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Review Article

A Review of Moringa oleifera on Physical and Mental Health Effects for Its Nutritional and Therapeutic Potential

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Abstract :

Moringa oleifera Lam (Moringaceae) is a highly valued plant, distributed in many countries of the tropics and subtropics. It has an impressive range of medicinal uses with high nutritional value. Different parts of this plant contain a profile of important minerals, and are a good source of protein, vitamins, β-carotene, amino acids and various phenolics. The Moringa plant provides a rich and rare combination of zeatin, quercetin, β-sitosterol, caffeoylquinic acid and kaempferol. In addition to its compelling water purifying powers and high nutritional value, M. oleifera is very important for its medicinal value. 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, antiinflammatory, 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. In addition to this, it helps to improve mood maintaing sound health due to its constituent tryptophan–an amino acid. This review focuses on the detailed phytochemical composition, medicinal uses, along with pharmacological properties of different parts of this multipurpose tree.

Introduction:

Moringa oleifera is the most widely cultivated species of a monogeneric family, the *Moringaceae,* that is native to the sub-Himalayan tracts of India, Pakistan, Bangladesh and Afghanistan. All parts of the *Moringa* tree are edible and have long been consumed by humans. There fore this tree is cultivated for foods and medicinal purposes[1].According to Fuglie[2] 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),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. In the West, one of the best known uses for *Moringa* is the use of powdered seeds to flocculate contaminants and purify drinking water [3,4,5], but the seeds are also eaten green, roasted, powdered and steeped for tea or used in curries [4]. *Moringa* leaves are known to have a high content of protein,minerals and vitamin,hence an ideal nutritional supplement[6].*Moringa* leaves have been used to combat malnutrition,especially among infants and nursing mothers and hasten uterine contraction during child birth in pregnant women.The leaves and pods are helpful in increasing breast milk in nursing mothers during breastfeeding and leaf dedoction has been found useful in the treatment of asthma,back pain and rheumatism.This tree has in recent times been advocated as an outstanding indigenous source of highly digestible protein, Ca, Fe, Vitamin C, suitable for utilization in many of the so called developing regions of the world where undernourishment is a major

concern[6]. In some parts of the world for example Senegal and Haiti, healh workers have been treating malnutrition in small children,pregnant and nursing women with *Moringa* leaves powder.

So far no comprehensive review has been compiled from the literature encompassing the efficacy of this plant in all dimensions.Its versatile utility as a medicine,functional food,nutrititive and water purifying potential motivated to bridge the information gap in this area,and to write a comprehensive review on the medicinal and nutritional attributes of this plant of high economic value.

Nutrition:

Moringa trees have been used to combat malnutrition, Leaves can be eaten fresh, cooked, or stored as dried powder for many months without refrigeration, and reportedly without loss of nutritional value. *Moringa* is especially promising as a food source in the tropics because the tree is in full leaf at the end of the dry season when other foods are typically scarce.

A large number of reports on the nutritional qualities of *Moringa* now exist in both the scientific and the popular literature. It has been reported that "ounce-for-ounce, *Moringa* leaves contain more Vitamin A[7]than carrots, more calcium than milk, more iron than spinach, more Vitamin C than oranges, and more potassium than bananas, [8]"and that the protein quality of *Moringa* leaves rivals that of milk and eggs. In fact, the nutritional properties of *Moringa* are now so well known that there seems to be little doubt of the substantial health benefit to be realized by consumption of *Moringa* leaf powder in situations where starvation is imminent. Nonetheless, the outcomes of well controlled and well documented clinical studies are still clearly of great value.

