



## Sufficing Nutraceutical Rich Multipurpose Leafy Vegetable on Earth : Moringa

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Plants are gifts of God described mainly as grains, fruits and vegetables form mankind's basic foodstuffs, and have been domesticated for millennia. Leafy vegetables, also called potherbs, greens, vegetable greens, leafy greens or salad greens, are plant leaves eaten as a vegetable. Nearly one thousand species of plants with edible leaves are known. The leafy vegetables are said to tone up the energy and vigour in human being. Though leafy vegetables are low in calories and fat but high in dietary fibre, iron, Phosphorous calcium and magnesium content and very high in phytochemicals such as vitamin (A, B, C, K), carotenoids, lutein, folate, magnesium. It has been found that the person who consumes less amount of vegetables suffer from malnutrition, which in turn hampers the immune system. Several chemical compounds from leafy vegetables having therapeutic effect against several ailments have been identified, especially antioxidants and bioflavonoid which protect the body from free radicals. It could potentially prevent chronic disease due to their antioxidant content. But, broadly reporting leafy vegetables should form a regular component in our day to day diet to suffice the vital protective nutrients that are required for healthy living. In India, leafy vegetables are greatly preferred by the countrymen, either cooked to different

delicacies or sometimes adorn the table in the form of fresh salads. Leaf vegetables most often come from short-lived herbaceous plants (lettuce and spinach). Woody plants whose leaves can be eaten as leaf vegetables include *Moringa*, *Adansonia*, *Aralia*, *Morus*, and *Toona* species.

Sajana' or 'miracle tree', is one of the most popular trees in the villages of India is an important member of the family *Moringaceae* and belongs to genus *Moringa*. The name '*Moringa*' derived from the Tamil word *murunggai* or the Malayalam word *muringa*. The family *Moringaceae* includes near about 13 species but among them *Moringa oleifera Lam.*, a multipurpose tree native to the foothills of the Himalayas in northwestern India is the most popularly cultivated one. It is believed to have originated in the semi-arid habitats from North Africa to Southeast Asia (Mabberley et al 1997). It is commonly found from sea level to 1,400 m on recent alluvial land or near riverbeds and streams. It grows at elevations from sea level to 1400 m. Due to high water content and fibre, it aids in digestion and utilization of more concentrated food in human diet. Ample of the plant is edible by humans or by farm animals, besides leaves; the flowers of *sajana* are also very tasty. It is an indigenous vegetable, gained its importance due to nutraceutical value and is

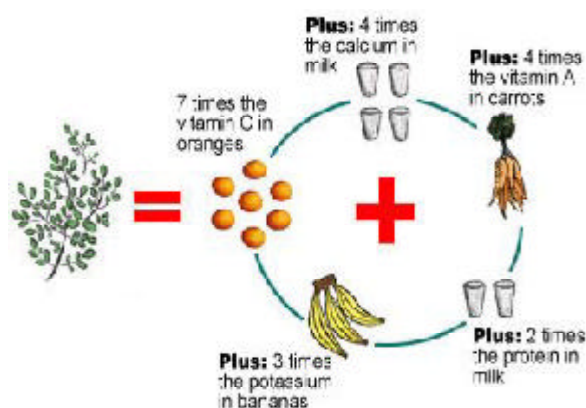


Fig. 1 Comparison of nutrient content of *moringa* leaf with other foods (Source: [moringa.yolasite.com](http://moringa.yolasite.com))

considered as indispensable plant for health management. The leaves demonstrated all

essential amino acids (Table 1) and are rich in protein, vitamin A, vitamin B, vitamin C and minerals (Janick et al 2008).

Researchers at the Asian Vegetable Research and Development Center (AVRDC) demonstrated that leaves of *Moringa* species contained high levels of nutrients and antioxidants. They also observed that boiled *moringa* leaves or leaf powder provided at least three times more bio-available iron than raw leaves. Boiling also enhanced antioxidant activity of the leaves. Experiments at the University of Baroda, India demonstrated that cooking leaves with oil helps retain beta carotene and enhances the conversion of beta carotene to vitamin A in our body.

