

Medicinal and Nutritional properties of Miracle Tree (MORINGA OLEIFERA): A review

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Abstract

Moringa oleifera is a widely distributed plant of the Moringaceae family. Nearly, every portion of this tree has extraordinary qualities for food, medicine, or other industrial uses that's why this plant is known as miracle tree. This study is to gather an overview of global research, pharmacological activity, nutritional and medicinal properties of *M. oleifera*. *Moringa* species have long been recognized for their antioxidant, anti-inflammatory, anticancer, and antihyperglycaemic properties. Most of their biological action is due to their high presence of flavonoids, glucosides, and glucosinolates. Furthermore, after analyzing the current *M. oleifera* research, it can be concluded that *M. oleifera* is a plant of highly nutritional and medicinal value. This plant should be planted in area where malnutrition problem is common.

Keywords: *Moringa oleifera*, Medicinal uses, Pharmacological activity, Phytochemistry, Nutritional value.

Introduction:

Moringa oleifera is the most widely cultivated species in the genus *Moringa*, the only genus in the plant family Moringaceae. Common names include *Moringa*, Sahjan, drumstick tree (from the long, slender, triangular seed-pods), horseradish tree (from the taste of the roots, which resembles horseradish), and ben oil tree or benzoil tree (42).

M. oleifera is a fast growing, drought resistant tree, native to tropical and subtropical regions of South Asia. As per reports available there are about 33 species of Moringaceae family. *Moringa oleifera* is one of the most common species of Moringaceae family. Worldwide distributed, common and well known thirteen species of *Moringa* are namely: *M. arborea*, *M. borziana*, *M. concanensis*, *M. drouhardi*, *M. hildebrandtii*, *M. longituba*, *M. oleifera*, *M. ovalifolia*, *M. peregrina*, *M. pygmaea*, *M. rivae*, *M. ruspoliana* and *M. stenopetala*.

Plant is widely cultivated for its young seeds, pods and leaves used as vegetables and for traditional herbal medicine (31, 12, 23).

Description:

M. oleifera is a fast-growing, deciduous tree that can reach a height of 10–12 m (32–40 ft) and trunk diameter of 45 cm (1.5 ft). The bark has a whitish-grey colour and is surrounded by thick cork. Young shoots have purplish or greenish-white, hairy bark. The tree has an open crown of drooping, fragile branches and the leaves build up feathery foliage of tripinnate leaves.

The flowers are fragrant and hermaphroditic, surrounded by five unequal, thinly veined, yellowish-white petals. The flowers are about 1.0–1.5 cm (1/2") long and 2.0 cm (3/4") broad. They grow on slender, hairy stalks in spreading or drooping flower clusters which have a length of 10–25 cm.

Flowering begins within the first six months after planting. In seasonally cool regions, flowering only occurs once a year between March and June. In more constant seasonal temperatures and with constant rainfall, flowering can happen twice or even all year-round.

The fruit is a hanging, three-sided brown capsule of 20–45 cm size which holds dark brown, globular seeds with a diameter around 1 cm. The seeds have three whitish papery wings and are dispersed by wind and water (15, 37).

Cultivation:

M. oleifera can be grown in any tropical and subtropical regions of the world with a temperature around 25–35 °C. It requires sandy or loamy soil with a slightly acidic to slightly alkaline pH and a net rainfall of 250–3000 mm. The direct seeding method is followed as it has high germination rates. Since Moringa seeds are expected to germinate within 5–12 days after seeding and can be implanted at a depth of 2 cm in the soil. Moringa can also be propagated using containers. The saplings are placed in plastic bags containing sandy or loamy soil. After it grows to about 30 cm, it can be transplanted. However, utmost care has to be taken while transplanting as the tap roots are tender and tend to get affected. The tree can also be cultivated from cuttings with 1 m length and 4–5 cm in diameter, but these plants may not have a good deep root system. Such plants tend to be sensitive to drought and winds. For commercial purposes large scale intensive and semi-intensive plantation of Moringa may be followed. In commercial cultivation, spacing is important as it helps in plant management and harvest.

