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Moringa Oleifera: A Health Promising Plant with Pharmacological Characters

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ABSTRACT: *Moringa oleifera* Lam. is a fast growing tree, native to the sub-Himalayan tracts of India, Pakistan, Bangladesh and Afghanistan where it is used in folk medicine, which is at the moment distributed all over the world. It is a multipurpose tree, used as vegetables, spice, and source of cooking and cosmetic oil and as a medicinal plant. It is reported to contain alkaloids, flavonoids, anthocyanin, proanthocynidins, cinnamates. A number of phytochemicals act on animal cells and tissues to inhibit membrane bound enzymes, affects DNA formation, destroy cell membranes. Many of them are strong antioxidants, effective antimicrobials, possess substantial anticarcinogenic and anti-mutagenic properties.

An overview of pharmacological actions and its effects on health are given in the present paper.

INTRODUCTION

The Moringaceae family consists of 10 (Somali et al. 1984) or 12 (Morton, 1991) species that belong to only one genus called *Moringa*. All *Moringa* species are native to India, from where they have been introduced into many warm countries (Sengupta and Gupta, 1970). Morton (1991) reported that the most common species are *Moringa oleifera* (syn. *M. pterygosperma* Gaertn.), *Moringa peregrina* (forsk) *fiori* (syn. *M. aptera* Gaertn.; *M. arabica* (Lam.) Pers., *Moringa zeylanica* Sieb.; *Balanus myrepsica* Blackm), *Moringa stenopetala* Cufod, *Moringa borziana* Mattei, *Moringa longituba* Engl., *Moringa concanensis* Nimmo, *Moringa ovalifolia* Dinter & A. Berger, and *Moringa drouhardii*. Bianchini et al. (1981) also reported *Moringa hildebrantii*.

Distribution

The best known and most widely distributed species is *Moringa oleifera* (syn. *M. pterygosperma* Gaertn.) (Morton, 1991; Sengupta and Gupta, 1970), which is a native of the western (Kantharajah and Dodd, 1991) and sub-Himalayan tracts (Sengupta and Gupta, 1970) of India and other countries of Asia (Morton, 1991; Kantharajah and Dodd, 1991; Sengupta and Gupta, 1970), Africa (Bianchini et al. 1981; Morton, 1991), the Middle East (Kantharajah and Dodd, 1991), The Philippines, Cambodia, Central America, northern South America, and the Caribbean islands (Morton, 1991).

The tree ranges in height from 5 to 10 m and sometimes even 15 m (Morton, 1991). Sengupta et al. 1970; Morton ,1991) reported that the tree grows rapidly even in poor soil and is little affected by drought. The leaves, flowers, fruits (which are called “pods”), and roots of the tree are used as

vegetables (Kantharajah and Dodd, 1991; Morton, 1991; Ramachadran et al. 1980; Sengupta and Gupta, 1970), and the trunk is used in the paper industry (Kantharajah and Dodd, 1991; Verma et al. 1976). The fruits are usually 25-45 cm long, although Ramachadran et al. (1980) reported fruits up to 120 cm in length. Fruits contain _20 seeds (Sengupta and Gupta, 1970), which are globular, _1 cm in diameter, and three-winged, with wings produced at the base of the apex, 2-2.5 cm long, 0.4-0.7 cm wide, and scarious (Ramachadran et al. 1980). Sengupta and Gupta (1970) reported that the seeds are three-angled and on average weigh _0.3 g, with the kernel responsible for 70-75% of the weight. Ibrahim et al. (1974) reported that the oil content and its properties show a wide variation depending mainly on the species and the environmental conditions.

History

Although the name "Shigon" for *M. oleifera* is mentioned in the "Shushruta Sanhita" which was written in the beginning of the first century A.D., there is evidence that the cultivation of this tree in India dates back many thousands of years. The Indians knew that the seeds contain edible oil and they used them for medicinal purposes. It is probable that the common people also knew of its value as a fodder or vegetable. This tree can be found growing naturally at elevations of up to 1,000 m above sea level. It can grow well on hillsides but is more frequently found growing on pastureland or in river basins.

