Medicinal uses and pharmacological properties of *Moringa oleifera*

P. Sudhir Kumar1*, Debasis Mishra1, Goutam Ghosh1, Chandra S. Panda2

*Corresponding author:
P. Sudhir Kumar
1. School of Pharmaceutical Sciences, Siksha O Anusandhan University, Bhubaneswar, Orissa, India
2. NISER, Institute of Physics, Bhubaneswar, Orissa, India.

Abstract

*Moringa oleifera* Lam [Moringaceae] is a highly valued plant, distributed in many countries of the tropics and subtropics. It has an impressive range of medicinal uses with high nutritional value. Different parts of this plant contain a profile of important minerals, and are a good source of protein, vitamins, β-carotene, aminoacids and various phenolics. 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, possess anitumor, antipyretic, antiepileptic, antiinflammatory, antiulcer, antispasmodic, diuretic, antihypertensive, cholesterol lowering, antioxidant, antidiabetic, hepatoprotective, antibacterial and antifungal activities, and are being employed for the treatment of different ailments in the indigenous system of medicine. This review focuses on the detailed phytochemical composition, medicinal uses, along with pharmacological properties of different parts of this multipurpose tree.

**Keywords:** *Moringa oleifera; β–carotene; anitumor*

Introduction

*Moringa oleifera* Lam [syn. *M. ptreygosperma* Gaertn.] is one of the best known and most widely distributed and naturalized species of a monogeneric family *Moringaceae*. 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. It can grow well in the humid tropics or hot dry lands, can survive destitute soils, and is little affected by drought. *Moringa oleifera*, native of the western and sub-Himalayan tracts, India, Pakistan, Asia Minor & Africa. *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. In the Philippines, it is known as ‘mother’s best friend’ because of its utilization to increase woman’s milk production.
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 hepatorenal disorders. The seeds of *Moringa* are considered to be antipyretic, acrid, bitter [1] 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 [2]. Its versatile utility as a medicine, functional food, nutraceutical and water purifying potential motivated us to bridge the information gap in this area, and to write a comprehensive review on the medicinal, phytochemical and pharmacological attributes of this plant of high economic value.

**Medicinal Uses and Pharmacological Properties**

*Moringa oleifera* also has numerous medicinal uses, which have long been recognized in the Ayurvedic and Unani systems of medicine [3]. The medicinal attributes and pharmacological activities ascribed to various parts of *Moringa* are detailed below.

**Antihypertensive, diuretic and cholesterol lowering activities**

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*; [4]. 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 [5-7]. Most of these compounds, bearing thiocarbamate, carbamate or nitrile groups, are fully acetylated glycosides, which are very rare in nature [7].

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 niazininA_B which showed a blood pressure lowering effect in rats mediated possibly through a calcium antagonist effect [8]. Activity-directed fractionation of the ethanol extract of pods of *M.oleifera* has led to the isolation of thiocarbamate and isothiocyanate glycosides which are known to be the hypotensive principles [7]. Methyl hydroxybenzoate and β-sitosterol investigated in the pods of *M. oleifera* have also shown promising hypotensive activity [9], *Moringa* roots, leaves, flowers, gum and the aqueous infusion of seeds have been found to possess diuretic activity [10,11] and such diuretic components are likely to play a complementary role in the overall blood pressure lowering effect of this plant. 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 phytoconstituent, i.e. β-sitosterol [12]. *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 [13].

**Antispasmodic, antiulcer and hepatoprotective activities**

*M. oleifera* roots have been reported to possess antispasmodic activity [14]. *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 [14,15]. 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 [14]. Moreover, spasmolytic activity exhibited by
different constituents provides pharmacological basis for the traditional uses of this plant in gastrointestinal motility disorder [16]. The methanol fraction of *M. oleifera* leaf extract showed antiulcerogenic and hepatoprotective effects in rats. Aqueous leaf extracts also showed antiulcer effect [17] 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[18].

**Antibacterial and antifungal activities**

*Moringa* roots have antibacterial activity [20] 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. A similar compound is found to be responsible for the antibacterial and fungicidal effects of its flowers [19]. The root extract also possesses antimicrobial activity attributed to the presence of 4-α-L-rhamnosyloxybenzyl isothiocyanate [21]. The aglycone of deoxy-niazimicine [N-benzyl, S-ethyl thiophorate] isolated from the chloroform fraction of an ethanol extract of the root bark was found to be responsible for the antibacterial and antifungal activities [25]. The bark extract has been shown to possess antifungal activity [22], while the juice from the stem bark showed antibacterial effect against *Staphylococcus aureus* [24]. The fresh leaf juice was found to inhibit the growth of microorganisms [**Pseudomonas aeruginosa** and *Staphylococcus aureus*], pathogenic to man [23].

