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Ethnomedicinal and nutraceutical potentialities of *Moringa oleifera*: A Review

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ABSTRACT

Moringa oleifera is a perennial plant popularly known as 'Miracle plant' with great ethnomedicinal, nutritional and economical importance due to high content of nutrients, essential phytochemicals and antioxidants etc. The different parts of these plants such as leaves, flowers, fruits (pods), stem bark, roots, seeds and gum etc are used traditionally as alternative medicines for socially neglected people in addition to uses as good source of food nutrients. This plant contains a high profile of essential minerals, vitamins, proteins, carbohydrates, fats, fibre, carotenoids, amino acids and antioxidants like flavonoids, polyphenols, ascorbic acid, glycosides and glucosinolates etc. Various parts of this plant possess medicinal properties and act as cardiac stimulant, anti-inflammatory, anti-cancer, anti-tumor, anti-pyretic, anti-ulcer, anti-diabetic, anti-microbial and anti-fungal agent, anti-asthmatic due to its potential antioxidants and some other phytochemicals. In this background, this review compiles information on the multidimensional uses of *Moringa oleifera* in respect to its ethnomedicinal and nutraceutical potentialities in order to explore and evaluate for future research opportunities.

Keywords: *Moringa oleifera*, Ethnomedicinal, Nutraceutical, Phytochemicals, Antioxidants, Potentialities.

INTRODUCTION

Moringa oleifera Lam is a perennial angiospermic plant that belongs to Moringaceae family commonly known as Drumstick tree, Ben tree, Horse-radish tree, Sohjna or Saijna. It is indigenous to South Asian countries mainly in India, Nepal, Bangladesh, Afghanistan, Sri Lanka and largely scattered in many tropical and subtropical countries around the world. *Moringa oleifera* is still considered as underutilized plants which have nutritional as well as medicinal values in its almost all parts like leaves, flowers, fruits (pods), seeds etc. Its gum (liquid sap), roots and bark also used traditionally as medicines. Due to its diversified nutritional benefits, medicinal properties as well as uses of commercial products of this plant, it is popularly known as 'Miracle Tree' which has potentialities in agriculture and industry as well. *Moringa* plants are highly nutritious that provides daily nutritional supplement boosting the immune system both uses in human and animals. *Moringa* leaves might be used to combat malnutrition, especially among infants and nursing mothers [1].

It is considered as a natural energy booster due to its excellent source of nutrition. It can be intercropped with many fruits and vegetables crop species to augment socioeconomic condition of the rural people. It is evident that leaves and immature pods are act as natural antioxidant due to presence of higher amount of ascorbic acid, flavonoides, phenolics and carotenoids, glycosides and glucosinolates etc. Stem bark and roots are also rich in alkaloids such as moringine and moringinine which act as cardiac as well as circulatory stimulant, antiulcer and anti-inflammatory agents [2, 3]. *Moringa* seeds are used to extract oil known as 'Ben oil' which is rich in oleic acid, tocopherols and sterols etc. It has been reported that *Moringa* seed oil can be used in cooking as a substitute for olive oil, as cosmetics, lubrication as a source of biodiesel etc. Different studies expose that *Moringa* plays a significant role in agriculture, nutrition, medicine, water purification, animal fodder, environment (drought resistant), socio-economic development, biodiversity, sanitation/ domestic cleaning agent, fertilizer, fuel wood and other uses. The main aim of this review is to gather multipurpose uses of *Moringa* in regards to mainly medicine as well as nutrition for human and animals to combat various nutritional disorders and disease control.

Nutraceutical Potentialities of *M. Oleifera*

Moringa oleifera is used as a nutrient-rich plant especially in its leaves [1] and leaves are rich source of minerals like calcium, potassium, zinc, magnesium, iron and copper etc. However, different proteins, minerals and vitamins like A, B, C, D and E etc also in other parts of this plant like stem bark, flower buds, seeds, pods, gum etc. Among these minerals, Ca, Fe and Zn are important minerals for human growth which presents in abundant in different parts of this plant. Some essential amino acids, phenolics and also S-containing amino acids like methionine and cystine are available in different parts of this

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plant. It has been reported that leaves are highly nutritious than that of other parts which contains two times more protein than yogurt, four times more vitamin A than carrots, three times more potassium than bananas, seven times more vitamin C than oranges, and four times more calcium than milk [4]. Such nutrients and health-promoting phytochemicals could able to overcome the disorders like under-nutrition and obesity etc. Many International organizations like World Health Organization (WHO) as well as Food and Agriculture

Organization (FAO) recognized *Moringa oleifera* as a multidimensional uses plant having lots of health benefits to solve poverty and hunger related issues in many parts of the world. Traditionally as well as commercially the diets present in vegetables and fruits of this plant uses as nutritional supplement for human and animal to combat malnutrition. Table 1 reviewed different phytonutrients composition and their nutraceutical properties found in different parts of the *Moringa* plants.

