Moringa oleifera

"Drumstick tree" and variants thereof redirect here. This name is also used for the golden shower tree (*Cassia fistulosa*)

Moringa oleifera is the most widely cultivated species

Pods of Moringa oleifera *in Panchkhal, Nepal*

of the genus *Moringa*, which is the only genus in the family Moringaceae. English common names include: **moringa**,[2] **drumstick tree**[2] (from the appearance of the long, slender, triangular seed-pods), **horseradish tree**[2] (from the taste of the roots, which resembles horseradish), **ben oil tree**, or **benzoil tree**[2] (from the oil which is derived from the seeds). It is a fast-growing, drought-resistant tree, native to the southern foothills of the Himalayas in northwestern India, and widely cultivated in tropical and subtropical areas where its young seed pods and leaves are used as vegetables. It can also be used for water purification and hand washing, and is sometimes used in herbal medicine.

1 Etymology

Moringa derives from the Tamil word *murungai*.[3][4]

2 Description

M. oleifera is a fast-growing, deciduous tree.[5] It can reach a height of 10–12 m (32-40 ft) [6] and the trunk can reach a diameter of 45 cm (1.5 ft).[7] 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 a feathery foliage of tripinnate leaves.

The flowers are fragrant and bisexual, 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 later flower clusters which have a length of 10–25 cm.[6]

Flowering begins within the first six months after planting. In seasonally cool regions, flowering only occurs once a year between April and June. In more constant seasonal temperatures and with constant rainfall, flowering can happen twice or even all year-round.[6]

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.[7]

In cultivation, it is often cut back annually to 1–2 m (3-6 ft)and allowed to regrow so the pods and leaves remain within arm's reach.[8]

3 Cultivation

The moringa tree is grown mainly in semiarid, tropical, and subtropical areas, corresponding in the United States to USDA hardiness zones 9 and 10. It tolerates a wide range of soil conditions, but prefers a neutral to slightly acidic (pH 6.3 to 7.0), well-drained sandy or loamy soil.[9] In waterlogged soil the roots have a tendency to rot.[9] Moringa is a sun- and heat-loving plant, thus does not tolerate freezing or frost. Moringa is particularly suitable for dry regions, as it can be grown using rainwater without expensive irrigation techniques.

3.1 Production area

India is the largest producer of moringa, with an annual production of 1.1 to 1.3 million tonnes of tender fruits from an area of 380 km^2. Among the states, Andhra Pradesh leads in both area and production (156.65 km^2) followed by Karnataka (102.8 km^2) and Tamil Nadu (74.08 km^2). In other states, it occupies an area of 46.13 km^2. Tamil Nadu is the pioneering state in·so·much as it has varied genotypes from diversified geographical areas and introductions from Sri Lanka.[11]

Moringa is grown in home gardens in Odisha and as living

fences in southern India and Thailand, where it is commonly sold in local markets.[12] In the Philippines, it is commonly grown for its leaves which are used as food. Moringa is also actively cultivated by the World Vegetable Center in Taiwan, a center for vegetable research. In Haiti, it is grown as windbreaks and to help reduce soil erosion.

More generally, Moringa grows in the wild or is cultivated in Central America and the Caribbean, northern countries of South America, Africa, Southeast Asia and various countries of Oceania.[13]

As of 2010, cultivation in Hawaii, for commercial distribution in the United States, is in its early stages.[14]

3.2 Cultivation practice

Moringa can be grown as an annual or perennial plant. In the first year, all pods are edible. Later years also bear inedible bitter pods. Therefore, moringa is often commercially cultivated as an annual. On less favorable locations, perennial cultivation has big advantages. Erosion is much smaller with perennial cultivation.[15] Perennial cultivation of moringa is also practiced in agroforestry.

3.2.1 Soil preparations

In tropical cultivation, soil erosion is a major problem. Therefore, the soil treatment has to be as shallow as possible. Plowing is required only for high planting densities. In low planting densities, “it is better to dig pits and refill them with the soil. This ensures good root system penetration without causing too much land erosion. The pits must be 30 to 50 cm deep, and 20 to 40 cm wide.” [10]

3.2.2 Propagation

Moringa can be propagated from seed or cuttings. Direct seeding is possible because the germination rate of *M. oleifera* is high. After 12 days, the germination rate is about 85%.[10] Production in seedbeds or containers is very time-consuming. In these techniques, the plants can be better protected from insects and other pests. They are also used in areas where soil erosion is a problem.

