40mmol/1 for *Mycobacterium phlei* and 56mmol/l for *Bacillus subtilis*[23]. The antimicrobial activity of leaves, root, bark and seeds were also investigated against bacteria, yeast, dermatophytes and helminths pathogenic to man. The fresh leaf juice and aqueous extract of seeds inhibited the growth of *Pseudomonas aeruginosa* and *Staphylococcus aureus*[24]. The seed extract exhibited significant antibacterial activity against pyodermia (skin infection) causing bacterium, *S. aureus* in experimental mice[25]. The aglycone of deoxy-niazimicine [N-benzyl, Sethyl thioformate] isolated from the chloroform fraction of an ethanol extract of the root bark was found to be responsible for the antibacterial and antifungal activities [26]. The bark extract has been shown to possess antifungal activity [27].

Antifertility

Bark of drumstick tree was screened for its antifertility effect on early pregnancy in albino rats. The aqueous extract of root and bark at a dose of 200 mg/kg and 400 mg/kg, respectively showed post-coital antifertility effect in rat and also induced foetal resorption at late pregnancy[28]. The aqueous or ethanolic (90%) extract of root showed abortifacient and teratogenic effect in rat[29]. The aqueous extract of roots possesses antioestrogenic and antiprogestational activity[30]. The aqueous extract of root was found to induce biochemical alteration in female genital tract of ovariectomised rat[31] and exhibited biphasic effect on periodicity of oestrous cycle in adult intact rat[32].

Antidiabetic activity:

An extract from the moringa leaf has been shown to be effective in lowering blood sugar levels within 3hrs ingestion, though less effectively than the standard hypoglycemic drug, glibenclamide[33].

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. Pretreatment with methanolic extract caused significant protection against strychnine- and leptazol-induced convulsions[34].

Coagulant agent:

Moringa seeds are one of the best natural coagulants discovered so far[35]. Crushed seeds are a viable replacement of synthetic coagulants[36]. In Sudan, seed crude extract is used instead of alum by rural women to treat the highly turbid Nile water because of a traditional fear of alum causing gastrointestinal disturbances and Alzheimer's disease [37, 38]. *Moringa* seeds are very effective for high turbidity water and show similar coagulation effects to alum . The coagulation effectiveness of *M. oleifera* varies depending on the initial turbidity and it has been reported that *M. oleifera* could reduce turbidity by between 92% and 99%[39]. *Moringa* seeds also have softening properties in

addition to being a pH correct ant [alkalinity reduction], as well as exhibiting a natural buffering capacity, which could handle moderately high to high alkaline surface and ground waters. The *Moringa* seeds can also be used as an antiseptic in the treatment of drinking water[40]. It is believed that the seed is an organic natural polymer[41]. The active ingredients are dimeric proteins with a molecular weight of about 1300 Da and n iso-electric point between 10 and 11. The protein powder is stable and totally soluble in water. *Moringa* coagulant protein can be extracted by water or salt solution (commonly NaCl). The amount and efectiveness of the coagulant protein from salt and water extraction methods vary significantly. In crude form, the salt extract shows a better coagulation performance than the corresponding water extract[42].

CONCLUSION

M. oleifera, popularly known as 'The miracle tree', mainly contains alkaloids, flavonoids, anthocyanins, proanthocyanidins and cinnamates. The alkaloid-moringine is reported to resemble ephedrine in its action. Seed extracts have been proposed as an environment-friendly alternative, due to their traditional use for the clarification of drinking water. Thus, activity guided phytochemical and phytoanalytical studies may lead to development of novel agents for various disorders.

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