

ISSN 1996-0700

Asian Journal of  
**Biotechnology**

## **A Review on Horse Radish Tree (*Moringa oleifera*): A Multipurpose Tree with High Economic and Commercial Importance**

Ritu Paliwal, Veena Sharma and Pracheta

Department of Bioscience and Biotechnology, Banasthali University, Banasthali-304022, Rajasthan, India

*Corresponding Author: Veena Sharma, Department of Bioscience and Biotechnology, Banasthali University, Banasthali-304022, Rajasthan, India Tel: +01438-228386*

### **ABSTRACT**

From time immemorial, man has remained dependent on plants for medicine. From a historical perspective, it is evident that the fascination for plants is as old as mankind itself. The plant kingdom represents a rich storehouse of traditional medicines and organic compounds that may lead to development of novel agents for various disorders. *Moringa oleifera* Lam (Syn *Moringa pterygosperma* Gaertn) commonly known by regional names such as drumstick tree, sajiwan, kelor, murungai kaai, saijhan and sajna, is a natural as well as cultivated variety of the genus *Moringa* belonging to the family Moringaceae. It is a small or medium sized tree, about 10 m high, cultivated throughout India. It is a multipurpose tree known as nature's medicine cabinet. It is best known as excellent source of nutrition and natural energy booster. Different parts of this plant are being employed for the treatment of various ailments in the indigenous system of medicine. It possesses antitumor, antipyretic, antiepileptic, anti-inflammatory, antiulcer, antispasmodic, diuretic, antihypertensive, cholesterol lowering, antioxidant, antidiabetic and hepatoprotective activities. This plant have broad spectrum activities so, this review focuses on numerous economic application, distribution and commercial importance of *Moringa oleifera* along with its traditional medicine and culinary uses, so that it can be grown enormously and can be used for various indigenous purposes. Considering its relevance, further research is required to explore the potential from this medicinal tree.

**Key words:** *Moringa oleifera*, distribution, nutrition, traditional, culinary

### **INTRODUCTION**

*Moringa oleifera* is the most widely cultivated species of monogeneric family, the Moringaceae, which is indigenous to south Asia, where it grows in the Himalayan foothills from northeastern Pakistan to Northern West Bengal, India (Sharma *et al.*, 2011). It has been introduced and become naturalized in other parts of India, Pakistan, Afghanistan, Bangladesh, Sri Lanka, Southeast Asia, West Asia, the Arabian peninsula, East and West Africa, Southern Florida, throughout the West Indies, and from Mexico to Peru, Paraguay and Brazil. In Puerto Rico, it is grown chiefly as an ornamental and in fencerows and hedges and has become naturalized along roadsides on the coastal plains and lower foothills. The rapid growing tree was utilized by the ancient Romans, Greeks and Egyptians; it is now widely cultivated and has become naturalized in many locations in the tropics (Fahey, 2005; Sachan *et al.*, 2010).

*Moringa oleifera* is the best known of the thirteen species in the genus *Moringa* of family Moringaceae. These are *Moringa oleifera*, *M. arborea*, *M. borziana*, *M. concanensis*, *M. drouhardii*,

*M. hildebrandtii*, *M. longituba*, *M. ovalifolia*, *M. peregrine*, *M. pygmaea*, *M. rivae*, *M. ruspoliana* and *M. stenopetala* (Mahmood *et al.*, 2010).

This fast-growing tree is grown for human food, medicine, dye, fodder and water clarification. It has an impressive range of medicinal uses with high nutritional value. In addition to its compelling water purifying powers and high nutritional value, *M. oleifera* is very important for its medicinal value. All parts of the Moringa tree are edible and have long been consumed by humans. According to Fuglie (1999) the many uses for Moringa include: alley cropping (biomass production), animal forage (leaves and treated seed-cake), biogas (from leaves), domestic cleaning agent (crushed leaves), blue dye (wood), fencing (living trees), fertilizer (seed-cake), foliar nutrient (juice expressed from the leaves), green manure (from leaves), gum (from tree trunks), honey and sugar cane juice-clarifier (powdered seeds), honey (flower nectar), medicine (all plant parts), ornamental plantings, biopesticide (soil incorporation of leaves to prevent seedling damping off), pulp (wood), rope (bark), tannin for tanning hides (bark and gum), water purification (powdered seeds) (Adebayo *et al.*, 2011). In the West, one of the best known uses for Moringa is the use of powdered seeds to flocculate contaminants and purify drinking water (Berger *et al.*, 1984; Gassenschmidt *et al.*, 1995). Various parts of this plant such as the leaves, roots, seed, bark, fruit, flowers and immature pods act as cardiac and circulatory stimulants, possess antitumor, antipyretic, antiepileptic, anti-inflammatory (Kumar *et al.*, 2009), antiulcer, antispasmodic, diuretic, antihypertensive, cholesterol lowering, antioxidant, antidiabetic, hepatoprotective, antibacterial and antifungal activities and are being employed for the treatment of different ailments in the indigenous system of medicine, particularly in South Asia (Anwar *et al.*, 2007; Fakurazi *et al.*, 2008; Paliwal *et al.*, 2011a). It is generally known in the developing world as a vegetable, a medicinal plant and a source of vegetable oil (Bennett *et al.*, 2003; Paliwal *et al.*, 2011b). In the light of aforementioned properties of drumstick tree the following review highlights its vernacular names, distribution, economic and commercial importance along with traditional medicine and culinary uses.