Cuttings of 1 m length and a diameter of at least 4 cm can be also used for propagation.[10] At least one third of the cutting must be buried in the soil. In the Philippines, moringa is propagated by planting 1– to 2-m-long limb cuttings, preferably from June to August. It can also be propagated by seeds, which are planted an inch below the surface and can be germinated year-round in well-draining soil.

3.2.3 Planting

For intensive leaf production, “the spacing of plants should be 15 x 15 cm or 20 x 10 cm, with conveniently spaced alleys (for example: every 4 m) to facilitate plantation management and harvests. Another option is to space the seeding lines 45 cm apart and to sow every 5 cm on those lines. One can also space the lines only 30 cm apart and sow at a larger distance on the lines (10 to 20 cm)".[10] Weeding and disease prevention are difficult because of the high density. In a semi-intensive production, the plants are spaced 50 cm to 1 m apart. This gives good results with less maintenance.

Moringa trees can also be cultivated in alleys, as natural fences and associated with other crops. The distance between moringa rows in an agroforestry cultivation are usually between 2 and 4 meters.[10] In Haiti, it is used as fencing and windbreaks on farms.

4 Breeding

In India, from where moringa most likely originated, the diversity of wild types is large.[15] This gives a good basis for breeding programs. In countries where moringa has been introduced, the diversity is usually much smaller among the cultivar types. Locally well-adapted wild types,though, can be found in most regions.

Because moringa is cultivated and used in different ways, there are different breeding aims. The breeding aims for an annual or a perennial plant are obviously different. The yield stability of fruits are an important breeding aim for the commercial cultivation in India, where moringa is cultivated as an annual. On less favorable locations, perennial cultivation has big advantages. Erosion is much smaller with perennial cultivation.[15] In Pakistan, varieties have been tested for their nutritional composition of the leaves on different locations.[16] The different breeding aims result in a different selection. India selects for a higher number of pods and dwarf or semidwarf varieties. Breeders in Tanzania, though, are selecting for higher oil content.[17]

5 Yield and harvest

M. oleifera can be cultivated for its leaves, pods, and/or its kernels for oil extraction and water purification. The yields vary widely, depending on season, variety, fertilization, and irrigation regimen. Moringa yields best under warm, dry conditions with some supplemental fertilizer and irrigation.[18] Harvest is done manually with knives, sickles, and stabs with hooks attached.[18] Pollarding, coppicing and lopping or pruning are recommended to promote branching, increase production and facilitate harvesting.[19]

5.1 Fruits

When the plant is grown from cuttings, the first harvest can take place 6–8 months after planting. Often, the fruits are not produced in the first year, and the yield is generally low during the first few years. By year two, it produces around 300 pods, by year 3 around 400-500. A good tree can yield 1000 or more pods.[20] In India, a hectare can produce 31 tons of pods per year.[18] Under North Indian conditions, the fruits ripen during the summer. Sometimes, particularly in South India, flowers and fruit appear twice a year, so two harvests occur, in July to September and March to April.[21]

5.2 Leaves

Average yields of 6 tons/ha/year in fresh matter are can be achieved. The harvest differs strongly between the rainy and dry seasons, with 1120 kg/ha per harvest and 690 kg/ha per harvest, respectively. The leaves and stems can be harvested from the young plants 60 days after seeding and then another seven times in the year. At every harvest, the plants are cut back to within 60 cm of the ground.[22] In some production systems, the leaves are harvested every 2 weeks.

The cultivation of *M. oleifera* can also be done intensively with irrigation and fertilization with suitable varieties.[23] Trials in Nicaragua with 1 million plants per hectare and 9 cuttings/year over 4 years gave an average fresh matter production of 580 metric tons/ha/year, equivalent to about 174 metric tons of fresh leaves.[24]

5.3 Oil

One estimate for yield of oil from kernels is 250 l/ha.[18] The oil can be used as a food supplement, as a base for cosmetics, and for hair and the skin.

6 Pests and diseases

The moringa tree is not affected by any serious diseases in its native or introduced ranges. In India, several insect pests are seen, including various caterpillars such as the bark-eating caterpillar, the hairy caterpillar or the green leaf caterpillar. The budworms Noctuidae are known to cause serious defoliation. Damaging agents can also be aphids, stem borers, and fruit flies. In some regions, termites can also cause minor damage. If termites are numerous in soils, insects management costs are not bearable.[6]

The moringa tree is a host to *Leveillula taurica*, a powdery mildew which causes damage in papaya crops in south India. Cultivation management should therefore be checked.