**Table 1: Nutraceutical value of *Moringa* on different tissues**

Plant Parts	Nutraceutical significance
Leaves	Rich in protein (arginine: 0.38 g; histidine: 0.14; lysine: 0.32; tyrosine: 0.10g; phenylalanine: 0.29g; methionine: 0.11; cysteine: 0.13; threonine: 0.25; leucine: 0.46; isoleucine: 0.28 and valine: 0.35.), carotene, iron and ascorbic acid. contain magnesium: 24 mg; potassium: 259 mg;
Flower	Copper: 0.62mg; sulphur: 137 mg; chlorine: 423 mg; oxalic acid : 101 mg ; and phytin P:44mg, lysine is found in the flowers,
Pods	Rich in amino acid (alanine, arginine, glycine, serine, threonine, valine, glutamic acid and aspartic acid ) and lysine. Sucrose also occurs in the fruit.
Seed	benzylisothiocyanate derivative and benzoisothiocyanate
Stem	hydroxymellein, vanillin, octacosanoic acid, beta-sitosterol and betasitostenone, reported for the first time from a plant species
Stem Bark	white crystalline alkaloid, two resins, an inorganic acid and mucilage (gum)
Root	Anthomine and pterygospermine (an antibiotic). The root yields a very pungent essential oil, which is offensive in odour.
Root bark	moringinine and spirochine along with benzylamine and glucotropacoline



The seeds of *sajana* fruits can be used like green peas in different places. Ancient Indian literature makes mention of *Moringa* as an interesting plant due to its widespread use in agriculture, medicine and industry. India is the largest producer of *Moringa* with an annual production varies from 1.1 to 1.3 million tonnes of tender fruits from an area of 38,000 ha. Among the states, Andhra Pradesh leads in both area and production (15,665 ha) followed by Karnataka (10,280 ha) and Tamil Nadu (7,408 ha). Tamil Nadu is the pioneering state and it has varied genotypes from diversified geographical areas, as well as introductions from Sri Lanka. (Sing, 2011)



Fig. 2. *Moringa* tree, A) Full grown *moringa*

### Uses of *Moringa*

The *Moringa* tree has probably been the most popular plant in ECHO's seed bank of underutilized tropical crops. It affords extreme



Fig. 2. *Moringa* tree, B) Fruit and Flower bearing *moringa*

nourishment to the human body. It appears to have a tremendous potential for improvement of the humans in particular and the society in general. Besides the leaves and containing an edible fruit, this tree has many everyday uses. The seed extracted oils are also used as lubricant in the watch and computer manufacturing industry. India's ayurvedic medicine uses every part of the *Moringa* tree and considers it one of the most valuable and useful plants. Around the world every part of this tree has been used effectively against varying ailments. Its uses are as unique as the names it is known by, such as clarifier tree, horseradish tree and drumstick tree (referring to the large drumstick shaped pods) and in East Africa it is called "mother's best friend". There are literally hundreds of uses for this tree.

**1. Dietary use:** It is an important vegetable crop and the whole plant of *Moringa* can be used to serve the mankind in several ways.

Table 2: Dietary value of *Moringa*

Part	Dietary use
Leaves and foliage	Eaten as fresh, cooked and stored as dried powder for many months without



refrigeration and without loss of nutritional value.

Flowers and pods	Excellent vegetable.
Seeds	Used as green peas and extraction of oil from seeds is very equal to olive oil and this can be used to cook a variety of dishes.