### Scientific classification (*Moringa oleifera*)

Kingdom	:	Plantae
Division	:	Magnoliophyta
Class	:	Magnoliopsida
Order	:	Viales
Family	:	Moringaceae
Genus	:	Moringa
Species	:	<i>Oleifera</i>
Family ayurvedic	:	Shobhanjan kul

### Vernacular names of *Moringa oleifera* in Asia

#### India

(Bengalese): Munga ara, Sajna, Sojna, Sujana  
(Gujarati): Midho-saragavo, Saragavo, Saragvo, Suragavo  
(Hindi): Munga ara, Shajmah, Shajna, Segra  
(Hindi/Orissa): Sanjna, Saijna, Shajna, Soandal  
(Kanarese): Nugga egipa, Nugga, Noogay, Nuggi Mara

(Kol): Mulgia, Munga ara, Mungna  
(Kumao-Himalayan region): Sunara  
(Konkani/Goa): Moosing, Mosing  
(Malayalam): Sigru, Moringa, Muringa, Murinna, Morunna  
(Marathi): Sujna, Shevga, Shivga  
(Modesia/W. Bengal): Mangnai  
(Monghye/Punjab): Sejana  
(Oriya): Munigha, Sajina  
(Punjabese): Sanjina, Soanjana  
(Rajasthan): Lal Sahinjano  
(Sanskrit): Danshamula, Shobhanjana, Sigru Shobhanjan, Sobhan jana  
(Sindhi): Swanjera  
(Tamil): Morunga, Murungai, Murunkak-kai  
(Telugu): Sajana, Tella-Munaga  
(Teling): Morunga, Morungai  
(Urdu): Sahajna  
(Central provinces): Mulaka, Saihan  
(Western region): Sundan

### **Burma**

**(Burmese):** Dandalun, Daintha, Dandalun-bin, Dandalonbin.

### **Cambodia**

Ben ailé, Daem mrum.

### **Nepal**

Sitachini

### **Pakistan**

Saijan, Sohanjna

### **Philippines**

(Tagalog): Kalungai, Kamalungua, Malongai, Malungai, Mulanggay, Malunkai.

(Bikol): Kalungai

(Bisaya): Alúngai, Dool, Malungit.

(Kisaya): Kalungai

(Ibanag): Marongai, Marungai

(Ilóko): Marongai, Marungai, Komkompilan

(Pampangan): Dool, Kamalungua, Malúngit.

(Panay Bisaya): Kalamúngai, Kamalongan

(Pangasinán): Rúnggai

### **Thailand**

(Thai): Kaanaeng-doeng, Phak eehuem, Phak eehum, Phak-nuea-kai, Se-cho-ya

(Central highlands): Ma rum

(North): Ma khonkom

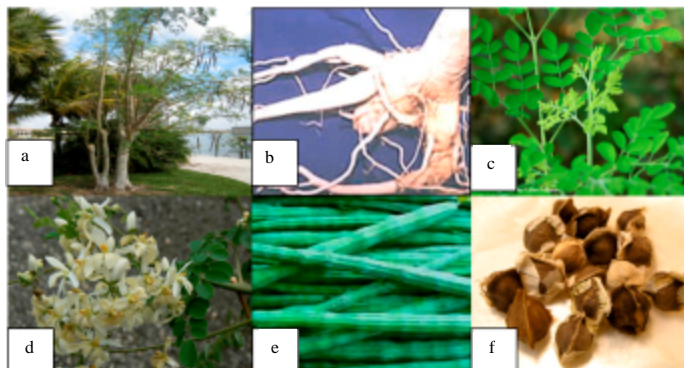


Fig. 1: Various useful parts of *Moringa oleifera*. (a) Tree, (b) Root, (c) Leaves, (d) Flowers, (e) Pods (Fruit) and (f) Seeds

### Vietnam

Chum Ngay

### BOTANICAL DESCRIPTION

**Morphology and physical characteristics:** Moringa is a slender softwood tree that branches freely and can be extremely fast growing. Although it can reach 3 heights in excess of 10 m (33 f) and a diameter of 20-40 cm at chest height, it is generally considered a small- to medium-size tree (Radovich, 2009) (Fig. 1a-f).

