

Review Article

<https://doi.org/10.20546/ijcmas.2020.908.300>

Moringa oleifera: The Miracle Tree on the Earth

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ABSTRACT

Keywords

Moringa oleifera,
Multipurpose tree,
Miracle tree,
Nutrition, Health

Article Info

Accepted:
22 July 2020
Available Online:
10 August 2020

Moringa is an outstanding source of multi nutritional components. Almost every part of this tree holds products useful for human health. *Moringa oleifera* contains essential amino acids, carotenoids in leaves, and components with nutraceutical properties, supporting the idea of using this plant as a nutritional supplement or constituent in food preparation. It has proved to be an excellent source of phytonutrients and has therefore nutritional and medicinal applications for both human and animals. The seed, leaves, roots and flowers are often used in traditional medicine products in human food. It is one of most rich source of vitamin A, vitamin C, milk protein etc. Present review gives information which is required to prove its nutritional importance.

Introduction

Moringa oleifera are both annual and perennial tree, still considered as among underutilized plant and falls under Moringaceae family. The plant is also known as drumstick, sahan or sohanjana in India. All plant parts are having remarkable range of some functional and nutraceutical properties (Singh *et al.*, 2012).

Moringa is a fast growing tree with about 10m in height and a diameter of 2.04m at chest height. It has a soft trunk, white corky;

and a gummy bark bearing branches. Each twice or thrice pinnate compound leaf bears small leaf leg. The flowers are pleasantly fragrant, white in colour and the three wings seeds are scattered by the winds. MO flowers, tenders leaves and pods are eaten as vegetables. India being the largest producer of Moringa, has an annual production of between 1.1 to 1.3 million tonnes of tender fruits from an area of 380 km² (Rajangam *et al.*, 2001).

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. Moringa is an edible plant. From ancient times, it has been a regular component of conventional eatables in India (Singh *et al.*, 2012).

The World Health Organization (WHO) has been promoting the use of this the plant to help those countries suffering from malnutrition, which is one of the major causes of death worldwide. United Nations Food and Agriculture reported that one in twelve people worldwide is malnourished, including 160 million children under the age of 5 years (United Nations Food and Agriculture Statistics, 2008).

Moringa oleifera is sometimes called “Mother Best Friend” and “Miracle Tree”. Since 1998, the World Health Organisation (WHO) has promoted this tree as an alternative to imported food supplies to treat malnutrition in poor countries (Johnson, 2005). This ‘Miracle tree’ is very impressive and amazing plant due to its tested, trusted and high potential benefits from nutritional and medicinal point of view (Iqbal and Bhangar, 2006).

Different parts of this plant contain a profile of important minerals and are a good source of protein, vitamins, beta-carotene, amino acids and various phenolics. The Moringa plant provides 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). Nutrition content of a plant plays an essential function in medicinal, nutritional, and therapeutic properties (Al-Kharusi *et al.*, 2009).

Botanical Classification	
Kingdom	Plantae
Division	Magnoliophyta
Class	Magnoliopsida
Order	Brassicales
Family	Moringaceae
Genus	Moringa
Species	oleifera.

Moringa leaves have been reported to be a rich source of β -carotene, protein, vitamin C, calcium and potassium and act as a good source of natural antioxidants; and thus enhance the shelf-life of fat containing foods due to the presence of various types of antioxidant compounds such as ascorbic acid, flavonoids, phenolics and carotenoids (Dillard and German, 2000).

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 (Singh *et al.*, 2019).

Moringa is known by various vernacular names- (Varmani and Garg, 2014).

Language	Common names
English	drumstick tree & horseradish tree
Guajarati	saragvo
Hindi	soanjna
Bengali	sajna
Kannada	nugge
Malayalam	sigru
Marathi	shevga
Sanskrit	shobhanjana
Telegu	munaga
Tamil	murungai
Oriya	sajana
Punjabi	surajana
Nepali	sajwan or swejan
Assamese	sojina
Sinhalese	murunga

Nutritional constituents of *Moringa oleifera*

Protein which is required for tissue growth and deficiency of which can lead to growth retardation, kwashiorkor etc. the leaves and other parts of the tree contain high amount of crude protein and amino acids, comparable to soybean (Joy, 1998).

Vitamins like vitamin A which is important for health of eyes & hair, vitamin C and other B group vitamin.

Minerals like calcium which helps in building bones & teeth and its deficiency can cause rickets, bone pain, osteoporosis etc. It is claimed that eight ounces of Moringa leaves give 1000 mg of calcium and dry Moringa powder can give 4000 mg calcium while milk only 300-400 mg of calcium (Gopala Krishnan, 2016).

Potassium which transmits nerve impulses & its deficiency can cause loss of appetite and sometimes coma.

