A REVIEW ON COMMERCIAL, TRADITIONAL USES, PHYTOCONSTITUENTS AND PHARMACOLOGICAL ACTIVITY OF MORINGA OLEIFERA

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ABSTRACT

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. People in India have been using it as an item of their daily food for nearly 5000 years. It originated initially in the Northern part of India some 5000 years back and soon moved into the Southern parts as well, where it was known as ‘Murungai keerai’ (Moringa leaves) and ‘Murungai kaai’ (Moringa vegetable). The Moringa tree had spread to most part of Asia, nearly the whole of Africa, South America, southern part of North America and some pockets in Europe. It has been found useful in nutrition, agriculture, soil control, water purification, industrial applications, cattle feed etc and also for treating various types of illnesses in humans and livestock. It is also used as a vegetable and oil source. Moringa pods are an important commercial vegetable crop throughout India.

Key words: Moringa oleifera, Commercial uses, Traditional uses, Pharmacological activity

INTRODUCTION

Moringa oleifera is the most widely cultivated species of a monogenetic family, the Moringaceae that is native to the sub-Himalayan tracts of India, Pakistan, Bangladesh and Afghanistan. This rapidly-growing tree (also known as kelor, marango, mlange, moonga, mulangay, 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 an important crop in India, Ethiopia, Philippines, Sudan and is being grown in West and East South Africa, tropical Asia, Latin America, Florida and in Pacific Islands. All parts of the Moringa tree are edible and have long been consumed by humans. According to Fuglie 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 plant, 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. 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 [1].

The moringa tree, Moringa oleifera has probably been the most popular plant in ECHO’s seed bank of underutilized tropical crops. The tree is native to India but has been planted around the world and is naturalized in many localities. Moringa is known by many names worldwide. In the Philippines, it is called "mother's best friend" and "malunggay" where the leaves of the moringa are cooked and fed to babies. Other names for it include the benzoilive tree (Haiti), horseradish tree (Florida), Nébéday (Senegal) and drumstick tree (India). There are about 13 species of moringa trees in the family Moringaceae [2, 3].

A number of medicinal properties have been ascribed to various parts of this highly esteemed tree. 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[4].

The seeds from this plant contain active coagulating agents characterized as dimeric cationic proteins, having molecular weight of 13 kDa and an isoelectric point between 10 and 11. The seeds also have antimicrobial activity and are utilized for waste water treatment. In some developing countries, the powdered seeds of M. oleifera are traditionally utilized as a natural coagulant for water purification because of their strong coagulating properties for sedimentation of suspended undesired particles [5] the seeds are also eaten green, roasted, powdered and steeped for tea or used in curries.

Fig.1. Moringa oleifera - pods and seeds [3,6]

Table 2: Scientific classification [8]

<table>
<thead>
<tr>
<th>Kingdom</th>
<th>Plantae</th>
</tr>
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<tbody>
<tr>
<td>Division</td>
<td>Magnoliophyta</td>
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<tr>
<td>Class</td>
<td>Violes</td>
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<tr>
<td>Order</td>
<td>Moringaceae</td>
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<tr>
<td>Genus</td>
<td>Moringa</td>
</tr>
<tr>
<td>Species</td>
<td>Oleifera</td>
</tr>
<tr>
<td>Family (ayurvedic)</td>
<td>Shobhanjan Kul</td>
</tr>
</tbody>
</table>

Cultivation

It grows well in hot, semi-arid and humid regions and in well-drained sandy or loamy soils. Seed must be relatively fresh to give a good germination. Warm temperatures are important for germination. Planted seeds would be kept out of reach of mice and wood lizards, as the seed is nutty and considered a tasty morsel by these little scavengers. Stem cuttings, 10-60 cm long, can also be struck in spring and summer. Trees are grown extensively in tropical, sub tropical and warm temperature areas. [3]

Geographical distribution

Drumstick tree is indigenous to the Himalayan foothills of South Asia from northeastern Pakistan (33 °N, 73 °E) 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. It grows at elevations from sea level to 1400 m. [9, 10]

Morphology

Moringa oleifera is a small, fast-growing evergreen or deciduous tree that usually grows as high as 9 m. with a soft and white wood and with corky and gummy bark. Roots have the taste of horseradish. Leaves are longitudinally cracked. Leaves have long main axis (30-75 cm) and jointed branch. Branches are glandular at joints. Leaflets are glabrous and entire. The leaflets are finely hairy, green and almost hairless on the upper surface, paler and hairless beneath, with red-tinged mid-veins, 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. Flowers are white, scented in large auxiliary down panicles, pods are pendulous, ribbed, and seeds are 3-angled. [11,12]

