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A CRITICAL REVIEW OF MIRACLE TREE Moringa oleifera: PRESENCE OF NUTRITIONAL & BIO-ACTIVE COMPOUNDS

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ABSTRACT

Naturally occurring compounds are high in demand these days for their less side-effects with high disease curing capability. *Moringa oleifera* being a miracle tree which has a high source of essential minerals, amino acids, macro, and micronutrients. Along with these properties studies have revealed that moringa's antioxidant, anti-cancerous, anti-diabetic, malnutrition, anti-inflammatory, etc. can significantly affect the onset of chronic or acute disorders/diseases. Numerous phytochemicals like flavonoids, phenols, alkaloids, etc. have been identified in the extract of moringa's plant parts which having the capability to fight against diseases. A new polysaccharide (MOP-2) has been identified which can be used in foods to eradicate malnutrition in population. Herbal medicines play a major role in developing a suitable candidate for the discovery of new drugs hence, moringa have a very high impact on pharmaceutical industries in modern world. Numerous compounds extracted from different parts of the plant give different bioactive compounds like quercetin, kaempferol, apigenin, luteolin, caffeoxylquinic acids, feruloylquinic acids, β-carotene, luteoxanthin etc. are actively helps in fight against the diseases.

KEYWORDS: *Moringa*, *oleifera*, Herbal Medicine, Bioactive Compounds, Malnutrition.

INTRODUCTION

Moringa oleifera natively found in the region of Himalayan, India and Southeast Asia, Africa & Arabia and this plant usually Xeriscape, tall, deciduous tree that can grow up to the height of 40 feet in short span of time. This fastest growing tree having a whitish-gray colored bark with thick cork around it. The flowers are hermaphrodite in nature.

Commonly known as drumstick tree, this tree is resistant to most of the pests and usually not affected by any other significant diseases irrespective of the region it was introduced. Some insects like aphids, stem borers, termites, caterpillars of snout moth can cause mild damage to the leaves and bark of the tree.[1] The moringa trees are highly yieldable when they are grown in the region of semiarid, tropical, and subtropical areas having soil pH 5 to 9 with loamy, sandy, or sandy loam soil type.[2]

Drumstick tree scientifically known as moringa oleifera having the genus name derived from the Tamil word, murungai (pods which are wrapped) and the species name oleifera is emanate from the Latin words oleum (oil) and ferre (to bear). Different regions are called differently by drumstick tree, horseradish tree, or simply moringa.[3]

Moringa known as a super food is good for consumption by humans and animals, leaves of this plant are rich in proteins, minerals, β-carotene and antioxidant compounds are not only used in food consumptions of human and animals they are also commonly used in the traditional medicine.[4]

Usually, the leaves are produced during the dry season, and they are highly regarded as excellent sources of vitamins, iron, and other vital minerals. Among 13 different species of moringa, *Moringa oleifera* is highly cultivated and consumed by humans.[5]

It can be easily propagated through using the seeds or the stem cuttings of the plant and they sprouted well around the year. Moringa trees are highly rich in minerals and vitamins which are essential for normal body functions, as they contained high amount of vitamin C which helps in iron retention in the body as the vitamin C present in the leaves of Moringa is more than the vitamin C rich plant itself.[6]

This helps with oxidative stress. Moringa's leaves, seeds, bark and root having different properties, but they are rich in bio-active components, numerous studies around the decade shows that the plant contains a great quality of pharmacological properties like anti-cancer, anti-diabetic, anti-inflammatory and antioxidant, anti-diuretic, malnutrition, UTI, constipation, fluid retention/edema and diarrhea.[7]

Figure No. 1: Showing the Moringa Oleifera Tree, Frits, Flowers, And Seeds.

Moringa having a diverse range of bio-active compounds, and pharmacological properties, how its active compounds have adverse beneficial effect on human health and curing many disorders and diseases, this review aims to investigate and understand how moringa is beneficial for human health, and its possible role as a pharmacological agent.

Taxonomical classification of *Moringa oleifera*

Table No. 1: Source: United States Department of Agriculture.