In many cultures throughout the tropics, differentiation between food and medicinal uses of plants (e.g. bark, fruit, leaves, nuts, seeds, tubers, roots, flowers), is very difficult since plant uses span both categories and this is deeply ingrained in the traditions and the fabric of the community [9]. Thus, **Table 1,2,3** in this review captures both nutritional and medicinal references as they relate to *Moringa.*

Table 1. Nutrients analysis of *Moringa oleifera* leaves[10]

Table2. Mineral composition of *Moringa oleifera* leaves[10]

Minerals	% composition
Sodium	11.86
Potassium	25.83
Calcium	98.67
Magnesium	107.56
Zinc	148.58
Iron	103.75
Lead	2.96

Table 3. Some common medicinal use of different parts of Moringa oleifera

Plant	Medicinal uses
Root	act as a cardiac tonic,as axative, bortifacient, heumatism, tricular pain,antifertility,anti-inflammatory[11,12,13]
leaves	purgative, used for piles,fever,sore throat, ronchitis, eye and ear infection leave juice is believed to control glucose level[14,15]
Stembark	rubifacient, vesicant and used to cure eye disease, has antitubercular activity, prevent enlargement of spleen [16,17].
Gum	used for dental caries,gum mixed with seasame oil is used to relieve headache, fever, dysentery, asthma, used as abortifacient and to treat syphilis and rheumatism[7].
Flower	high medicinal value as a stimulant, abortifacient, used to cure inflammation,muscle disease, hysteria,tumours, lower the serum cholesterol, phospholipid, triglyceride, VLDL,LDL [17,18,19].
Seed	seed extract exert its protective effect by decreasing liver lipid peroxides, antihypertensive compounds thiocarbamate and isothiocyanate glycosides have been isolated from the extract of *Moringa* pods [20,21] reduction of Schistosome cercariae titre[22]

In addition to these vitamins and minerals, one of the most significant benefits of *Moringa oleifera* is the ability of this plant to provide protein including 19 of the 20 prominent protein amino acids(Table 4).The roles that amino acids play in the fundamental processs of tissue formation,regeneration and function are so distinctive that this class of substances is considered to be the primary component of all living matter.The nutritional value of proteins in our diet involves understanding something about both the quality and quantity of proteins consumed.Humans do not have the ability to synthesize all of the amino acids required for normal,good health.Those that must be supplied in our diets are called essential amino acids.*Moringa oleifera* contains all of the eight amino acids considered essential (Table 4).Although proteins found in meat,eggs and milk are considered to have the best nutritional value, such foods are those which should be limited due to their negative effect on serum cholesterol.Moreover, persons who either cannot or who

Nutrients	% composition
Carbohydrate	45.43
Protein	16.15
Fat	6.35
Fibre	9.68
Moisture	11.76
Ash	10.64

choose not to consume these foods (lactose intolerance) may run the risk of developing protein deficiency.Daily stress and pregnancy cause a deficiency of amino acids, and greater consumption of protein is required for these conditions for optimal health.

Table 4. Prominent amino acids contained in *Moringa oleifera* leaves [23] For such individuals *Moringa oleifera* is an important source of these vital nutrient.

Amino acid	Essential	*Moringa oleifera*
Glycine		√
Alanine		√
Serine		√
Threonine	√	√
Valine	√	√
Leucine	√	√
Isolucine	√	√
Cysteine		√
Cystine		√
Methionine	√	√
Phenylalanine	√	√
Tyrosine		√
Proline		√
Hydroxyproline		
Tryptophan	√	√
Aspartic acid		√
Glutamic acid		√
Histidine		√
Lysine	√	√
Arginine		√

Phytochemistry:

Phytochemicals are, in the strictest sense of the word, chemicals produced by plants. Commonly, though, the word refers to only those chemicals which may have an impact on health, or on flavor, texture, smell, or color of the plants, but are not required by humans as essential nutrients. An examination of the phytochemicals of *Moringa* species affords the opportunity to examine a range of fairly unique compounds. In particular, this plant family is rich in compounds containing the simple sugar, rhamnose, and it is rich in a fairly unique group of compounds called glucosinolates and isothiocyanates[24,25]. For example, specific components of *Moringa* preparations that have been reported to have hypotensive, anticancer, and antibacterial activity include4-(4'-*O*-acetyl-α-L-rhamnopyranosyloxy) benzylisothiocy-anate, 4-(α-L-rhamnopyranosyloxy) benzyl isothiocyanate, niazimicin, pterygospermin, benzylisothiocyanate and 4-(α-L-rhamnopyranosyloxy) benzyl glucosinolate. While these compounds are relatively unique to the *Moringa* family, it is also rich in a number of vitamins and minerals as well as other more commonly recognized phytochemicals such as the carotenoids (including β-carotene or pro-vitamin A). These attributes are all discussed extensively by Lowell Fuglie[8] and others.