M. oleifera is a drought-resistant pioneer species mainly grows in semi-arid tropical and subtropical areas. It is found up to 1000 m altitude and in areas with annual rainfall of 750–2,250 mm. While it grows best in dry sandy soil, it is adaptable to various soil conditions from 4.5 to 8 pH. M. oleifera, which can easily adapt to varied ecosystems and farming systems is known for its resistance to drought and
diseases. The tree is fast growing as it has been found to grow 6-7m in one year in areas receiving less than 400 mm mean annual rainfall. [13]

![Fig. 2: Compound leaf: paler lower surfaces of leaflets flower panicle](image)

**Ecology**

In its native Indian range, *M. oleifera* is susceptible to several insect pests. These include bark-eating caterpillar *Indarbela quadrinotata* WLK; hairy caterpillar *Eupterote molifera* WLK; green leaf caterpillar *Noorda blitealis* WLK and budworm *N. moringae* TAMS; larvae of *Tetragonia siva*, *Metanastia hyrtaca*, *Heliothis armigera*, and *Helopeltis antonii* SIGN. The scale insects *Ceroplastodes cajani* and *Diaspidotus* species [14, 15, 16].

**Pathology**

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**Properties**

*Moringa oleifera* have broad activities like galactagogue, rubefacient, diuretic, stimulant, purgative, antibiotic, antifungal, antimicrobial antibacterial, anti-inflammatory, antitumor, antioxidant, anti-aging, estrogenic, antiprostational, hypoglycemic, anti-hyperthyroidism, anti-ulcer, hypocholesterolemic, antispasmodic, decreasing blood pressure, relieving headaches and migraines. [3]

**Phytochemistry**


- I.M. Villasenor *et al.* (1989) reported certain biosynthetically and chemically related compounds from roasted seeds of *Moringa oleifera*. Their structures have been elucidated by spectral analysis as 4(-L-rhammosyloxy) phenylacetonitrile, 4-hydroxyphenylacetonitrile, and 4-hydroxyphenyl-acetamide [17, 18]

- S. Faizi *et al.* (1994) reported the isolation of two nitrile glycosides from the ethanolic extracts of *Moringa oleifera* leaves, niazirin and niazirinin and three mustard oil glycosides, 4-[(4′-O-acetylalpha-L-rhamnosyloxy)benzyl]isothiocyanate, niaziminin A, and niaziminin B. Niazirinin is a new compound. Niaziminins A and B have previously been obtained from the left extract as a mixture, while 4-[(4′-O-acetyl-alpha-L-rhamnosyloxy)benzyl]isothiocyanate is new from this source. Structural determination was accomplished by means of spectroscopic methods including appropriate 2D nmr experiments and chemical reactions. This is the first report of the isolation of nitriles, an isothiocyanate, and thiocarbamates from the same plant species. [19]

- S. Faizi *et al.* (1995) isolated six new and three synthetically known glycosides from the leaves of *Moringa oleifera*, employing a bioassay-directed isolation method on the
ethanolic extract. Most of these compounds, bearing thiocarbamate, carbamate or nitrile groups, are fully acetylated glycosides, which are very rare in nature.

Elucidation of the structures was made using chemical and spectroscopic methods, including 2D NMR techniques. [20]

- S. Faizi et al. (1998) isolated two new compounds from the ethanolic extract of whole pods of Moringa oleifera, O-[2'-hydroxy-3'-(2''-heptynol)]-propyl undecanoate and O-ethyl-4-[{(alpha-L-rhamnosyloxy)-benzyl] carbamate along with the known substances like methyl hydroxybenzoate and beta-sitosterol [21]

A.Murakami et al. (1998) isolated niaziminin, a thiocarbamate from the leaves of Moringa oleifera. [22]

- A.P. Guevara et al. (1999) investigated the ethanolic extracts of the seeds of Moringa oleifera and isolated a new compound O-ethyl-4-(alpha-L-rhamnosyloxy)benzyl carbamate together with seven known compounds, 4(alpha-L-rhamnosyloxy)benzyl carbamate along with the known substances like methyl hydroxybenzoate and beta-sitosterol [23]


- F. Nikkon et al. (2003) isolated aglycone of Deoxy-Niazimicine which is characterized as N-benzyl; S-ethyl thioformate from the chloroform extract of Moringa oleifera roots barks.[26]

- Phytocultural studies on Moringa oleifera by M. Ndong et al. (2007) revealed major polyphenols such as quercetin glucosides, rutin, kaempferol glycosides and chlorogenic acids in Moringa oleifera powder by HPLC analysis. [27]