Rank	Scientific Name and Common Name
Kingdom	Plantae- belongs to Plants kingdom
Sub-kingdom	Tracheobionta/Tracheophytes- Vascular plants
Super-division	Spermatophyte – Seed plants
Division	Magnoliophyte – Flowering plants
Class	Magnoliopsida – Dicotyledons
Sub-class	Dilleniidae
Order	Capparales
Family	Moringaceae martinov – Horse-radish tree family
Genus	**Moringa**
Species	***oleifera*** – **Moringa *oleifera*** Lam– Horseradish tree

As we reviewed before there are 13 known species of moringa in Moringaceae family, moringa being the sole genus in the family. The list is below in table No: - 2

Table no. 2: Lists of Different Species of Genus – Moringa.[8]

Binomial Nomenclature	Origin (Indigenous)
Moringa *arborea* Verdc.	Kenya
Moringa *borziana* Mattei	Somalia
Moringa *concanensis* Nimmo	India [North]
Moringa *drouhardii* Jum.	Madagascar [Southwestern]
Moringa *hildebrandtii* Engl.	Madagascar [Southwestern]
Moringa *longituba* Engl.	Ethiopia and Somalia
Moringa *oleifera* Lam	India [Northwestern]
Moringa *ovalifolia* Dinter & Berger	Namibia and Angola
Moringa *peregrina* Fiori.	Arabian Peninsula and Southern Sinai, Egypt
Moringa *pygmaea* Verdc.	Somalia
Moringa *rivae* Chiov.	Kenya and Ethiopia
Moringa *ruspoliana* Engl.	Ethiopia
Moringa *stenopetala* Cufod.	Kenya and Ethiopia

Nutritional, Bio-active and Chemical composition of moringa oleifera and its effect on human health

Moringa bio-active compounds are rigorously studied for their effects on human health and how it interacts with the physiology of the human body and associated health conditions. Phytochemicals which are present in the different parts of the plants are the secondary aromatic metabolites which are widely used in preventing diseases.

Most of the phytochemicals which are present in the plants are extensively studied for their natural effects on chronic diseases like cancer, cardiovascular, neurological etc. as we know phytochemicals like carotenoids, phenolic acids, flavonoids, tannins, saponins, alkaloids, and glucosinolates are studied for their favorable effects on human health conditions.[9]

Specifically, Moringa leaves seeds fruits are used for medicinal values and they are manufactured and sold in India and abroad for their pharmaceutical benefits.[10] High beneficial effects of moringa and its diverse effects on health conditions gave the name **"Miracle Tree or Tree of Life".**[11] Recent studies have shown that the moringa leaves extract having all most all the nutrition required for the normal body functions.

Nutritional benefits of M. *oleifera*

The plant is considered as miracle tree due to its abundance nutritive properties as it contains various components likes proteins, carbohydrate, minerals, vitamins etc. having nearly 10-30% of crude proteins, 13-63% of carbohydrates, 6-20% of fat, 7-35% of crude fiber, and 7-10% of mineral matters in leaves per 100 grams of dry weight of plant material.[12,13]

The nutritive properties of moringa solely depend on the land in which its being cultivated and the environment around it.[14]

Some studies have promisingly shown that 100 grams fresh moringa leaves contain nearly 17% of required protein for the day by the body.

A new polysaccharide has been isolated from the leaves of moringa named MOP-2 (the multidrug/oligosaccharidyl-lipid/polysaccharide) through hot water extraction and chromatographic technique used for its purification, this newly isolated polysaccharide might be used as immunoregulatory agent in many functional foods[15], some of the nutritional value tabled below. referred from.[12,13]

Table No. 3: Nutritional value of Moringa *oleifera* leaves per 100g of plant material.

Nutrients	Fresh Leaves	Dried Leaves	Leaf Powder
Calories (cal)	92	329	205
Crude protein (g)	6.7	29.4	27.1
Fat (g)	1.7	5.2	2.3
Carbohydrate (g)	12.5	41.2	38.2
Fiber (g)	0.9	12.5	19.2
Calcium (mg)	440	2185	2003
Potassium (mg)	259	1236	1324
Iron (mg)	0.85	25.6	28.2
Magnesium (mg)	42	448	368
Phosphorus (mg)	70	252	204
Copper (mg)	0.07	0.49	0.57
Vitamin A (mg)	1.28	3.63	16.3
Vitamin B_1 (mg)	0.06	2.02	2.64
Vitamin B_2 (mg)	0.05	21.3	20.5
Vitamin B_3 (mg)	0.8	7.6	8.2
Vitamin C (mg)	220	15.8	17.3
Vitamin E (mg)	448	10.8	113
Chlorophyll (mg)	80	45	1268
Arginine (g/16 gN)	6%	1.78%	1.33%
Histidine (g/16 gN)	2.1%	0.716%	0.61%
Lysine (g/16 gN)	4.3%	1.637%	1.32%
Tryptophan (g/16 gN)	1.9%	0.486%	0.43%
Phenylalanine (g/16 gN)	6.4%	1.64%	1.39%
Methionine (g/16 gN)	2%	0.297%	0.35%
Threonine (g/16 gN)	4.9%	1.357%	1.19%
Leucine (g/16 gN)	9.3%	1.96%	1.95%
Isoleucine (g/16 gN)	6.3%	1.177%	0.83%
Valine (g/16 gN)	7.1%	1.413%	1.06%

