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Review Article

MORINGA OLEIFERA LAM.: A VALUABLE MEDICINAL PLANT, BOON OF NATURE

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ABSTRACT

Moringa oleifera Lam., is often referred to as "The Miracle Tree" due to its highly utility and it is said that every part of this tree have beneficial properties that can serve humanity. *Moringa oleifera* Lam., is native to the Indian sub-continent and naturalized in tropical and sub tropical areas around the world. It is very important and highly valuable medicinal plant. It has impressive range of different pharmacological action of various parts of this plant such as leaves, roots, seeds, bark, pods, flowers shows anti-bacterial, anti-inflammatory, anti-fungal, antispasmodic, antipyretic, hypotensive, cholesterol lowering, anti-diabetic, anti-biotic etc. activity. Different parts of this plant contain a unique combination of important nutritional minerals, vitamins, amino acids, ß-carotene, and various phenolics. It is widely used for medicinal and therapeutically with its high nutritional value in the indigenous system of medicine. The aim of present review study is to explore the importance of *Moringa oleifera* Lam., to reveal the nutritional and medicinal properties of this plant and summarize scientific evidence of pharmacological properties that supports the value and multifunctional uses.

INTRODUCTION

Moringa oleifera Lam. (syn. *M. pterygosperma* Gaertn), is commonly known as Drumstick plant, being used since ancient time as medicinal purpose and in Ayurveda it is known as *Shigru* and described so many therapeutic properties. It is used for various purposes besides therapeutic such as vegetable, spices and cosmetics. *Moringa oleifera* Lam., is most widely cultivated species of Moringaceae family, that is a soft wooden small or middle sized tree, about 8-10m in height with pungent roots, large 3-pinnately leaves having articulated rachis, small elliptical leaflets, white flowers, a long pendulous cylindrical 9-ribed pod constricted between seeds and enclosing trigonous seeds broadly winged at the angles. It is found in sub Himalayan tracts, Pakistan, Bangladesh, Afghanistan and growing throughout the India [1].

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All parts of the Moringa tree are edible and have long been consumed by humans. The many uses for Moringa include[2]: 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). Moringa seed oil (yield 30-40% by weight), also known as Ben oil, is a sweet non-sticking, non-drying oil that resists rancidity. It has been used in salads, for fine machine lubrication, and in the manufacture of perfume and hair care products[3]. In the West, one of the best known uses for Moringa is the use of powdered seeds to flocculate contaminants and purify drinking water[4,5,6], but the seeds are also eaten green, roasted, powdered and steeped for tea or used in curries[6]. This tree has in recent times been advocated as an outstanding indigenous source of highly digestible protein, Ca, Fe, Vitamin C, and carotenoids suitable for utilization in

many of the so-called "developing" regions of the world where undernourishment is a major concern.

This plant is known in various names *Shigru, Shobhanjan, Akshiva* and *Mochak* in Sanskrit, *Sahajan* in Hindi, Horse-radish tree and Drum stick plant in English[7].

Table 1: Vernacular names of *Moringa oleifera* Lam.

Country	Language	Vernacular names with reference
	Bengali	Shajina [7]
	Gujrati	Sargavo, Segato[7]
	Kannada	Nugge mara,Nugge kayi [8]
	Malayalam	Muringa, Morunna [8]
	Marathi	Shevga [7]
	Punjabi	Soanjana[8]
	Tamil	Murungai [7]
	Telugu	Tella-Munaga, Mulaga [7,8]
Pakistan		Suhanjana [8,5]
Sri Lanka	Sinhali	Murunga[8]
Bangladesh		Sajina [8]
Philippines		Mulangai [8]

White (*Shveta*) and Red (*Rakta*) variety of Moringa, is explained in Ayurveda text books.[7] Raj Nighantu [9] also described blue flower variety. There are 12 other different species of Moringa found in the world wide today.[10]

1. *M. arborea*
2. *M. concanensis*
3. *M. drouhardii*
4. *M. hildebrandtii*
5. *M. longituba*
6. *M. borziana*
7. *M. ovalifolia*
8. *M. peregrine*
9. *M. pygmaea*
10. *M. rivae*
11. *M. ruspoliana*
12. *M. stenopetala*

