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REVIEW

Medicinal Properties of Miracle Plant: *Moringa oleifera*

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Abstract

Phytomedicines are thought to have advantages over conventional pharmaceuticals, and recent research is rekindling interest in them. *Moringa oleifera*, often known as a miracle tree, drumsticks, or horseradish, is a tree with medicinal benefits. Its various parts, including the seeds, delicate pods, and leaves, are high in vitamins, minerals, amino acids, proteins, phenolic compounds, and beta-carotene. Because of their nutritional value, the leaves and branches can be used as livestock and fish feed. The growing demand for moringa-based goods that are environmentally friendly has opened up new avenues for researchers to investigate this plant. The objective of the article is to provide a comprehensive overview of *Moringa* species that have both nutritional and therapeutic properties.

Keywords: *Moringa oleifera*; Phytochemicals; Plant medicines; Ben oil; Phytomedicine

Introduction

Herbal plants in medicine, also known as phytomedicine, are still reliable and commonly used as a low-cost alternative to pharmaceuticals (Abalaka et al., 2009). *Moringa oleifera*, a member of the Moringaceae family, is native to the South Asian continent and is known to be cultivated primarily in the Himalayan foothills (Sharma et al., 2011). It has long been known that it can be used as a nutritional supplement for nursing mothers and newborns (Dalukdenia et al., 2016). The plant has been used for centuries to treat various problems and diseases such as anemia, bronchitis, skin infections, cholera, catarrh (Khawaja et al., 2010; Hamza, 2010; Singh et al., 2012). Many scientists have reported that it has anti-hypertensive, anti-pyretic, anti-tumor, cholesterol-lowering, diuretic, anti-diabetic, and hepatoprotective properties (Sharma et al., 2012; Paliwal et al., 2011; Lai et al., 2010; Huang et al., 2012).

Khawaja et al. (2010) has reported it as “the most nutrient rich plant yet discovered”. Multiple studies have reported multipurpose application of moringa plant and its parts such as cake by Kolawole et al. (2013), bread by Chinma et al. (2014) and biscuits by Alam et al. (2014). Foidl et al. (2001), reported that fresh moringa leaves can be used to extract juice which can be applied as growth hormone to enhance crop yield by 25-35%. Scientists have also reported its use for water treatment to purify water and remove bacteria up to 99% (Foidl et al., 2001; Villafuerte and Abonal, 2009).

Biochemical and Biological Aspects

Root: Widely used as a laxative, rubefacient, anti-inflammatory, carminative and as a cardiac tonic. It is also used in the treatment of rheumatism, inflammations, kidney related issues, backache and constipation (Anwar et al., 2007; Padmarao et al., 1996; Ruckmani et al., 1998; The Wealth of India, 1962).

Leaf: Leaves act as Purgative, used to cure different types of fever, piles, sore throat, breathing related issues, eyes and ear related infections and scurvy; leaf juice helps in controlling levels of glucose in the body and reduces the glandular swelling (Anwar et al., 2007; Morton, 1991; Fuglie, 2000; Makonnen et al., 1997).



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Stem: The stem of this plant is often used as a rubefacient and is also used to cure diseases related to eyes. It is used to treat delirious patients, also prevents spleen enlargement and formation of tuberculous glands of the neck. It's usage has been found in treating different types of tumors and in healing ulcers. Its juice is found to be quite effective in curing earaches and often used as a pain killer in case of a toothache due to tooth cavity. It also shows effective anti-tubercular activity (Anwar et al., 2007; Bhatnagar et al., 1961; Siddhuraju and Becker, 2003).

Gum: The gum of this plant is found to be useful in curing dental caries and is also used as a rubefacient; Gum mixed with sesame oil, is often used to cure fever and headaches. It is also used to cure intestinal issues, asthma and dysentery. It is also used to treat syphilis and rheumatism (Anwar et al., 2007; Fuglie, 2000).

