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# Moringa for nutritional security (*Moringa oleifera* Lam.)

**G Sandeep[1], T Anitha[2], KR Vijayalatha[3], A Sadasakthi[4]**

[1] PG Research Scholar, Biochemistry, Horticulture College and Research Institute, TNAU, Periyakulam, Tamil Nadu, India
[2] Assistant Professor, Biochemistry, Horticulture College and Research Institute, TNAU, Periyakulam, Tamil Nadu, India
[3] Assistant Professor, (Hort.) TNAU-Information & Training Centre, Chennai, Tamil Nadu, India
[4] Professor and Head, TNAU-Information & Training Centre, Chennai, Tamil Nadu, India

**Abstract**
*Moringa oleifera Lam.* Lam. A crop of the tropical and subtropical countries is grown universally as food, fodder and medicine. The seed, leaves, roots and flowers are often used in traditional medicine products in human food. Some studies using powdered leaf preparation of *Moringa oleifera* have demonstrated anti-dyslipidaemic and antidiabetic activities. Different studies have shown that hydro alcohol and aqueous activities such as antihypertensive, antiulcer, antioxidant, immunomodulation and analgesic actions. Phenolic, polyphenols, alkaloids and flavonoids are responsible for the observed effect commercial production, processing and utilization of this wonder crop is gaining momentum in many of the countries due to its multifaceted uses. The aim of this research paper was to review *Moringa oleifera* as a potential tree for its wide range of uses. Therefore, there is an urge to focus research on the uses of moringa leaves that can be value added. This research work would serve as a background for future research programmes in post-harvest management and value addition in moringa.

**Keywords:** *Moringa oleifera*, moringa, nutrition, value addition

## Introduction
The mineral packed, vitamin rich, nutritious vegetable called the Miracle tree or drumstick or horse radish tree or West Indian Ben is botanically *Moringa oleifera Lam.* Lam. This is the most economically important species among the 12 species that belongs to the family Moringaceae (Morton, 1991) [12]. The name drumstick derives from the shape of the pod, resembling the slender and curved stick used for beating the drum. Probably the name radish tree originates from the pendulous, slender and thin shape of the immature fruits of the tree resembling very much the siliqua of the radish. The tree is indigenous to North West India and is well known for its multipurpose attributes, wide adaptability and ease of establishment. It is grown commercially in India, Egypt, Philippines, Ceylon, Thailand, Malaysia, Burma, Pakistan, Singapore, West Indies, Cuba, Jamaica, Nigeria, South and Central America, Hawaii and Mexico. There exist several vernacular names such as dandalonbin in Burmese, sobhanjana in Sanskrit, shajmah or shajna in Hindi, sajna in Bengalese, munigha in Oriya, Sanjna in Punjabese, sujna in Marathi, murungai in Tamil, muringa in Malayalam.

India is the prime producer of Moringa (Drumstick) with an annual production of 2.2 to 2.4 million tonnes of tender fruits from an area of 43600 ha leading to the productivity of around 50 tonnes per ha. Among the different states, Andhra Pradesh leads in both area and production (15,665 ha) followed by Karnataka (10,280 ha) and Tamil Nadu (13250 ha). In total, other states occupy an area of 4,613 ha. Tamil Nadu is the pioneering state as it has varied genotypes from diversified geographical areas. (Sekhar *et al*., 2017) [24].

Principally perennial types have been known for cultivation for a very long time. However, perennial types are beset with many production constraints, such as a relatively long pre-fruit bearing period, non-availability of planting materials (stem cuttings), requirement of a greater number of rainy days in regions where water is scarce and vulnerability to pests and diseases. Important varieties of Moringa are Moolanur Moringa, Valayapatti Moringa, Chavakacheri Moringa, Chemmurungai, Jaffna Type, Kattu Moringa, Kodikkal Moringa, Palmurungai, Punamurungai, Palamedu Moringa. Horticultural college and research institute, TNAU is a pioneer institution in release of 2 annual moringa varieties viz. PKM-1 and PKM-2 for commercial cultivation throughout India and worldwide.