Table 1: Nutritional composition found in different parts of *Moringa oleifera* plants

S. No.	Nutrient compositions	Source of plant parts	Nutritional properties	References
(i)	Vitamin C (Ascorbic acid)	Leaves and pods	Acts as an antioxidant that reduces free radicals within the cell	[5, 6, 7]
(ii)	β-carotene of vitamin A, vitamin B such as folic acid, pyridoxine and nicotinic acid, vitamin C, D and E	Leaves	Vitamin A and E act as a natural antioxidant to inhibit free radicals and required for improving the immune system and skin repair.	[4]
(iii)	Vitamins C, B and A, riboflavin, pyridoxine, folic Acid, β-carotene, nicotinic acid, α-tocopherol, with high mineral content for Fe, Ca and major source of essential amino acids.	Leaves	Involved in carbohydrateas well as in energy metabolism and folate synthesis.	[5]
(iv)	Protein, calcium, iron, Vitamin A, Ascorbic acid and Antioxidant compounds such as carotenoids, flavonoids, vitamin E and Phenol.	Leaves and seeds	Provides energy indispensable for growth and maintenance of the cell.	[6]
(v)	Amino acids such as Arg, His, Trp, Phe, Thr, Leu, Met, Ile, Lys, Val.	Leaves	Amino acids are building blocks of proteins that have role in various biochemical and metabolic processes.	[7]
(vi)	Vitamin B	Leaves and pods	Involved in DNA synthesis and cell division	[8]
(vii)	Rich in protein and low in fat, fiber, and ash. Vitamin C, Ca, P and K.	Dried leaves	These nutrients give a balance of food ingredients for human and animal diets.	[9]
(viii)	Potassium (K), Iron (Fe), Calcium (Ca) and Magnesium (Mg).	Leaves, immature fruits and other parts	-	[7, 10, 12 & 13]
(ix)	Carbohydrates and proteins.	Leaf powder	Increase the nutritional value of staple foods.	[14]
(x)	Fiber (11.23±0.16 g per 100g), protein (9.38±0.23g per 100g), carbohydrate (56.33±0.27g per 100g), and energy contents, essential amino acids especially Lysine, essential minerals such as Na, K, Mg, Ca, P and Fe and vitamins like A, B1, B2, B3, C and E.	Leaves	Fibers help to clean the digestive tract by removing potential carcinogens from the body and hence prevent the absorption of excess cholesterol. The fat and carbohydrate content is very valuable as a main source of energy for human body. Na and K maintain the water balance in the body and lowering the blood pressure.	[1]
(xi)	Rich in minerals, vitamins.	Leaves	-	[11]
(xii)	Vitamins, carotenoids, antioxidant substances and trace elements.	Leaf extract	-	[17, 18]
(xiii)	Rich in mineral elements such as P, Ca, K, Mg, Fe, Cu, Zn and Mn etc.	Leaf extract	Enhances the growth, yield and nutrients accumulation of pea plants.	[20]
(xiv)	High energy and rich in protein with appreciable levels of ash, fats, crude fibers and total carbohydrate, cellulose, Hemicelluloses and lignin etc. The leaves were found rich in vitamins and high level minerals like Mg ²⁺ , Ca ²⁺ , Zn ²⁺ and K ⁺ .	Dried leaves	-	[28]
(xv)	Proteins, fiber, carbohydrates, amino acids, vitamins, minerals and secondary metabolites (carotenoids and tocopherols).	Leaf, fresh pod (fruit) and seed	-	[32]
(xvi)	Greatest sources of potassium, calcium, magnesium, iron, copper, total phenols and proteins.	Leaves	-	[44]
(xvii)	Contains stearic acid, saturated palmitic acid and oleic acid.	Seeds	-	[49]
(xviii)	Contains in high amount of palmitic, linolenic, linoleic and oleic acids.	Immature flowers and pods	-	[51]
(xix)	Contains higher amount of fiber, non-structural carbohydrates, protein, fatty acids like oleic acid, linoleic and linolenic acid, palmitic acid etc.	Pods	Poly Unsaturated Fatty Acids (PUFA) like oleic acid, linoleic acid, palmitic acid and linolenic acid in the pods may be used to overcome the obesity problems.	[53]
(xx)	Contains high amount of calcium, potassium, amino acids and nectar.	Flowers	Nectar makes them viable for use by beekeepers.	[53, 54]

