

Review Article

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Medicinal and Nutritional Values of Drumstick Tree (*Moringa oleifera* - A Review

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ABSTRACT

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Moringa oleifera is also known as “Miracle Tree” and it’s almost all parts have nutritional and pharmacological properties. It is highly nutritious crop cultivated mostly in all parts of the world. It is a valuable food crop, grows very fast and even beyond food it serves many benefits. It has been used to fight against malnutrition, especially among young ones and lactating mothers. Its various plant parts are used for different purposes. It is the richest plant source of Vitamins A, B, C, D, E and K. Minerals present in this tree include K, Mg, Ca, Mn, Zn, Cu, and Fe. Its various parts are used for the treatment of various diseases. It is resistant to drought duration because of long taproot system. Its cultivation is very simple and requires fewer efforts. It plays an important role in conservation of soil, water, and mitigating climatic change. This review article provides a brief overview about the nutritional importance, health benefits, and their production technology including water purification properties.

Introduction

Moringa (*Moringa oleifera* Lam) is indigenous to Indian subcontinent and has become naturalized in the tropical and subtropical areas of the world. Tree occupies important position in the Indian vegetable industry. It is a drought tolerant, fast growing, perennial and easily adapted to diverse eco and farming systems. It is still supposed to be underutilized plant in family *Moringaceae*. Regional names of *Moringa* are Drumstick tree, Sajna, Horseradish tree, Mulangay, Kelor, Saijihan, and Benzolive, (Fahey, 2005). Almost all parts of the tree may be edible and have been consumed from long times. *Moringa* is cultivated in Tamil Nadu,

Andhra Pradesh, Kerala, and Karnataka in Indian states. Fuglie (1999) described many uses of *Moringa* tree like: biomass production, animal forage, biogas, domestic cleaning agent, in feeding programs to fight against malnutrition especially in Africa like countries, as blue dye, for fencing purpose, as fertilizer, green manure, for gum extraction and honey juice-clarifier, various medicines, as ornamental plantation, as bio-pesticide against seedling damping off, rope making, tannin purpose for tanning hides and water purification.

Almost all parts of the plant contain some remarkable properties including medicinal and pharmaceutical etc. Due to this reason,

irrespective of the era and area the plants have always been important for humankind since commencement of life (Singh *et al.*, 2012). All these properties make it unique biomaterials for food and allied uses. Different preparation from *Moringa* leaves, flowers, and fruits are used in Indian subcontinent for various purposes. Due to high nutritional value, it is a popular vital food source against PEM, which is quite common in under developed and developing countries.

It is used in more than 80 countries to relieve vitamin and mineral deficiencies, supporting cardiovascular system, blood-glucose levels, reducing malignancy by neutralizing free radicals, excellent support for anti-inflammatory and immune system of the body. Above all, it has probable benefits in mental alertness, improvement in eyesight, general weakness, lactating mothers, menopause, bone strength, and depression (Nouman *et al.*, 2014).

Moringa belongs to mono generic family named *Moringaceae*, and this family includes 12 species of various type trees etc. (Olson, 2002). *Moringaceae* family exhibits a wide range of tree forms, like bottle to cylindrical shaped trees, or tuberous type shrubs (Olson and Carlquist, 2001). Although *Moringa* tree is indigenous to India and Pakistan (Duke, 2001) but according to (Fahey, 2005) this genus is native to various countries like Afghanistan, Pakistan, Africa, Bangladesh, Namibia, India and Madagascar in the northwestern province of the Himalayans. This tree is extensively cultivated in dry areas of tropical type in Middle East and Africa (Nouman *et al.*, 2013). Trees of *Moringa* are widely disseminated various tropical areas such as Ghana, Philippines, Ethiopia, Haiti, Uganda, Nicaragua and several other nations of the world in which soil is suitable for survival of *Moringa* (Table 1).

It is a fast-growing, deciduous tree having height of 10–12 m and trunk diameter of 1.5 ft. It has an open crown of fragile, drooping branches and the leaves are tri-pinnate. The flowers are aromatic and five unequal yellowish-white petals. The flowers are about 1.0–1.5 cm long and 2.0 cm in diameter. They are produced on slender, hairy stalks in clusters, which are 10–25 cm lengthy. Flowering appears after 6 months of planting. In cooler regions, flowering occurs once in April and June month while in some areas, having constant seasonal temperatures and rainfall; flowering occurs twice or even all year-round.