Almost every part of the plant has some beneficial uses. The pods and leaves are consumed as food. Several research findings have shown moringa to have vitamin A, vitamin C, potassium, calcium and proteins which are higher when compared to those in carrots, bananas, milk and eggs respectively (Fahey, 2005). [5] The seeds are used in purifying water due to their antimicrobial and coagulant properties and also yield a high quality oil (ben oil) which is edible and has potential use as biofuel. The leaves, roots and bark are used in the treatment and or prevention of over 300 ailments (National Institutes of Health-NIH, 2018).

## Botany
*M. oleifera* is a deciduous-to-evergreen shrub or small tree, fast growing perennial tree which can reach a maximum height of 7 to 12 m and a diameter of 20-60 cm at chest height. The stem is normally straight that reaches a height of 1.5 - 2.0m before it begins branching and it can reach upto 3.0m. The leaves are alternate, twice or thrice pinnate leaves crowded at the end of the branches, long petiole with 8-10 pair of pinnate leaves each bearing two pairs of opposite, elliptic or obovate, rounded or emarginated, entire, dull green on both sides, at first shortly grey, pubescent, glabrous. The tree is widely cultivated and naturalized worldwide in the tropics and sub-tropical regions of the world. The other species *M. concanensis*, a small tree that resembles *M.*

*oleifera* grows wild in India (Rajasthan, Madhya Pradesh, Gujarat, Maharashtra, Goa, Andhra Pradesh and Tamil Nadu). This little known species differs from the former in bi-pinnately compound longer leaves and yellow flowers streaked with pink or red. It is locally used for edible fruits and medicinal purpose (INDIA, C.O.S., 1962; Singh *et al*., 2000) [23].

The flowers are pleasantly fragrant, bisexual, oblique, stalked, erect axillary, many flowered drooping panicles of 10-25 cm long densely pubescent, 2.5 cm wide. They are white or cream coloured and yellow doted at the base. The five reflexes sepals are linear lanceolate. The 5 petals are slender, spatulate, yellowish white with a greenish base, 5 stamens with hindmost stamen the longest and others are much shorter, ovary is stalked, terete with 3 longitudinal furrows, 1-celled, 3 placentae bearing double rows of ovules, thin style, curved, white shortly pubescent and hollowed at the apex.

The fruits are three lobed pods, pendulous linear, acuminate, usually 20-45 cm long, sometimes up-to 120cm long, 3 valve spongy and thick. The seeds are numerous, globular, 1 cm in diameter, 3 winged; wings produced at the base and the apex, 2.2.5 cm long, 0.4 - 0.7 cm wide, scarious; outer walls of the epidermis of testa thick. (Ramachandra *et.al.*, 1980) [20].

**Moringa: A versatile tree**

Moringa is being considered as a potential source of dietary calcium intake in developing countries (Issa *et. al.*, 2013) [3] as well as combating under-nutrition in general (Thurber and Fahey, 2009.) [25]

**1. Human consumption**

*Moringa oleifera Lam.* tree has probably been one of the most underutilized tropical crops. This vegetable serves as a valuable source of nutrient for all age groups. For example, in Senegal and Haiti, health workers have been treated malnutrition in small children, pregnant and nursing women with moringa leaf powder. The leaves are known as a great source of vitamins & minerals when served as raw, cooked or dried (Price, 2000) [18].

The tree is mainly valued for its edible, tender pods, which have a taste very similar to asparagus. These are eaten as nutritious vegetable, either cooked or pickled. The tender leaves taste like watercress and along with the flowers is eaten cooked or raw. They are rich in protein, minerals, beta-carotene, thiamin, riboflavin and other vitamins particularly vitamins A and C (Dahot, 1988; FAO 1982; Nautiyal et.al, 1987; Ramachandran et.al, 1980) [2, 15, 20]. The ascorbic acid (vitamin C) content of the green pods ranges from 92 to 126 mg per 100 g of pulp (Dogra et.al 1975) [1]. The young fruits, flowers and leaves contain 5 to 10 percent protein. The immature seeds which taste like peanuts after frying are also consumed raw or cooked (Ramachandran et.al, 1980) [20].