**Stem:** The stem is normally straight but occasionally is poorly formed. The tree grows with a short, straight stem that reaches a height of 1.5-2 m before it begins branching but can reach up to 3.0 m (Foidl *et al.*, 2001).

**Branch:** The extended branches grow in a disorganized manner and the canopy is umbrella shaped.

**Leaves:** Tripinnate compound leaves are feathery with green to dark green elliptical leaflets 1-2 cm (0.4-0.8 in) long. The tree is often mistaken for a legume because of its leaves. The alternate, twice or thrice pinnate leaves grow mostly at the branch tips. They are 20-70 cm long, grayish-downy when young, long petiole with 8-10 pairs of pinnae each bearing two pairs of opposite, elliptic or obovate leaflets and one at the apex, 1-2 cm long (Morton, 1991).

**Flowers:** Conspicuous, lightly fragrant flowers are borne on inflorescences 10-25 cm (4-10 in) long, and are generally white to cream colored, 2.5 cm in diameter, borne in sprays, with 5 at the top of the flower, although they can be tinged with pink in some varieties. The flowers, which are pleasantly fragrant and 2.5 cm wide are produced profusely in axillary, drooping panicles 10-25 cm long (Sachan *et al.*, 2010). They are white or cream colored and yellow-dotted at the base. The five-reflexed sepals are linear-lanceolate. The five petals are slender-spatulate. They surround the five stamens and five staminodes and are reflexed except for the lowest.

Table 1: Physical properties of pods and seeds of Moringa

Determination	1	2	3
Average weight of pod (g)	7.60	-	7.95
Average weight of seeds (g) / pod	3.59	5.03	4.83
Average number of seeds / pod	12.00	17.00	16.00
Average weight (g) / 100 seeds	29.90	29.60	30.20
Average weight of kernels (g) / 100 seeds	21.20	-	22.50
Percent weight of kernel in relation to entire seed	72.50	-	74.50
Percent weight of hull in relation to entire seed	27.50	-	25.50
Moisture in kernel (%)	4.50	-	6.50
Moisture in hull (%)	9.20	-	12.90
Moisture in whole seed (%)	5.80	-	7.50

Foidl *et al.* (2001), Carlos Foletti in 1996 (Personal communication), Proyecto Biomasa (1996)

**Fruits:** The fruits are trilobed capsules, and are frequently referred to as pods. Immature pods are green and in some varieties have some reddish color. Pods are pendulous, brown, triangular, splitting lengthwise into 3 parts when dry, 30-120 cm long, 1.8 cm wide, containing about 20 sec embedded in the pith, pod tapering at both ends, 9-ribbed. Fruits production in March and April in Sri Lanka (Burkill, 1966).

**Seeds:** The seeds are round with a brownish semi-permeable seed hull, with 3 papery wings. Seed hulls are generally brown to black, but can be white if kernels are of low viability. Viable seeds germinate within 2 weeks. The hull itself has three white wings that run from top to bottom at 120° intervals. Each tree can produce between 15,000 and 25,000 seeds/year. The average weight per seed is 0.3 g and the kernel to hull ratio is 75:25 (Makkar and Becker, 1997). Physical characterization of pods and seeds are given in Table 1.

## DISTRIBUTION

Moringa is native to the Himalayan foothills (India/Bangladesh). As a commercial crop, it is cultivated extensively in India and parts of Africa. It would be challenging to find a region in the tropics or subtropics where moringa is not grown as a backyard tree for leaf and pod consumption, medicinally and for fiber. Moringa is most commonly found in areas with South and Southeast Asian (particularly Filipino) populations. Today it is widely cultivated in Africa, Central and South America, Sri Lanka, India, Mexico, Malaysia, Indonesia and the Philippines. It is considered one of the world's most useful trees, as almost every part of the Moringa tree can be used for food or has some other beneficial property.

## ECOLOGY: ENVIRONMENTAL PREFERENCES AND TOLERANCES

**Climate:** Moringa is widely adapted to the tropics and subtropics. Optimum leaf and pod production requires high average daily temperatures of 25-30°C (77-86°F), well-distributed annual rainfall of 1000-2000 mm (40-80 in), high solar radiation and well-drained soils (Odee, 1998). Growth slows significantly under temperatures below 20°C (68°F). Ideal elevation is less than 600 m (1, 970 f). Moringa is relatively tolerant of drought and poor soils and responds well to irrigation and fertilization.