**2. Pharmaceutical use:** Medicinal property of *Moringa* is a well-known fact. The stem bark, root bark, fruit, flowers, leaves, seeds and gum are all economically viable parts widely used in Indian folk medicine. It is a vital component in Ayurveda, Siddha, Unani and Indian medicine systems. Researchers based on the phytochemical studies demonstrated the various parts of the plant are very effective against hypertension and high cholesterol. The leaves act as perfect tonic for strengthening maintenance of skeletal system, purification of bloodstream in our body and also very important role in periods of pregnancy, post-delivery complications and lactation, while its antibacterial, antifungal and antioxidant properties are already well known to practitioners of both traditional and modern medicine.

**Table 3: Pharmaceutical properties of *Moringa* on different plant parts**

Part	Pharmacological properties
Leaves	Anti-ulcer, hyperthyroidism, anti-diabetic, hypolipidemic, anti-helminthic, anti-oxidant, hypo-cholesterolemic, hepatoprotective, antifungal, antibacterial, nutritional supplement etc.
Foliage	Lactation enhancer
Flowers	Anti-arthritis
Pods and seeds	Hypotensive
Seeds	Analgesic, anti-spasmodic, diuretic, anti-allergic, anti-bacterial, larvicidal, anti-viral
Seed kernels	Anti-asthmatic, anti-inflammatory
Bark	Anti-urolithiatic
Root	Analgesic, anti-convulsive, anti-nociceptive, anti-inflammatory, anti-cancer, Anti-urolithiatic

**Table 4: Some very beneficial *Moringa* based commercial health care product**

Product	Company	Details
<i>Moringa zinga oleifera</i>	American <i>Moringa</i> leaf Capsule Company	Pure leaf powder capsules without filters
<i>Moringa pharm</i>	-	Organic <i>Moringa</i> leaf capsules. Energy and health supplement
<i>Moringa</i> capsules	-	Energy and health supplement
<i>Moringa</i> seeds	Veg India Exports	Seed cakes (for water purification)
<i>Moringa</i> leaf powder	<i>Moringa</i> Export	Energy and health supplement



*Moringa* fruit powder

*Moringa* capsules

*Moringa* dry leaves

*Moringa* Tea

<i>Moringa</i> Tea	Local Product	Nourishing beverage
Miracle malunggay	Local Product	100% pure <i>Moringa</i> leaf. Food supplement
Pooga monga <i>moringa</i> energy capsule	Local Product	Energy and health supplement
Pooga monga <i>moringa</i> Tea	Local Product	Nourishing beverage
Pooga monga ( health drink)	Local Product	Health drink
Zija Smart drink	Local Product	Mixture of pomegranate: <i>Moringa</i> : aloe health drink

**3. Cosmetic use:** Sajana seeds are immensely valuable in the cosmetic industry. *Moringa* oil is among the most desired oils in the formulation of skin care products (Soap), **anti-aging and wrinkle reduction products**, increase the health and strength of the **hair and scalp** and cosmetics. Besides this, the oil contains 38-40% colourless and an odourless non-volatile substance that is never perishable and therefore it is very beneficial for production of expensive and natural perfumes and fragrances.

**4. Organic water purifier:** The cake obtained after extracting the oil from the seed is used as the organic water purifier in the pond, well and in different water bodies as a complementary to Aluminium, sulphate or alum used as a conventional chemical coagulant. It can be also used for the purification of vegetable oil, depositing juice (Sugarcane) and beer. The doses required for water treatment did not exceed 250 mg/l (Table 5).

**Table 5: Dosage of the coagulant**

Raw water turbidity NTU	Dose range mg/l
<50	10-50
50-150	30-100
>150	50-200

**5. Agricultural use:** Researchers at Proyecto BIOMASA, an agricultural research programme located in Nicaragua, demonstrated that *Moringa* can be used as a foliar spray to increase plant growth and as a green manure to improve soil fertility. They also observed that leaf extract contains a plant growth hormone, leaf juice spray effectively increasing yields by 25-30 % for nearly any crop: onions, bell pepper, soya, maize, sorghum, coffee, tea, chili, melon etc.

#### **Package of practices for *Moringa* cultivation**

*Moringa* is fast growing, drought tolerant and easily adapted to varied ecosystems and



farming systems. There are two types of *sajana* (Annual and Perennial) available in Indian continent.