About two decades ago, in the southern states of India, and especially in Tamilnadu, *M. oleifera* was cultivated as single trees in homesteads, round cattle sheds, on farm boundaries, and as isolated plants in fences and as groups of trees on village waste lands. In the early 1990s in southern Tamilnadu people started growing perennial types - Moolanoor as an intercrop on field scale and their allies were cropped with vegetablesand Sorghum. This system evolved as *Moringa* offered some protection to alley cropsfrom drying winds during summer and *Moringa* provided some additional income.

With the migration of people from south to north India, the demand for *Moringa* products increased. However attempts to grow this crop in North India were not very successful due to wide variations in temperature. In all the places concerned, with their differing conditions, cultivation of *M. oleifera* was not given the required attention and systematic production practices were not followed as people failed to notice that it was a commercially viable alternate crop in Arid Zone Horticulture. The taboo that ghosts dwell in *Moringa* trees and the fact that it was inauspicious to have the first vision of the tree when day dawns were further reasons for this situation. In spite of this, the leaves and fruits were sought after and utilised by rich and poor alike.

These perennial ecotypes cultivated had some undesirable features such as large trunks (1-2 mts.); they grew very tall (5-6 mts), and were always seen oozing gum, often with swarms of hairy caterpillars. These hairy caterpillars undergo metamorphosis intopupa during which they shed their hairs which are dispersed by wind causing itching in human beings. People saw that hairy caterpillar and *M. oleifera* were inseparable and this was the reason for growing the tree as a backyard crop or in remote parts of farms (Anbarassan et al. 2001).

The demand for the pod of *M. oleifera* also increased due to increased urban settlements and migration of people to urban colonies. With taste and flavour as deep seated customs, ethnic Indians settled elsewhere in the world, predominantly in the Far East and Gulf countries, and longed for *Moringa* products in their diet. All these simultaneous developments led to the focus on commercial cultivation of *M. oleifera* and organised market networking (Anbarassan et al. 2001).With the demand for bulk quantities of Moringa products, farmers started increasing the number of trees by taking branch cuttings of perennial types in the late 1980s.

Scientific classification (*Moringa oleifera*)

Kingdom : Plantae
Division : Magnoliopsida
Class : Mangnoliopsida
Order : Violes
Family : Moringaceae
Genus : Moringa
Species : *Oleifera*

Morphology

Appearance: The fruits are pendulous, linear, three-sided pods with nine longitudinal ridges, usually 20 to 50 cm long, but occasionally up to 1 m or longer, and 2.0 to 2.5 cm broad.

The pods, each usually containing up to 26 seeds. Seeds measure about 1 cm in diameter, with three whitish papery wings on the angles. Seed weights differ among varieties,

ranging from 3,000 to 9,000 seeds per kilogram (Negi, 1977).

Colour: Yellowish white flowers, dark green pods, dark brown seeds

Odour: Aroma reminiscent of roasted nuts

Taste: Bitter taste

***Moringa* nutrition fact**

1. 92 Nutrients
2. 46 Antioxidants
3. 36 Anti-Inflammatories
4. 18 Amino Acids, 9 Essential Amino Acids
5. Nourishes The Immune System
6. Promotes Healthy Circulation
7. Supports Normal Glucose Levels
8. Natural Anti-Aging Benefits
9. Provides Anti-Inflammatory Support
10. Promotes Healthy Digestion
11. Promotes Heightened Mental Clarity
12. Boosts Energy Without Caffeine
13. Promotes Softer Skin
14. Encourages Balanced Metabolism
15. Provides Relief From Acne
16. Supports Normal Hormone Levels

Rare for a plant source - *Moringa* leaves contain all the essential amino acids to build strong healthy bodies.