**Soils:** Moringa tolerates a wide range of soil types and pH (4.5-9) but prefers well-drained soils in the neutral pH range. It can grow well in heavy (clay) soils provided that they do not become

Table 2: Analysis of Moringa pods, fresh (raw) has showed it to contain the following per 100 grams of edible portion

Factors	PODS
Moisture (%)	86.90
Calories	26.00
Protein (g)	2.50
Carbohydrate (g)	3.70
Fiber (g)	4.80
Minerals (g)	2.00
Ca (mg)	30.00
Mg (mg)	24.00
P (mg)	110.00
K (mg)	259.00
Cu (mg)	3.10
Fe (mg)	5.30
S (mg)	137.00
Oxalic acid (mg)	10.00
Vitamin A- $\beta$ carotene	0.11
Vitamin B- choline (mg)	423.00
Vitamin B <sub>1</sub> - thiamine (mg)	0.05
Vitamin B <sub>2</sub> -riboflavin (mg)	0.07
Vitamin B <sub>3</sub> .nicotinic acid	0.20
Vitamin C- ascorbic acid (mg)	120.00
Fat (g)	0.10

From Moringa oleifera: Natural Nutrition for the Tropics by Fuglie (2001)

saturated for prolonged periods of time. Light (sandy) soils are preferred for rooting branch cuttings directly in the ground.

**Growth and development:** Plants from seed can grow very rapidly under ideal conditions. Selected early flowering varieties are sometimes called annual types because they produce vegetable pods for market within a year and may be removed and new plantings established. Examples of early flowering types include 'PKM-1 and 'PKM-2' developed primarily for vegetable pod production by Tamil Nadu University in India. Early flowering types can produce market-mature pods in 6 months compared to over a year for other types. Moringa varieties generally tolerate the same climatic conditions. After coppicing, branches grow quickly and immature pods are harvested in 6 months.

**Flowering and fruiting:** Moringa is free flowering. Flowering generally occurs 4-12 months after planting, depending on the type. Some selections flower 4-5 months after planting.

**Cultivation:** The plant is propagated by planting limb cuttings 1-2 m long, from June to August. The plant starts bearing pods 6-8 months after planting, but regular bearing commences after the second year. The tree bears for several years. It does not tolerate freeze or frost. It can also be propagated by seed. As with all plants, optimum cultivation depends on producing the right environment for the plant to thrive. Moringa is a sun and heat loving plant. Seeds are planted an inch below the surface and can be germinated year-round in well-draining soil. 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<sup>2</sup>. Among the states, Andhra Pradesh leads in both area and production

(156.65 km<sup>2</sup>) followed by Karnataka (102.8 km<sup>2</sup>) and Tamil Nadu (74.08 km<sup>2</sup>). In other states, it occupies an area of 46.13 km<sup>2</sup>. Tamil Nadu is the pioneering state inasmuch as it has varied genotypes from diversified geographical areas and introductions from Sri Lanka. Moringa is common in India, where its triangular, ribbed pods with winged seeds are used as a vegetable crop. It is particularly suitable for dry regions. The drumstick can be grown using rainwater without expensive irrigation techniques. The yield is good even if the water supply is not. The tree can be grown even on land covered with 10-90 cm of mud (Rajangam *et al.*, 2001).

**Scale of commercial production:** Commercial production of immature pods for processing is a large industry in India with about 1.2 million MT (metric tons) (1.1 million T) produced annually on 38,000 ha (94, 000 ac).

## NUTRITION

Moringa trees have been used to combat malnutrition, especially among infants and nursing mothers. Three non-governmental organizations in particular—Trees for Life, Church World Service and Educational Concerns for Hunger Organization have advocated Moringa as natural nutrition for the tropics. *M. oleifera* leaves have essential amino acids, including the sulfur-containing amino acids in higher levels (Fuglie, 2000; Fahey, 2005) than those recommended by the Food and Agriculture Organization (FAO), patterns similar to those of soybean seeds.

Moringa has long been considered a panacea for improving the nutrition of poor communities in the tropics and subtropics. Leaves can be eaten fresh, cooked, or stored as dried powder for many months without refrigeration, and reportedly without loss of nutritional value. Protein content of leaves is high (20-35% on a dry weight basis). Most important is that the protein is of high quality having significant quantities of all the essential amino acids. This amino acid balance is very unusual in plant foods. Moringa leaves also contain high quantities of nutrients (per 100 g fresh weight): vitamin A (7564 IU), vitamin C (51.7 mg), calcium (185 mg) and potassium (337 mg) (Foidl and Paull, 2008).