7 Nutrients

Many parts of the moringa are edible. Regional uses of the moringa as food vary widely, and include:

- The immature seed pods, called “drumsticks”, are popular in Asia and Africa.
- Leaves are eaten, particularly in the Cambodia, the Philippines, South India, Sri Lanka, and Africa.
- Mature seeds
- Oil pressed from the mature seeds
- Roots

In some regions, the young seed pods are most commonly eaten,[25] while in others, the leaves are the most commonly used part of the plant. The flowers are edible when cooked and are said to taste like mushrooms. The bark, sap, roots, leaves, seeds, oil, and flowers are used in traditional medicine in several countries. In Jamaica, the sap is used for a blue dye.

7.1 Leaves

Nutritional content of 100 g of fresh *M. oleifera* leaves (about 5 cups) is shown in the table (right; USDA data), while other studies of nutrient values are available.[26][27]

*Sonjna (*Moringa oleifera*) leaves with flowers in Kolkata, West Bengal, India*

The leaves are the most nutritious part of the plant, being a significant source of B vitamins, vitamin C, provitamin A as beta-carotene, vitamin K, manganese, and protein, among other essential nutrients.[28][29] When compared with common foods particularly high in certain nutrients per 100 g fresh weight, cooked moringa leaves are considerable sources of these same nutrients. Some of the calcium in moringa leaves is bound as crystals of calcium oxalate[30] though at levels 1/25th to 1/45th of that found in spinach, which is a negligible amount.

The leaves are cooked and used like spinach and are commonly dried and crushed into a powder used in soups and

sauces. As with most foods, heating moringa above 140 °F destroys some of the nutritional value.

7.2 Drumsticks

An Indian drumstick

The immature seed pods, called "drumsticks", are commonly consumed in South Asia. They are prepared by parboiling, and cooked in a curry until soft.[31] The seed pods/fruits, even when cooked by boiling, remain particularly high in vitamin C[32] (which may be degraded variably by cooking) and are also a good source of dietary fiber, potassium, magnesium, and manganese.[32]

7.3 Seeds

The seeds, sometimes removed from more mature pods and eaten like peas or roasted like nuts, contain high levels of vitamin C and moderate amounts of B vitamins and dietary minerals.

7.4 Seed oil

Mature seeds yield 38–40% edible oil called ben oil from its high concentration of behenic acid. The refined oil is clear and odorless, and resists rancidity. The seed cake remaining after oil extraction may be used as a fertilizer or as a flocculent to purify water.[33] Moringa seed oil also has potential for use as a biofuel.[34]

7.5 Roots

The roots are shredded and used as a condiment with sharp flavor qualities deriving from significant content of polyphenols.[35]

8 Malnutrition relief

Moringa trees have been used to combat malnutrition, especially among infants and nursing mothers. Five NGOs in particular — Trees for Life International, The Christian and Missionary Alliance, Church World Service, Educational Concerns for Hunger Organization, and Volunteer Partnerships for West Africa — have advocated moringa as "natural nutrition for the tropics."[27] One author stated, "the nutritional properties of Moringa are now so well known that there seems to be little doubt of the substantial health benefit to be realized by consumption of Moringa leaf powder in situations where starvation is imminent."[27][36][37]

Moringa is especially promising as a food source in the tropics because the tree is in full leaf at the end of the dry season when other foods are typically scarce.[37] Furthermore, since moringa thrives in arid and semiarid environments, it is particularly well-suited for consumption during dry seasons.

To recognise the value of the plant, the Food and Agriculture Organisation of the United Nations has featured *M. oleifera* as the Traditional Crop of the Month in September 2014.[38]

9 Culinary uses

Dunt-dalun chin-yei, *Burmese drumstick sour soup*

Moringa has numerous applications in cooking throughout its regional distribution. It may be preserved by canning and exported.

In Bangladesh, it is made into a variety of curry dishes by mixing with coconut, poppy seeds, and mustard or

boiled until the drumsticks are semisoft and consumed directly without any extra processing or cooking. It is used in curries, *sambars*, *kormas*, and *dals*, although it is also used to add flavor to cutlets and other recipes.

The fruit meat of drumsticks, including young seeds, is used for soup. Young leaves can either be fried with shrimp or added as a topping in fish soup.

Several traditional Cambodian dishes use leaves (*sluc*) of the moringa tree known as *daum m'rum*,[39] such as *korko* (a mixed vegetable soup). As it is a favorite vegetable, Cambodians traditionally grow moringa trees close to their residences.

Tender drumstick leaves, finely chopped, are used as garnish for vegetable dishes and salads. It is also used in place of or along with coriander. In some regions, the flowers are gathered and cleansed to be cooked with *besan* to make *pakoras*.