Examples of some few nutritional value of *Moringa*- (Gram-for-gram comparison of nutritional data).

1. 2times – the Protein of Yogurt
2. 3times – the Potassium of Bananas
3. 4times – the Calcium of Milk
4. 4times – the Vitamin A of Carrots
5. 7times – the Vitamin C of Oranges

Mineral contents of *Moringa* leaves in India (Becker and Makkar, unpublished)

Macro elements (g kg^{-1} DM)

1. Calcium – 26.4
2. Phosphorus – 1.36
3. Magnesium – 0.11
4. Sodium – 2.73
5. Potassium – 21.7

Micro-elements (mg kg^{-1} DM)

1. Iron – 175
2. Magense – 51.8
3. Zinc – 13.7
4. Copper – 7.1

Health benifits of *M. oleifera*

1. *Moringa* plant possesses unique nutritional qualities that hold promise to millions of impoverished communities around the world those lack in many nutritional supplements such as protein, minerals, and vitamins. Moringa has Vitamin A (Beta Carotene), Vitamin B1 (Thiamine), Vitamin B2 (Riboflavin), Vitamin B3 (Niacin), Vitamin B6 Pyrodixine), Vitamin B7 (Biotin), Vitamin C (Ascorbic Acid), Vitamin D (Cholecalciferol), Vitamin E (Tocopherol) and Vitamin K.

2. Leaves are an excellent source of protein that can be rarely found in any other herbs and green leafy vegetables. 100 g of fresh raw leaves provide 9.8 g of protein or about 17.5% of daily-required levels. Dry, powdered leaves indeed are a much-concentrated source of many quality amino acids.
3. Fresh pods and seeds are a good source of oleic acid, a health-benefiting monounsaturated fat. *Moringa* as high-quality oilseed crop can be grown alternatively to improve nutrition levels of populations in many drought-prone regions of Africa and Asia.
4. Fresh leaves and growing tips of *Moringa* are the richest source of vitamin A. 100 g of fresh leaves 7564 IU or 252% of daily-required levels. Vitamin A is one of the fat-soluble anti-oxidant offering several benefits, including mucus membrane repair, maintenance of skin integrity, vision, and immunity.
5. Fresh *Moringa* pods and leaves are excellent sources of vitamin-C. 100 g of pods contain 145 µg or 235% of daily-required levels of vitamin C. 100 g of greens provide 51.7 µg or 86% of daily-recommended intake values of this vitamin. Research studies have shown that consumption of fruits/vegetables rich in vitamin C helps the body develop immunity against infectious agents, and scavenge harmful oxygen-free radicals from the body.
6. The greens as well as pods also contain good amounts of many vital B-complex vitamins such as folates, vitamin-B6 (pyridoxine), thiamin (vitamin B-1), riboflavin, pantothenic acid, and niacin. Much of these vitamin functions as co-enzymes in carbohydrate, protein, and fat metabolism.
7. Furthermore, its leaves are one of the fine sources of minerals like calcium, iron, copper, manganese, zinc, selenium, and magnesium. Iron alleviates anemia. Calcium is required for bone strengthening. Zinc plays a vital role in hair-growth, spermatogenesis, and skin health.

PHARMACOLOGICAL USES

Antibacterial and Antifungal Activity

A considerable reduction in the growth of test bacteria was observed by distillate of *M. oleifera* suggesting antibacterial effect. Among bacteria tested, more inhibition was observed in case of *E. coli* followed by *S. aureus, K. pneumoniae, P. aeruginosa and B. subtilis.* Inhibition of fungi was also observed as reduced colony diameter in plates poisoned with distillate as compared to control plates. More inhibition of *A. niger* was found followed by *A. oryzae, A. terreus and A. nidulans*. The antimicrobial activity and antifungal activities of steam distillate of *M. oleifera* might be possibly due to the essential oil fraction of the plant material present in the distillate fraction (Kekuda et al. 2010).