With α-linolenic acid being the most important unsaturated fatty acid, contained 57% and 43% of saturated and unsaturated fatty acid respectively. Studies confirmed that it also contained 16-19 amino acids among them 10 are essential amino acids they are: - lysine, leucine, isoleucine, histidine, phenylalanine, methionine, tryptophan, threonine, tyrosine, and valine.[16]

Compared to other naturally or synthetically available compounds to lower the obesity, moringa leaves also shown low calorific value which can be used to treat obese conditions and various minerals like iron, zinc, magnesium, copper etc. have been found in the leaves, seeds of the moringa plant, contains high amount of iron which can eradicate anemia.[17]

Bio-active compounds present in Moringa

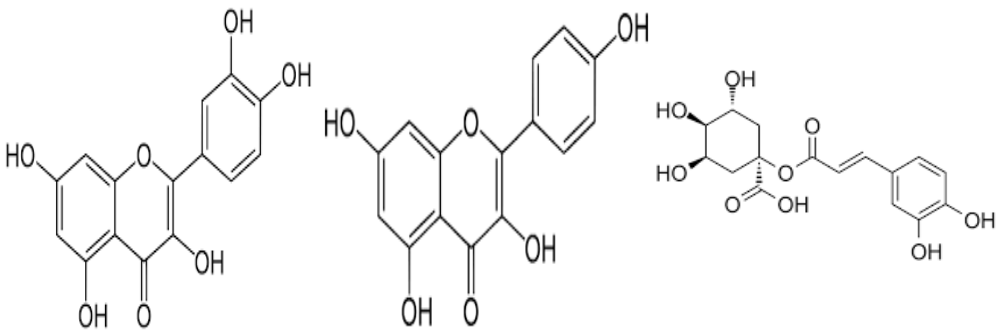
Moringa oleifera contains numerous bioactive compounds such as alkaloids, trepans, phenolic acids, flavonoids, saponins, tannins, catechol tannins, anthraquinones. Usually, phenolic compounds are bound by one or more hydroxy group bonded to the aromatic ring and it is occurred in plant as ester or glycosides bonds are present in nature which are mostly derivatives of hydroxycinnamic acid (free-phenolics) and hydroxybenzoic acid (bound-phenolics).[18]

Several studies show numerous phenolic compounds are present in moringa plants. The major phenolic compound found in moringa leaves is.[19]

Table No. 4: Active phenolic compounds present in the Moringa.

Lignans	26 Flavonoids	11 Phenolic Acids and Their Derivatives
Medioresinol	Quercetin	Caffeoylquinic
Isolariciresinol	Kaempferol	Feruloylquinic
Secoisolariciresinol	Apigenin	Coumaroylquinic Acids and Their Isomers
Epipinoresinol Glycosides	Luteolin, Myricetin	

Most common flavonoids present in the moringa oleifera plants are listed below in figure.



Quercetin Kaempferol 1-Caffeoylquinic acid

Figure No. 2 flavonoids present in the moringa plant.[29,30]

Compared to spinach and other plants a higher number of flavonoids and its derivatives were found in moringa.[20] Along with the presence of phenolic compounds moringa is also a rich source of carotenoids which is a photosynthetic pigment, they are antioxidant in nature which protects from ageing, cellular damage, and other chronic disorders.

M.O leaves contain rich carotenoids ranging from 44-80mg/100g fresh weight. Major alkaloids, Glucosinolates and Iso-Thiocyanates present in the moringa oleifera which helps in extensively for treating various health conditions. The notable glucosinolates present in the M.O leaves are 4-O-(a-L-rhamnopyranosyloxy)-benzylglucosinolate (glucomoringin).

The 7 different carotenoids, alkaloids, present in M. O leaves are.[21,22]

Table No. 5. Carotenoids and Alkaloids Present in M. *oleifera*.

Carotenoids	Alkaloids
luteoxanthin	α-L-rhamnopyranosyl vincosamide
15-Z-β-carotene	phenylacetonitrilepyrrolemarumine
13-Z-lutein	40-hydroxyphenylethanamide-α-L-rhamnopyranoside
β-carotene	glucopyranosyl derivative
all-E-β-carotene	
all-E lutein	
all-E zeaxanthin	

Other major bioactive components include minerals, vitamins, folates, tannins, saponins, and fatty acids. And some water-soluble vitamins, folate are also present which helps in cell metabolisms.[23] Main folates present in the moringa oleifera are 5-Formyl-5,6,7,8-tetrahydrofolic acid, 5,6,7,8-tetrahydrofolic acid, 5-Methyl-5,6,7,8-tetrahydrofolic acid, and 10-Formylfolic acid.[21]

Bioactive components and Peptide and protein profile of moringa oleifera plant are studied for their anticancer, antibacterial, antioxidant, hepatoprotective, and antidiabetic.