Nutritional properties:

Every part of *M. oleifera* is a storehouse of important nutrients and anti-nutrients. The leaves of *M. oleifera* are rich in minerals like calcium, potassium, zinc, magnesium, iron and copper. Vitamins like beta-carotene of vitamin A, vitamin B such as folic acid, pyridoxine and nicotinic

acid, vitamin C, D and E also present in *M. oleifera*. Phytochemicals such as tannins, sterols, terpenoids, flavonoids, saponins, anthraquinones, alkaloids and reducing sugar present along with anti-cancerous agents like glucosinolates, isothiocyanates, glycoside compounds and glycerol-1-9-octadecanoate. Moringa leaves also have a low calorific value and can be used in the diet of the obese. The pods are fibrous and are valuable to treat digestive problems and colon cancer. Research shows that immature pods contain around 46.78% fiber and around 20.66% protein content. Pods have 30% of amino acid content, the leaves have 44% and flowers have 31%. The immature pods and flowers showed similar amounts of palmitic, linolenic, linoleic and oleic acids (7, 35).

Moringa has lot of minerals that are essential for growth and development among which, calcium is considered as one of the important minerals for human growth. While 8 ounces of milk can provide 300–400 mg, Moringa leaves can provide 1000 mg and Moringa powder can provide more than 4000 mg. Moringa powder can be used as a substitute for iron tablets, hence as a treatment for anemia. Beef has only 2 mg of iron while Moringa leaf powder has 28 mg of iron. It has been reported that Moringa contains more iron than spinach. A good dietary intake of zinc is essential for proper growth of sperm cells and is also necessary for the synthesis of DNA and RNA. *M. oleifera* leaves show around 25.5–31.03 mg of zinc/kg, which is the daily requirement of zinc in the diet (43, 13). A complete list of nutrients available in different parts of plant are shown in Table 1 & 2.

Benefits/uses of Moringa:

There are many uses of Moringa tree and these will all be: medicines, Human food, Water purification, Animal fodder, Alley cropping, Fertilizer, Living fence, Living fence, Domestic cleaning agent, Fuel wood and other uses. Moringa increased physical energy - Tune your body up with naturally

occurring nutrients to make your energy last longer. Numerous research reports reveal that, parts of Moringa plant can be used in different techniques. Moringa oleifera seed

and leaves is advantageous source of nutrients, medicines, clean dirty water and it can be used for alley cropping; because, it has lots of leafy material.

Table 1. The nutrient compositions of leaves, leaf powder, seeds and pods.

Nutrients	Fresh leaves	Dry leaves	Leaf powder	Seed	Pods
Calories (cal)	92	329	205	–	26
Protein (g)	6.7	29.4	27.1	35.97 ± 0.19	2.5
Fat (g)	1.7	5.2	2.3	38.67 ± 0.03	0.1
Carbohydrate (g)	12.5	41.2	38.2	8.67 ± 0.12	3.7
Fibre (g)	0.9	12.5	19.2	2.87 ± 0.03	4.8
Vitamin B1 (mg)	0.06	2.02	2.64	0.05	0.05
Vitamin B2 (mg)	0.05	21.3	20.5	0.06	0.07
Vitamin B3 (mg)	0.8	7.6	8.2	0.2	0.2
Vitamin C (mg)	220	15.8	17.3	4.5 ± 0.17	120
Vitamin E (mg)	448	10.8	113	751.67 ± 4.41	–
Calcium (mg)	440	2185	2003	45	30
Magnesium (mg)	42	448	368	635 ± 8.66	24
Phosphorus (mg)	70	252	204	75	110
Potassium (mg)	259	1236	1324	–	259
Copper (mg)	0.07	0.49	0.57	5.20 ± 0.15	3.1
Iron (mg)	0.85	25.6	28.2	–	5.3
Sulphur (mg)	–	–	870	0.05	137

*All values are in 100 g per plant material.

The uses Moringa oleifera are well documented as nutritional, industrial, medicinal, and of agricultural advantage. Moringa oleifera has great potential for prevention of different diseases like nutrient deficiency, cancer, and anemia as well as for dirty water purification. Moringa powder contains sufficient amount of vitamins, nutrients and chemicals in it. This makes the tree a medicine for many different diseases. Moringa oleifera has also promoted by World Health Organization (WHO) as an alternative to imported food source to treat malnutrition.

Table 2: Common Nutritional uses/benefits of different parts of Moring oleifera Lam. Tree.

