

A Multipurpose Tree- *Moringa oleifera*

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ABSTRACT

Moringa oleifera Lam. (Moringaceae) is a highly valued plant, distributed in many countries of the tropics and subtropics. Moringa is best known as excellent source of nutrition and a natural energy booster. Different parts of this plant are being employed for the treatment of different ailments in the indigenous system of medicine. 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. This review focuses on the detailed phytochemical composition, medicinal uses, along with pharmacological properties of different parts of this multipurpose tree.

Keywords: *Moringa oleifera*, pharmacology, Phytochemistry.

INTRODUCTION

Moringa oleifera, native of the western and sub-Himalayan tracts, India, Pakistan, Asia, Africa and Arabia (Somali *et al.*, 1984; Mughal *et al.*, 1999) is now distributed in the Philippines, Cambodia, Central America, North and South America and the Caribbean Islands (Morton, 1991). In some parts of the world *M. oleifera* is referred to as the 'drumstick tree' or the 'horse radish tree', whereas in others it is known as the kelor tree (Anwar and Bhangar, 2003). While in the Nile valley, the name of the tree is 'Shagara al Rauwaq', which means 'tree for purifying' (Von Maydell, 1986). In Pakistan, *M. oleifera* is locally known as 'Sohanjna' and is grown and cultivated all over the country (Kaiser, 1973; Anwar *et al.*, 2005). *Moringa oleifera* Lam is one of the best known and most widely distributed and naturalized species of a monogeneric family *Moringaceae* (Nadkarni, 1976; Ramachandran *et al.*, 1980). The tree ranges in height from 5 to 10 m (Morton, 1991). 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 (The Wealth of India, 1962;

Kaiser, 1973). It can grow well in the humid tropics or hot dry lands, can survive destitute soils, and is little affected by drought (Morton, 1991). 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 (Palada and Changl, 2003).

Moringa oleifera is an important food commodity which has had enormous attention as the 'natural nutrition of the tropics'. 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 (D'souza and Kulkarni, 1993; Anwar and Bhangar, 2003; Anwar *et al.*, 2005). *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 (Dillard and German, 2000; Siddhuraju and Becker, 2003). In the Philippines, it is known as 'mother's best friend' because of its utilization to increase woman's milk

production and is sometimes prescribed for anemia (Estrella *et al.*, 2000; Siddhuraju and Becker, 2003). A number of medicinal properties have been ascribed to various parts of this highly esteemed tree. Almost all the parts of this plant: leaf, root, bark, gum, 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 hepatorenal disorders (The Wealth of India, 1962; Singh and Kumar, 1999; Morimitsu *et al.*, 2000; Siddhuraju and Becker, 2003). The seeds of *Moringa* are considered to be antipyretic, acrid, bitter (Oliveira *et al.*, 1999) and reported to show antimicrobial activity (The Wealth of India, 1962). The seed can be consumed fresh as peas; or pounded, roasted, or pressed into sweet, non-desiccating oil, commercially known as 'Ben oil' of high quality. The unique property is the ability of its dry, crushed seed and seed press cake, which contain polypeptides, to serve as natural coagulants for water treatment (Ndabigengesere and Narasiah, 1998).

Phytochemistry

Moringa oleifera is rich in compounds containing the simple sugar, rhamnose called glucosinolates and isothiocyanates (Fahey *et al.*, 2001; Bennett *et al.*, 2003). The stem bark contains two alkaloids, namely Moringine and moringinine (Kerharo, 1969). Vanillin, sitosterol, β -sitostenone, 4-hydroxymellin and octacosanoic acid have been isolated from the stem of *M. oleifera* (Faizi *et al.*, 1994a). Purified, gum exudate from *M. oleifera* has been found to contain L-arabinose, galactose, -glucuronic acid, and L rhamnose, mannose, xylose and degraded-gum polysaccharide consisting of L-galactose, -glucuronic acid and L-mannose has been obtained on mild hydrolysis of the whole gum with acid (Bhattacharya *et al.*, 1982). Flowers contain nine amino acids, sucrose, D-glucose, traces of alkaloids, wax, quercetin and kaempferat; the ash is rich in potassium and calcium (Ruckmani *et*