- L.O. Manguro & P. Lemmen (2007) reported the isolation of five flavonol glycosides Characterised as kaempferide 3-O-(2''-3''-diacetylglucoside), kaempferide 3-O-(2''-O-galloylhamnoside), kaempferide 3-O-(2''-O-galloylrutinoside)-7-O-alpha-rhamnoside, kaempferol 3-O-[beta-glucosyl(1 → 2)]-[alpha-rhamnosyl(1 → 6)]-beta-glucoside-7-Oalparhamnoside and kaempferol 3-O-[alpha-rhamnosyl(1 → 2)]-[alpha-rhamnosyl(1 → 4)]-Betaglucoside-7-O-alpha-rhamnoside together with benzoic

- R.N. Bennett et al. (2003) isolated various glucosinolates and phenolic compounds from various parts of Moringa oleifera. The seeds only contained 4-(alpha-L-rhammosponyloxy)- benzylglucosinolate at high concentrations. Roots of Moringa oleifera contains high concentrations of both 4-(alpha-L-rhamnosopryanosloxy)-benzylglucosinolate and benzyl glucosinolate. Leaves of the plant contains 4-(alpha-L-rhammosponyloxy)-benzylglucosinolate and three monosacetyl isomers of this glucosinolate. Only 4-(alpha-L-rhammosponyloxy) - benzylglucosinolate was detected in Moringa oleifera bark tissue. The leaves also contains quercetin-3-O-glucoside and quercetin-3-O-(6''-malonyl-glucoside), and lower amounts of kaempferol-3-O-glucoside and kaempferol-3-O-(6''-malonyl-glucoside), 3- caffeoylquinic acid and 5-caffeoylquinic acid. [24]
acid 4-O-beta-glucoside, benzoic acid 4-O-alpha-rhamnosyl-(1 → 2)-beta-glucoside and benzaldehyde 4-O-beta-glucoside have been isolated from methanolic extract of *Moringa oleifera* leaves. Also obtained from the same extract were known compounds, kaempferol 3-O-alpha-rhamnoside, kaempferol, syringic acid, gallic acid, rutin and quercetin 3-O-beta-glucoside. Their structures were determined using spectroscopic methods as well as comparison with data from known compounds.\(^{[28]}\)


- F. Anwar & U. Rashid (2007) reported various sterols, tocopherols and fatty acids present in the seeds and seed oil from the n-hexane extract. Among the sterols, stigmasterol has the highest percentage (18.8%), whereas among the tocopherols, alpha-tocopherol was present in high amount (140.5mg/kg).\(^{[30]}\)

- K. Shanker *et al.* (2007) isolated nitrile glycosides (niaziridin & niazirin) from the leaves, pods and bark of *Moringa oleifera* by reverse phase HPLC.\(^{[31]}\)

- Hueih-Min Chen *et al.* (2007) reported forty four compounds from the essential oil isolated from the leaves of *Moringa oleifera* by GC-MS analysis.\(^{[32]}\)

- D. Yammuenart *et al.* (2008) isolated seven compounds, beta-sitosterol-3-O-beta-D-glucopyranoside, beta-sitosterol, linoleic sitosteroate, linoleic acid, 1,2,3-triolein, a mixture of 1,3-dilinoleoyl-2-olein, 1,3-dioleoyl-2-linolein and 1,2,3-trilinolein and iso-thiocyanatomethylbenzene from the ethylene chloride extract of *Moringa oleifera*.\(^{[33]}\)

\[
\text{Linoleic sitosteroate}
\]

- A.O. Ogunbinu *et al.* (2009) isolated monoterpenoid compounds (81.8%) from the essential oil of *Moringa oleifera* extracted by hydrodistillation and analysed by GC and GC-MS. The oil consists of alpha-phellandrene with highest percentage (25.2%) along with p-cymene (24.9%).\(^{[35]}\)

- B.N. Singh *et al.* (2009) reported presence of gallic acid, chlorogenic acid, ellagic acid, ferulic acid, kaempferol, quercetin and vanillin from the aqueous extracts of leaves, fruits and seeds of *Moringa oleifera*. All compounds were analyzed by HPLC and MS/MS techniques.\(^{[36]}\)

\[
\text{Moringyne}
\]

- A.R. Verma *et al.* (2009) reported presence of phenolic acids like gallic acid, chlorogenic acid, ellagic acid, ferulic acid and flavonoids like kaempferol, quercetin and rutin from the leaves of *Moringa oleifera* by HPLC techniques.\(^{[37]}\)