Seed: Seed extract of *Moringa oleifera* employs its protecting effect by lowering the level of lipid peroxides in liver. Thiocarbamate and isothiocyanate glycosides are antihypertensive compounds which have been extracted from Moringa pods ethanolic extract (Anwar et al., 2007; Faizi et al., 1998; Lalas and Tsaknis, 2002).

Flower: Moringa flower is having excellent medicinal value. It is used stimulant, aphrodisiac, abortifacient and cholagogue. It is helpful in the treatment hysteria, inflammations, muscle related diseases and spleen enlargement. It is also found to decrease the lipid profile of liver and heart (Dahot, 1988; Anwar et al., 2007; Mehta et al., 2003; Bhattacharya et al., 1982; Siddhuraju and Becker, 2003).

Scientific classification

Kingdom	Plantae
Division	Magnoliophyta
Class	Magnoliopsida
Order	Viales
Family	Moringaceae
Genus	<i>Moringa</i>
Species	<i>oleifera</i>

Phytochemistry

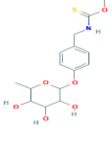
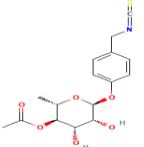
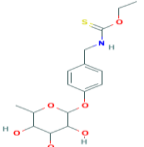
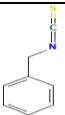
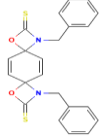
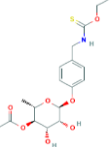
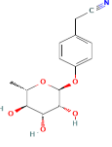
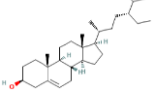
Moringa oleifera comprises of phytochemicals mainly rich in simple sugars, rhamnose and an important group of compounds called isothiocyanates and glucosinolates (Anwar et al., 2007; Fahey et al., 2001). Leaves of this plant are found to have a high protein content (25-35% on dry weight basis) and the protein found is also of high quality consisting of all essential amino acids. This kind of balance among amino acids seen here is not commonly found in other plants. Leaves of *Moringa oleifera* comprises of huge amounts of nutrients like vitamin A, vitamin C, calcium and potassium. The flowers of this plant consists of nine amino acids, sucrose, D-glucose, few alkaloids, wax, kaempferat and quercetin, The ash of this plant is rich in calcium and potassium (Ruckmani et al., 1998). *Moringa* also contains flavonoid pigments like alkaloids, kaempherol, kaempferitrin and isoquercitrin (Anwar et al., 2007; Faizi et al., 1994; Siddhuraju and Becker, 2003). Seeds of *Moringa* have known to show the presence of quite high levels of proteins and lipids which is much higher than some of the common leguminous seeds in respect of human nutrition. Moringa seeds have higher lipid content than several key soyabean cultivars. The main examples of saturated fatty acids present in the seeds are Palmitic acid, stearic acid, arachidic acid, and benic acids while the most stable unsaturated fatty acid is Oleic acid, with its high concentration it is beneficial in terms of nutrition and is used in cooking and frying. Pods and stem of *Moringa* comprises of irrelevant number of tannins but alkaloids and saponins are also found to be present in significant amounts (Das et al., 2012).

Chemical Composition

Moringa stem contains two important alkaloids, moringine and moringinine (Kerharo, 1969). Phytochemicals such as Octacosanoic acid, vanillin, β -sitostenone, β -sitosterol and 4-

hydroxymellin have been also isolated from the stem of *M. oleifera* (Faizi et al., 1994). The highly purified whole-gum exudate of *Moringa oleifera* comprises of L-rhamnose, D-glucuronic acid, D-mannose, D-galactose, D-xylose and L-arabinose, L-arabinose being present in highest molar ratio, while a homogeneous, degraded-gum polysaccharide consist of D-mannose, D-galactose and D-glucuronic acid, D-galactose being present in highest molar ratio as obtained from mild acid hydrolysis of gum (Bhattacharya et al., 1982) (Table 1). Antihypertensive phytochemicals such as thiocarbamate and isothiocyanate glycosides were identified in ethanol extract of the *Moringa* pods (Faizi et al., 1998). Also, cytokinins have been identified in the fruit of this plant (Nagar et al., 1982).