**Antitumor and anticancer activities**

Makonnen *et al.* [1997] found *Moringa* leaves to be a potential source for antitumor activity. *O*-Ethyl- 4-α-L-rhamnosyloxybenzyl carbamate together with 4α-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 [26]. The seed extracts have also been found to be effective on hepatic carcinogen metabolizing enzymes, antioxidant parameters and skin papillomagenesis in mice [27]. A seed ointment had a similar effect to neomycin against *Staphylococcus aureus pyoderma* in mice [28]. 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-L-rhamnosyloxy)benzyl, significantly inhibited tumor-promoter induced Epstein–Barr virus activation, suggesting that the isothiocyanoyl group is a critical structural factor for activity [29].

**Other diverse activities**

*Moringa oleifera* has also been reported to exhibit other diverse activities. Aqueous leaf extracts regulate thyroid hormone and can be used to treat hyperthyroidism and exhibit an antioxidant effect [17,30,31]. A methanol extract of *M. oleifera* leaves conferred significant radiation protection to the bone marrow chromosomes in mice [20]. *Moringa* leaves are effective for the regulation of thyroid hormone status [31]. A recent report showed that *M. oleifera* leaf may be applicable as a prophylactic or therapeutic anti-HSV[Herpes simplex virus type 1] medicine and may be effective against the acyclovir-resistant variant [33]. The flowers and leaves also are considered to be of high medicinal value with anthelmintic activity [34]. An infusion of leaf juice was shown to reduce glucose levels in rabbits [32]. *Moringa oleifera* is coming to the forefront as a result of scientific evidence that *Moringa* is an important source of naturally occurring phytochemicals and this provides a basis for future viable developments. Different parts of *M. oleifera* are also incorporated in
various marketed health formulations. *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.

**Water purifying attributes of *M. Oleifera* seed**

*Moringa* seeds as coagulant

*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 [38, 39,40, 37]. *Moringa* seeds are very effective for high turbidity water and show similar coagulation effects to alum [37]. 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% [37]. *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 [41]. It is believed that the seed is an organic natural polymer [42]. The active ingredients are dimeric proteins with a molecular weight of about 1300 Da and n iso-electric point between 10 and 11 [35]. 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 effectiveness 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 [43]. This may be explained by the presence of higher amount of soluble protein due to the salting-in phenomenon. However, purification of the *M. oleifera* coagulant protein from the crude salt extract may not be technically and economically feasible. The coagulation mechanism of the *M. oleifera* coagulant protein has been explained in different ways. It has been described as adsorption and charge neutralization [35,44] and interparticle bridging [45]. Flocculation by inter-particle bridging is mainly characteristic of high molecular weight polyelectrolytes. Due to the small size of the *M. oleifera* coagulant protein [6.5–13 kDa], a bridging effect may not be considered as the likely coagulation mechanism. The high positive charge [pI above 10] and small size may suggest that the main destabilization mechanism could be adsorption and charge neutralization.

**Microbial elimination with *Moringa* seeds**

*Moringa* seeds also possess antimicrobial properties [48,47,46] reported that a recombinant protein in the seed is able to flocculate Gram-positive and Gram-negative bacterial cells. In this case, microorganisms can be removed by settling in the same manner as the removal of colloids in properly coagulated and flocculated water [49]. On the other hand, the seeds may also act directly upon microorganisms and result in growth inhibition. Antimicrobial peptides are thought to act by disrupting the cell membrane or by inhibiting essential enzymes [50, 51, 52] reported that *Moringa* seeds could inhibit the replication of bacteriophages. The antimicrobial effects of the seeds are attributed to the compound 4[α-L-rhamnosyloxy] benzyl isothiocynate [53].

*Moringa* seeds as biosorbent

*Moringa* seeds could be used as a less expensive biosorbent for the removal of cadmium [Cd] from aqueous media [54]. The aqueous solution of *Moringa* seed is a heterogeneous complex mixture having various functional groups, mainly low molecular weight organic acids [amino
These amino acids have been found to constitute a physiologically active group of binding agents, working even at a low concentration, which because of the ability to interact with metal ions is likely to increase the sorption of metal ions [55]. The proteineous amino acids have a variety of structurally related pH dependent properties, generating a negatively charged atmosphere and play an important role in the binding of metals [56].

References


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