Anti-Oxidant Activity

The antioxidant property of *Moringa* may be due to the presence of phenolic compounds that was confirmed by phytochemical screening of the hydro-ethanolic extract. In this respect, *Moringa* pods contain important bioactive compounds including glucosinolates, isothiocyanates, thiocarbamates, and flavonoids (Bharali et al. 2003). These compounds quench ROS, chelate metal ions and regenerate membrane-bound antioxidants (Kumar and Pari, 2003). β-carotene, the major component reported from the drumsticks of the plant (Bharali et al. 2003) and vitamin A and C present in *M. oleifera* serve as an explanation for their mode of action in the induction of antioxidant profiles in the present investigation.

The aqueous extract of *Moringa oleifera* exhibited strong scavenging effect on 2, 2-diphenyl-2-picryl hydrazyl (DPPH) free radical, superoxide, nitric oxide radical and inhibition of lipid per oxidation. The extracts of *Moringa oleifera* both mature and tender leaves have potent antioxidant activity against free radicals, prevent oxidative damage to major biomolecules and afford significant protection against oxidative damage (Sreelatha and Padma, 2009). The *Moringa oleifera* hydro- alcoholic leaf extracts (1000 mg/kg) and *Moringa oleifera* aqueous pod (fruit) extract (750 mg/kg) contain high amount of tannin, phenolic compounds and flavonoids. The poly phenolic constituents of this plant could be contributory to their ethano-medical use. Thus, it can be concluded that extracts of *Moringa oleifera* produce significant antioxidant activity (Sharma and Singh, 2010) and the presence of kaempferol in leaves of *Moringa oleifera* showed the antioxidant activity which was also reported by (Bajpai et al. 2005).

Antimicrobial and Antihelmintic Activity

Antimicrobial components of *Moringa oleifera* have been validated after the discovery of inhibitory activity against several microorganisms. In a recent study, aqueous extracts of *Moringa oleifera* was found to be inhibitory against many pathogenic bacteria, including *Staphylococcus aureus, Bacillus subtilis, Escherichia coli,* and *Pseudomonas aeruginosa*

in dose dependent manner (Saadabi and Abu Zaid, 2011). *Moringa oleifera* extracts was also found to be inhibitory against *Mycobacterium phlei* and *B. subtilis* (Eilert et al. 1981). Leaf extract of *Moringa oleifera* was found to be effective in checking growth of fungi *Basidiobolus haptosporus* and *Basidiobolus ranarums* (Nwosu and Okafor, 1995). Another study involving aqueous methanolic extract and fixed oil against microorganisms was performed using *Scenedesmus obliquus* (green algae), *E. coli ATCC 13706, P. aeruginosa ATCC10145, S. aureus NAMRU 3 25923, Bacillus stearothermophilus* (bacterial strains) and Herpes Simplex virus type 1 (HSV 1) and Polio virus type1 (sabin vaccine). Varying degree of antimicrobial activity was observed ranging from sensitive for *B. stearothermophilus* to resistant for *P. aeruginosa* (Ali et al. 2004). Beside antibacterial activity of *Moringa oleifera* oils, it also posses anti-fungal activity (Chuang et al. 2007). Study comparing relative antimicrobial activity of seed extracts against bacteria (*Pasturella multocida, E. coli, B. subtilis* and *S. aureus*) and fungi (*Fusarium solani* and *Rhizopus solani*) revealed that *P. multocida* and *B. subtilis* were the most sensitive strains, and their activity was influenced by cations (Na+, K+, Mg2+ and Ca2+) (Jabeen et al. 2008). Another relative comparison of antibacterial and antifungal efficacy of *Moringa oleifera* steam distillate observed more inhibition for *E. coli* followed by *S. aureus, Klebsiella pneumoniae, P. aeruginosa and B. subtilis.* In case of fungi, *Aspergillus niger* was strongly inhibited followed by *Aspergillus oryzae, Aspergillus terreus* and *Aspergillus nidulans* (Kekuda et al. 2010). Contrary to resistance against *P. aeruginosa* and *Candida albicans* for *Moringa oleifera* in other studies, one study using ethanolic extract of leaves, seeds and flowers showed the antimicrobial activity against *E. coli, K. pneumoniae, Enterobacter* species, *Proteus mirabilis, P. aeruginosa, Salmonella typhi* A, *S. aureus, Streptococcus* and *Candida albicans* (Nepolean et al. 2009). *Moringa* contains pterygospermin (originally found in *Moringa pterygosperma*) which has powerful antibacterial and fungicidal effects (Rao et al. 1946). Several other specific components of *Moringa* have been reported with antibacterial activity, including 4- (4'-O-acetyl-a-L-rhamnopyranosyloxy) benzyl isothiocyanate, 4-(a-L-rhamnopyranosyloxy) benzyl isothiocyanate, niazimicin, benzyl isothiocyanate, and 4- (a-L-rhamnopyranosyloxy) benzyl glucosinolate (Fahey, 2005). Other bioactive compounds, such as Spirochin and Anthonine are found in root and are active against several bacteria. Anthonine has potent inhibitory activity against *Vibrio cholerae* (Nwosu and Okafor, 1995). *Moringa oleifera* flower and leaves are also capable of controlling parasitic worms, their antihelmintic activity has been demonstrated during several studies (Bhattacharya et al. 1982). Moreover, it has also been reported to inhibit Indian earthworm *Pheritima posthuma* with *Moringa oleifera* leaves ethanolic extracts (Rastogi et al. 2009).