Table 1. Important phytochemicals of Moringa plant

Compound Name	Molecular Formula	2D Chemical Structure
Niazinin A	$C_{15}H_{21}NO_6S$	
4-(4-O-Acetyl-alpha-L-rhamnopyranosyloxy)benzyl isothiocyanate	$C_{16}H_{19}NO_6S$	
Niazimicin	$C_{16}H_{23}NO_6S$	
Benzyl isothiocyanate	C_8H_7NS	
Pterygospermin	$C_{22}H_{18}N_2O_2S_2$	
Niaziminin	$C_{18}H_{25}NO_7S$	
Niazirin	$C_{16}H_{17}NO_5S$	
Beta-Sitosterol	$C_{29}H_{50}O$	

Traditional knowledge/scriptures

Moringa oleifera is being considered a panacea for improving health and the nutrition of poor communities in the tropical and subtropical areas. The leaves of this plant can be eaten raw and uncooked, or after being gently cooked. The dried powder of its leaves can also be stored for many months without even refrigerating it, and it has been observed that the nutritional value of the plant remains almost the same even after prolonged storage (Foidl et al., 2008).

This plant was introduced and grown efficiently in many parts of India along with West Asia and the Arabian Peninsula. Later it also became naturalized in East and West Africa, Bangladesh, West Indies, Afghanistan, Southeast Asia, Sri Lanka, and from Mexico to Peru, Paraguay and Brazil. *Moringa* is often grown as an ornamental plant in Puerto Rico and this tree became naturalized along the roadsides of coastal plains and lower foothills. During the ancient period, the Egyptians, Romans and The Greeks frequently used this fast-growing plant. But now it is most widely cultivated and has also become naturalized in many of the tropical areas (Das et al., 2012; Fahey, 2005; Sachan et al., 2010). In the West, powdered seeds of *Moringa* are often used in flocculating the contaminants and purifying the drinking water but the seeds are also consumed in green or roasted form. It has been used widely in the preparation of curries or steeped for tea (Berger et al., 1985; Gassenschmidt et al., 1995; Olsen, 1987).

Applications/Medicinal uses of the plant

Medicinal properties

The leaf extract consists of various pharmacological properties (Figure 1). The phytochemicals that are present in the leaf contribute to these wonderful medicinal properties (Anwar et al., 2007). Some of the important medicinal properties are as follows:

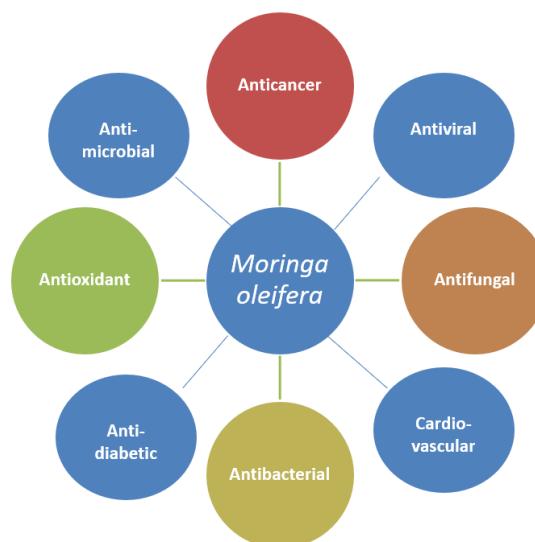


Fig. 1. Medicinal uses of *Moringa oleifera*

Anti-fertility activity

Various studies have shown that the leaf extract of *Moringa oleifera* has the power to fight against the male infertility disorders. This leaf extract is also found to enhance the sperm concentration, sperm count, mounting frequency and intromission number. It also helps in increased testosterone level, raised dopamine quantity which all contributes to proper erection (Anwar et al., 2007).