The fruit is a three-sided brown colored capsule 20–45 cm sized dark brown seeds of diameter 1 cm. Three whitish papery wings help the seeds to scatter by water and wind. During cultivation tree is cut back every year to 1 - 2 meter to limit height so that harvesting may become easy. The research work done at TNAU, which has modernized cultivation.

Moringa is grown in tropical and subtropical areas with annual rainfall of 760 to 2500 mm and temperature ranging from 18-28 °C. It grows in any soil type except waterlogged ones. Slightly alkaline clay along with sandy loam soils is considered ideal due to their good drainage properties (Abdul, 2007) (Table 2).

Present status in India

In India, it is grown for its leaves, flowers, and pods. Its pod is a prevalent vegetable in south part of India and appreciated for their noticeably inviting flavor. Marimuthu *et al.*, (2001) stated that *Moringa* seeds have no dormancy, due to this property planting can be done soon after maturity and remain viable for up to one year. Spotty germination is recorded in case of older seeds. It flowers and

fruit yearly but in some regions twice. Its cultivation is suitable for dry regions, as it is easy to cultivate without expensive irrigation methods.

Various types of planting systems are used for sowing purpose like; direct sowing and transplanting of young seedlings along with stem cuttings. 2 or 3 seeds, at depth of 2-3 cm and spacing of 1 m for leaf production while spacing should be more i.e. 3 to 5 m for production of seed, leaf and pod. It has been observed that *Moringa* gives better results with direct sowing. This tree may be easily cultivated in diverse eco systems and inhabits a distinctive position in the vegetable industry. In Southern India, best sowing time is September month. Sowing time should be exactly followed otherwise the flowering will be overlapped with monsoon rains and ultimately result in flower shedding. The seed rate is 260-270 g/acre. Pinching is very necessary when the plant attains height of 75 cm. This practice will stimulate the growth of side branches and the height of the tree is also limited. Kumar *et al.*, (2000) observed that pinching of growing terminals at 60 days after sowing seeds was better than pinching at 90 days. Fruits are harvested before they develop fiber. Approximate yield is 250-400 fruits/year/tree. In old garden of coconut in Tamil Nadu *Moringa* tree have been successfully cultivated as intercrop (Marimuthu *et al.*, 2001).

A single gram of *Moringa* is important because its leaf powder contains 25 times iron of spinach, 10 times the vitamins of carrots, 9 times the protein of yoghurt, 0.5 times the vitamins of oranges, 15 times K of banana fruits, and 17 times Ca of milk. Apart from these fatty acids, minerals, and amino acids are also found (Teixeira *et al.*, 2014). The leaves of *Moringa* tree are rich source of minerals and vitamins and exhibits antioxidant activity and phenolic compound

like quercetin and kaempferol. Fresh leaves of *Moringa* are a good source of carotenoids with pro-vitamin A. They contain 6.6–6.8 mg/100 g of β -carotene, greater than apricots, pumpkin and carrots (Kidmose *et al.*, 2006). Bark of *Moringa* is boiled in water and soaked in alcohol to acquire drinks and infusions that can be used to cure various ailments joint pain, diabetes, hemorrhoids hypertension, poor vision, anemia, tooth ache, and uterine disorder (Yabesh *et al.*, 2014).

Medicinal properties

These are used to cure health related problems like sore throat, ear infections, sprain, hypertension, cough, anxiety, headache, hysteria, skin infections, epilepsy, for intestinal worms, respiratory disorders, joints pain, anemia, blackheads, pimples cholera, diarrhea bronchitis, lactation diabetes, abnormal blood pressure, swelling chest congestion conjunctivitis, asthma, fever, scurvy, tuberculosis and semen deficiency (Mishra *et al.*, 2012). *Moringa* tree have been proved to contain several chemical compounds having beneficial pharmacological properties with potential medicinal applications. They comprise cholesterol lowering compounds, antiulcer, hypoglycemic, with infectious skin curing, anti-hypertensive, antispasmodic, and anticancer properties (Anwar *et al.*, 2007).