Phosphorus which has role in the formation of bones and teeth, is also needed for the body to make protein for growth, make ATP, maintenance, repair of cells & tissues.

Iron and can replace iron tablets. Zinc content of Moringa is also in accordance of the dietary requirements, which is important for the RNA & DNA synthesis (Gopala Krishnan, 2016).

Fiber which helps in maintaining a healthy gut.

Bioactive compounds like tannins, alkaloids, phenolic compounds, amino acids, sterols and carbohydrates (Masurekar, 2014).

The Moringa's incredible medicinal usage which is claimed by many cultures and communities based on real-life experiences are now slowly being confirmed by science. Through research, the Moringa was found to

contain many essential nutrients, for instance, vitamins, minerals, amino acids, beta-carotene, antioxidants, anti-inflammatory nutrients and omega 3 and 6 fatty acids (Fahey, 2005; Hsu *et al.*, 2006; Kasolo *et al.*, 2010). (Table 1)

Moringa trees have been used to combat malnutrition, especially among infants and nursing mothers. Leaves can be eaten fresh, cooked, or stored as dried powder for many months without refrigeration, and reportedly without loss of nutritional value. A large number of reports on the nutritional qualities of Moringa now exist in both the scientific and the popular literature. Moringa was used extensively in Ayurveda, where virtually all parts were considered useful with a plethora of healing attributes (Hebbar *et al.*, 2014).

Nutritional constituents of *Moringa oleifera*

Comparison of 100 grams edible portion with moringa fresh leaf



Medicinal properties

M. oleifera is often referred as a panacea and can be used to cure more than 300 diseases. Moringa has long been used in herbal medicine by Indians and Africans. The presence of phytochemicals makes it a good medicinal agent. In this section the effect of

moringa on diseases like diabetes, cancer etc.

The WHO has recommended to moringa as an alternative to imported food supplies for the treatment of malnutrition. Besides being edible all parts of the *M. oleifera* have long been deployed for the treatment of numberless diseases and for that reason in many instances, it is been called as ‘‘Miracle Tree’’ (Mbikay, 2012) (Table 2).

Benefits/uses of Moringa

There are many uses of Moringa tree and these will all be medicines, Human food, Water purification, Animal fodder, Alley cropping, Fertilizer, Living fence, Living fence, Domestic cleaning agent, Fuel wood and other uses. Moringa increased physical energy - Tune your body up with naturally occurring nutrients to make your energy last longer. Numerous research reports reveal that, parts of Moringa plant can be used in different techniques. *Moringa oleifera* seed and leaves is advantageous source of nutrients, medicines, clean dirty water and it can be used for alley cropping; because, it has lots of leafy material (Mekonen Daba, 2016).

Biosorption and water purification

The contamination of soil and water resources with environmentally harmful chemicals is an alarming issue, for the survival of all living organisms including humans. The progressing industrialization and urbanization has exposed the natural environment to increasing levels of toxic elements, such as heavy metals. Biosorption is the removal of toxic heavy metals from wastewater to enhance its quality from initial metal concentrations of 1–100 mg l⁻¹, to final concentrations of < 0.01–0.1 mg l⁻¹ (Naja *et al.*, 2010; Meneghel *et al.*, 2013). The seed cake may be used for water purification purposes because it contains effective water purifying components (Anwar and Bhangar, 2003). Powdered seeds of

Moringa contain cationic polyelectrolytes which act as a natural flocculent to clarify even the most turbid water. The seed-powder joins with the solids in the water, settles down and also removes 90–99% of bacteria contained in water (Omotesho *et al.*, 2013, Ndasbigengeser, 1998). Water purification begins with flocculation, sedimentation, antibiosis and even reduction of *Schistosoma cercariae* titer. This simple technique replaces chemicals such as aluminum sulphate, which are dangerous to people and the environment, and are expensive. *M. oleifera* has several advantages over commonly used coagulants which includes low operational cost, biodegradable sludge production, lower sludge volume, and unchanged pH of water.

Cattle feed

The leaves of this plant added to cattle feed increased their daily weight gain by upto 32 percent, feed of milk cows was supplement with 15-17 kg of fresh leaves daily and the cattle’s milk production increased by 43 percent. Feed supplemented with 3 kg dry matter per day and milk production increased by 65 percent. Therefore, in developing countries, the milk production could be increased in this way and our country can solved the problem of people with protein deficiency.

Plant growth enhancer

Lab experimentation had shown that Moringa spray had a wide range of beneficial effects on plant crop. Effects of spray indicated accelerated growth of young plants. Plants were firmer, more resistant to pests and disease, longer life-span, heavier roots, stems and leaves, produced more fruit, larger fruit, increase in yield 20-35% even a fraction of these results could be reproduced in the field, it could be a great help in increasing food supplies for millions of hungry people (Fahey 2005).