Hepatoprotective activity

Moringa oleifera leaf extract is known to show the hepatoprotective effect. Studies have shown that the leaf extract of *Moringa* has a unique ability to protect the liver against the damages caused by antitubercular drugs like isoniazid (INH), pyrazinamide (PZA), rifampicin (RMP), and diclofenac

ccl₄. When supplemented, its leaf extract had shown potential hepatoprotective effect that can be well observed by the changes in the level of glutamic pyruvic transaminase, bilirubin, glutamic oxaloacetic transaminase and alkaline phosphatase in the serum; lipids, and lipid per oxidation levels in liver.

Cardiovascular activity

A number of studies have shown that the *Moringa oleifera* leaf extract plays a very important role in protection from cardio vascular diseases. The active components like Niaziminin A and B that are isolated from the leaves of *Moringa* show hypotensive activity. The *Moringa* leaf extract contains thiocarbamates which possess hypotensive activity and hypocholesterolemic effect (Faizi et al., 1994).

Antidiabetic activity

The leaf extract of *Moringa* has also been found to be very effective against diabetic disorders. *Moringa* leaf extract significantly reduces the glucose levels, HbA_{1c} and glycogen level.

Diuretic and Antiurolithiatic activity

The aqueous extracts of *Moringa* leaves is widely used in many sub-tropical and tropical areas for its diuretic activity. Studies have shown that the leaf extract possess an antiurolithiatic activity also. The leaf extract decreases the enhanced urinary oxalate, thus showing a regulatory action on the endogenous oxalate synthesis. The leaf extract also reduces the elevated serum levels of nitrogen, urea, uric acid and creatinine.

CNS Activity

Various studies have shown in the past that leaf extract of *Moringa* restores the monoamine levels of brain regions to near control levels. Flavonoids are present in the leaf extract that can conveniently cross the blood brain barrier (BBB) and exert various effect on Central Nervous System viz. memory, neuro-degeneration and cognition. Triterpinoid, saponins and flavonoids is found to have an agonistic action on the GABAA receptor complex and therefore may act like benzodiazepine like molecules. Therefore, these compounds play a major role as the Central Nervous System depressant and also show muscle relaxant activity (Bhattacharya et al., 1982).

Analgesic, Antipyretic, Antitumor and wound healing activity

Leaf extract of *Moringa* possess both central analgesic and peripheral activities. It also possess the antipyretic and wound healing activity. The major possibility of the mechanism behind the analgesic activity of extract is due to the antagonism of NMDA receptors. The anti-cancer activity is one of the most important properties of *Moringa* leaf extract. This therapeutic property is due to the presence of phytochemicals such as thiocarbamates present in its leaf extract. Various research has shown that the anti-tumour activity of this plant is due to the presence of isothiocyano group in it. Few more predominantly found phytochemicals in the leaf extract of *Moringa oleifera* like O ethyl- 4-(alpha-L-rhamnosyloxy) benzyl carbamate along with other phytochemicals such as niazirin, 4(alpha-L-rhamnosyloxy)-benzyl isothiocyanate, beta-sitosterol, niazimicin, 3-O-(6'-O-oleoyl-beta-D-glucopyranosyl)- betasitosterol, glycerol-1-(9-octadecanoate), and beta-sitosterol-3-O-beta-D-glucopyranoside is responsible for its antitumour property as given by Murakami et al. (1998).

Antioxidant activity

The leaf extract also possesses number of valuable antioxidant isolates, which makes it a good antioxidant. Various studies have shown the presence of kaempferol in *Moringa* leaf extract and thereby making it a good antioxidant.

Anti-microbial activity

Moringa oleifera leaf extract can also be used as an effective anti-microbial agent. *Moringa oleifera* extracts are found to inhibit the growth of *Mycobacterium phlei* and *B. subtilis*. The leaf

extract of *Moringa* was also found to inhibit the growth of many pathogens like *Bacillus subtilis*, *Staphylococcus aureus*, *Escherichia coli* and *Pseudomonas aeruginosa*.

Anti-Inflammatory activity

The leaf extract of *Moringa* possesses an anti-inflammatory activity. The anti-inflammatory effect of *Moringa* leaf extract could be because of the inhibition of the enzyme cyclooxygenase and by subsequent inhibition of prostaglandin synthesis.