Disease Treatment and Prevention :

The benefits for the treatment or prevention of disease or infection that may accrue from either dietary or topical administration of *Moringa* preparations (e.g. extracts, decoctions, poultices, creams, oils, emollients, salves, powders, porridges) are not quite so well known[26].

Moringa preparations have been cited in the scientific literature as having antibiotic, antitrypanosomal, hypotensive, antispasmodic, antiulcer, anti-inflammatory, hypo-cholesterolemic, and hypoglycemic activities, as well as having considerable efficacy in water purification by flocculation, sedimentation, antibiosis and even reduction of Schistosome cercariae titer (Table 1).

In many cases, published *in-vitro* (cultured cells) and *in-vivo* (animal) trials do provide a degree of mechanistic support for some of the claims that have sprung from the traditional folk medicine. For example, numerous studies now point to the elevation of a variety of detoxication and antioxidant enzymes and biomarkers as a result of treatment with *Moringa* or with phytochemicals isolated from *Moringa*[27,28,29,30].

Antibacterial and antifungal activity :

Moringa roots have antibacterial activity.These are reported to contain an active antibiotic principle,Pterygospermin, which has powerful antibacterial and fungicidal effects.It is also reported that the aglycone of deoxy-nizamicine isolated from the chloroform fraction of an ethanol extract of the root bark was found to be responsible for the antibacterial and antifungal activities[31].*Moringa oleifera* leaves extract showed appreciable antibacterial activity against *S.aureus, E.coli, Pseudomonus fluorescens, Streptococcus* sp. indicating its high antibacterial potential and effctiveness in the treatment of wound infections[10].Crude extract and essential oil of *Moringa oleifera* have antifungal effect on *dermatophytes Trichophyton sp.,Epidermophyton ,Microsporum canis* [32] Aware of the reported antibiotic activity of cognate isothiocyanate,Benzyl isothiocyanate and other isothiocyanates and plants containing them, have undertaken to determine whether some of them were also active against *Helicobacter pylori*.It is a major cause of

gastritis, and of gastric and duodenal ulcers, and it is a major risk factor for gastric cancer (having been classified as a carcinogen by the W.H.O. in 1993). Cultures of *H. pylori*, it turned out, were extraordinarily susceptible to cognate isothiocyanate , and to a number of other isothiocyanates[33,34].

Cancer Prevention:

Since *Moringa* species have long been recognized by folk medicine practitioners as having value in tumor therapy[35], the compounds4-(4'-*O*-acetyl-α-L-rhamnopyranosyloxy)benzylisothiocy-anate and 4-(α-L-rhamnopyranosyloxy)benzyl isothiocyanate are attribute for their cancer preventive potential[27]. In an even more recent study, Bharali and colleagues have examined skin tumor prevention following ingestion of drumstick (*Moringa* seedpod) extracts[36]. In this mouse model, which included appropriate positive and negative controls, a dramatic reduction in skin papillomas was demonstrated.

Modern practitioners have used crude extracts and isolated bioactive compounds.The proof required by modern medicine has not been realized because neither the prevention of cancer nor the modification of relevant biomarkers of the protected state has been adequately demonstrated in human subjects. More vivid study is required in order to achieve a level of proof required for full biomedical endorsement of *Moringa* as, in this case, a cancer preventative plant.