The plant and its medicinal properties has been described in Ayurveda treatise, Bhava Prakash [11] and it is used in the treatment of rheumatism, asthma, inflammation, ascites, epilepsy and hysteria [1]. The root bark is useful in heart diseases, eye diseases, dyspepsia and spleenomegaly[12] and root is laxative, expectorant, diuretic and beneficial for bronchitis, piles, stomatitis[13]. The root and bark is abortificant.[12] Leaves are galactogoue, aphrodisiac, anthelmintic and useful in hiccup, fainting fits, abcess, spasmodic problems of bowels and roots, leaves, fruits, seeds are attributed with a number of medicinal properties such as aphorodisiac, cardiotonic, fever and joints pain.[1] Along with other therapeutic applications. The Ayurvedic Pharmacopoeia of India indicated the use of the dried root bark in goitre, glycosuria and lipid disorders (also dried seeds), and leaf, seed, root bark and stem bark in internal abscess, piles and fistula-in-ano[14].

Phytochemical of *Moringa oleifera* Lam., revealed high contents of minerals, vitamins, amino acids, proteins, sterols, terpenes, ß-carotene, and various phenolics and act as a good source of natural antioxidant compounds such as flavanoids, carotinoids and ascorbic acid [15].

Its versatile utility as a medicine, functional food, nutraceutical and water purifying potential motivated to collect the information and to write a comprehensive review on the medicinal, nutritional, phytochemical and pharmacological attributes of this plant of high economic value.

Phytochemicals

Phytochemicals are, in the strictest sense of the word, chemicals produced by plants. Extensive phytochemicals have been isolated from plant *Moringa oleifera* Lam. Phytochemical studies of *Moringa oleifera* Lam., have shown the presence of various versatile constituents including flavonoides, carotinoids, Vit.C. An examination of the phytochemicals of *Moringa oleifera* Lam., species affords the opportunity to examine a range of fairly unique compounds. In

particular, this plant is rich in compounds containing the simple sugar, rhamnose, and it is rich in a fairly unique group of compounds called glucosinolates and isothiocyanates [16]. Plant stem contains 4-hydroxymellein, vanillin, ß-sitosterol, octacosanic acid and ß-sitosteron [17,18]. The leaves contain quercetin-3-0-glucoside and quercetin-3-0-(6´´-malonyl-glucoside), 4-(α-L-rhamnopyranosyloxy)-benzylglucosinolate, kaempferol, moringine, moringinine[12] and 3-caffeoylquinic acid [16]. The ethanolic extract of leaves contains two nitrile glycosides, niazirin and niazirinin, 4-[4´-O-acetyl-α-L-rhamnosyloxy) benzyl], isothyocynate, niaziminin A&B [19]. The gum contains L-arabinose, D-galactose, D-mannose, D-xylose and leucoanthocyanin [20]. The pods are showed nitriles, isothiocynate, indole acetonitrile, pterygosepermine, carotene and ß-sitosterol [18,21].

Nutritional Value

The *Moringa oleifera* Lam., is an outstanding source of nutrition and has very high nutrition value such as vitamins, minerals, amino acids, protein, carbohydrates. The Moringa contains 46 powerful antioxidants[22] compounds that protect the body against the destructive effects of free radicals. Nutritional analysis of *Moringa oleifera* Lam., indicates a wealth of essential, disease preventing nutrients. They even contain all of the essential amino acids, which is unusual for a plant source. *Moringa oleifera* Lam. dried leaves are contains higher amount of many nutrients except vitamin C. Table 2 shows the nutritional value of *Moringa oleifera* Lam., fresh leaves, dried leaves and pods are analyzed as per 100 grams of edible portion and Table 3 shows the Amino acids.