Anti-inflammatory Activity

Moringa plant parts have substantial anti-inflammatory activity. For instance, the root extract exhibits significant anti-inflammatory activity in carrageenan induced rat paw oedema (Ezeamuzie et al. 1996; Khare et al. 1997). The crude methanol extract of the root inhibits carrageenaninduced rat paw oedema in a dose dependent manner after oral administration. Moreover, n-butanol extract of the seeds of *Moringa oleifera* shows anti-inflammatory activity against ovalbumin-induced airway inflammation in guinea pigs (Mahajan et al. 2009). Amelioration of inflammation associated chronic diseases can be possible with the potent anti-inflammatory activity of *Moringa oleifera* bioactive compounds (Muangnoi et al. 2011).

Considering potent anti-inflammatory activity of *Moringa* plant, it can be surmised that this plant shows profound influence on inflammation associated diseases and resultant symptoms. As a consequence, this plant shows beneficial effects on asthma, pain, and other resultant symptoms.

Hypotensive and Spasmolytic Activity

Bioassay directed fractionation of an ethanolic extract of *M. oleifera* leaves showing hypotensive activity led to the isolation of two nitrile glycosides, niazirin (Anwar et al. 2007) and niazirinin (Ezeamuzie et al. 1996) and three mustard oil glycosides, 4-[(4'-O-acetyl-alpha-L-rhamnosyloxy) benzyl] isothiocyanate (Sulaiman et al. 2008), niaziminin A, and niaziminin B. Isothiocyanate 4 and the thiocarbamate glycosides niaziminin A and B showed hypotensive activity while nitrile glycosides 1 and 2 were found to be inactive in this regard (Faizi et al. 1991). Moreover, spasmolytic activity exhibited by the constituents of the plant provides a scientific basis for the traditional uses of the plant in gastrointestinal motility disorders (Gilani et al. 1994).

Cardioprotective Activity

Nandave *et al*. (2009) evaluated cardioprotective effect of lyophilized hydroalcoholic extract of *M. oleifera* in the isoproterenol (ISP)-induced model of myocardial infarction. Chronic treatment with *M. oleifera* demonstrated mitigating effects on ISP-induced hemodynamic [HR, (+) LV dP/dt, (-) LV dP/dt, and LVEDP] perturbations. Chronic *M. oleifera* treatment resulted in significant favorable modulation of the biochemical enzymes (superoxide dismutase, catalase,

glutathione peroxidase, lactate dehydro- genase, and creatine kinase-MB) but failed to demonstrate any significant effect on reduced glutathione compared to the ISP control group. *Moringa* treatment significantly prevented the rise in lipid peroxidation in myocardial tissue. Furthermore, *M. oleifera* also prevented the deleterious histopathological and ultrastructural perturbations caused by ISP.