The leaves may be fried and mixed with dried-fried tuna chips (Maldive fish), onions and dried chillies. This is equivalent to a *sambal* and eaten along with rice and curry. In one area in the Maldives, a soup is made with these leaves and rice, and eaten especially for breakfast during Ramazan. It is also a common ingredient in an omelet. The pods are used to cook a mild curry.

Traditional Thai kaeng som *with drumstick pods and fresh* pla thu

In the Punjab region of India and Pakistan, moringa, called *soanjhna*, flowers are first separated from the stem, boiled, mashed, and cooked. Curdle is an important element of its recipe to create a specific taste and favorite dish.

In Tamil Nadu, Moringa is known as “Murungakkai” and is used in Sambar.

The green pods, leaves, and flowers are used in a variety of Thai dishes, such as curries, stir-fries, soups, omelets, and salads. One of the most traditional dishes is sour Thai curry made with the drumstick pods and fish.

In the Philippines, moringa leaves, known as *kamunggay*, *malunggay*, *kalunggay*, or *marungay*, are commonly added to broth as a simple soup. The leaves may also be used as a typical ingredient in *tinola*, a traditional chicken dish consisting of chicken in a broth, moringa leaves, and either green papaya or another vegetable or in the all vegetable dish known as *utan*. The leaves can also be processed with olive oil and salt for a pesto-like pasta sauce that has become popular on the Filipino culinary scene. Moringa juice may be mixed with *lemonsito* juice to make ice candies or cold drinks, possibly more palatable to those who dislike vegetables.

In 2007, Filipino Senator Loren Legarda campaigned for the popularization of moringa. She asked the government to make moringa among its priority crops for propagation, citing a Bureau of Plant Industry report about moringa’s nutritional content.[40][41] The leaves may also be used in making *polvoron* (a milky, powdered snack), biofuel, and ben oil.

10 Preliminary clinical applications

A variety of potential medicinal effects have been the subject of laboratory and clinical studies.[42] These include:

- Preliminary studies show it might affect blood lipid profiles,[43] although further clinical studies indicate it is not effective in human subjects.[44]
- Antiasthmatic activity of finely powdered dried seed kernels[45]

10.1 Potential adverse effects

Adverse effects may occur from consuming moringa bark,[43] roots or flowers, as these components contain chemicals that appear be toxic when eaten.[42]

11 Other uses

In developing countries, moringa has the potential to improve nutrition, boost food security, foster rural development, and support sustainable landcare.[36] It may be used as forage for livestock, a micronutrient liquid, a natural anthelmintic, and possible adjuvant.[46][47]

Moringa oleifera leaf powder was as effective as soap for hand washing when wetted in advance to enable antiseptic and detergent properties from phytochemicals in the leaves.[48]

Moringa has been used in folk medicine,[37] including Siddha medicine and Ayurvedic traditional medicines and in the Philippines.[49] In Ayurvedic traditional medicine, the leaves are believed to affect blood pressure and glucose levels.[50] In Africa, Indonesia, and the

Philippines, moringa leaves are given to nursing mothers in the belief that they increase lactation.[36][51]

11.1 Water purification

Moringa seed cake, obtained as a byproduct of pressing seeds to obtain oil, is used to filter water using flocculation to produce potable water for animal or human consumption.[52][53] Moringa seeds contain dimeric cationic proteins[54] which absorb and neutralize colloidal charges in turbid water, causing the colloidal particles to clump together, making the suspended particles easier to remove as sludge by either settling or filtration. Moringa seed cake removes most impurities from water. This use is of particular interest for being nontoxic and sustainable compared to other materials in moringa-growing regions where drinking water is affected by pollutants.[53]

12 Gallery

- Moringa leaves in a market in Baguio
- A fully grown moringa tree in the Philippines
- A skipper on a flower of moringa
- A fully grown moringa tree with flowers and leaves in West Bengal
- Dried moringa with pods and seeds on the ground in Hawaii
- Fully grown moringa tree in a backyard in Hawaii
- Moringa “drumstick” pods
- Moringa leaves
- Branches and leaves of moringa tree
- Branch and leaves of moringa tree

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14 External links

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- Dressler, S.; Schmidt, M. & Zizka, G. (2014). [http://www.africanplants.senckenberg.de/root/index.php?submitForm=true&page_id=77&searchTextMenue=Moringa+oleifera&filterRegionIDs{[}{]}=6&filterRegionIDs{[}{]}=1&filterRegionIDs{[}{]}=2&filterRegionIDs{[}{]}=3&filterRegionIDs{[}{]}=5 "*Moringa oleifera*"]. *African plants – a Photo Guide*. Frankfurt/Main: Forschungsinstitut Senckenberg.

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