al., 1998). They have also been reported to contain some flavonoid pigments such as alkaloids, kaempferol, rhamnetin, isoquercitrin and kaempferitrin (Faizi *et al.*, 1994a; Siddhuraju and Becker, 2003). Thiocarbamate and isothiocyanate glycosides have been isolated from the acetate phase of the ethanol extract of *Moringa* pods (Faizi *et al.*, 1998). The cytokinins have been shown to be present in the fruit (Nagar *et al.*, 1982). Lately, interest has been generated in isolating hormones/growth promoters from the leaves of *M. oleifera*. Nodulation of blackgram (*Vigna munga* L.) has been shown to increase vigorously with the application of an aqueous-ethanol extract (Bose, 1980) of *M. oleifera* leaves, although the nature of the active ingredient is still unknown. *Moringa* leaves act as a good source of natural antioxidant due to the presence of various types of antioxidant compounds such as ascorbic acid, flavonoids, phenolics and carotinoids (Anwar *et al.*, 2005; Makkar and Becker, 1996). The high concentrations of ascorbic acid, oestrogenic substances and β -sitosterol, iron, calcium, phosphorus, copper, vitamins A, B and C, α -tocopherol, riboflavin, nicotinic acid, folic acid, pyridoxine, β -carotene, protein, and in particular essential amino acids such as methionine, cystine, tryptophan and lysine present in *Moringa* leaves and pods make it a virtually ideal dietary supplement (Makkar and Becker, 1996). The composition of the sterols of *Moringa* seed oil mainly consists of campesterol, stigmasterol, β -sitosterol, Δ^5 -avenasterol and clerosterol accompanied by minute amounts of 24-methylenecholesterol, Δ^7 -campestanol, stigmastanol and 28-isoavenasterol (Tsaknis *et al.*, 1999; Anwar and Bhangar, 2003; Anwar *et al.*, 2005; Table 2). The sterol composition of the major fractions of *Moringa* seed oil differs greatly from those of most of the conventional edible oils (Rossell, 1991). The fatty acid composition of *M. oleifera* seed oil reveals that it falls in the category of high-oleic oils (C18:1, 67.90%–76.00%). Among the other component fatty acids C16:0 (6.04%–7.80%), C18:0 (4.14%–7.60%), C20:0 (2.76%–4.00%), and C22:0 (5.00%–6.73%) are important

(Tsaknis *et al.*, 1999; Anwar and Bhanger, 2003; Anwar *et al.*, 2005). *Moringa oleifera* is also a good source of different tocopherols (α -, γ - and δ -); the concentration of those is reported to be 98.82–134.42, 27.90–93.70, and 48.00–71.16 mg/kg, respectively (Anwar and Bhanger, 2003; Tsaknis *et al.*, 1999).

Pharmacological Activities Diuretic Activity

Moringa roots, leaves, flowers, gum and the aqueous infusion of seeds have been found to possess diuretic activity (Morton, 1991; Caceres *et al.*, 1992) and such diuretic components are likely to play a complementary role in the overall blood pressure lowering effect of this plant.

Cholesterol lowering

The crude extract of *Moringa* leaves has a significant cholesterol lowering action in the serum of high fat diet fed rats which might be attributed to the presence of a bioactive Phytoconstituents, i.e. β -sitosterol (Ghasi *et al.*, 2000). *Moringa* fruit has been found to lower the serum cholesterol, phospholipids, triglycerides, low density lipoprotein (LDL), very low density lipoprotein (VLDL) cholesterol to phospholipid ratio, atherogenic index lipid and reduced the lipid profile of liver, heart and aorta in hypercholesteremic rabbits and increased the excretion of fecal cholesterol (Mehta *et al.*, 2003).

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 (Faizi *et al.*, 1994a; 1994b; 1995). Most of these compounds, bearing thiocarbamate, carbamate or nitrile groups, are fully acetylated glycosides, which are very rare in nature (Faizi *et al.*, 1995). Bioassay guided fractionation of the active ethanol

extract of *Moringa* leaves led to the isolation of four pure compounds, niazinin A, niazinin B, niazimicin and niazinin A + B which showed a blood pressure lowering effect in rats mediated possibly through a calcium antagonist effect (Gilani *et al.*, 1994a).