Root bark of *Moringa* contains alkaloid moringinine which acts as cardiac stimulant through its effect on sympathetic nervous system (Duke, 2001). The aforementioned effects can also result due to the prevention of hyperlipidemia. It has been demonstrated that *Moringa oleifera* prevent hyperlipidemia in male Wister rat due to iron deficiency (Ndong et al. 2007). During a study performing comparison of *Moringa oleifera* leaf extract with antenolol (a selective β1 receptor antagonist drug, used for cardiovascular diseases) on serum cholesterol level, serum triglyceride level, blood glucose level, heart weight and body weight of adrenaline induced rats, it was found that *Moringa oleifera* leaf extract cause significant changes in cardiovascular parameters. This study reported *Moringa oleifera* leaf extract as hypolipidimic, lowering body weight, heart weight, serum triglyceride level and serum cholesterol level in experimental animals (Ara et al. 2008). Based on the results of the present study, it can be concluded that *M. oleifera* extract possesses significant cardioprotective effect, which may be attributed to its antioxidant, antiperoxidative, and myocardial preservative properties.

Antifertility Activity

Moringa oleifera plant also has pertinent antifertility activity. The aqueous extract obtained from root and bark of *Moringa oleifera* showed post-coital antifertility effect in rat and also induced foetal resorption at late pregnancy (Prakash et al. 1987). Moreover, aqueous extract of *Moringa oleifera* roots was also evaluated for estrogenic, anti-estrogenic, progestational and antiprogestational activities. This extract induces several consequences for affecting its antifertility property (Shukla et al. 1988). During another study analyzing anti reproductive potential of folk medicine plants, *Moringa oleifera* leaf extracts were found to be 100% abortive with doses equivalent to 175 mg/kg of starting dry material (Nath et al. 1992).

Ocular Effects

Vitamin A deficiency is a major cause of blindness, which ranges from impaired dark adaptation to night blindness. Consumption of *Moringa oleifera* leaves, and pods and leaf powder which contain high proportion of vitamin A can help to prevent night blindness and eye problems in children. Ingesting drumstick leaves with oils can improve vitamin A nutrition and can delay the development of cataract (Pullakhandam and Failla, 2007).

Anticancer Activity

Paste of drumstick leaves has been screened for its influence on carcinogen detoxifying glutathione-S-transferase (GST) in Swiss mice. It increased GST activity by more than 78% in stomach, liver oesophagus and show protective activity against carcinogenesis. The crude ethanolic extract of seeds exhibited anti tumor activity against Epstein-Barr virus-early antigen (EBV-EA) (Guevara et al. 1999).

Antiulcer Activity

The methanolic extract of *Moringa oliefera* leaves inhibited gastric lesion formation induced by aspirin, serotonin, or indomethacin in rats (Pal, Mukherjee and Saha 1995). The methanolic extract of flower buds showed antiulcerogenic activity against aspirin induced gastric ulcer at a dosage of 4g/kg body weight (Kumar and Pari, 2003).

Antispasmodic Activity

Moringa root and leaves contain several compounds with spasmolytic activity. These compounds include 4- (alpha- L-rhamnosyloxybenzyl)-o-methyl thiocarbamate which is possibly affected through calcium channel blockade, niazinin A, niazinin B, niazimicin, etc., with hypotensive and bradycardiac effect. The spasmolytic activity of different constituents support for traditional uses of this plant in gastrointestinal motility disorder (Gilani et al. 1994).