Fuglie (1999) [6], reported that 8g serving of dried leaves powder will satisfy a child within age of 13 years with 14% of the protein, 40 % of the calcium, 23 % of the iron and nearly all the vitamin A that the child needs in a day. 100 g of leaves could provide women with over a third of her daily need of calcium and give her important quantities of iron, protein, copper, Sulphur and vitamin B. The leaves were reported to have 25.1 % crude protein, 0.50 % methionine and a metabolisable energy value of 2271 kcal/kg reported by (Nakker and Becker, 1997) [14]. Flowers can be cooked and mixed with other food or fried in butter. They can also be placed in hot water for five minutes to make a kind of tea for drinking. They are also a good source of nectar for honey producing bees. The root is medicinal and similar to horse radish source and can be taken when the seedlings are 60 cm tall. The Nutritional composition of moringa is presented in table 1

**Table 1:** Nutritious composition of *Moringa oleifera Lam.* leaf per 1 cup

| Nutrients | Quantity |
|---|---|
| Vitamin B6 | 19% of the RDA |
| Vitamin c | 12% of the RDA |
| Iron | 11% of the RDA |
| Riboflavin (B2) | 11% of the RDA |
| Vitamin A (from beta carotene) | 9% of the RDA |
| Magnesium | 8% of the RDA |
| Protein | 2 g |

The roots which have the pungent taste of horse radish (*Armoracia rusticana*) are used as a condiment or garnish after peeling, drying and mixing with vinegar (Martin and Ruperte, 1979) [11]. The root bark must be completely removed as it is rich in alkaloids, notably moringine, a toxic compound allied to ephedrine. According to Fuglie (1999) [6], the root bark should be completely removed as it contains harmful substances, the root is grinded up and vinegar is added.

The seeds contain 19 to 47 percent oil (Khan *et.al.* 1975) [10]. Known commercially as ben oil, it is similar to olive oil and is rich in palmetic, stearic, behmic and oleic acids (Verma and Banerji, 1976) and is used for human consumption and in cosmetics and soaps. The oil is highly valued by perfumers for its power of absorbing and retaining odors and by watchmakers as a lubricant (Ramachandran et.al, 1980) [20].

**2. Medicinal uses**

In traditional Indian medicine, various parts of the tree are used therapeutically including for treatment of ascites, rheumatism, venomous bites and as cardiac and circulatory stimulants. The roots, leaves and seeds are of particular importance in Ayurveda and the uses of the roots, root bark, stem bark, stem exudates, leaves, flowers and seeds treating a wide range of ailments have been discussed in ancient Sanskrit texts on medicine (Ramachandran et.al, 1980) [20]. The root of young trees and also the root bark are considered rubefacient, vescicant carminative, stomachic and abortifacient; among other uses, they are commonly applied externally to cure inflammatory swellings. The flowers are also used as a tonic, diuretic and cholagogue. The leaves are rich in vitamin A and C which are considered very useful in scurvy and respiratory ailments; they are also used as emetic. The juice extracted from the leaves has strong antibacterial and antimalarial properties (Gbeassor et.al, 1990) [7]; a paste of the leaves used as an external application to promote healing of wounds. The seed oil is applied externally to treat rheumatism and gout (Parrotta, 1993) [19].

Across the globe, every part of the moringa tree has been used effectively against varying ailments. The leaves rubbed against the temple can relieve headaches. To stop bleeding from a shallow cut, apply a poultice of fresh leaves, there is an antibacterial and anti-inflammatory effect when applied to wound or insect bite. Extracts can be used against bacterial or fungal skin complaints. The seeds are used for their antibiotic and anti-inflammatory properties to treat arthritis. The seeds

are roasted, pounded, mixed with coconut oil and applied in the problem area.

**3. Economic uses**

The press cake obtained as a by-product of the oil extraction process contains a very high level of proteins, some of these proteins (approximately 1%) are active cationic polyelectrolyte's, having molecular weight between 7-17 Daltons. The cationic polyelectrolyte neutralizes the colloids in moody or dirty water since the majority of these colloids have a negative electric charge. This protein can therefore be used as a non-toxic natural polypeptide for sedimentary mineral particles and organics in the purification of drinking water, for cleaning vegetable, oil, or for sedimentary fibers in the juice and beer industries as discussed by D. Odee, 1998.

The corky bark yields a coarse fiber which is utilized in making mats, paper and cordage. The stem exudes a mucilaginous gum that is used in leather tanning and calico printing (Nautiyal et.al, 1987) [15]. In many parts of its range, the leaves and twigs are used as fodder for cattle, sheep, goats and camels (Mahatab, 1987) [13]. The flowers are a good source of pollen for honey bees (Rajan, 1986) [21].