Biopesticides

Biopesticides, being a promising alternative to conventional pesticides are eco-friendly, cost-effective and are ineffective to non-target organisms as birds, insects, and mammals. When used in Integrated Pest Management (IPM) programs, biopesticides can significantly reduce the use of conventional pesticides without affecting the crop yield. Moringa seed oil has the potential to be deployed as a biopesticide (Fahey, 2005). The aqueous Moringa seed extract (AMSE) and leaf extracts have been reported to exhibit as insect repellent and fungicidal properties (Riad and Abdalla, 2014).

Biodiesel

Biodiesel is an alternative to petroleum-based conventional diesel fuel and is defined as the mono-alkyl esters of vegetable oils and

animal fats. Biodiesel has been prepared from numerous vegetable oils, such as cottonseed, canola (rapeseed), palm, soybean, peanut and sunflower oils. The greatest potential for *M. oleifera* is currently thought to be in its cultivation for the production of biodiesel (Fernandes *et al.*, 2015). A yield of about 20 metric tonnes of pods / hectare / year is achievable for this species. This could provide 3000 and 4000 liters of biodiesel / hectare / annum. After acid pre-treatment to reduce the acid value of the *M. oleifera* oil, biodiesel is obtained by a transesterification procedure with methanol and an alkali catalyst at 60 °C.

The methyl esters (biodiesel) obtained from Moringa seed oil exhibit a high cetane number of approximately 67, one of the highest found for a biodiesel fuel. Overall, *M. oleifera* oil appears to be promising input for biodiesel (Schill, 2008; Santos *et al.*, 2015).

Table.1 The nutrient compositions of leaves, leaf powder, seeds and pods

Nutrients	Fresh leaves	Dry leaves	Leaf powder	Seed	Pods
Calories (cal)	92	329	205	–	26
Protein (g)	6.7	29.4	27.1	35.97 ± 0.19	2.5
Fat (g)	1.7	5.2	2.3	38.67 ± 0.03	0.1
Carbohydrate (g)	12.5	41.2	38.2	8.67 ± 0.12	3.7
Fibre (g)	0.9	12.5	19.2	2.87 ± 0.03	4.8
Vitamin B1 (mg)	0.06	2.02	2.64	0.05	0.05
Vitamin B2 (mg)	0.05	21.3	20.5	0.06	0.07
Vitamin B3 (mg)	0.8	7.6	8.2	0.2	0.2
Vitamin C (mg)	220	15.8	17.3	4.5 ± 0.17	120
Vitamin E (mg)	448	10.8	113	751.67 ± 4.41	-
Calcium (mg)	440	2185	2003	45	30
Magnesium (mg)	42	448	368	635 ± 8.66	24
Phosphorus (mg)	70	252	204	75	110
Potassium (mg)	259	1236	1324	-	259
Copper (mg)	0.07	0.49	0.57	5.20 ± 0.15	3.1
Iron (mg)	0.85	25.6	28.2	-	5.3
Sulphur (mg)	-	-	870	0.05	137

All values are in 100g per plant material (Barminas *et al.*, 1998).

Table.2 Nutritional compositions and medicinal uses of different parts of Moringa

