

Moringa Oleifera-A Miracle Tree with Immense Potential as a Sustainable Crop

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INTRODUCTION

Moringa oleifera also known as Moringa, drumstick tree, horseradish tree, ben oil tree, and benzoil tree and sahjan which represents the sole genus within the Moringaceae family is an important perennial multipurpose vegetable grown widely in India. Almost all parts of the Moringa trees have historical usage as natural remedies. Its exceptional nutritional value, rapid growth, and resilience to drought make Moringa is a valuable food crop. Drumstick is native to the southern foothills of the Himalayas in north-western India, as it is found growing wild in the sub-Himalayan tract from river Chinab eastwards to Sarda and in Tarai tract of Uttar Pradesh in India. Its wild forms can be seen in the Tarai belts of Uttar Pradesh and Bihar. It has long been cultivated in rural areas throughout the Indian subcontinent as well as much of Southeast Asia.

Nutritional values

It is also known as the miracle tree because of its diversified beneficial features, contain high amount of vitamin A (four times more than carrot), vitamin C (seven times more than orange), protein (5-10%), calcium (four times more than milk) and potassium (three times more than banana). Mature seeds of *M. oleifera* contain about 40% oil of an excellent quality (73% oleic acid) but *Moringa. peregrina* is known to produce higher quantity of oil (50%), which can be extracted from seeds at home. Mature seeds are roasted, mashed and placed in boiling water for 5 minutes. After straining and sitting overnight, the oil floats to the surface. The oil contains high levels of unsaturated fatty acids, especially oleic acid up to 67.80%. The dominant saturated acid is behenic acid up to 6.81% and stearic acid up to 5.86%. Due to its substantial protein content, wealth of vitamins and minerals, and adaptability to diverse cultivation conditions, *Moringa oleifera* is touted as a potential solution to malnutrition.

It is widely cultivated for the diversified use of its young seed pods and green leaves as vegetables and for medicine. It is considered as a very good supplement because of its high protein value. It was found that bioactive constituents are present in every part of the plant. So far, more than one hundred compounds from different parts of *Moringa oleifera* have been characterized, including alkaloids, flavonoids, anthraquinones, vitamins, glycosides, and terpenes.

Uses

Fresh green leaves and tender pods of drumstick are used extensively in cooking in Asia, Africa and Caribbean cuisine. Only tender growing tips and young leaves are generally used as greens in cooking. However, mature leaves can be dried, powdered and stored for many days to be used like that of dried fenugreek leaves in the recipes. Its leaf powder is being used in sauces. Livestock relish the foliage so much that in some region's drumstick is an important fodder, e.g. water buffaloes in India are fed the chopped-up leaves and branches, which are said to boost milk production. Ethanol extracts of drumstick leave at 0.04-0.08% is known to increase nodulation and nitrogenase activity in leguminous crops. The immature seed pods, called drumsticks, are commonly consumed in South Asia in the form of curries. The seeds sometimes removed from more mature pods are eaten like peas or roasted like nuts. Young seedlings are pulled up, boiled and eaten whole.

Botany

Drumstick is a very fast-growing deciduous perennial tree thrives in tropical and subtropical regions globally with slender and drooping branches, which are brittle with corky bark. It can attain a height of 5 m or more within a year of planting. Its moderate size, trifoliate leaves, inflorescences of 10-25 cm, and pod-like fruits are characteristic. The tree yields approximately 15,000-25,000 brown seeds annually, possessing a straight

trunk, often irregular branches, and an umbrella-shaped canopy.

Soil and climate requirements

Drumstick is a tropical plant and performs well up to an altitude of 600 m above mean sea level. Growth of the plant becomes restricted if it is grown above 1600 m altitude *Moringa oleifera*. The most optimum temperature range is 25-35°C. The temperature above 40°C causes flower drop. It requires sandy or loamy soil with a slightly acidic to slightly alkaline pH and a net rainfall of 250-3000 mm. The optimum temperature range for seed germination is 20-30°C. 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.

Cultivars

Bhagya, Chavakacheri Muringal, Chemmurungai, Jaffna, Kattumurungai, Kodikalmurungai, Palmurungai, PKM 1, PKM 2, Punamurungai, Yazphanam Muringa, Rohit, Dhanraj, Coimbatore 2.

Planting time

Perennial type drumsticks are propagated by stem cuttings after the harvesting of pods from March to June, though the annual type varieties perform best under the conditions of north Indian dry plains when propagated by seeds from June to August. In southern parts of the country, it is sown in November to December with assured irrigation.

Seed rate

About 1800–2000 seedlings of drumstick are required for planting a hectare of land area, and for the production of seedlings sufficient for a hectare area, a seed rate of 600–700 g is enough. In general, the seed rate for dwarf varieties is 250 g/ha, tall varieties 100 g/ha and annual type 500–625 g/ha.