Plant parts	Nutritional uses/benefits	Phytochemistry	References
Leaves	(i). Moringa leaves are very rich source of vitamin A, C, Calcium, Potassium, protein and essential elements in comparison to locally available in market viz. Carrot, orange,	Vitamin A 6.780mg – Carrot : 1.890 mg; vitamin C 220 mg – Orange: 30 mg; calcium 440 mg – Cow's milk: 120 mg; potassium 259 mg – Banana: 88 mg; protein 6.6 mg –	4, 3, 11, 18, 21, 39, 38, 40, 48

	<p>cow milk, banana etc. The leaves may be supplemented as essential food and Alternative of tea leaves. The leaves can be serve to check malnutrition in the poor's. It is a nutraceutical and panacea for various diseases having 35 elements.</p> <p>(ii). Leaf powder used as hand washing product-hand hygiene to reduce gastrointestinal and respiratory illness.</p> <p>(iii). Leaves tender twigs and immature pods used as fodder for cattle's to increase milk.</p> <p>(iv). Pregnant woman consumed leaves and flowers to increase milk for infants.</p> <p>(v). Leaf powder used as biocontrol in crops, as fertilizers and pesticides.</p>	<p>Cow's milk: 3.2 mg; 14 macroelements and 21 microelements (total 35 elements).</p> <p>During hand washing the mechanical friction by the dry leaf powder reduces the bacterial effect in comparison to nonmedicated liquid soap.</p> <p>Having higher percentage of vitamins, essential elements and proteins. Leaves having iron, minarals, vitamins and proteins.</p>	<p>46</p> <p>21, 40</p> <p>21, 40</p> <p>21, 40</p>
Stem	Stem pulp used in picking-sticks, and newspaper making and textile industries. Stem corky bark yield Fibbers used in making mats, paper, cordages etc.	Having cellophane	40, 48
Pods	Immature pods cooked as vegetable or pickled, having high nutritional- and medicinal values.	Having higher percentage of vitamins essential elements, glycosides etc.	40, 48

Seeds	<p>(i). Seed powder paste used as water purifier to improve the quality of drinking water by absorbing the heavy metals viz. Cadmium, Copper, Chromium, Lead and Zink. Which are highly toxic to human being.</p> <p>(ii). The seeds can be used as nutritional supplements and for industrial and agriculture purpose. It is also being used in perfume industries, cosmetic, lubricate, soap as antioxidant activity oil being used as body cream. It can also used as vegetable in daily consumption.</p>	<p>Moringa is a cationic polyelectrolyte of short chain and low, molecular weight. Heavy metals having higher charges.</p> <p>Seeds oil locally known as “ben oil” “Drumsticks” similar to olive oil and is rich in Palmetic, stearic, Behenic and oleic acids. The oil is clear, odourless and resists rancidity, oil possesses 75% oleic acid.</p>	<p>34</p> <p>36</p>
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Medicinal properties of Moringa:

In this section, medicinal uses of Moringa are reviewed. Different studies shown that, all parts of Moringa oleifera (leaves, fruits, immature pods, and flowers) are incorporated into the traditional food of humans in many tropical and sub-tropical countries.

M. oleifera is often referred as a panacea and can be used to cure more than 300 diseases. Moringa has long been used in herbal medicine by Indians and Africans. The presence of phytochemicals makes it a good medicinal agent. In this section, the effect of Moringa on diseases like diabetes and cancer etc. are reviewed.

Anti-diabetic properties

Moringa has been shown to cure both Type 1 and Type 2 diabetes. Type 1 diabetes is one where the patients suffer from non-production of insulin, which is a hormone that maintains the blood glucose level at the required normal value. Type 2 diabetes is one associated with insulin resistance. Type 2 diabetes might also be due to Beta cell dysfunction, which fails to sense glucose levels, hence reduces the signaling to insulin, resulting in high blood glucose levels (8). Several studies have shown that, Moringa can act as an anti-diabetic agent. A study has shown that the aqueous extracts

of M. oleifera can cure streptozotocin-induced Type 1 diabetes and also insulin resistant Type 2 diabetes in rats (10). In another study, the researchers fed the STZ-induced diabetes rats with Moringa seed powder and noticed that the fasting blood glucose dropped (2). Also, when the rats were treated with about 500 mg of Moringa seed powder/kg body weight, the antioxidant enzymes increased in the serum. This shows that the antioxidants present in Moringa can bring down the reactive oxygen species (ROS) caused in the Beta-cells due to the Streptozotocin or streptozocin (STZ) induction (28). STZ causes ATP dephosphorylation reactions and helps xanthine oxidase in the formation of superoxides and reactive oxygen species (ROS) in Beta cells (49). In hyperglycemic patients, the beta cells get destructed. Therefore, high glucose enters the mitochondria and releases reactive oxygen species. Since beta cells have low number of antioxidants, this in turn causes apoptosis of the beta cells (20, 41). This reduces insulin secretion leading to hyperglycemia and in turn diabetes mellitus Type-2. The flavonoids like quercitin and phenolics have been attributed as antioxidants that bring about a scavenging effect on ROS. It can be hypothesized that the flavonoids in

Moringa scavenge the ROS released from mitochondria, thereby protecting the beta cells and in turn keeping hyperglycemia under control (19, 2).