Phytochemicals Present in Different Parts of *Moringa oleifera* Plants

There are several indispensable phytochemicals that are present in different parts of *Moringa oleifera* such as leaves, stem bark, flower buds, seeds, pods and roots etc used as an effective remedy for malnutrition [7] especially combat malnutrition among infants and nursing mothers [1]. *Moringa* seed oil contains around 76% PUFAs (Poly Unsaturated Fatty Acids) such as linoleic acid, linolenic acid and oleic acid etc that makes it ideal for use as a substitute for olive oil [52] and such fatty acids have the ability to manage cholesterol

level. Different parts of this plant are well known for its phytochemicals like phytohormones, several bioactive compounds, secondary metabolites like alkaloids, flavanoids, phenolics, tannins, steroids, glucosides and glucosinolates etc, antioxidants (flavonoids, polyphenols, and ascorbic acid) to fight against free radicals (scavenging the ROS) which cause oxidative stress, cell membrane damage, and inflammation. Such phytochemicals have anti-inflammatory, anticancer, antitumor, antipyretic, and anti-hyperglycemic properties. Table 2 reviewed and discussed on different phytochemicals composition and their properties found in different parts of the *Moringa* plants.

Table 2: Phytochemicals found in different parts of *Moringa oleifera* plants

S. No.	Phytochemical's compositions	Source of plant parts	Chemical properties	References
(i)	High phenolic contents and flavonoid contents in methanol and aqueous extract, respectively.	Flower pods	Methanol and aqueous extract exhibited high antibacterial and antioxidant activity, respectively. Methanol extract also have great potential to be used as natural preservative and nutraceutical in food industry.	[16]
(ii)	Phenolic compounds and flavonoids.	Leaves	These are very important constituents that have antioxidant activity by scavenging free radicals.	[1]
(iii)	Phenolic compounds like phenolic acids, tannins, flavonoids, phytosterols, and alkaloids.	Leaves	-	[11]
(iv)	Phytochemicals such as kaempferitrin, isoquercitrin, rhamnetin, kaempferol, β -Sitosterol, Zeatin, caffeoylquinic acid and quercetin.	Leaf extract	-	[19, 27]
(v)	Rich in plant hormones, amino acids, bioactive compounds and many other ingredients.	Leaf extract	-	[17, 21, 22]
(vi)	Good source of natural plant hormones viz. IAA gibberellins, cytokinin, and zeatin.	Leaf extract	-	[23]
(vii)	Used as an effective plant growth regulator.	Leaf extract	Plant growth hormone enhances seed germination, improving yield and growth in plants.	[24, 25]
(viii)	Antioxidant compounds like zeatin, ascorbic acid, phenolic, flavonoids, vitamin E and minerals.	Leaves	Leaves can be used to enhance the metabolism of plants and overcoming plants from environmental stress.	[23, 26]
(ix)	High concentrations of Flavonoids, Alkaloids, and Saponins; but with low oxalate content, with appearance of saponins, flavonoids, steroids and cardiac glycosides.	Leaves methanolic extract	-	[28, 30, 31]
(x)	Good source of polyphenols, alkaloids, saponins, carotenes, minerals, amino acids and sterols.	Leaf, root, seed, flower and stem bark	Potentiality in antioxidant activity due to presence of such phytochemicals.	[39, 40, 41]
(xi)	Contains phytochemical like saponins, alkaloids, glycosides, tannins, carbohydrates, flavonoids, resins and proteins.	Leaves methanolic extract	Higher phytochemical compositions present in methanolic extract than aqueous and ether extract.	[43]
(xii)	High in tannins, saponins, alkaloids, flavonoids, phenols and glycosides.	Leaves	-	[46]
(xiii)	Rich source of tannins, steroids, flavonoids, alkaloids, glycosides, quercetin and terpenoids.	Flowers	-	[47]
(xiv)	Contains gallic acid, catechins, epicatechin, ferulic acid, vanillin, caffeic acid, cinnamic acid, phytosterol, quercetin, glycosides.	Seeds	-	[48]
(xv)	Contains major phytochemicals like tannin, sterols, terpenoids, flavonoids, saponins, anthraquinones, alkaloids, reducing sugar and some anti-cancerous agents like glucosinolates, isothiocyanates, glycoside etc.	Different parts	-	[50]

Potentialities of *M. oleifera* for strengthening pharmacological uses and alternative traditional folk medicine

Around 85% of the population in developing countries around the world uses the leaves, stem bark, gum, roots, flowers, immature pods, seeds, oil etc as traditional folk medicine that have ethnomedicinal and pharmacological potentialities. They have marvelous pharmacological application that possesses anti-diabetic, analgesic,

anti-inflammatory, anti-cancerous, anti-ulcer, anti-microbial, anti-oxidant, antipyretic, anti-asthmatic, hepatoprotective and wound healing properties [57]. Different parts of this plant are uses as cardiac and circulatory stimulants, cholesterol lowering and for the treatment of different ailments, respiratory disorders, skin problems and various waterborne diseases etc both in human and animals. Table 3 reviewed and discussed on the ethnomedicinal and pharmacological uses of different parts of *Moringa* plants.