Analyses of the proximate composition of *M.oleifera* seeds have showed high levels of lipids and proteins (Anhwange *et al.*, 2004), with minor variations. Abdulkarim *et al.* (2005), have described high levels of total proteins (383.0 standard deviation-SD = 13.0 g kg<sup>-1</sup> dry matter), which turned out to be greater than important leguminous seeds with respect to human nutrition, whose dry seeds usually contain 18 to 25% of protein, nearly double the contents of cereals. The seed lipid content is greater than that of some soybean varieties (149-200 g kg<sup>-1</sup> meal). The major saturated fatty acids present in the seeds are palmitic, stearic, arachidic and benic acids. Oleic acid is the main unsaturated fatty acid (67.9-70.0%) whose high concentration is desirable in terms of nutrition and stability during cooking and frying. Moreover, as a natural source of benic acid, the *M.oleifera* seed oil has been used as a solidifying agent in margarines and other foodstuffs containing solid and semi-solid fat, therefore eliminating hydrogenation processes. Pods and stem contain irrelevant amounts of tannins but saponins and alkaloids are present in amounts biologically important in leaves (80 g kg<sup>-1</sup>) and stem, respectively, although in levels considered nontoxic to ruminants. *M.oleifera* fresh (raw) pods contains the following per 100 g of edible portion (Table 2).

## TRADITIONAL MEDICINE

Medicinal properties of plants have also been investigated in the light of recent scientific developments through out the world, due to their potent pharmacological activities, low toxicity and economic viability, when compared with synthetic drugs (Pracheta *et al.*, 2011). Among myriad of



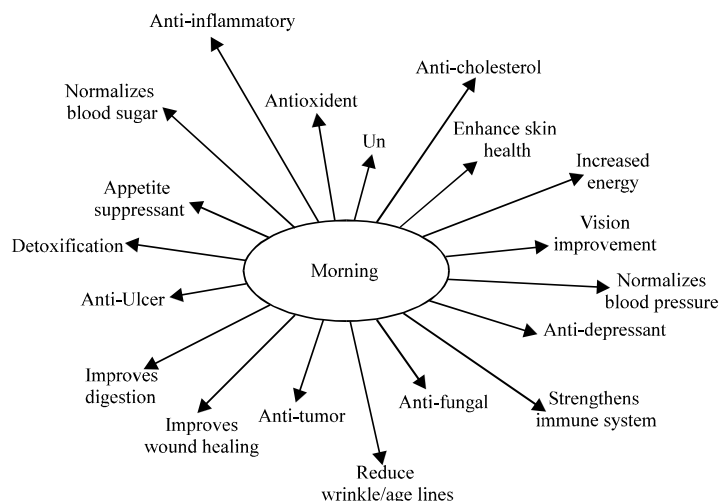


Fig. 2: Outlines important medicinal uses of *Moringa oleifera*

natural plants *Moringa oleifera* Lam. is called Miracle vegetable because of it is both a medicinal and a functional food. *Moringa oleifera* possess highly therapeutic and pharmacological values, so its consumption in regular diet could possibly reduce the risk of degenerative diseases (Paliwal *et al.*, 2011c). *Moringa oleifera* is believed to possess numerous medical properties and is being used for the treatment of ascites, rheumatism (Anwar *et al.*, 2007), venomous bites (Mishra *et al.*, 2009), enhancing cardiac function (Limaye *et al.*, 1995), inflammation (Ezeamuzie *et al.*, 1996), liver disease (Rao and Misra, 1998), cancer, hematological, hepatic and renal function (Mazumder *et al.*, 1999). Almost all the parts of this plant: root, bark, gum, leaf, fruit (pods), flowers, seed and seed oil have been used for various ailments in the indigenous medicine of South Asia, including the treatment of inflammation and infectious diseases along with cardiovascular, gastrointestinal, hematological and hepatorenal disorders (Fig. 2) (Paliwal *et al.*, 2011b).

*Moringa* has been used in the traditional medicine passed down for centuries in many cultures around the world, for skin infections, anaemia, anxiety, asthma, blackheads, blood impurities, bronchitis, catarrh, chest congestion, cholera, conjunctivitis, cough, diarrhoea, eye and ear infections, fever, glandular, swelling, headaches, abnormal blood pressure, hysteria, pain in joints, pimples, psoriasis, respiratory disorders, scurvy, semen deficiency, sore throat, sprain, tuberculosis, for intestinal worms, lactation, diabetes and pregnancy (Nikkon *et al.*, 2003). The healing properties of *Moringa* oil, have been documented by ancient cultures. *Moringa* oil has tremendous cosmetic value and is used in body and hair care as a moisturizer and skin conditioner. *Moringa* oil has been used in skin preparations and ointments since Egyptian times (Ramachandran *et al.*, 1980; Sairam, 1999; Marcu, 2005).

It is vata and kapha suppressant. Due to its hot potency it is helpful in relieving from pain and also reduces inflammation. It is also helpful in curbing the infection in the body. It is very much effective in stimulating the nervous system. Due to pungent taste it is effective in treating the digestive disorders, worm infestation, and constipation. It stimulates heart and also increases the blood density because of its hot potency. It is also a good antitussive and helps in resolving from extra mucus in the respiratory tract because of its bitter nature. Due to hot potency it is helpful in maintaining the proper menstrual cycle. It is also helpful in relieving from skin related problems as it generates sweat in the body.