- R.E. Renitta *et al.* (2009) investigated various phytochemicals present in the leaves, seeds and flowers of ethanolic extract of *Moringa oleifera* by GC-MS. The leaves contain fifteen components. The major compounds were hexadecanoic acid, Ethyl palmitate, Palmitic acid ethyl ester, 2, 6-Dimethyl-1, 7-octadiene-3-ol, 4-Hexadecen-6-yne, 2-hexanone, 3-cyclohexyliden-4-ethyl - E2-Dodecylacetate, Hi-oleic safflower oil, Safflower oil. From the seeds, the major compounds were Roridin E, Veridiflorol, and 9-Octadecenoic acid. From the flowers, 9-Octadecen – 1- ol, cis – 9 – Octadecen – 1 – ol, Oleol, Satol, Ocenol, Sipo, Decanoic acid, Dodecanal were identified as major compounds.\(^{[38]}\)
The seeds also contain Moringyne, 4-(α-L-rhamnosyloxy) benzylisothiocyanate & several amino acids. [39-42]

Moringyne

Uses of different part of Moringa Oleifera

Pod
The Moringa fruit is a long thin pod, resembling a drumstick. In South India, it is used to prepare a variety of curries, sambar, korm. It is also preserved by canning and exported worldwide. It can be made into a variety of curry dishes by mixing with coconut, poppy seeds, and mustard. It can just be boiled until the drumsticks are semi-soft and consumed directly without any extra processing or cooking. Drumstick dal is also a very tasty version of the traditional ‘toor dal’

Leaves
The Moringa oleifera leaves are highly nutritious, being a significant source of beta-carotene, Vitamin C, protein, iron, and potassium. The leaves are cooked and used like spinach. In addition to being used fresh as a substitute for spinach, its leaves are commonly dried and crushed into a powder, and used in soups and sauces. Amino acids in green leaf vegetables vary considerably, and many that are staples, are low in the sulphur bearing amino acids methionine and cystine.

Flowers
The flowers are edible when cooked, and are said to taste like mushrooms. Flowers infused in honey are used as a cough remedy.

Table 3: Some common traditional uses of different parts of Moringa oleifera

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Plant part</th>
<th>Medicinal uses</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Root</td>
<td>Antilithic, rubefacient, laxative, abortifacient, vesicant, carminative, anti-inflammatory, stimulant in paralytic afflictions; act as a Cardiac/circulatory tonic; used in treating Rheumatism, articular pains, lower back or kidney pain and constipation</td>
</tr>
<tr>
<td>2</td>
<td>Leave</td>
<td>Purgative, applied as poultice to sores, rubbed on the temples for Headaches; used for piles, fevers, sore throat, bronchitis, eye and Ear infections, scurvy and catarrh; leaf juice is believed to control Glucose levels, applied to reduce glandular swelling</td>
</tr>
<tr>
<td>3</td>
<td>Stem bark</td>
<td>Rubefacient, vesicant and used to cure eye diseases and for the treatment of delirious patients; prevent enlargement of the spleen and formation of tuberculous glands of the neck, used to destroy tumors and to heal ulcers. The juice from the root bark is put into ears to relieve earaches and also placed in a tooth cavity as a pain killer, and has anti-tubercular activity</td>
</tr>
<tr>
<td>4</td>
<td>Gum</td>
<td>Used for dental caries, and as astringent and rubefacient; Gum, mixed with sesame oil is used to relieve headaches, fevers, intestinal complaints, dysentery, asthma and sometimes used as an abortifacient, and to treat syphilis and rheumatism</td>
</tr>
<tr>
<td>5</td>
<td>Flower</td>
<td>Stimulant, aphrodisiac, abortifacient, cholagogue; used to cure inflammations, muscle diseases, hysteria, tumors, and enlargement of the spleen; lower the serum cholesterol, phospholipid, triglyceride, VLDL, LDL cholesterol to phospholipid ratio and atherogenic index; decrease lipid profile of liver, heart and aorta in hypercholesterolaemic rabbits</td>
</tr>
<tr>
<td>6</td>
<td>Seed</td>
<td>Seed extract exerts its protective effect by decreasing liver lipid peroxides [43]</td>
</tr>
</tbody>
</table>

Commercial and traditional application of Moringa oleifera

Ben Oil
The Moringa seeds yield 38–40% edible oil (called ben oil from the high concentration of behenic acid contained in the oil). The refined oil is clear, odorless, and resists rancidity at least as well as any other botanical oil. The seed cake remaining after oil extraction may be used as a fertilizer or as a flocculent to purify water. Oil from the seed, called oil of Ben, is used for earache and in ointments for skin conditions. The oil rubbed on the skin is said to prevent mosquitoes from biting.