Antiurolithiatic Activity

The effect of oral administration of aqueous and alcoholic extract of *M. oleifera* root-wood on calcium oxalate urolithiasis has been studied in male Wistar albino rats. Ethylene glycol feeding resulted in hyperoxaluria as well as increased renal excretion of calcium and phosphate. Supplementation with aqueous and alcoholic extract of *M. oleifera* root-wood significantly reduced the elevated urinary oxalate, showing a regulatory action on endogenous oxalate synthesis. The increased deposition of stone forming constituents in the kidneys of calculogenic rats was also significantly lowered by curative and preventive treatment using aqueous and alcoholic extracts. Thus the results indicate

that the root-wood of *M. oleifera* is endowed with antiurolithiatic activity (Karadi et al. 2006).

Hepatoprotective Activity

Moringa oleifera has shown significant hepatoprotective activity in several studies. *Moringa oleifera* leaves ethanolic extracts showed significant protection against liver damage induced by antitubercular drugs [isoniazid (INH), rifampicin (RMP), and pyrazinamide (PZA)] in rats. It was found that hepatoprotective activity of *Moringa oleifera* is medicated by its effect on the levels of glutamic oxaloacetic transaminase (aspartate aminotransferase), glutamic pyruvic transaminase (alanine aminotransferase), alkaline phosphatase, and bilirubin in the serum; lipids, and lipid peroxidation levels in liver (Pari and Kumar, 2002). Moreover, methanolic and chloroform extracts of *Moringa oleifera* leaves also showed significant protection against CCl4 induced liver damage in albino rats. Besides hepatoprotective activity of *Moringa oleifera* leaves, its root and flowers also possess strong hepatoprotective activity.

Moringa flowers contain a well recognized flavonoid (Quercetin), which may be responsible for its potent hepatoprotective activity (Ruckmani et al. 1998).

Miscellaneous Activities

Tahiliani and Kar (2000), studied role of aqueous leaf extract in the regulation of thyroid hormone status in adult Swiss rats. Other than the thyroid hormone concentrations, hepatic lipid peroxidation and the activity of antioxidant enzymes superoxide dismutase and catalase were evaluated. Reduction in the serum T3 concentration and an increase in the T4 concentration were observed suggesting the inhibiting nature of leaf extract in peripheral conversion of T4 to T3. It is suggested that the lower concentration of this plant extract may be used for the regulation of hyperthyroidism.

RECOMMNEDED DOSAGE AND SIDE EFFECTS OF *M. OLEIFERA*

There is not a lot of human evidence at this point in time, but the majority of animal evidence uses rats as the models and uses a water extract of the leaves. When those conditions are met, it appears that 150-200mg/kg oral intake is deemed as optimal (greater potency than higher and lower doses) and in this case a preliminary human dose can be estimated at:

1. 1,600-2,200 mg for a 150lb person
2. 2,100-2,900 mg for a 200lb person
3. 2,700-3,600 mg for a 250lb person

While supplemental dosages listed above appear to be safe from all tested toxicity, a relatively small increase (3-4 times the recommended does) is known to cause genotoxic damage and may promote cancer formation whereas doses around 3-4 fold higher than that cause overt organ damage (mostly liver and kidneys). Beyond that, very reasonable supplemental dosages appear to be able to induce abortions in pregnant rats and thus supplementation is contraindicted (not advised) in pregnant women. Higher Supplementation of either the leaves or the seeds should be avoided; otherwise *M. oleifera* is extremely safe from biological significance.

Social impact

Moringa has a high commercial potential for communities in developing countries. Native to India, the *Moringa* tree grows widely in Africa, where, up until recently, it was used solely around houses to form hedges or to give shade. In a country where hundreds of debt-ridden farmers routinely take their lives after their crops fail, growing drumsticks may be a solution. Growing drumsticks makes eminent good sense in a country such as India with patchy irrigation systems. Drumsticks can be grown using rainwater without expensive irrigation techniques since the yield is good even if there is no water supply.