**Soil:** For the cultivation of this vegetable, it does not require well fertilized soil, so it has the potential to be grown in the dry areas of Odisha like Rayagada, Jeypore, Sunabeda etc. It can be grown in a wide range of soil and climatic condition except heavy clay soil.

**Propagation:** It is propagated either by stem cuttings (limb cutting) or by seed. In perennial types, limb cuttings 100-150cm in length with a diameter of 14-16 cm are planted *in situ* during the rainy season. For annual crops the seedlings are raised from the seed in the polythene which is helpful for better crop stand and also there is a provision for gap filling in the main field if the seedlings die due to any unforeseen reason.

**Seed treatment:** Treatment of the seeds with Azospirillum cultures at the rate of 100 g per 625 g of seeds before sowing resulted in early germination, and increased seedling vigour, growth and yield.

**Seed percentage:** The seed requirement per hectare is 625g. When planted in single rows along with irrigation channels, a spacing of 2m is sufficient.

**Planting:** In the main field is dugged with 60×60 cm pit which is filled with FYM and soil and then the selected cutting of the stem or the seedlings are planted. For the perennial crop the plant to plant distance will be 4.5m and the row to row distance will be 3.0 m. While planting, one-third of the cutting should be kept inside the pit. Under moderate clay situations, watering should be done just to optimum levels to avoid root rot. For the annuals spacing will be maintained 2.5×2.5m. One

month before planting, each pit should be filled with 10 kg FYM, 100g urea, 100 g SSP and 50 g MOP and after one and half month after planting application of 100 g additional urea in each pit helps in increasing both crop growth and production, giving a plant population of 1600 plants/ha. In addition to that fertilisers should be applied at the time of pinching (75 days after sowing) at the rate of 44 : 16 : 30 g NPK/ tree and Nitrogen @ 44g / tree must be applied as top dressing at first flowering (150-160 days after sowing) stage (Suthanrapandian *et al.*, 1989).

**Plant population:** It may vary with the spacing, but generally plant population of 1600 plants/ha is suitable if standard spacing is followed.

**Season:** The limb cuttings are planted in the pits during the months of June to August. The monsoon rains during the period facilitate easy rooting and further growth. The seeds of annual *moringa* may be directly dibbled in the pit to ensure accelerated and faster growth of the seedlings. The best suited season for sowing the seeds is September under Southern Indian conditions. The time of sowing has to be strictly adhered to because the flowering phase should not coincide with monsoon seasons, which results in heavy flower shedding.

**Irrigation:** Growing moringa plants may not require watering except during hot weather when they may be irrigated once a week. Annual *moringa* responds well to irrigation and the yield can be doubled (vegetable moringa fruit) by drip irrigation as compared to rain-fed crops, Drip irrigation at the rate of 4 lit/day can enhance yields by 57 per cent as compared to rain-fed crop (Rajakrishnamoorthy *et al.*, 1994).

**After care:** Pinching and earthing up are the two practices which should be followed for *sajana*. Pinching the terminal bud on the central leader



stem is necessary when it attains a height of 75cm (two months after sowing). This will promote the growth of many lateral branches and reduce the height of the tree. In addition, pinching also reduces the damage due to heavy wind and makes harvesting much easier. Vijayakumar *et al.* (2000) It is found that early pinching of growing tips carried out 60 days after sowing is better than pinching 90 days after sowing for obtaining a higher yield. Sometimes, due to heavy rain or wind there is a possibility of breaking the tree so, earthing up of the soil at the base of the tree is useful to give it the strength. Vijayakumar *et al.* (2000) reported that Spraying of GA<sub>3</sub> @ 20 ppm on 90th day of sowing increased all the pod characters, such as length, specific gravity, number of seeds, flesh content and pulp, more than untreated check.