According to ayurveda it contains:

**Gunna (properties)**-laghu (light), ruksh (dry) and tikshan (sharp)

**Rasa (taste)**-katu (pungent) and tickta (bitter)

**Virya (potency)**-ushan (hot)

### CULINARY USES

The Moringa pod is known as "munga", *saragwa* or *saragwe* in India and is often referred to as drumstick in English. In South India, it is used to prepare a variety of sambars and is also fried. In other parts of India, especially West Bengal and also in a neighboring country like Bangladesh, it is enjoyed very much. It is made into a variety of curry dishes by mixing with coconut, poppy seeds and mustard or boiled until the drumsticks are semi-soft 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, etc. In Maharashtra, the pods are used in sweet and sour curries called Aamatee. Tender drumstick leaves, finely chopped, are used as garnish for vegetable dishes, dals, sambars, salads, etc. It is also used in place of or along with coriander, as these leaves have high medicinal value. In some regions the flowers are gathered and cleansed to be cooked with besan to make pakoras. It is also preserved by canning and exported worldwide.

### SOCIO-ECONOMIC IMPORTANCE

*M. oleifera* is one of the most useful tropical trees. The relative ease with which it propagates through both sexual and asexual means and its low demand for soil nutrients and water after being planted makes its production and management easy. Introduction of this plant into a farm, which has a biodiverse environment, can be beneficial for both the owner of the farm and the surrounding eco-system. Distinction of cultivars has not yet been formally carried out. *M. oleifera* was well known to the ancient world, but only recently has it been rediscovered as a multi-purpose tree with a tremendous variety of potential uses.

*M. oleifera* is certainly under-exploited at present. Its numerous uses as a vegetable, seed oil, gum, hedge tree, ornamental and medicinal plant, and its easy propagation and cultivation justify more intensive research into its biological and economic potential. Germplasm exist in natural stands and maintenance of long, large fruited types is usually practiced.

### COMMERCIAL USES

*Moringa oleifera* is coming to the forefront as a result of scientific evidence that Moringa is an important source of naturally occurring phytochemicals and this provides a basis for future viable developments. Different parts of Moringa are also incorporated in various marketed health formulations, such as:

- Rumalaya and Septilin (the Himalaya Drug Company, Bangalore, India)
- Orthoherb (Walter Bushnell Ltd, Mumbai, India)
- Kupid Fort (Pharma Products Pvt. Ltd, Thayavur, India)
- Livospin (Herbals APS Pvt. Ltd, Patna, India)

Moringa seeds have specific protein fractions for skin and hair care. Two new active components for the cosmetic industry have been extracted from oil cake. Purisoft consists of peptides of the

Moringa seed. It protects the human skin from environmental influences and combats premature skin aging. With dual activity, antipollution and conditioning/strengthening of hair, the *M. oleifera* seed extract is a globally acceptable innovative solution for hair care.

## LIMITATIONS

Though quite tolerant to drought, the tree is deciduous, and it loses most of its leaves in periods of mended water-stress. The wood of Moringa is relatively soft. Because of this, it is not used in heavy construction. The tree is also susceptible to breakage in high winds. The pods of some varieties taste quite bitter and may be poisonous if eaten in large quantities. Moringa is relatively short-lived reaching only 20 years on average. Because it is so easy to establish, however, this imitation does not discourage cultivation of this very useful and adaptable tree (Mayde, 1986).

## FUTURE PROSPECTS AND CONCLUSION

The multiple benefits of *M. oleifera* made it a true miracle of nature. The *Moringa oleifera* plant is the most inexpensive and credible alternative to not only providing good nutrition, but also the cure and prevention of a lot of diseases. In view of the edible nature of the plant, more research work can be done on humans so that a drug with multifarious effects will be available in the future market. Moringa tree could easily and cheaply be cultivated and grown in Asia. The poor countries should promote planting and use of Moringa instead of waiting for bounties of food relief from the rich west. India could easily fight against the problems of malnutrition, hunger, poverty, diseases, unemployment, and edible oil export by utilizing its full benefits. The lot foreign exchange could be earned by exporting product of Moringa instead spending foreign exchange on imports. Moringa truly appears to be a Miracle plant having countless benefits for humanity and thus should be taken as a high quality gift of nature at very low price. In view of its multiple uses, the *M. oleifera* plant needs to be widely cultivated in most of the areas where climatic conditions favour its optimum growth. In this way, a maximum yield of its different usable parts could be achieved to derive the maximal amount of commodities of a multifarious nature for the welfare of mankind.

## ACKNOWLEDGMENTS

The authors are thankful to the authorities of Banasthali University for providing financial support to the study.