Water treatment
Seeds crushed to a powder are used to clarify turbid, dirty water. The cleansing takes place by a process of electrical charges established between the muddy particles suspended in the water and the pulverized seeds and gradually, after about an hour, the muddy particles are pulled to the bottom of the water by the force of gravity. Research shows that the seed not only
settles the mud, but can carry with it over 90% of bacteria and viruses as well. The Moringa seeds can also be used as an antiseptic in the treatment of drinking water.

Moringa makes a great fodder for cattle. The weight of livestock increased up to 32 per cent through Moringa feed and their milk yield of cows increased by 43 percent. The dried leaves appear to be much more effective.

Bio-gas
Methane gas can also produce out of the leaves. Experiments have established that it is possible to produce 4400 cubic meters of bio gas per hectare per year.

Industrial uses
The seed oil is used in arts and for lubricating watches and other delicate machinery and useful in the manufacture of perfumes and hair dressings. The pressed cake obtained after oil extraction may be used as a fertilizer. The industrial uses of the drumstick tree include the use of its wood in paper and textile industries, bark in the tanning industry. [43–46]

Traditional Uses
Traditionally, the plant is used as antispasmodic, stimulant, expectorant and diuretic. Fresh root is acrid and vesicant (has the taste of horse-radish). Internally it is used as stimulant, diuretic and antilithic. Gum is bland and mucilaginous. Seeds are acrid and stimulant. Bark is emmenogogue and even abortifacient, antifungal, antibacterial. Flowers are chologogue, stimulant, tonic and diuretic and useful to increase the flow of bile. The plant is also a cardiac circulatory tonic and antiseptic.

Pods are antipyretic, analgesic, fried pods are used in diabetes. Root juice is employed in cardiac tonic, antiepileptic. Also used for nervous debility, asthma, enlarged liver and spleen, deep seated inflammation and as diuretic in calculus affection. Decoction is used as a gargle in hoarseness and sore throat. Root and fruit are antiparalytic. Leaf juice is used in hiccough (emetic in high doses); cooked leaves are given in influenza and catarrhal affections. Root-bark is used as antiviral, anti-inflammatory, analgesic. Stem-bark and flowers are hypoglycemic. Infusion of seed is anti-inflammatory, antispasmodic and diuretic and also given in venereal diseases. The Ayurvedic Pharmacopoeia of India indicated the use of the dried root bark in goitre, glycosuria and lipid disorders (also dried seeds), and leaf, seed, root bark and stem bark in internal abscess, piles. [47]

PHARMACOLOGICAL PROPERTIES

(a) 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. 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. Most of these compounds, bearing thiocarbamate, carbamate or nitrile groups are fully acetylated glycosides which are very rare in nature. 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. Another study on the ethanol and aqueous extracts of whole pods and its parts, i.e. coat, pulp and seed revealed that the blood pressure lowering effect of seed was more pronounced with comparable results in both ethanol and water extracts indicating that the activity is widely distributed. 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. Methyl phydroxybenzoate and sitosterol, investigated in the pods of M. oleifera have also shown promising hypotensive activity. Moringa roots, leaves, flowers, gum and the aqueous infusion of seeds have been found to possess diuretic activity 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. sitosterol. 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. [49-51]

(b) Antispasmodic, antiulcer and hepatoprotective activities
M. oleifera roots have been reported to possess antispasmodic activity. Moringa leaves have been extensively studied pharmacologically and it has been found that the ethanol extract and its constituent’s exhibit antispasmodic effects possibly through calcium channel blockade. The antispasmodic activity of the ethanol extract of M. oleifera leaves has been attributed to the presence of 4-[(L-rhamnosyloxy) benzyl] - o-methyl thiocarbamate (Trans), which forms the basis for its traditional use in diarrhea. Moreover, spasmyloytic activity exhibited by different constituents provide pharmacological basis for the traditional uses of this plant in gastrointestinal motility disorder. The methanolic fraction of M. oleifera leaf extract showed anti ulcerogenic and hepatoprotective effects in rats. Aqueous leaf extracts also showed antiulcer effect 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. [52-54]