Anti-cancer properties

Cancer is a common disease and one in seven deaths is attributed due to improper medication. Around 2.4 million cases are prevalent in India, while there are no specific reasons for cancer to develop. Several factors like smoking, lack of exercise and radiation exposure can lead to the disease (32). Cancer treatments like surgery, chemotherapy and radiation are expensive and have side effects. *M. oleifera* can be used as an anticancer agent as it is natural, reliable and safe, at established concentrations. Studies have shown that Moringa can be used as an anti-neoproliferative agent, thereby inhibiting the growth of cancer cells. Soluble and solvent extracts of leaves have been proven effective as anticancer agents. Furthermore, research papers suggest that the anti-proliferative effect of cancer may be due to its ability to induce reactive oxygen species in the cancer cells. Researches show that the reactive oxygen species induced in the cells leads to apoptosis. This is further proved by the up regulation of caspase 3 and caspase 9, which are part of the apoptotic pathway (45, 17, 25). Moreover, the ROS production by Moringa is specific and targets only cancer cells, making it an ideal anticancer agent. Tiloke et al. (45) also showed that the extracts increased the expression of glutathione-S-transferase, which inhibits the express of antioxidants. Anticancer agents targeting cancer using ROS induction are common, but these substances should also be able to attack the antioxidant enzymes (26). However, Moringa leaf extracts have been shown to be antioxidants and anticancer agents which induce ROS. The exact behavior of the two contrary attributes of the leaves is yet to be explored. The compounds of the leaves that are held responsible for the anticancer

activities are glucosinolates, niazimicin and benzyl isothiocyanate (14). Benzyl isothiocyanate has been shown to be linked with cancer. Research shows that BITC causes intracellular ROS, which leads to cell death. This could be one of the reasons for Moringa to be a good anticancer agent (33, 29, 24).

Other diseases

Moringa can be used as a potent neuroprotectant. Cerebral ischemia is caused due to obstruction of blood flow to the brain. This leads to reperfusion and lipid peroxidation, which in turn results in reactive oxygen species. Moringa with its antioxidants can reduce the reactive oxygen species, thereby protecting the brain (5, 22). *M. oleifera* is used to treat dementia, as it has been shown to be a promoter of spatial memory. The leaf extracts have shown to decrease the acetylcholine esterase activity, thereby improving cholinergic function and memory (44). Adeyemi et al. (1) showed that Moringa in diet of rats, can increase protein content and decrease levels of urea and creatinine in blood, preventing renal dysfunction. Moringa decreased acidity in gastric ulcers by a percentage of 86.15% and 85.13% at doses of 500 mg and 350 mg, respectively and therefore can be used as an antiulcer agent (9). Moringa is prescribed by herbal practitioners for patients with AIDS. Moringa is suggested to be included in the diet, with the view of boosting the immune system of HIV positive individuals. However, more research is essential to validate the effect of Moringa on anti-retroviral drugs (30). The hydro-alcoholic extract of Moringa flowers reduced the levels of rheumatoid factor, TNF-alpha and IL-1 in arthritic rats. This proves that Moringa can be a potent therapy for arthritis (27). Microbial diseases are widespread and there is a need for antimicrobial agents, *M. oleifera* has been proven as a good antimicrobial agent. A study by Viera et al. (47) has shown that the extracts of *M. oleifera* can act against

bacteria like *Bacillus subtilis*, *Staphylococcus aureus* and *Vibrio cholera*. The antibacterial effects of the seeds were accounted for by the presence of pterygospermin, moringine and benzyl isothiocyanate (16).

Conclusion:

Moringa oleifera tree is indeed a miracle tree with enormous potentials yet to be fully

explored in medicinal and food application. All parts of *Moringa oleifera* tree is said to have useful assets that can help humankind. This plant can be useful in eradicating the problem of malnutrition. Further, it may be helpful in treatment of various diseases. Government is required to prioritize this plant species for large scale plantation.

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