Planting method

Drumstick is propagated by direct seeding, transplanting and using year-old stem cuttings. Annual drumstick is propagated by either direct seeding or transplanting, whereas, perennial ones are mostly propagated by hard stem cuttings. Direct seeding is also preferred when plenty of seed is available and labour is limited.

Nutritional requirements

Drumstick grows well in most soils without addition of fertilizer. Once the plant is established, the extensive and deep root system of drumstick is efficient in mining nutrients from the soil. However, for optimum growth and yield, 3–5 kg farmyard manure or compost should be added in trenches of 50 m² at the time of planting. The nutrients requirement of a year-old drumstick is 250:125:125 g NPK per plant. One-fourth amount of nitrogen, full phosphorus and half dose of potassium should be applied at planting and the rest of the dose of nitrogen should be applied in two equal splits at 45–60 days and during flowering, whereas, remaining half dose of potassium should be applied before flowering in the month of February to March. In some parts of India, during rainy season, 15 cm deep ring trenches are dug about 10 cm away from the tree base and filled with green leaves, manure and ash, and then, covered with soil.

Irrigation requirement

Drumstick is a drought tolerant crop so irrigation at 10–15 days interval is sufficient. In northern plains of India, irrigation is not necessary during monsoon season (June to September), however, irrigation during very

dry conditions is supplied regularly for the first 2 months.

Intercultural operations**Hoeing and weeding**

Drumstick is a fast-growing tree, thus, weeds pose no serious problem with the crop. One hand weeding near the plant at 30–45 days after planting is advised to ward off weeds in early growth stages. Intercropping with sunflower is found beneficial for the control of weeds.

Pinching and terminal tips

In annual drumsticks, first pinching should be performed at 60 days after sowing in terms of improving the biometric parameters of the crop. When seedlings reach a height of 60 cm in the main field, the top 10-cm growing tips should be trimmed with fingers to encourage shoot growth. About a week later, the secondary branches begin to appear on main stem below the cut. When they reach a length of 20 cm, they are again cut back to 10 cm making a slanting cut with downward facing. Tertiary branches may also be pinched in the same manner. Pinching is done four times in about a period of 3 months before flowering as it encourages the tree to become bushy and develop a strong frame for maximizing the yield. In the absence of pinching, the tree has the tendency to grow vertically like a mast with sparse flowers and fewer pods only at the top.

Training and pruning

As the plant attains a height of 70–75 cm, the shoot tips are nipped to encourage side branching. If plant stem is weak and very tall, it is susceptible to heavy wind and branches may break easily. At the same time, nipping reduces the plant height and facilitates easier harvesting. Mounting of soil is done up to a height of 30–40 cm above ground level to provide better support. Annual pruning encourages auxiliary and lateral branches. In young planting of drumstick, intercropping with okra can be done to get better profits. In annual drumsticks, usually severe pruning is done only once at the end of the harvest. In

this, the main trunk of the tree is cut back to about 90 cm from ground level. About 2 weeks later, 15-20 sprouts appear below the cut, however, only-four to five robust branches are allowed to grow and the remaining sprouts are pinched off while they are young. The pinching process can be repeated as done for new seedlings to make the tree bushy. After taking the second crop, the tree can be replaced by new seedlings for obtaining higher yield. In perennial drumsticks, the old, dead and infected scaffold branches are cut back to 50 cm every year at harvest. Once in 4-5 years, the main trunk of tree should be cut back to 1 m from ground to allow re-growth the pods are harvested at fully mature pulpy stage since the pods at this stage are preferred for the preparation of Sambhar and Rasam. Harvesting in local perennial cultivars is done during March to April, while the harvesting in annual cultivars, is done from March to May

Harvesting

Drumstick is usually harvested when the pods are still young (about 1 cm in diameter) and snapped easily. Older pods develop a tough exterior but white flesh and seeds remain edible until the ripening process begins. In north India, pods are generally harvested at a tender stage, while in south India, the pods are

harvested at fully mature pulpy stage since the pods at this stage are preferred for the preparation of Sambhar and Rasam. Harvesting in local perennial cultivars is done during March to April, while the harvesting in annual cultivars, is done from March to May.

CONCLUSION

The review summarizes various aspects of *Moringa oleifera*, including its worldwide research, ethnopharmacology, pharmacology activities, phytochemistry, psychopharmaceutic formulations, clinical studies, toxicology, and other miscellaneous parameters. The presence of alkaloids, phenolic acid, glycosides, sterols, glycosylates, flavonoids, terpenes and fatty acids are responsible for the medicinal effects of *Moringa oleifera*. The plant's active compounds, alongside its vitamins, micronutrients, and carotenoids, contribute to its medicinal value. *M. oleifera* displays potential in treating neuropathic pain, cancer, diabetes, and other conditions, necessitating further clinical exploration. Overall, *Moringa oleifera* lives up to its "Miracle tree" label, potentially serving as a psychopharmaceutic and functional superfood for addressing chronic diseases.