By purchasing *Moringa* from West Africa, more *Moringa* plantations can be established, which will lead to improved health and nutrition of the members of the local community, economic empowerment of the farmers (*Moringa* farmers earn an above-average income for their harvests), poverty reduction for the local community, and sustainable development of the land.

CONCLUSION

Medicinal potential of *Moringa oleifera* is enormous and difficult to cover in a single article, despite this current article provided glimpses of *Moringa oleifera* applications for performing appraisal of this promising nutrition and medicinal plant. Although, many bioactive compounds have been discovered from *Moringa*, still the knowledge is in infancy, in term of its total reserve. The Pharmacological studies reported in the present review confirm the therapeutic value of drumstick tree. Pharmacologically reported effects include anti-bacterial, antifungal, anti-inflammatory, antioxidant, anti-ulcer, anaesthetic cardioprotective, and antiurolithiatic activity

etc. Thus, photochemical and phytoanalytical studies may lead to development of novel agents and herbal medicines for various disorders.

Table: Detail of research work employed by scientists.

Reference	Year	Detail of research work
Rao et al.	1946	Antibacterial and antifungal activity of Moringa *pterygosperma*
Eilert et al.	1981	Antimicrobial activity against *Mycobacterium phlei* and *B. subtilis*
Bhattacharya et al.	1982	Capability of controlling parasitic worms, their antihelmintic activity
Prakash et al.	1987	Antifertility effect in rat and induced foetal resorption
Shukla et al.	1988	Absorptive properity of *Moringa* leaf extract with doses
Faizi et al.	1991	Bioassay directed fractionation of ethanolic extract
Nath et al.	1992	Antiferlity effect in rats
Gilani et al.	1994	Spasmolytic activity (plant constituents in gastrointestinal motility disorders
Pal, Mukherjee and Saha	1995	Antiulcer (inhibition of gastric lesion formation in rats)
Ezeamuzie et al.	1996	Anti-inflammatory activity of root extracts in carrageenan induced rat paw oedema
Khare et al.	1997	Anti-inflammatory
Ruckmani et al.	1998	Hepatoprotective flavanoid (quercetin) in *Moringa*
Guevara et al.	1999	Anti tumor activity against EBV-EA by seed extracts
Tahiliani and Kar	2000	Thyroid hormone concentrations, hepatic lipid peroxidation and antioxidant enzymes evalution
Duke	2001	Alkaloid moringinine as cardiac stimulant
Bharali et al.	2003	Anti-oxidant activity of bioactive compounds of *Moringa*
Kumar and Pari	2003	Anti-oxidant activity of bioactive compound
Bajpai et al.	2005	Anti-oxidant activity of compounds of pod
Fahey	2005	Components of *Moringa* in antimicrobial activity
Karadi et al.	2006	Antiurolithiatic effect in male Wistar albino rats
Anwar et al.	2007	Hypotensive activity of nitrile glycosides niazirin niazirinin
Chuang et al.	2007	Antimicrobial and Antihelminitic activity of *Moringa* oil
Ndong et al.	2007	Antihyperlipidemia in male Wister rat
Pullakhandam and Failla	2007	Ocular effects (source of vitamin A in blindness)
Ara et al.	2008	Cardioprotective (*Moringa oleifera* leaf extract as hypolipidimic in experimental animals
Sulaiman et al.	2008	Hypertensive and Spasmolytic (activity of mustard oil glycosides)
Mahajan et al.	2009	Anti-inflammation against ovalbumin-induced airway inflammation in guinea pigs
Rastogi et al.	2009	Antihelmintic activity against Indian earthworm *Pheritima posthuma*
Sharma and Singh	2010	Anti-oxidant activity of *Moringa oleifera*
Muangnoi et al.	2011	Anti-inflammatory activity of bioactive compounds of *Moringa oliefera*
Saadabi and Abu Zaid	2011	Anti-microbial and Antihelmintic activity against many pathogenic bacteria in dose dependent manner

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