Antihypertensive,diuretic and cholesterol lowering activities:

Nitrile,mustard oil glycosides and thiocarbamate glycosides have been isolated from *Moringa* leaves,which were found to be responsible for the blood pressure lowering effect[28].*Moringa* roots,leaves,flowers,gum and the aqueous infusion of seeds have been found to possess diuretic activity[14,37].The crude extract of *Moringa* leaves has a significant cholesterol lowering action in serum of high fat diet fed rats which might be attributed to the presence of a bioactive phytoconstituent,ie. β-sitosterol.[38].

Antispasmodic,antiulcer and hepatoprotective activities:

It has been found that the ethanol extract of *Moringa oleifera* and its constituents exhibit antispasmodic effect possibly through calcium channel blockade[39,40]. The antispasmodic activity has been attributed to the presence of 4-(α-L-rhamnopyranosyloxy)benzyl o-methyl thiocarbamate which forms the basis for its traditional use in diarrhea[40].

The methanol fraction of *Moringa oleifera* leaf extract showed antiulcerogenic and hepatoprotective effects in rats[41]. Aqueous leaf extracts also showed antiulcer effect[41].Hepatoprotective effect may be due to the presence of quercetin,a well known flavonoid [13,42].

Hypoglycaemic and other diverse activities:

Moringa oleifera leaf acts as a good source of antioxidants such as flavonoids,phenolics, ascorbic acid. So supplementation of antioxidants may be a protective factor against free radical induced β cell damage[43]. On the other hand , flavonoids inhibit cAMP phosphodiesterase and cAMP is a modulator of insulin secretion[44].

Leaf extract regulate thyroid hormone and can be used to treat hyperthyroidism and exhibit an antioxidant effect[41].A recent report showed that *Moringa oleifera* leaf may be applicable as a prophylactic or therapeutic anti- HSV (Herpes simplex virus type 1) medicine and may be effective against acyclovir resistant variant[45]. The flowers and leaves also are considered to be of high medicinal value with antihelminthic activity[18].

Moringa oleifera and mental clarity:

Moringa oleifera – a natural supplement helps to relieve stress and improve mood, making healthier.The secret is in the tryptophan[23] it contains, an amino acid which is required for serotonin and niacin production.It is well established that decreased amine concentration specially serotonin in limbic system is responsible for depression.Antidepressant drugs act by increasing amine concentration in brain[46]. The combination of the tryptophan, calcium and protein in *Moringa oleifera* makes it a virtual powerhouse of happiness.

The level of mental clarity depends on two minerals: iron and zinc. The iron is responsible for the amount of oxygen that brain receives, while the zinc controls the amount of activity between the right and left hemispheres of brain. *Moringa oleifera* supplements contain both of these, and in astonishing amounts.

Anti-aging effect of *Moringa oleifera* :

The less cell regeneration and less production of collagen and elastin turn one older which are the two most important elements of firm skin. The anti-oxidants in *Moringa oleifera* stop free radicals in their tracks, while the numerous proteins accelerate the regrowth of new cells.The antioxidant activity of various extracts of *Moringa oleifera* leaf has been repoted by several authors[47,48].Additionally, the vitamin A it contains assists in the production of collagen and elastin, helping firm skin and rid it of unsightly wrinkles.

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.It protect the human skin from environmental influences and combats premature skin aging.With dual activity,antipollution and conditioning/strengthing of hair, the *Moringa oleifera* seed extract is a globally acceptable innovative solution for hair care[49].

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 part of *Moringa oleifera* also incorporated in various marketed healthy formulations,such as Rumalaya and Septilin (Bangalore, India) Orthoherb (Mumbai,India), *Moringa* plant -capsule,

powder,tea,extract etc. are marketed by Hauswachter (Berlin), Silent Disco (Germany).

Since this plant naturally occurs in varying habitats, there is a great magnitude of variation in the concentration and composition of chemical ingredients in different parts of the tree. Thus detailed studies are required to evaluate the extent to which the chemical composition varies in populations adapted to varying habitats. In view of its multiple uses, the *Moringa oleifera* plant needs to be widely cultivated in most of the areas where climatic conditions favor 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.

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