Moringa leaf extracts have been used to manage hyperthyroidism and anti-Herpes Simplex Virus Type-1 (Lipipun *et al.*, 2003). *Moringa* pod and seeds contains high nutrients, and phytochemical compounds such as amino acid, vitamins β -carotene, protein, minerals, and various phenolics (Farooq *et al.*, 2007). According to Ayurveda, traditional medicine system *Moringa* can prevent more than 300 diseases (Ganguly *et al.*, 2013). *Moringa* seed oil also known as Ben oil and resists rancidity. In modern times, this tree

has been promoted as an outstanding primary source of digestible calcium, protein, vitamin c, and Fe, carotenoids for consumption in undernourishment is a foremost concern. *Moringa* quantitatively offers higher nutrients per gram of plant than other plants. *Moringa* is used for malnourished children and for improvement of the immune system, against AIDS and HIV linked illnesses. It is also used in traditional medicine against various kinds of illnesses like recovery from liver impairment. Now it is being studied as a bio-enhancer of nutrients and drugs because of its

antibiotic properties (Lopez, 2011). By experimentation with rabbit, it has been revealed that anticipation of atherosclerotic plaque formation in arteries as well as the lipid and cardiovascular diseases, *Moringa* has therapeutic potential for the prevention of the same (Chumark *et al.*, 2008). Researches indicate that *Moringa* leaf powder encourages neuro-protection and proves a promising pharmacological significance regarding ethno-medically and nutritionally well-being of nervous system (Hannan *et al.*, 2014) (Table 3 and 4).

Table.1 Botanical classification

Kingdom	Planate
Division	Magnoliophyta
Class	Magnoliopsida
Order	Brassicales
Family	Moringaceae
Genus	Moringa
Species	M. oleifera

Source-Fahey (2005)

Table.2 Geographic distribution of various species

Shape of Tree	Name of species	Geographical location
Slender shaped	<i>Moringa concanensis</i>	India
	<i>Moringa</i> Lam.	India
	<i>Moringa peregrina</i>	Horn of Africa, Arabia Fiori Red Sea
Bottle shaped	<i>Moringa drouhardii</i>	Madagascar

	<i>Moringa hildebrandtii</i>	Madagascar
	<i>Moringa ovalifolia</i>	S.W. Angola and Namibia
	<i>Moringa stenopetala</i>	Ethiopia and Kenya
Tuberous shrubs	<i>Moringa arborea</i>	North Eastern Kenya
	<i>Moringa borziana</i>	Somalia and Kenya
	<i>Moringa longituba</i>	Ethiopia, Kenya and Somalia
	<i>Moringa pygmaea</i>	Somalia
	<i>Moringa ruspoliana</i>	Somalia, Ethiopia, Kenya
	<i>Moringa rivae</i>	Ethiopia and Kenya

Source-(Arora *et al.*, 2013)

Table.3 Medicinal uses and nutritional compositions of *moringa*

Particular Part of tree	Medicinal usages	Nutritional properties	Overall Benefit	References
Leaves	Treat headaches, hyperglycemia, scurvy, skin diseases, Dyslipidemia, asthma, flu, syphilis, pneumonia heartburn, malaria, ear infections, bronchitis, and diarrhea, governs cholesterol and blood pressure, acts as an anti-atherosclerotic agents, neuroprotectant, antioxidant antimicrobial anticancer and anti-diabetic	Contains proteins, fiber and various minerals like Mg, Ca, S, K, and Fe and Vitamins like A, B-choline, B1-thiamine, riboflavin, ascorbic acid and nicotinic acid. Amino acids like Arg, Val, Thr, Met, Trp, His, Ile, Phe, Leu and Lys, are existing. Various phytochemicals like saponins, phenolics, sterols, quercitin tannins, terpenoids, alkaloids besides flavanoids like, glycoside, isothiocyanates, and isoquercitin, kaemfericitin etc.	Having antioxidant, anti-diabetic and anticancer agents, anti-proliferative properties. Vitamins and minerals help in improving immune system.	(Rockwood <i>et al.</i> , 2013), (Mbikay, 2012), (Fuglie, 2005), (Jung, 2014), (Choudhary <i>et al.</i> , 2013)
Seeds	Help in treating Chrohn's disease, STDs, epilepsy cramp rheumatism simplex virus arthritis hyperthyroidism, anti-herpes, gout and acts as anti-inflammatory and antimicrobial agents	Comprises oleic acid and antibiotic termed as pterygospermin, along with several fatty acids like linolenic acid, behenic acid, and Linoleic acid. Some phytochemicals like phytate flavanoids tannins lectins, saponin, terpenoids and phenolics. In addition to it some minerals, proteins, along with vitamins like A, B, and amino acids and fats.	Anti-inflammatory and anti-microbial properties.	(Rockwood <i>et al.</i> , 2013; Kasolo <i>et al.</i> , 2010; Thurber and Fahey, 2010; Sotalangka <i>et al.</i> , 2013; Nair and Varalakshmi, 2011)
Root Bark	Contains cardiac stimulant compound, anti-inflammatory and anti-ulcer property	Some alkaloids substances like moriginine morphine and minerals like magnesium, sodium and calcium	Antiulcer and a cardiac stimulant	(Adeyemi and Elebiyo, 2014; Monera and Mponga, 2012)
Flower	Anti-arthritic agents and hypocholesterolemic properties which can cure urinary diseases	Contains Ca, K and amino acids.	Feasible for use by beekeepers due to nectar.	(Fuglie, 2005; Sotalangka <i>et al.</i> , 2013)
Pods	Helps in treatment of joint pain, liver or spleen problems, and diarrhea	Rich in lipids non-structural carbohydrates, protein, fiber and ash. Various fatty acids like linoleic acid etc. are present	In the diet of obese because of PUFA	(Fuglie, 2005)