The bark fiber is use in making rope, mats and the wood produce a blue dye, chipping of wood can be used to make a good quality paper, the trees also produce viscose resin that are used in the textile industries.

**Moringa a potential tree for value addition**

Various value added product manufactured out of moringa are delineated below

**Table 2:** Various value added products of Moringa

| Sl.No | Name of the value – added product | Raw materials used | Product in use of curing |
|---|---|---|---|
| 01 | Moringa Oil | Moringa Seeds | Skin Allergies, Moisturizing, Softness to Skin |
| 02 | Moringa Leaf Tablets | Moringa Leaves | Vitality and Nutrient Supplement |
| 03 | Moringa Tea in Four Different Tastes | Moringa Leaves + Lemon or Ginger or Mint or Tulasi | Nourishing and Detoxifying Nutrient-rich Super food, Reduce Body weight |
| 04 | Moringa Leaf Powder | Moringa Leaves | Activating Role, Balancing Health, Cleansing Role in the Body (ABC) |
| 05 | Mogo Energy Bites | Moringa Leaves + Padam+Peanut+Almond + Alfafa + Spirulina + Cardamom + Dry Ginger + Country Sugar | Energy Chocolate and Nutrient Supplement |
| 06 | Mogo-Colostrums Organic Energy Bar | Colostrums + Groundnut + Almond + Moringa Leaves + Spirulina + Alfafa + Cardamom + Dry Ginger | Energy Chocolate with Nutrient Supplement |
| 07 | Moringa Energy Drops | Moringa Leaves | Concentrated Drops for General Health |
| 08 | Bio Moringa Instant Soup | Moringa Fresh Pods | ABC Role Plus General Health |
| 09 | Moringa Kernel – Pepper Fry | Moringa Seed Kernel + Ghee + Pepper | General Health and Nutrient Supplement |
| 10 | Moringa Oil Cake | Moringa Seeds | Water Purifier |
| 11 | Moringa Bio Booster | Different Parts of Moringa + Other Extracts | Plant Growth Promoter |
| 12 | Moringa Wunder Mix | Moringa Leaves + A Tuber from Nature + Nutmeg + Cashew + Cardamom + Dry Ginger | General Health and Vitality |
| 13 | Moringa Honey | Moringa Flowers | Medicinal Use |
| 14 | Moringa Chips | Tender Moringa Pods | General Health and Protein Supplement |
| 15 | Moringa Idly Powder | Moringa Leaves + Blackgram + Redgram + Red Chilli + Salt | General Health |
| 16 | Moringa Dry Flowers | Moringa Flowers | General Health |
| 17 | Moringa Gum Powder | Moringa Gum | Diuretic, Astringent, Fever, Dysentry, Asthma, Intestinal Cancer |
| 18 | Moringa Capsules | Moringa Leaves | General Health |

Owing to the versatile uses of moringa many herbal preparations gleaned from anecdotal evidence are manufactured to cure number of diseases. Moringa powder use at home as nutritional supplement, Moringa leaf tea packed in tea bags for easy infusion, soaps, body lotions and creams are produced with moringa oil and leaves. Newer moringa based food products are developed such as moringa soups, baby food blends, herbal tea blends etc. (De-heer, 2011) [3]. Tetteh *et al*. (2010) [26] established the effect of pre-treatment viz. blanching and dehydration methods to minimize nutrition loss during processing moringa leaves for tea. Ellis *et.al.* (2011) [4] developed high nutritious biscuits from cassava and sweet potato flour fortified with moringa leaf powder which is suitable for gluten intolerants.

Several researches in human have indicated that leaf powder of moringa when administered orally poses a significant antioxidant, antidyslipidimic and antihyperglycemic effect without any adverse effect. The research concluded that moringa leaf where found to effect 1.6% reduction in total plasma cholesterol and 6.3% reduction in HDL (Nambiar *et. al.*, 2010) [22].

**Conclusion**

Moringa is a miracle tree that is locally available to the common man both in India and other countries, because of the nutritional and medicinal importance of moringa, the demand for moringa and its value added products are increasing which in turn demands for year round supply further research needs to be focused to develop the moringa industry tailoring it to improve livelihood, nutrition and poverty. Also regulatory bodies to enforce industry standards in order to safeguard the health and safety of all stakeholders.

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