Part of tree	Medicinal uses	Nutritive properties	Suggestion
Leaves	Moringa leaves treat asthma, hyperglycemia, Dyslipidemia, flu, heart burn, syphilis, malaria, pneumonia, diarrhea, headaches, scurvy, skin diseases, bronchitis, eye and ear infections. Also reduces, blood pressure and cholesterol and acts as an anticancer, antimicrobial, Antioxidant, anti diabetic and anti-atherosclerotic agents, neuroprotectant.	Moringa leaves contain fiber, fat proteins and minerals like Ca, Mg, P, K, Cu, Fe, and S; Vitamin-A (β -carotene), vitamin B-choline, vitamin B1-thiamine, riboflavin, nicotinic acid and ascorbic acid are present. Various amino acids like Arg, His, Lys, Trp, Phe, Thr, Leu, Met, Ile, Val are present. Phytochemicals like tannins, sterols, saponins, terpenoids, phenolics, alkaloids and flavonoids like quercetin, isoquercetin, kaemfericetin, isothiocyanates and glycoside compounds are present	Presence of flavonoids provides leaves the anti diabetic and antioxidant properties. The isothiocyanates are anticancer agents. Flavonoids like quercetin and others are known for anti-proliferative, anticancer agent. Presence of minerals and vitamins help in boosting the immune system and cure a myriad of diseases.(Rockwood <i>et al.</i> , 2013, Mbikay <i>et al.</i> , 2012, Barminas <i>et al.</i> , 1998, Ijarotimi <i>et al.</i> , 2013, Tiloke <i>et al.</i> , 2013)
Seeds	Help in treating hyperthyroidism, Chrohn's disease, antiherpes-simplex virus arthritis, rheumatism, gout, cramp, epilepsy and sexually transmitted diseases, can act as antimicrobial and anti-inflammatory agents	Contains oleic acid (Ben oil), antibiotic called pterygospermin, and fatty acids like Linoleic acid, linolenic acid, behenic acid, Phytochemicals like tannins, saponin, phenolics, phytate, flavanoids, terpenoids and lectins. Apart from these, fats, fiber, proteins, minerals, vitamins like A, B, C and amino acids	Flavonoids have anti-inflammatory property. The antibiotic pterygospermin is responsible for antimicrobial properties. The other phytochemicals help in treating various diseases (Rockwood <i>et al.</i> , 2013, Thurber <i>et al.</i> , 2010, Choudhary <i>et al.</i> , 2013, Nair <i>et al.</i> , 2011).
Root Bark	Root bark acts as a cardiac stimulant, antiulcer and anti-inflammatory agent	Alkaloids like morphine, moriginine, minerals like calcium, magnesium and sodium	The alkaloid helps the bark to be antiulcer, a cardiac stimulant and helps to relax the muscles (Ravikumar <i>et al.</i> , 2013, Monera <i>et al.</i> , 2012)
Flower	Moringa flowers act as hypocholesterolemic, anti-arthritic agents can cure urinary problems and cold	It contains calcium and potassium and amino acids. They also contain nectar	The presence of nectar makes them viable for use by beekeepers (Barminas <i>et al.</i> , 1998, Baker <i>et al.</i> , 1998)
Pods	Moringa pods treat diarrhea, liver and spleen problems, and joint pain	Rich in fiber, lipids, non-structural carbohydrates, protein and ash. Fatty acids like oleic acid, linoleic acid, palmitic acid and linolenic acid are also present	The presence of PUFA in the pods can be used in the diet of obese (Barminas <i>et al.</i> , 1998)

Various value added products of Moringa

S.no	Name of the value – added product	Raw materials used	Product in use of curing
1	Moringa Oil	Moringa Seeds	Skin Allergies, Moisturizing, Softness to Skin
2	Moringa Leaf Tablets	Moringa Leaves	Vitality and Nutrient Supplement
3	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
4	Moringa Leaf Powder	Moringa Leaves	Activating Role, Balancing Health, Cleansing Role in the Body (ABC)
5	Mogo Energy Bites	Moringa Leaves + Padam+Peanut+Almond + Alfafa + Spirulina + Cardamom + Dry Ginger + Country Sugar	Energy Chocolate and Nutrient Supplement
6	Mogo-Colostrums Organic Energy Bar	Colostrums + Groundnut + Almond + Moringa Leaves + Spirulina + Alfafa + Cardamom + Dry Ginger	Energy Chocolate with Nutrient Supplement
7	Moringa Energy Drops	Moringa Leaves	Concentrated Drops for General Health
8	Bio Moringa Instant Soup	Moringa Fresh Pods	ABC Role Plus General Health
9	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, Dysentery, Asthma, Intestinal Cancer
18	Moringa Capsules	Moringa Leaves	General Health

(G.Sandeep *et al.*, 2018)

Biogas

Much research on *Moringa stenopetala* has been reported for the production of Biogas. Availability of water is a prerequisite for large scale biogas production from *M. stenopetala* seed cake powder. The pH of the system should be monitored very well in biogas production. The Moringa biogas plant can contribute to solve a waste problem for industries with organic wastes; can provide cheap energy to that industry; produces a digestate that can be an excellent fertilizer, and which can be sold e.g. to farmers. Replacing chemical fertilizers with this bio fertilizer will add important minerals to the soil, and thereby contribute to increase the fertility of farmed land. The biogas plant reduces the percentage of methane released to the atmosphere and shall replace the use of fossil fuels. Last but not the least a biogas plant can serve the food producing industry (Mulugeta and Fekadu, 2014).

In conclusion, *Moringa oleifera* really recognized to be a "Miracle tree", because it has multipurpose use for humankind and thus named as a nature gift at very low price. In order to discover and utilize full uses of this miracle tree, market development strategies, Strong policies, and research were required. Due to its multipurpose unlimited benefits for humanity, supports the fact that it is often referred to as both "miracle tree" and "gift of nature". India could easily fight against the problems of malnutrition and diseases through plantation in unutilized areas to build up socioeconomic importance

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How to cite this article:

Barkha Sharma, Sarvesh Tripathy, Chatra Ram Kantwa, Ramdhan Ghaswa, Rohatash Singh Bhadauria and Dhani Ram Pachauri. 2020. *Moringa oleifera*: The Miracle Tree on the Earth. *Int.J.Curr.Microbiol.App.Sci.* 9(08): 2623-2632. doi: <https://doi.org/10.20546/ijcmas.2020.908.300>