## REFERENCES

- Abdulkarim, S.M., K. Long, O.M. Lai, S.K.S. Muhammad and H.M. Ghazali, 2005. Some physico-chemical properties of *Moringa oleifera* seed oil extracted using solvent and aqueous enzymatic methods. *Food Chem.*, 93: 253-263.
- Adebayo, A.G., H.A. Akintoye, A.O. Olufolaji, O.O. Aina, M.T. Olatunji and A.O. Shokalu, 2011. Assessment of organic amendments on vegetative development and nutrient uptake of *Moringa oleifera* lam in the nursery. *Asian J. Plant Sci.*, 10: 74-79.
- Anhwange, B.A., V.O. Ajibola and S.J. Oniye, 2004. Chemical studies of the seeds of *Moringa oleifera* (Lam) and *Detarium microcarpum* (Guill and Sperr). *J. Biological Sci.*, 4: 711-715.
- Anwar, F., S. Latif, M. Ashraf and A.H. Gilani, 2007. *Moringa oleifera*: A food plant with multiple medicinal uses. *Phytother. Res.*, 21: 17-25.

- Bennett, R.N., F.A. Mellon, N. Foidl, J.H. Pratt, M.S. DuPont, L. Perkibns and P.A. Kroon, 2003. Profiling glucosinolates and phenolics in vegetative and reproductive tissues of the multi-purpose trees *Moringa oleifera* L. (Horseradish Tree) and *Moringa stenopetala* L. *J. Agric. Food Chem.*, 51: 3546-3553.
- Berger, M.R., M. Habs, S.A. Jahn and S. Schmahl, 1984. Toxicological assessment of seeds from *Moringa oleifera* and *Moringa stenopetala*, two highly efficient primary coagulants for domestic water treatment of tropical raw waters. *East Afr. Med. J.*, 61: 712-716.
- Burkill, J.H., 1966. A Dictionary of Economic Products of the Malay Peninsula. Vol. 2, Art Printing Works Publishers, Kuala Lumpur, Malaysia.
- Ezeamuzie, I.C., A.W. Ambakederemo, F.O. Shode and S.C. Ekwebelm, 1996. Antiinflammatory effects of *Moringa oleifera* root extract. *Int. J. Pharmacog.*, 34: 207-212.
- Fahey, J.W., 2005. *Moringa oleifera*: A review of the medical evidence for its nutritional, therapeutic and prophylactic properties: Part I. *Trees Life J.*, 1: 5-5.
- Fakurazi, S., U. Nanthini and I. Hairuszah, 2008. Hepatoprotective and antioxidant action of *Moringa oleifera* Lam. against acetaminophen induced hepatotoxicity in rats. *Int. J. Pharmacol.*, 4: 270-275.
- Foidl, N., H.P.S. Makkar and K. Becker, 2001. The Potential use of *Moringa oleifera* for Agriculture and Industrial uses. In: *The Miracle Tree/The Multiple Attributes of Moringa oleifera*. Fuglie, L.J. (Ed.). CTA, USA.
- Foidl, N. and R. Paull, 2008. *Moringa Oleifera*. In: *The Encyclopedia of Fruit and Nuts*, Janick, J. and R.E. Paull, (Eds.). CABI, Oxfordshire, UK pp: 509-512.
- Fuglie, L.J., 1999. *The Miracle Tree: Moringa oleifera*, Natural Nutrition for the Tropics. Church World Service, Dakkar, Senegal, pp: 68.
- Fuglie, L.J., 2000. New uses of moringa studied in nicaragua. ECHO Development Notes No. 68. <http://map-abcdf.com.ph/documents/submitted%20papers/NEW%20USES%20OF%20MORINGA%20STUDIED%20IN%20NICARAGUA.pdf>.
- Fuglie, L.J., 2001. *The Miracle Tree-Moringa oleifera: Natural Nutrition for the Tropics*. Church World Service, Dakar..
- Gassenschmidt, U., K.D. Jany, B. Tauscher and H. Niebergall, 1995. Isolation and characterization of a flocculating protein from *Moringa oleifera* Lam. *Biochimica Biophysica Acta.*, 1243: 477-481.
- Kumar, A.K., M. Chalamaiah, R.R. Kumar and K.N. Babu, 2009. Preliminary studies on biotransformation of drumstick (*Moringa oleifera*) and watermelon (*Citrullus lanatus*) seed oils using Baker's Yeast. *Asian J. Biol. Sci.*, 2: 118-123.
- Limaye, D.A., A.Y. Nimbkar, R. Jain and M. Ahmad, 1995. Cardiovascular effects of the aqueous extract of *Moringa pterygosperma*. *Phytother. Res.*, 9: 37-40.
- Mahmood, K.T., T. Mugal and I.U. Haq, 2010. *Moringa oleifera*: A natural gift-A review. *J. Phar. Sci. Res.*, 2: 775-781.
- Makkar, H.P.S. and K. Becker, 1997. Nutrients and antiquality factors in different morphological parts of the *Moringa oleifera* tree. *J. Agric. Sci.*, 128: 311-322.
- Marcu, M.G., 2005. *Miracle Tree*. KOS Health Publications, USA., ISBN-13: 9781583083963.
- Mayde, U.H.J., 1986. *Trees and shrubs of the sahel, their characteristics and uses*, deutsche Gesellschaft für Technische Zusammenarbeit (GTZ). Federal Republic of Germany, pp: 334-337.