Antispasmodic, Antiulcer and Hepatoprotective Activities

M. oleifera roots have been reported to possess antispasmodic activity (Caceres *et al.*, 1992). *Moringa* leaves have been extensively studied pharmacologically and it has been found that the ethanol extract and its constituents exhibit antispasmodic effects possibly through calcium channel blockade (Gilani *et al.*, 1992; 1994a; Dangi *et al.*, 2002). The antispasmodic activity of the ethanol extract of *M. oleifera* leaves has been attributed to the presence of 4-[α -(L-rhamnosyloxy) benzyl]- *o*-methyl thiocarbamate (*trans*), which forms the basis for its traditional use in diarrhea (Gilani *et al.*, 1992). Moreover, spasmolytic activity exhibited by different constituents provides pharmacological basis for the traditional uses of this plant in gastrointestinal motility disorder (Gilani *et al.*, 1994a). The methanol fraction of *M. oleifera* leaf extract showed antiulcerogenic and hepatoprotective effects in rats (Pal *et al.*, 1995a). Aqueous leaf extracts also showed antiulcer effect (Pal *et al.*, 1995a) indicating that the antiulcer component is widely distributed in this plant. *Moringa* roots have also been reported to possess hepatoprotective activity (Ruckmani *et al.*, 1998). The aqueous and alcohol extracts from *Moringa* flowers were also found to have a significant hepatoprotective effect (Ruckmani *et al.*, 1998), which may be due to the presence of quercetin, a well known flavonoid with hepatoprotective activity (Gilani *et al.*, 1997).

Antitumor and Anticancer Activities

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- β -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 chemopreventive agent in chemical carcinogenesis (Guevara *et al.*, 1999). The seed extracts have also been found to be effective on hepatic carcinogen metabolizing enzymes, antioxidant parameters and skin papillomagenesis in mice (Bharali *et al.*, 2003). A seed ointment had a similar effect to neomycin against *Staphylococcus aureus pyoderma* in mice (Caceres and Lopez, 1991). It has been found that niaziminin, a thiocarbamate from the leaves of *M. oleifera*, exhibits inhibition of tumor-promoter-induced Epstein–Barr virus activation. On the other hand, among the isothiocyanates, naturally occurring 4-[(4'-O-acetyl- α -i-rhamnosyloxy) benzyl], significantly inhibited tumor-promoter induced Epstein–Barr virus activation, suggesting that the isothiocyano group is a critical structural factor for activity (Murakami *et al.*, 1998).

Antibacterial and Antifungal Activities

Moringa roots have antibacterial activity (Rao *et al.*, 1996) and are reported to be rich in antimicrobial agents. These are reported to contain an active antibiotic principle, pterygospermin, which has powerful antibacterial and fungicidal effects (Ruckmani *et al.*, 1998). A similar compound is found to be responsible for the antibacterial and fungicidal effects of its flowers (Das *et al.*, 1957). The root extract also possesses antimicrobial activity attributed to the presence of 4- α -L-rhamnosyloxy benzyl isothiocyanate (Eilert *et al.*, 1981). The aglycone of deoxy-niazimicine (N-benzyl, S-ethyl 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 (Nikkon *et al.*, 2003). The bark extract has been shown to possess antifungal activity (Bhatnagar *et al.*, Septilin (the Himalaya Drug Company, Bangalore, India), Orthoherb (Walter Bushnell Ltd, Mumbai, India), Kupid Fort (Pharma Products Pvt. Ltd, Thayavur, India) and Livospin

(Herbals APS Pvt. Ltd, Patna, India), which are reputed as remedies available for a variety of human health disorders (Mehta *et al.*, 2003). *Moringa* seeds have specific protein fractions for skin and hair care. Two new active components for the cosmetic industry have been extracted from oil cake. Purisoft® consists of peptides of the *Moringa* seed. It protects the human skin from environmental influences and combats premature skin aging. With dual activity, antipollution and conditioning/strengthening of hair, the *M. oleifera* seed extract is a globally acceptable innovative solution for hair care (Stussi *et al.*, 2002).

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.

Wound Healing Properties

Three wound models viz excision wound, incision wound and dead space wound were selected for assessing wound healing activity of ethanolic and ethyl acetate extracts of leaves. Ethyl acetate extracts (10% extract in the form of ointment) showed significant wound healing activity that is comparable with the standard vicco turmeric cream. Phytosterols and phenolic compounds present in these extracts promote the wound healing activity.