Miscellaneous uses of *Moringa*

Moringa is a plant that is highly rich in its nutritional value and its medicinal value. Although, there have been various other uses of *Moringa* other than its medicinal value, like blue dye, forage for animals, alley cropping involving biomass production, production of biogas, fencing of the house and other buildings, foliar nutrient, fertilizer (seed-cake), green manure (from leaves), gum (tree trunk) (Fuglie, 2000). It is also found to be useful in medicine (all plant parts), ornamental plants, biopesticide, to make ropes from its bark, purification of water from its powdered seeds. In recent time it is an outstanding indigenous source of highly digestible protein, Vitamin C, Fe, Ca and carotenoids suitable for use in many of the so-called "developing" areas of the world where undernourishment is an important issue. It was found that the bean seed soaking in its leaf extract can overcome salt (NaCl) stress and its effect on growth of the bean and enhance the production yield. The crude extract that is isolated from the mature leaves of *Moringa oleifera* is used as protease inhibitor with power for its utilization as a therapeutic drug and also as a seafood preservative. The aqueous extract of leaves of *Moringa oleifera* was found to exhibit a strong potential for the formation of silver nano particles by speedy reduction of silver ions (Eman, 2014). The seed oil of *Moringa* is called as Ben oil. It is a non-sticky, non-drying oil and sweetly flavoured, resistant to rancidity. Mainly used in preparations of salads, lubrication of machines and in hair care and perfume manufacturing industry (Fuglie, 2000; Tsaknis et al., 1999).

The leaf extract of *Moringa oleifera* comprises of many valuable medicinal properties due to the phytochemicals present in it. So, it gives important evidence for the use of leaf extract of *Moringa oleifera* in nutraceuticals. Powdered form of *Moringa* leaf extract is used as a natural replacer for treating male infertility. The leaf can be taken as food and reduces body heat and is used to cure indigestion and eye diseases. Flower of *Moringa* is taken as food and it gives nice coldness to eyes and promotes sperm production in men (Muthu et al., 2006). *Moringa oleifera* oil has also been evaluated as potential feedstock for biodiesel (Rashid et al., 2008). It can be used as an ideal tree for social forestry (Anwar et al., 2007; Nautiyal and Venhataraman, 1987).

Future

It would be naive to expect a significant deal of diversity in the quantity and content of chemical components in different areas of the tree as this plant grows in a variety of environments. Numerous research has been performed on various sections of the *M. oleifera* tree, however there is a pressing need to extract and discover novel chemicals from various parts of the tree that may act as anticancer promoters or inhibitors. Although preliminary research into the anti-inflammatory, antispasmodic, antihypertensive and diuretic properties of *M. oleifera* seed is underway in several laboratories, these studies should be expanded to include humans due to the plant's edible nature. The roots and leaves of *Moringa* have long been used to relieve constipation. Studies to back up these claims are needed, especially given the purported antispasmodic properties, which run counter to its medical use as a gut motility stimulant. The extent to which chemical composition differs in populations acclimated to different environments, however, is unknown. As a result, in-depth research is necessary to investigate this issue.

Conclusion

Moringa plant is a wonder tree with immense medical and culinary potential that has yet to be completely realized. *Moringa oleifera* is a multifunctional tree that is rapidly growing and highly suited to growing in harsh climate circumstances, according to several studies, which makes it impossible to overlook in today's struggle against climate change. This article attempted to

examine the multifunctional uses of *Moringa oleifera* as well as make recommendations for future climate change mitigation. All components of the *Moringa oleifera* tree claim to offer beneficial properties to humans and is widely utilized in medicine, colouring, fodder, fence, and as nutrition, among other things. It's also used as ornamental plants, biopesticide pulp (wood), tannin (bark and gum), rope (bark), water filtration (powdered seeds). Moringa oil or Ben oil, is a valuable oil. Market development methods, strong policies, and researches are necessary in order to uncover and exploit the full potential of this miraculous tree.

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Competing interest

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Not applicable.



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