(c) Antibacterial and antifungal activities
Moringa roots have antibacterial activity and are reported to be rich in antimicrobial agents. These are reported to contain an active antibiotic principle, pterygospermin, which has powerful
antibacterial and fungidal effects. A similar compound is found to be responsible for the antibacterial and fungidal effects of its flowers. The root extract also possesses antimicrobial activity attributed to the presence of 4-L-rhamnosyloxy benzyl isothiocyanate. The aglycone of deoxy- niazimicidine (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. The bark extract has been shown to possess antifungal activity, while the juice from the stem bark showed antibacterial effect against Staphylococcus aureus. The fresh leaf juice was found to inhibit the growth of microorganisms (Pseudomonas aeruginosa and Staphylococcus aureus), pathogenic to man. [55,56]

(d) Antitumor and anticancer activities
Makonnen et al. (1997) found Moringa leaves to be a potential source for antitumor activity. O-Ethyl- 4-(L-rhamnosyloxy)benzyl carbamate together with 4(2-L-rhamnosyloxy)-benzyl isothiocyanate, niazimicin and 3-O-(6'-O-oleyl-α-D-glucopyranosyl)-α-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. The seed extract have also been found to be effective on hepatic carcinogen metabolizing enzymes, antioxidant parameters and skin papillomagenesis in mice. A seed ointment had a similar effect to neomycin against Staphylococcus aureus pyoderma in mice. 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 isothiocyanate group is a critical structural factor for activity. [57,58]

Antiasthematics activities
The present study was carried out to investigate the efficacy and safety of seed kernels of Moringa oleifera in the treatment of bronchial asthma. Twenty patients of either sex with mild-to-moderate asthma were given finely powdered dried seed kernels in dose of 3 g for 3 weeks. The clinical efficacy with respect to symptoms and respiratory functions were assessed using a spirometer prior to and at the end of the treatment. Hematological parameters were not changed markedly by treatment with M. oleifera. However, the majority of patients showed a significant increase in hemoglobin (Hb) values and Erythrocyte sedimentation rate (ESR) was significantly reduced. Significant improvement was also observed in symptom score and severity of asthmatic attacks. Treatment with the drug for 3 weeks produced significant improvement in forced vital capacity, forced expiratory volume in one second, and peak expiratory flow rate values by 32.97 ± 6.03%, 30.05 ± 8.12%, and 32.09 ± 11.75%, respectively, in asthmatic subjects. Improvement was also observed in % predicted values. None of the patients showed any adverse effects with M. oleifera. The results of the present study suggest the usefulness of M. oleifera seed kernel in patients of bronchial asthma [59].

Antalgic activities
Moringa oleifera Lam. Seed has been documented to possess antimicrobial and water purifying activities and also used in the treatment of gout, eye infections and in arthritis. The alcoholic extract of Leaves of Moringa oleifera Lam. were reported to have analgesic activity but seed still not reported. The effect of alcoholic extract and its various fractions as Petroleum ether, Ethyl acetate, Diethyl ether, n-Butanol were tested for qualitative analysis which contain glycosides, Flavonoids, tannins, amino acids (alpha-4rhamnoloxo benzyl isothiocyanate). The extracts were also tested for their Analgesic activity was carried out by using Hotplate and Tail immersion method. Aspirin (25 mg/kg) was used as a standard [60].

Antioxidant activities
Antioxidants play an important role in inhibiting and scavenging free radicals, thus providing protection to human against infections and degenerative diseases. Current research is now directed towards natural antioxidants originated from plants due to safe therapeutics. Moringa oleifera is used in Indian traditional medicine for a wide range of various ailments. To understand the mechanism of pharmacological actions, antioxidant properties of the Moringa oleifera leaf extracts were tested in two stages of maturity using standard in vitro models. The successive aqueous extract of Moringa oleifera exhibited strong scavenging effect on 2, 2-diphenyl-2-picryl hydrazyl (DPPH) free radical, superoxide, nitric oxide radical and inhibition of lipid per oxidation. The free radical scavenging effect of Moringa oleifera leaf extract was comparable with that of the reference antioxidants. The data obtained in the present study suggests that the extracts of Moringa oleifera both mature and tender leaves have potent antioxidant activity against free radicals, prevent oxidative damage to major biomolecules and afford significant protection against oxidative damage [61].