Table.4 Macronutrients of *Moringa* plant in various parts (gram/100gram of plant)

Nutrients	Leaves	Seeds	Pods
Carbohydrates	0.1-10.6g	30-41g	0.1-5.0g
Proteins	25-30g	29-38g	6.7-43g
Fibers	0.1-28.5g	0.1-7.1g	0.1-27g
Lipids	0.1-43.9g	0.1-21g	0.1-38g

Table.5 Table showing treatment efficiency (%) of both coagulants used

Dosage (mg L ⁻¹)	Aluminum sulphate (%)	<i>Moringa oleifera</i> (%)
0	0.00	0.00
5	66.66	57.94
10	52.79	44.09
15	20.61	91.17
20	21.25	73.48
25	24.15	77.77
30	24.04	77.69
35	15.24	78.72
40	4.46	78.05
45	6.690	78.66
50	70.86	78.72
55	78.72	85.46
60	3.260	83.40

Water purification properties

Moringa seeds in powdered form may contain cationic polyelectrolytes, which work as a natural flocculent to clarify even the most muddled water. This powder joins with the solids present in the water and settles down. By doing so, it may remove 90–99% of bacteria that contained in water (Omotesho *et al.*, 2013). Noteworthy finding of using *Moringa oleifera* as coagulant is the decreasing the primary levels of turbidity at 15 mg L⁻¹ with 91.17% of deletion efficiency where the minimum turbidity was attained even with reduced doses used compared to aluminum sulphate at 55 mg L⁻¹ with 85.46% as recorded in Table 5.

Zand and Hoveidi (2015) have highlighted the significance of coagulant dosages on turbidity. Increased dosages may rise the cost of water treatment, which is not practicable. Alternative reason that why over-dosing should be escaped. Because there is a possibility of re-stabilization of the diluted particles to happen due to the saturation of the polymer bridge. It was reported that when concentration of seed powder was inclined from 0.016 to 0.08 g/L, rise in turbidity was recorded. Such phenomena may be defined by the existence of free positively charged particles of the flocculants resisting, leading to the flocks to the water. Pritchard *et al.*, (2010) reported that extract of the seed reduced the turbidity activity. They proved that seeds coagulate 80.0–99.5% turbidity process and efficiently leading to clear supernatant. This was simultaneously accompanied by a 90.00–99.99% bacterial load decrease in the sludge. Studies conducted by Adejumo *et al.*, (2013) revealed that there was no significant difference in coli form count after treating water sample with different concentrations of *Moringa* leaf powder. This might be due to deviations in compound concentration, which helps to

decrease coliform count. Quality of water treated with *Moringa* seed powder is enhanced through the proteins that encourage coagulation process (Santos *et al.*, 2009). Various compounds like tannins and polyphenol, which are present in *Moringa* and have been described to retain antibacterial action (Khosravi *et al.*, 2006). Moreover, humans (Anwar *et al.*, 2007) also use *Moringa* seeds to normalize pH and govern the microbial load in the treatment of water for consumption. Research work carried out by (Salazar-Gómez *et al.*, 2016) revealed that *Moringa* tree seeds were more effective and cheaper than aluminum sulfate in decreasing the turbidity of polluted water. Reduction in turbidity, microbial load, and micro particle content by seeds of *Moringa* as coagulants that can replace other normally used chemical coagulant like sand, which may be harmful to human, animal, and environmental health (Mangale *et al.*, 2012).

Moringa plant contains more than 90 nutritional compounds including lipids, proteins, carbohydrates along with dietary fibers. It is mainly used as a food source to overcome malnutrition, especially in children and infants in the tropics.

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