Table 2: **Nutritional analysis [23,24,25] of *Moringa oleifera* Lam. leaves and pods (per 100gm)**

Nutritional contents	**Fresh leaves** (per 100gm)	**Dried leaves** (per 100gm)	**Pods** (per 100gm)
A. Minerals			
Moisture (%)	75	7.5	86.9
Calories (cal)	92.00	205.00	26.00
Protein (g)	6.7	27.1	2.5
Fat (g)	1.70	2.3	.01
Carbohydrates (g)	13.4	38.2	3.7
Fiber (g)	.09	19.2	4.8
Ca (mg)	440.0	2003.0	30.0
Mg (mg)	42.0	368.0	24.0
P (mg)	70.0	204.0	110.0
Cu (mg)	1.1	0.06	3.1
Fe (mg)	0.7	28.2	5.5
Oxalic acid (mg)	101.0	0.0	10.0
S (mg)	137.0	870.0	137.0
K (mg)	259.0	1324.0	-
Zn (mg)	0.16	3.29	-
B. Vitamins (mg)			
Vit.A (ß-carotene)	6.8	16.3	0.1
Vit.B1 (Thiamin)	0.21	2.6	0.05
Vit.B2 (Riboflavin)	0.05	20.5	0.07
Vit.B3 (Nicotinic acid)	0.8	8.2	0.2
Vit.C (Ascorbic acid)	220	17.3	120
Vit.E (Tocopherols	-	113.0	-

Table 3: Amino acids [26] contents of *Moringa oleifera* Lam

Amino acid	Extracted Leaves		Unextracted Leaves	
Arginine	6.96	30.28	6.23	15.64
Alanine	6.59	28.67	7.32	18.37
Histidine	3.12	13.57	2.99	7.50
Lysine	6.61	26.77	5.6	14.06
Tryptophan	2.13	9.26	2.10	5.27
Tyrosine	4.34	18.88	3.87	9.71
Leucine	9.86	42.89	8.70	21.84
Isoleucine	5.18	22.53	4.50	11.30
Cystine	1.19	5.18	1.35	3.39
Methionine	2.06	8.96	1.98	4.97
Phenylalanine	6.24	27.14	6.18	15.51
Valine	6.34	27.58	5.68	14.26
Threonine	5.05	21.97	4.66	11.70
Serine	4.78	20.79	4.12	10.34
Glycine	6.12	26.62	5.47	13.73
Proline	5.92	28.67	7.32	18.37

*N=Natural protein. **DM= Dry matter

Nutritive Value Compare With Other Common Foods

The leaves are considered to offer great potential for those who are nutritionally at risk and may be regarded as a protein and calcium supplement. The leaves are rich in starch, minerals and proteins. It is particularly useful as a human food in tropical regions because of the leaves appears towards the end of the dry seasons when some of other sources of green leafy vegetables are not available. Table 4 shows the nutritive value with compare to other foods.

Table 4: *Moringa oleifera* Lam. leaves comparison to common foods content [23, 27] (per 100gm of edible portions)

Vitamin A content		
Carrot	**Fresh leaves**	**Dried leaves**
18mg	6.8mg	16.3mg
Vitamin C content		
Orange	**Fresh leaves**	**Dried leaves**
30mg	220mg	17.3mg
Calcium content		
Milk	**Fresh leaves**	**Dried leaves**
120mg	440mg	2003mg
Iron content		
Spinach	**Fresh leaves**	**Dried leaves**
1.14mg	0.7mg	28.2mg
Potassium content		
Banana	**Fresh leaves**	**Dried leaves**
88mg	259mg	1324mg
Protein content		
Yogurt	**Fresh leaves**	**Dried leaves**
3.1g	6.7g	27.1g

Comparison	
Vitamin A	Fresh leaves contains 4 times of carrot and 13 times of spinach dried leaves contains 10 times of carrot
Vitamin C	Fresh leaves contains 7 times of orange and dried leaves contains ½ times of orange
Vitamin B1	Dried leaves contains 4 times of pork meat
Vitamin B2	Dried leaves contains 50 times of Sarones
Vitamin B3	Dried leaves contains 50 times of peanuts
Vitamin E	Dried leaves contains 6 times of rapeseed oil
Calcium	Fresh leaves contains 4 times of milk and dried leaves contains 17 times of milk
Magnesium	Dried leaves contains 36 times of egg
Iron	Fresh leaves contains ¾ times of spinach and dried leaves contains 25 times of spinach
Protein	Fresh leaves contains 2 times of yoghurt/milk and dried leaves contains 9 times of yoghurt
Potassium	Fresh leaves contains 3 times of banana and dried leaves contains 15 times of bananas
Amino acid	Dried leaves contains 2 times of black vinegar
R-Amino acid	Dried leaves contains 30 times of brown rice and 4 times of GABA tea
Chlorophyll	Fresh leaves contains 4 times of wheat grass