Anthelmintic activities
The methanolic extract of Moringa oleifera seeds (MEMOS) was investigated for its anthelmintic activity. Petroleum Ether, chloroform, and alcoholic extract of seeds of Moringa oleifera were evaluated separately for anthelmintic activity on adult Indian earthworms, Pheretima posthuma. Various concentrations of all extracts were tested and results were expressed in terms of time for paralysis and time for death of worms. Piperazine citrate (10 mg/ml) was used as a reference standard and distilled water as a control group. Helminthic infections are among the most common infection in human beings, affecting a large proportion of the world population. Diseases caused by helminth parasites in livestock continue to be a major productivity constraint, especially in small ruminants in the tropics and subtropics, Anthelmintic drugs are used to eradicate or reduce the number of helminthic parasites in the intestinal tract or tissues of the body. These parasites have manybiochemical and physiological processes in common with their human hosts, yet there are subtle differences that are beginning to yield to pharmacologic investigation.
Helminthiasis or infection with parasitic worms, affects over two billion people worldwide, causing malnutrition, blindness, debility, disfigurement and death. There has not been enough emphasis on the research efforts and consequently not enough new agents discovered in the last 30 years to cope with the spreading of parasitic infections.

**Immunomodulatory activities**

The aim of the present study was to investigate the immunomodulatory action of methanolic extract of Moringa oleifera (MEMO) in an experimental model of immunity. The cellular immunity was evaluated using neutrophil adhesion test, cyclophosphamide induced neutropenia and carbon clearance assay, whereas, humoral immunity was tested by mice lethality test, serum immunoglobulin estimation and indirect haemagglutination assay in animals.

**Antidiarrheal activities**

Among medicinal plants, Moringa oleifera Lam. has been recommended for several disorders in folk medicine. Indian Materia Medica describes the use of roots of Moringa oleifera Lam in the treatment of a number of ailments, including asthma, gout, lumbago, rheumatism, enlarged spleen or liver, etc. Nevertheless, no pharmacological studies of Moringa oleifera Lam root have thus far evaluated for its anti diarrheal activity. Thus the aim of the present study is to evaluate scientifically the effect of hydroalcoholic (50:50) extract of root of Moringa oleifera Lam against castor oil induced diarrhea models in rats.

The parameters used for the evaluations are the decrease in severity and frequency in diarrhea caused due to castor oil, futher to understand the probable mechanism of its anti-diarrheal activity, its effect was evaluated on intestinal transit, castor oil induced intestinal fluid accumulation (enteropooling) and electrolyte concentration in the small intestinal fluid. The methanolic root extract of Moringa oleifera Lam 200 (p<0.01) and 400 mg/kg (p<0.001) produced a significant reduction in the severity and frequency of diarrhea, intestinal fluid accumulation, the volume of intestinal content and intestinal transit compared to normal saline control group, dose dependently more than atropine (3mg/kg i.p.). This signifies the usefulness of this model and the clinical effect of the extract. Moringa oleifera Lam root extract may be useful in a wide range of diarrheal states due to both disorders of transit e.g., functional diarrheas, radiation diarrhea or due to abnormal secretory mechanisms like in cholera or E.coli entero-toxin induced diarrhea. Further studies are necessary for chemical characterization of the active principles and more extensive biological evaluations.

**Hypotensive And Spasmolytic Activities**

Bioassay directed fractionation of an ethanolic extract of *Moringa oleifera* (MO) leaves resulted in the isolation of four pure compounds, niazinin A (1), niazinin B (2), niazimicin (3) and niaziminin A + B (4 + 5). Intravenous administration of either one of the compounds (1–10 mg/kg) produced hypotensive and bradycardiac effects in anaesthetized rats. Pretreatment of the animals with atropine (1 mg/kg) completely abolished the hypotensive and bradycardiac effects of acetylcholine (ACh), whereas cardiovascular responses to the test compounds remained unaltered, ruling out the possible involvement of muscarinic receptor activation. In isolated guinea-pig atria all the compounds (50–150 µg/mL) produced negative inotropic and chronotropic effects. Each compound inhibited K+ -induced contractions in rabbit aorta as well as ileal contractions induced by ACh or histamine at similar concentrations. Spontaneous contractions of rat uterus were also inhibited equally by all compounds. These data indicate that the direct depressant action of these compounds exhibited on all the isolated preparations tested is probably responsible for its hypotensive and bradycardiac effects observed in vivo. Moreover, spasmolytic activity exhibited by the constituents of the plant provides a scientific basis for the traditional uses of the plant in gastrointestinal motility disorders.

**Anti-fungal activity**

Investigations were carried out to evaluate the therapeutic properties of the seeds and leaves of Moringa oleifera Lam as herbal medicines. Ethanol extracts showed anti-fungal activities in vitro against dermatophytes such as Trichophyton rubrum, Trichophyton mentagrophytes, Epidermophyton floccosum, and Microsporum canis. GC-MS analysis of the chemical composition of the essential oil from leaves showed a total of 44 compounds. Isolated extracts could be of use for the future development of anti-fungi disease agents.