Antipyretic Activity

The antipyretic activity of ethanolic, petroleum ether, solvent ether and ethyl acetate extracts of seeds was screened using yeast induced hyperpyrexia method. Paracetamol I.P (200mg/ kg) was used as standard for comparison. The ethanolic and ethyl acetate extracts of seeds showed significant antipyretic activity in rats.

Analgesic Activity

The experimental studies using hot plate and tail immersion method have shown that alcoholic extract of leaves and seeds of *Moringa oleifera* possess marked analgesic activity (3). According to the

authors it is equipotent to standard drug (Aspirin 25mg/ kg.)

Anti-Inflammatory Activity

Poultice of leaves is beneficial in glandular swellings. The root extract exhibited significant anti-inflammatory activity in Carrageenan induced rat paw edema.

Anti Asthmatic Activity

A study was carried out to investigate the efficacy and safety of seed kernels of *Moringa oleifera* in the treatment of bronchial asthma. The results showed an appreciable decrease in severity of symptoms of asthma and also simultaneous improvement in respiratory functions.

In Blindness and Eye Infections

Though there are many causes of blindness Vitamin A deficiency causes impaired dark adaption and night blindness. Eating Moringa leaves, pods and leaf powder which contain high proportion of Vitamin A can help to prevent night blindness and eye problems in children. Ingesting drumstick leaves (Bcarotene and leutin) with oil helps in improving Vitamin A nutrition and perhaps delays the onset of cataract. Also the juice can be instilled into eyes in cases of conjunctivitis.

Cardiac and Circulatory Stimulant

All parts of the tree are reported to be used as Cardiac and circulatory stimulant. Moringinine acts on the sympathetic nervous system and act as a cardiac stimulant.

Antioxidant Activity

Antioxidant activity reported in oil from the dried seeds is higher than BHT and alpha Tocopheryl. Aqueous methanol (80%) and ethanol (70%) extracts of freeze dried leaves showed radical scavenging and antioxidant activities. The drumstick leaves are found to be a potential source of natural antioxidants.

Antifertility Activity

The aqueous extract of root and bark at a dose of 200mg/kg and 400mg/kg, respectively showed post-coital antifertility

effect in rat and also induced foetal resorption at late pregnancy (26). An aqueous extract of *Moringa oleifera* roots was investigated for its estrogenic, anti-estrogenic, progestational and antiprogestational activities. Doses up to 600 mg/kg of the extract orally failed to induce a decidual response in the traumatized uterus of ovariectomized rats. The antifertility effect of the extract appears to be due to multiple attributes.

Antiuroliathatic activity

The effect of oral administration of aqueous and alcoholic extract of *M. oleifera* root-wood on calcium oxalate urolithiasis has been studied in male Wistar albino rats. Ethylene glycol feeding resulted in hyperoxaluria as well as increased renal excretion of calcium and phosphate. Supplementation with aqueous and alcoholic extract of *M. oleifera* root-wood significantly reduced the elevated urinary oxalate, showing a regulatory action on endogenous oxalate synthesis. The increased deposition of stone forming constituents in the kidneys of calculogenic rats was also significantly lowered by curative and preventive treatment using aqueous and alcoholic extracts. Thus the results indicate that the root-wood of *M. oleifera* is endowed with antiuroliathatic activity.

Cosmetic Use

Various parts of *Moringa olifera* have cosmetic value. Cognis Laboratoires Serobiologiques team developed Puricare™ and Purisoft™, two active ingredients based on botanical peptides from the seeds of Moringa olifera tree that purify hair and skin and offer protection against the effects of pollution. Moringa seed oil, known as Behen oil is widely used as a carrier oil in cosmetic preparations. The healing properties of moringa oil were documented by ancient cultures. Moringa oil possesses exceptional oxidative stability which may explain why the Egyptians placed vases of Moringa oil in their tombs. It is high in oleic acid and similar in composition to olive oil. Moringa oil is light and spreads easily on the skin. It is good oil for use in massage and aromatherapy applications. It can be used

in body and hair care as a moisturizer and skin conditioner. Other uses include soap making and for use in cosmetic preparations such as lip balm and creams. *Moringa oleifera* butter, a semisolid fraction of Moringa oil, is used in baby products to contribute a free radicle resistant emollient with exceptionally long lasting skin softening and soothing effects.



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