Table 3: Ethnomedicinal as well as pharmacological uses of different parts of *Moringa oleifera* plants

S. No.	Traditional uses	Plant parts used	References
(i)	Used for prevention and treatment of several diseases like gastric ulcer, hay fever, fatigue, skin diseases and bronchitis, psychosis, eye diseases, fever and as an aphrodisiac in the Unani and Ayurvedic systems of medicine.	Different parts	[29]
(ii)	Act as cardiac and circulatory stimulants, antipyretic, antiepileptic; possess antitumor, anti-inflammatory, antiulcer.	Leaves, roots, seed, bark, fruit, flowers and immature pods.	[28]
(iii)	Used for the treatment of respiratory, gastrointestinal, inflammatory, cardiac, nutritional and skin diseases.	Different parts	[32]
(iv)	Used for the treatment of asthma, epilepsy, eye and skin diseases, fever, headache, hemorrhoids, anti-helminths, kidney stones and arthritis.	Different parts	[33, 34, 35]
(v)	Used to treat arthritis, pain in joints, head, and stomach, and ears, act as a cardiac and circulatory stimulant, to treat colds, fever, kidney and liver problems.	Different parts	[36, 37]
(vi)	Used to treat asthma, common flu, cough, gastritis, headache, fever and itching.	Different parts	[38]
(vii)	Used for treatment of fever (typhoid, malaria), ear and eye infections, skin diseases, common cold, diarrhea, blood sugar and blood pressure.	Leaves, stems and roots	[42]
(viii)	Act as astringent, rubefacient and uses for treatment of dental caries, headaches, fever, dysentery, asthma, joints pain and intestinal pain due to constipation.	Gum	[45]
(ix)	Used for the treatment of diarrhea, liver and spleen problems and joint pain etc.	Pods	[53]
(x)	Act as hypo-cholesterolemic, anti-arthritis agents can cure urinary problems and cold.	Flowers	[53, 54]
(xi)	Used to combat diseases like paralysis, asthma, diabetes, blood pressure, diarrhea, fever, cough, cholera, ulcer, liver and spleen disorders, and for wound healing.	Leaves	[55, 56]

CONCLUSION

Moringa oleifera is considered as a nutrient-rich and good source of traditional folk medicine in curing and prevention of many diseases in human being and animals. Different parts mainly leave and immature pods might have to be used to combat malnutrition, especially among infants and nursing mothers as they are rich in well balanced diets, antioxidants and so many essential phytochemicals etc. Thus, due to have an impressive range of medicinal uses with multifarious uses in food nutrition Government in particular take initiative to increase the areas under cultivation of such trees in unutilized as well as other areas.

Now a day, various researches is ongoing to evaluate the traditional uses of this plant based on the research supported the traditional claims. Present review summarized several ethnomedicinal as well as pharmacological properties of *M. oleifera* along with their nutraceutical uses that can be investigated further to exploit multidimensional uses of *Moringa* species and to isolate bioactive compounds for novel herbal medicine with great nutritional and economical importance. Moreover, further researches are needed for optimum production of these crops, identification and isolation of phytochemicals for the diversified utilization of humankind and animals.

Recommendation and future prospects

Moronga oleifera Lam. is a 'miracle plant' as its different parts contains important phytochemicals uses as nutritional supplement and traditional folk medicines. These plants have high medicinal and therapeutic properties as well as have an enormous nutritional benefit that provides future development in the arena of medical, socioeconomic, agricultural, industrial, commercial (cosmetics and water purifier), nutraceutical and pharmacological etc. We invited all scientists, investors, farmers, businessmen and all other peoples to promote and manage this miracle plant production and productivity so that people can fight against the problems of malnutrition, diseases, unemployment etc that supports the entire economy of the world. By launching different government and non-government aided

programmes and providing training and other resources for the resource poor farmers and other rural people helps to reduce poverty, increase rural income by generating employment and self-sustainability as because *Moringa* plant have enormous opportunities in future. So, please push and encourage the people to cultivate and spread *Moringa olifera* as the plant of multidimensional use.

Conflict of Interest

The author has no conflicts of interest to report this review on *Moringa Oleifera*.

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