Medicinal Uses

Moringa oleifera Lam. possesses highly medicinal uses, which have long been recognized in the Ayurved. *Moringa oleifera* Lam. is called Miracle tree among myriad of natural plants because of its medicinal as well as functional food and also it possess therapeutic and pharmacological values. Uses in daily diet it could possibly reduce the risk of various degenerative disease. Its uses is described in Ayurved in various ailments such as fever [18], anemia [18], asthma [13], bronchitis, joints pain, ascites [7], sore throat, eye infection [11] etc. For centuries, people in many countries have used *Moringa oleifera* Lam. as traditional medicine for common ailments such as for intestinal worms in Malaysia, skin infections in Guatemala, anemia, glandular swelling and lactating in Philippines [28]. Medicinal uses of *Moringa oleifera* Lam. is denoted in Ayurved and other ancient books are short listed in Table 5.

Table 5: Medicinal uses [7,11,13,15,18,25,28,29] of *Moringa oleifera* Lam.

Plant parts	Medicinal uses
Leaves	Diarrhea, dysentery, fever, anti-emetic, headache, anemia, antihypertensive, rheumatism, lactation enhancer, scurvy, bronchitis, catarrh, prostate, thyroid, anti-bacterial, vitamin/mineral deficiency, hypocholestemia, hiccup, glandular swelling, influenza, diuretic.
Bark	Aphrodisiac, hysteria, abortifacient, epilepsy, ulcer, colitis, common cold, sore throat, dental carries, toothache, fever, asthma, scorpion/snake bite.
Flowers	Throat infection, common cold, anthelmintic, anti-tumor, tonic, eye infection, rheumatism, diuretic, cholagogue.
Pods	Anthelmintics, anti-pyretic, skin disorders, diabetes, joints pain, arthritis.
Seeds	Warts, ulcer, rheumaism, antispasmodic, fever, eye infection, anthelmintic, vitamin/mineral deficiency, anti-tumor.
Roots	Diuretic, rubefacient, asthma, gout, splenomegaly, hepatomegaly, external sores, hepatorenal, headache, diarrhea, flatulence, abortifacient, low back pain, gout, vesicant, scurvy, diuretic, cardiotonic, dental carries, common cold, trypanosomes, aphrodisiac.
Gum (Exudates)	Otalgia, syphilis, fever, toothache, rheumatism, diuretic, asthma, rubefacient, typhoid, headache, dental carries.

Pharmacological Activities

Analgesic Activity

Methanolic extract of Moringa oleifera root bark shown analgesic activity in acetic acid induced writhing model in mice [28].

Antimicrobial and antifungal activity

Moringa root is to be reported as antibacterial activity and rich in antimicrobial agent. These are reported to contain an active antibiotic principle, pterygospermin, which has powerful antibacterial and antifungal effects. The root extract and seed shell shows antimicrobial activity attributed due to presence of 4-α-L-rhamnosyloxybenzyl isothiocyanate, an active antimicrobial compound[30]. The antimicrobial activity of leaves, root, bark and seeds were also investigated against bacteria, yeast, dermatophytes and helminthes. It was also reported that Moringa oleifera exhibit antifungal activity in both dilution and agar plate method against *Trichophyton rubrum* and *T. mentagraphytes*, *Epidemophyton xoccosum* [28, 31]. The aglycone of deoxy-niazimicine [N-benzyl, S-ethyl thioformate] isolated from the chloroform fraction of an ethanol extract of the root bark was found to be effective for the antibacterial and antifungal activity [32]. The fresh leaf and stem bark juice and aqueous extract of seed inhibited the growth of *Staphylococcus aureus* and *Pseudomonas aeruginosa* [33]. An experimental study on mice showed that the seed extract exhibited significant antibacterial against pyodermia, skin infection, causing bacterium [34]. Moringa seeds have shown anti-fungal activity and effectiveness against athlete's foot [35].