**Yield and Production:** Generally, six to nine months after planting flowering started and there are some varieties which give production for two to three times but this kind of varieties are not popularly cultivated in Odisha. For perennial crops, fruits yields are generally low during the first two years (80-90fruit/year), but from the third year onwards a single tree yield increase gradually 500-600 fruit/tree/ year up to the fourth and fifth years. The pods are harvested mainly between March and June. A second crop is normally harvested from September to October.

**Post-harvest care:** After harvesting the plant crop is cut keeping 1.5-2m from the soil then from that cut portion new branches come out that bear flowers and fruits. In annual *moringa*, when the harvest is in, the trees are cut down to a height of one metre above ground level for ratooning. These ratoon plants develop new shoots and start bearing four or five months after ratooning. Three ratooning operations are recommended during the

production cycle, after each harvest is over. During each ratooning operation, the plants are supplied with the recommended level of N, P and K nutrients along with 20-35 kg of FYM. Perennial types are also pollarded back to a height of 0.3-0.45m from ground level during October November, followed by manuring with organic matter (25kg) and the recommended input of fertilizers.

**Ecotype and Cultivar:** At least 20 commercially cultivable varieties of *Moringa* are available throughout India. Tamil Nadu Agricultural University have succeeded in developing two promising, high yielding, annual seed- propagated *Moringa* types PKM-1 (Selection) and PKM-2 (MP 31 X MP 28), Dhanraj (dwarf type) which has revolutionised the *Moringa* industry in the country.

KAU released one drumstick variety named Anupama. Besides that, some high-yielding land races are also cultivated in Tamil Nadu and Andhra Pradesh namely Jaffna Melanor, Saragva, Chavakacheri, Chemmurungai, Pal Murungai, Puna Murungai, Kodaikal Murungai and Saragvi etc.( mainly identified by the farmer's in a particular region) but whether these varieties are suitable in Odisha condition or not need to be further studied. Some varieties namely, KM 1, GKVK 1,2,3, KDM 1, Konkan Ruchira, Rohit 1 are known to be developed by the public sector, In India, more than 60,000 farmers are engaged in commercial cultivation of *Moringa* as it is a highly remunerative crop. The small farmers get a handsome amount of benefit from *Moringa* cultivation. Though several varieties are present in India but cultivation, improvement and outstanding new varietal production found in Odisha is inadequate. In Odisha only PKM 1 and PKM 2 is cultivated predominantly.



**Cost of cultivation:** Plant density 1,600 plant/ha

1<sup>st</sup> year cost of cultivation – Rs. 1,03,200=00

2<sup>nd</sup> year cost of cultivation – Rs. 96,900=00

3<sup>rd</sup> year cost of cultivation – Rs. 95,000=00

Yield in 1<sup>st</sup> year 10 kg/plant i.e 16,000 kg/ha

Yield in 2<sup>nd</sup> year 15kg/plant i.e 24,000 kg/ha

Yield in 3<sup>rd</sup> year 15 kg/plant i.e 24,000 kg/ha

Income in 1<sup>st</sup> year@ Rs.35=00/kg i.e 5,60,000  
(Net benefit = Rs. 4,56,800)

Income in 2<sup>nd</sup> year@ Rs.35=00/kg i.e 8,40,000  
(Net benefit = Rs. 7,43,100)

Income in 3<sup>rd</sup> year@ Rs.35=00/kg i.e 8,40,000  
(Net benefit = Rs. 7,45,100)

**Diseases and Pest:** The main reason for which the people does not like to keep *sajana* in their kitchen garden is due to the attack of most important pest i.e. caterpillar. This insect is the voracious feeder of the bark and leaves that damage the plant internally and the insects are seen throughout the dwelling. Moreover, due to the attack of stem borer *Diaxenopsis apomecynoides* sometimes it reduces the normal growth of the fruits as well as the market price. Developing fruits are damaged by the fruit fly *Gitona distigmata*. The budworm *Noordia moringae* and the scale insects *Diaspidotus sp.*, *Aphis craccibora* and *Ceroplastode cajani*.