Whereas researchers reported 7 essential and 10 nonessential amino acids, with 22.7g/100g protein of glutamic acid being the highest followed by arginine 15.78g/100g protein.[24,25] After the extraction of moringa seed oil a by-product seed cake is obtained which is highly studied for its chemical composition where Ca and K and 24 bioactive compounds are found in the residue of the seed cake of moringa oleic acid, 3-Hydroxy-2-p-tolyl-2-butenenitril, erucic acid, and eicosanoic acid.

This by-product obtained from the seed cake is rich in minerals like magnesium, phosphorus, nitrogen copper, calcium, manganese, nickel, zinc, and iron are used to increase the fertility

of the soil with 60% of protein found in it.[26,27] The chemical structure of some bio-active compounds present in moringa oleifera are lister below figure 3.

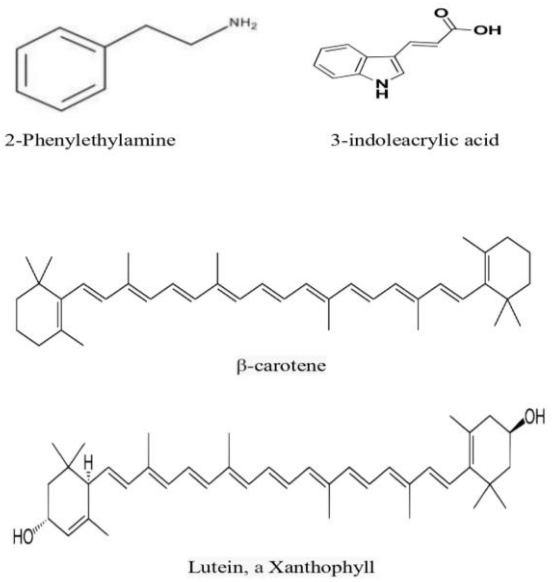


Figure No. 3: chemical structure of some of the bioactive compounds present in the moringa oleifera leaves.[28]

As we already discussed the lifesaving benefits of moringa plant, which is high in all the essential nutrients for the human body with lowering cholesterol level, helps in preventing anemia, antioxidant stress, anti-cancerous etc. the main focus of this paper is to understand the importance of moringa in day-to-day life with the presence of numerous Phyto-chemicals like alkaloids, flavonoids, phenolic compounds etc. have been actively proven in helping human and diseases associated with them and how beneficial is it in terms of nutritional or possible agent for pharmaceutical purpose.

DISCUSSION AND CONCLUSION

Moringa oleifera plant as we already known as miracle plant which helps human in various ways, by providing all the necessary minerals, vitamins, and Phyto-chemicals which reduce the oxidative stress, anti-cancerous, anti-diabetic, anti-anemia etc. this has been known as good source of micro-nutrients which help in fighting against malnutrition in children, recent studies shows that consuming moringa as fresh or as powdered form daily as a dietary supplement given promising results in overall human health condition by increasing iron content in the blood and helps fight against various ailments like cancer, diabetes,

hypertension etc. extraction of moringa leaves using different solvents showed rich source of natural anti-oxidants like Quercetin, kaempferol, ascorbic acid, β-carotene, isothiocyanates, polyphenols, and rutin helps in protecting against cellular damage.[31] Some researchers analyzed the antioxidant activity by DPPH scavenging assay where moringa shows higher percentage of inhibition of DPPH radicals compared to other antioxidant agents.[32] Some studies on rats which are induced with aluminum phosphide (AlP)-cardiotoxicity by reducing malondialdehyde (MDA) shows increased rate of antioxidant molecules in them.[33] The extracted moringa oleifera leaves are also tested for their antimicrobial activity against *Helicobacter pylori Escherichia coli*, *Staphylococcus aureus*, *Proteus vulgaris*, *Salmonella typhi*, *Klebsiella pneumonia*, Micrococcus Kristina, *Pseudomonas aeruginosa*, *Bacillus subtilus.*[34,35,36,37] Some studies show potential anti-cancerous activity of moringa leaves containing high number of flavonoids which act as anti-proliferating agent in human cancer cell lines.[38] This short review focused on moringa oliefera plants beneficial aspects and its other pathophysiological contribution to the world of science.

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