Anti-diabetic activity

Aqueous extract of Moringa oleifera Lam. leaves shows anti-diabetic activity on glucose tolerance in animal study [36]. Jaiswal D et al[37], found in their study that a variable dose of Moringa oleifera leaves aqueous extract administrated orally and the dose of 200mg/kg decreases blood glucose level of normal animals by 26.7% and 29.9% during fasting blood glucose level and glucose tolerance test studies respectively. In sub and mild diabetic animals the same dose produced a maximum fall of 31.1 and 32.8% respectively, during glucose tolerance test. In case of severely diabetic animals fasting blood glucose level and PP glucose levels were reduced by 69.2 and 51.2%. Thus this study exhibit glycemic control and acclaimed as an ethnomedicine of diabetes.

Anti-inflammatory activity

Methanolic extract of root bark, aqueous extract of root, methanolic extract of leaves and flowers as well as ethanolic extract of dried seed of Moringa oleifera Lam. is found to significant result in anti-inflammatory activity in animal study. A study showed that the ethanolic extract of dried seeds were effective its anti-inflammatory activity using carrageenan induced paw edema in mice and found that the dose of 3mg/kg body weight inhibited 85% inflammation and fresh green seed inhibited 77% at same dose and hot water infusions of flowers, leaves and bark showed anti-inflammatory activity while seed infusion showed diuretic activity also [28, 38].

Ezeamuzie IC *et al*. found anti-inflammatory effect of crude methanol extract of root in their study using the carrageenan induced rat paw edema of 6-days air pouch inflammatory model following the oral administration of extract in a dose dependent manner with IC_{50} of 660mg/kg. In the 6-day air pouch acute inflammation model induced with carrageenan, the extract was much more effective with IC_{50} values of 302mg/kg and 315.5mg/kg, for the inhibition of cellular accumulation and fluid exudation respectively and useful in inflammatory conditions [39]. An isolated compounds from roots, Aurantiamide acetate and 1,3-dibenzyl urea, shown its anti-inflammatory activity [28].

Anti-hyperlipidaemic and cardiovascular activity

Isolated five bioactive compounds, niazinin A & B, niazimicin and niaziminin A & B, from ethanol extract of leaves possesses hypotensive and bradycardiac effect in a study on rats using a doses of 1-10mg/kg i.v. by possibly its calcium antagonist effect [40]. Hydroalcoholic extract of leaves were reported to cardio protective effect in the isoproterenol induced myocardial infarction in rat model[28]. Methyl phydroxybenzoate and ß-sitosterol from pods of *Moringa oleifera* produced hypotensive activity [41].

It was found that the isolated compound, thiocarbamate and isothiocyanate glycosides, from ethanol extract of pods of Moringa oleifera are responsible for promising hypotensive activity [42].

The crude extract of Moringa oleifera leaves shown significant hypocholestremic effect was found in a study done by Ghasi S *et al*.[43] using the high fat-diet induced in male wistar rats model increased in serum, liver and kidney cholesterol level and found the decreased cholesterol level by 14.35% (115-103.2mg/100ml of serum), 6.40% (9.4-8.8mg/g wet wt) and 11.09% (1.09-0,97mg/g wet wt) respectively which might be attributed to the presence of a bioactive phytoconstituent, ß-sitosterol.

In another study on Moringa oleifera fruts followed by Mehta *et al*,[44] reported to possess hypolipidaemic effect. They were found to lower the serum cholesterol, phospholipids, triglyceride, LDL, VLDL, cholesterol to phospholipids ratio, atherogenic index lipid and reduced the lipid profile in hypercholesterolaemic rabbits.