**Antinociceptive activities**

The fresh leaf juice and ethanolic extract of the leaves of Moringa oleifera (Family: Moringaceae) were administered orally at doses of 25, 50, 100 mg/kg in mice and were tested for antinociceptive activities using three models: Acetic acid induced writhing, formalin induced paw licking and tail flick test using analgesimeter. Amongst all doses, a dose of 100mg/kg of both the administered extracts showed a significant antinociceptive activity in mice. The effect was significantly reversed by the opioid receptor antagonist naloxone indicating the role of both the central and peripheral opioid receptors in alleviating pain.

**Hypolipidemic activities**

The leaves of *Moringa oleifera* Lam., Moringaceae, are used by the Indians in their herbal medicine as a hypolipidemic agent in obese patients. Albino Wistar rats were fed with methanolic extract of *M. oleifera* (150, 300 and 600 mg/kg, p.o.) and simvastatin (4 mg/ kg, p.o.) along with hyperlipidemic diet for 30 days. Moringa oleifera and simvastatin were found to lower the serum cholesterol, triacylglyceride, VLDL, LDL, and atherogenic index, but were found to increase the LDL as compared to the corresponding high fed cholesterol diet group (control). The *Moringa oleifera* methanolic extract was also investigated for its mechanism of action by estimating HMG CO-A reductase activity. *Moringa oleifera* was found to increase the excretion of fecal cholesterol. Thus, the study demonstrates that *M. oleifera* possesses a hypolipidemic effect.
The seeds of malunggay, Moringa oleifera, were extracted with distilled ethanol and concentrated under reduced pressure at 40°C. The resulting extract was partitioned between hexane, ethylacetate, butanol and water. The solvent fractions were likewise concentrated under reduced pressure. The crude ethanol extract of dried seeds inhibited the carrageenan-induced inflammation in the hind paw of mice by 85% at a dosage of 3 mg/g body weight while the mature green seeds by 77%. The hexane fraction of the crude ethanol extract of the dried seeds also inhibited inflammation by 77% at the same dosage while both butanol and water fractions inhibited inflammation by only 34%. These results indicate the strong anti-inflammatory activities of the ethanol extract and the hexane fraction. On the other hand, the ethylacetate fraction caused a 267% increase in inflammation and exhibited toxicity. The mice died after oral administration of the fraction. The crude ethanol extract also inhibited the formation of Epstein-Barr virus-early antigen (EBV-EA) induced by 12-0-tetradecanoylphorbol-13-acetate (TPA). At a dosage of 100 μg/ml, the extract inhibited EBV-EA formation by 100% suggesting its antitumor-promoting activity [69].

After extensive dialyses of the crude WEMOS into water-soluble dialyzable (DF) and nondialyzable (NDF) fractions, only DF maintained its efficacy to kill larvae. Acute toxicity evaluations on daphnids (EC50 of 188.7μg/mL) and mice (LD50 of 446.5 mg/kg body weight) pointed out to low toxicity. Despite the thymus hypertrophy, WEMOS revealed to be harmless in compounds against Ae. aegypti larvae with apparent molecular mass lower than 12 kDa and moderately orally and subacutely-treated rats. In conclusion, WEMOS has thermostable bioactive toxic potential [70].

Moringa oleifera is a tropical tree whose numerous economic applications and facility of propagation are arousing growing international interest. It is needs to be widely cultivated in most of the areas where climatic conditions favor its optimum growth. In this way a maximum yield of its different useable parts could be achieved to derive the maximal amount of commodities of a multifarious nature for the welfare of mankind. So far numerous studies have been conducted on different parts of Moringa oleifera, but there is a dire need to isolate and identify new compounds from different parts of the tree, which have possible different promoters as well as inhibitory properties. Furthermore, the raw seeds are valuable because extracts have a flocculating protein that works as a coagulant of surface muddy and turbid water to tap-water in many African and Asian countries and Central America. Now that research and pilot scale tests have been carried out, consideration is being given to the production and use of the Moringa’s coagulants at national and international levels

REFERENCES:

2. Price Martin L ECHO Technical Note.1739 Durance Road, North Fort Myers, 2007, FL33917, USA.
16. Ram P. Rastogi, Mehrotra BN, Compendium of Indian Medicinal plants. Central drug Research Institute, Lucknow and National institute of science communication and Information resources, New Delhi, 2004:5-551-552.
32. Shanker K et al, Determination of bioactive nitrile glycoside(s) in drumstick (Moringa oleifera) by reverse phase HPLC, Food Chemistry 105 (2007) 376–382.