- Mazumder, U.K., M. Gupta, S. Chakrabarty and D.K. Pal, 1999. Evaluation of hematological and hepatorenal functions of methanolic extract of *Moringa oleifera* Lam. Root treated mice. Indian J. Exp. Biol., 37: 612-614.
- Mishra, D., R. Gupta, S. Pant, P. Kushwah, H.T. Satish and S.J.S. Flora, 2009. Co-administration of monoisoamyl dimercaptosuccinic acid and *Moringa oleifera* seed powder protects arsenic induced oxidative stress and metal distribution in mice. Toxicol. Mech. and Methods, 19: 169-182.
- Morton, J.F., 1991. The horseradish tree, *Moringa pterygosperma* (Moringaceae)-A boon to arid lands? Econ. Bot., 45: 318-333.
- Nikkon, F., S. Zahangir Alam, M. Habibur Rahman and Md. Ekramul Haque, 2003. *In vitro* antimicrobial activity of the compound isolated from chloroform extract of *Moringa oleifera* Lam. Pak. J. Biol. Sci., 6: 1888-1890.
- Odee, D., 1998. Forest biotechnology research in drylands of Kenya: The development of *Moringa* species. Dryland Biodiversity, 2: 7-12.
- Paliwal, R., V. Sharma, Pracheta and S. Sharma, 2011a. Elucidation of free radical scavenging and antioxidant activity of aqueous and hydro-ethanolic extracts of *Moringa oleifera* pods. Res. J. Pharm. Tech., 4: 566-571.
- Paliwal, R., V. Sharma, Pracheta, S. Sharma, S. Yadav and S.H. Sharma, 2011b. Antinephrotoxic effect of administration of *Moringa oleifera* lam in amelioration of dmbsa-induced renal carcinogenesis in swiss albino mice. Biol. Med., 3: 25-35.
- Paliwal, R., V. Sharma, Pracheta and S.H. Sharma, 2011c. Hepatoprotective and antioxidant potential of *Moringa oleifera* pods against DMBA-Induced hepatocarcinogenesis in male mice. Int. J. Drug Dev. Res. (In Press).
- Pracheta, V. Sharma, R. Paliwal, S. Sharma and L. Singh *et al.*, 2011. Chemoprotective activity of hydro-ethanolic extract of *Euphorbia nerrifolia* Linn. leaves against DENA-induced liver carcinogenesis in mice. Biol. Med., 3: 36-44.
- Proyecto Biomasa, 1996. Internal Report, UNI Managua. [www.moringaseeds.co.za/Planting3.html](http://www.moringaseeds.co.za/Planting3.html).
- Radovich, T., 2009. Farm and forestry production and marketing profile for moringa (*Moringa oleifera*). In: Specialty Crops for Pacific Island Agroforestry. Elevitch, C.R. (Ed.). Permanent Agriculture Resources (PAR), Holualoa, Hawai'i.
- Rajangam, J., R.S.A. Manavalan, T. Thangaraj, A. Vijayakumar and N. Muthukrishnan, 2001. Status of production and utilisation of Moringa in southern India. Development Potential for Moringa Products, October 29-November 2, Dar Es Salaam, Tanzania. [http://www.moringanews.org/actes/rajangam\\_en.doc](http://www.moringanews.org/actes/rajangam_en.doc).
- Ramachandran, C., K.V. Peter and P.K. Gopalakrishnan, 1980. Drumstick (*Moringa oleifera*): A multipurpose Indian vegetable Econ. Bot., 34: 276-283.
- Rao, K.S. and S.H. Misra, 1998. Anti inflammatory and antihepatotoxic activities of the rats of *Moringa pterygosperma* Geaertn. Ind. J. Pharma. Sci., 60: 12-16.
- Sachan, A., A.K. Meena, R. Kaur, B. Pal and B. Singh, 2010. Moringa oleifera: A Review. J. Pharm. Res., 3: 840-842.
- Sairam, T.V., 1999. Home Remedies: A Handbook of Herbal Cures for Common Ailments. Penguin, New Delhi, India.
- Sharma, V., R. Paliwal, Pracheta and S. Sharma, 2011. Phytochemical analysis and evaluation of antioxidant activities of hydro-ethanolic extract of *Moringa oleifera* Lam. Pods. J. Pharm. Res., 4: 554-557.