Hepatoprotective activity

The leaves, root, flowers and seeds of *Moringa oleifera* Lam. are reported to hepatoprotective activity. A study of ethanolic extract of Moringa leaves shown

hepatoprotective effect in antitubercular drugs such as isoniazid, rifampicin and pyrizinamide induced liver damage in rats and the extract was found to enhance the recovery in hepatic damage by antitubercular induced drugs [45].

The alcoholic and aqueous extract of root, seeds and flowers of Moringa plant were evaluated hepatoprotective activity in paracetamol induced hepatotoxicity in albino rats and this hepatoprotective activity may be attributed to the presence of phytocompound; quercetin, a flavanoid [46,47].

Anti-asthmatic Activity

Alcoholic extract of Moringa seed kernel showed spasmolytic action in acetylcholine, histamine, $BaCl_2$ and 5HT induced bronchospasm in animal study [48].

Antioxidant activity

Dried seed extracted oil showed higher antioxidant activity than α-tocopherol and butylated hydroxyl toluene [49]. Leaves are reported a highly potential source of natural antioxidant and aqueous, methanolic (80%) and ethanol (70%) extract of freeze dried leaves exhibited antioxidant and radical scavenging activity. The extracts were competence of scavenging peroxyl and superoxyl radicals. The leaves showed antioxidant activity due to the presence of a bioactive compound,Kaemferol [50].

Other Miscellaneous Activities

The aqueous extract of leaves of *Moringa oleifera* is effective for the regulation of Thyroid hormone status and observed reduction in the serum T_3 concentration and increase in the T_4 concentration in the studies on animal model and advised to be used to treat hyperthyroidism [51]. A seed ointment showed a similar effect to neomycin against *Staphylococcus aureus pyodermia* in mice [52]. The bark of Moringa oleifera was found to be its anti-fertility effect in early pregnancy on animal experiment and in other study the aqueous extract of root and bark showed post-coital anti-fertility at a dose of 200mg/kg and 400mg/kg respectively and also induced foetal resorption at late pregnancy [53]. Thiocarbamate compound, niaziminin isolated from Moringa leaves exhibits inhibitor of tumor promoter teleocidin B-4 induced Epstein-Barr virus activation in Raji cells [54].

DISCUSSION AND CONCLUSION

The plant *Morigna oleifera* Lam. is considered as versatile medicinal plant in the Ayurved and modern drug development area for its medicinal values and it is really known as miracle tree due to its highly nutritive values. All the parts of this plant is rich in nutritional component like minerals, phytochemicals, vitamins, protiein, starch etc. and energy which is necessary for body to growth, nutrition and cure the diseases. WHO has promoted this plant as an alternative food supplements in against malnutrition in poor countries where the proper diet is less and nutritional components are rarely intake [55,56]. India can easily fight against the problems of malnutrition, hunger, poverty, diseases, unemployment, and edible oil export by utilizing its full benefits. The lot of foreign exchange could be earned by exporting the products of "Moringa" instead of spending foreign exchange on imports. Moringa Oleifera contains more than 92 nutrients, 46 types of anti-oxidants, 36 anti-inflammatory agents as well as vitamins A, B1, B2, B3, B4, B7, C, D, E, and K. It promotes good digestion and better mental clarity while boosting energy and regulating metabolism. It also has anti-aging benefits and since it has the unique property of containing all essential amino-acids, which the body cannot make on its own, it provides strength and health to it even as its kaempferol content contributes to proper cellular function. It can retain high concentrations of electrolyte minerals; it allows the body to remain internally hydrated even in very dry conditions. This apart, the leaves can provide us with around 125 per cent of our daily requirements of calcium as well as 61 per cent of our daily manganese needs; given that these two minerals have to be taken together for better absorption, the leaves majorly enhance bone and teeth health. Needless, to more discuss that the *Moringa olefera* Lam. is a truly 'Miracle Tree' and boon of nature having countless benefits for humanity and thus should be taken as a high quality gift of nature at very low price. The State and Central Government and NGO'S should take initiative step to implant, cultivate and grow this tree widely and utilized its optimum nutrition against malnutrition problem. More research should be undertaken to development in phytochemical, crop production, culinary preparation, food fortification and malnutrition etc.

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