No major disease in India has been reported as affecting the economies of the crop. However, in severely waterlogged condition *Diplodia* root rot and damping off can occur, from annual *Moringa* at the seedling stages. A new disease has been reported from Maharashtra caused by *Drechslera haraiensis* where the maturity Pods showed extensive rot. The disease

symptoms are observed all over the surface of the pods, more conspicuously at the stigmatic end as well as on green pods. Recently researchers reported a new wilt disease caused by *Fusarium oxysporum fsp moringae*.

#### **Problems encounters for large scale cultivation:**

- Unavailability of suitable high-yielding variety under Odisha condition.
- Farmers do not pay due attention to this remunerative crop due to their ignorance which ultimately leads reduction in the yield.
- Use of unsuitable pruning methods for ratoon crop management.
- The commercial crop requires irrigation during summer and windy seasons when the water table is at its lowest.
- There is no such appropriate control measure available to combat fruit fly and caterpillar attacks.
- Packing systems are poor (uncovered bundles or in gunnies).
- Lack of co-operative marketing systems.
- Seasonal glut necessitates cold storage facilities.

#### **Future Scope of cultivation for the small and marginal farmers:**

- It does not require much attention and labour, only the family members can deal with the various operations as time requires.
- It can be cultivated with the suitable intercropping along with the other vegetable crops.
- *Moringa* requires minimum amount of manures and fertilizers as well as irrigation facilities for its commercial cultivation.





- If small farmers cultivate *Moringa* in less than one hectare of land, then their produce can easily be marketed in local market with a profitable price as it always has a medium to high demand depending upon the festival or occasion.
- As all the parts of *sajana* can be used in different purpose, so farmers can fetch some extra money by selling the products other than the fruits.
- Pruned materials can be effectively recycled for supplying pulp and paper industries, which is an additional advantage for small farmers.
- It also provides a good alternative of protective foods for the poor farmers and their family.

Though India harbours a lot varietal wealth but unfortunately, information on exhaustive research mainly based on conservation, cultivation, improvement and outstanding new varietal production found not only in India but also in Odisha is inadequate. The present report is, therefore, emphasized mainly on the tremendous potential for improvement of the human beings in particular and the society in general, easy cultivation and handsome benefits to initiate more cultivation. *Moringa*, having a good potential to be cultivated throughout Odisha, particularly in the dry land area where there is a scarcity of water, it can be grown successfully. Here, we have discussed about the cultivation aspect and its different uses and focused on its potential to grow as a remunerative by the small and marginal farmers. During our study, we have concentrated on the problems that farmers face for its commercial cultivation that has been also pointed out in this article. These problems can

only be overcome by the sincere effort of the scientists and the active farmers as well, and then only “Sajana” will become popular to the farmers and its commercial cultivation will get its unpaid attention.

### References :

- Janick, J and Robert E. Paull. (2008). The Encyclopaedia of Fruits and Nuts, CABI. pp: 509-510.
- Mabberley, D. J. (1997). The Plant Book. 2nd ed., Cambridge Univ. Press, Cambridge, UK, pp: 467.
- Rajakrishnamoorthy, V.; S. Santhanabosus, V.K.; Duraisamy, S. and Rajagopal, A. (1994). Drip irrigation in annual *moringa*. *Madras Agri. J*, 81 (12): 678-679.
- Singh, H.P. (2011). Exploring R & D potential of *Moringa* for nutrition and Healthcare. *Indian Horticulture*, Jan-Feb: 3-8
- Suthanrapandian, I. R.; S. Sambandamurth and Irallappan, I. (1989). Variations in seedling population of annual *Moringa*. *South Indian Horticulture*, 35(5): 301-302.
- Vijayakumar, R.M. (2000). Studies on influence of months of sowing & growth regulation on annual *moringa* (*Moringa pterigosperma* Gaertn). *Ph.D. Thesis*, TNAU, India.
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