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HEALTH BENEFITS OF *MORINGA OLEIFERA*: A MIRACLE TREE

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ABSTRACT

Plants have played substantial role in the maintenance of human health, from time immemorable. *Moringa oleifera* is one such multipurpose tree, commonly used in spices & cosmetic oils, and has various medicinal and therapeutic applications. *Moringa* is an outstanding source of nutritional components. Almost every part of this tree holds products useful for humans. Studies have shown that *Moringa* and its components possess wound healing, anti-inflammatory, antioxidant, antimicrobial & anti-helminthic, antipyretic, anti-diabetic, antihypertensive, lipid lowering, antifertility, antitumor, hepatoprotective, antiulcer properties etc. Further, phytoanalytical studies on *Moringa* are revealing more and more potential components and their action. This is a comprehensive review on this wonder tree and highlights its multidimensional actions. Medicinal potential of this promising healer is enormous and thus, can help in solving the health care needs in several problems related to health and nutrition. Its wide availability and easy cultivation offers immense opportunities as a commercially viable medicinal and nutritional supplement even in a developing country.

Keywords: *Moringa oleifera*, multipurpose tree, miracle tree, nutrition.

INTRODUCTION

Several plant products have found extensive use in the ancient medicinal system for various diseases. *Moringa* is one such versatile plant with extraordinary medicinal and therapeutic values used in alleviating and managing various disease states.

Moringa oleifera (*Mo*), an aboriginal of Indian subcontinent, is a member of the Moringaceae family of perennial angiosperm plants, which includes 13 other species (Nadkarni, 1976 and Farooq et.al., 2012). The plant is grown best in dry sandy or loamy soil that is slightly alkaline (Abdul, 2007 and Asante et.a., 2014). Although it is adaptable to various soil conditions from varying pH of 4.5 to 8.0, it is not able to tolerate water logging, freezing or frosts conditions (Asante et.a., 2014 and Radovich, 2011).

Moringa is known by various vernacular names- drumstick tree & horseradish tree (English) saragvo (Guajarati), soaanjna (Hindi), sajna(Bengali), nugge (Kannada), sigru(Malayalam), shevga (Marathi), shobhanjana (Sanskrit), munaga (Telegu), murungai(Tamil), sajana (Oriya), surajana (Punjabi), sajiwan or swejan (Nepali), sojina (Assamese), murunga (Sinhalese). Moringa is an edible plant. From ancient times, it has been a regular component of conventional eatables in India.

Botanical Classification	
Kingdom	Plantae
Division	Magnoliophyta
Class	Magnoliopsida
Order	Violes
Family	Moringaceae
Genus	*Moringa*
Species	*oleifera*.

Moringa is a fast growing tree with about 10m in height and a diameter of 2.04m at chest height. It has a soft trunk, white corky; and a gummy bark bearing branches. Each twice or thrice pinnate compound leaf bears small leaf leg. The flowers are pleasantly fragrant, white in colour; and the three wings seeds are scattered by the winds. *MO* flowers, tenders leaves and pods are eaten as vegetables. India being the largest producer of *Moringa*, has an annual production of between 1.1 to 1.3 million tonnes of tender fruits from an area of 380 km² (Rajangam et.al., 2001).

A report from Bureau of plant industry depicts that *Moringa* is a wonderful source of nutritional components. The leaves (weight per weight) have the calcium equivalent to four times that of milk, the vitamin C content almost seven times as compared to oranges,

while its potassium is three times when compared to that of a bananas, three times the spinach iron, four times the amount of vitamin A in carrots, and two times the protein in milk (Kamal, 2008). Besides, the pods and leaves of *Moringa* contains high amount of Ca, Mg, K, Mn, P, Zn, Na, Cu, and Fe (Aslam et.al., 2005). Latest research from two agro ecological zones in Ghana concluded that agro ecological zonation had no significant effect on the levels of most nutrients in *MO* leaves (Asante, 2014).

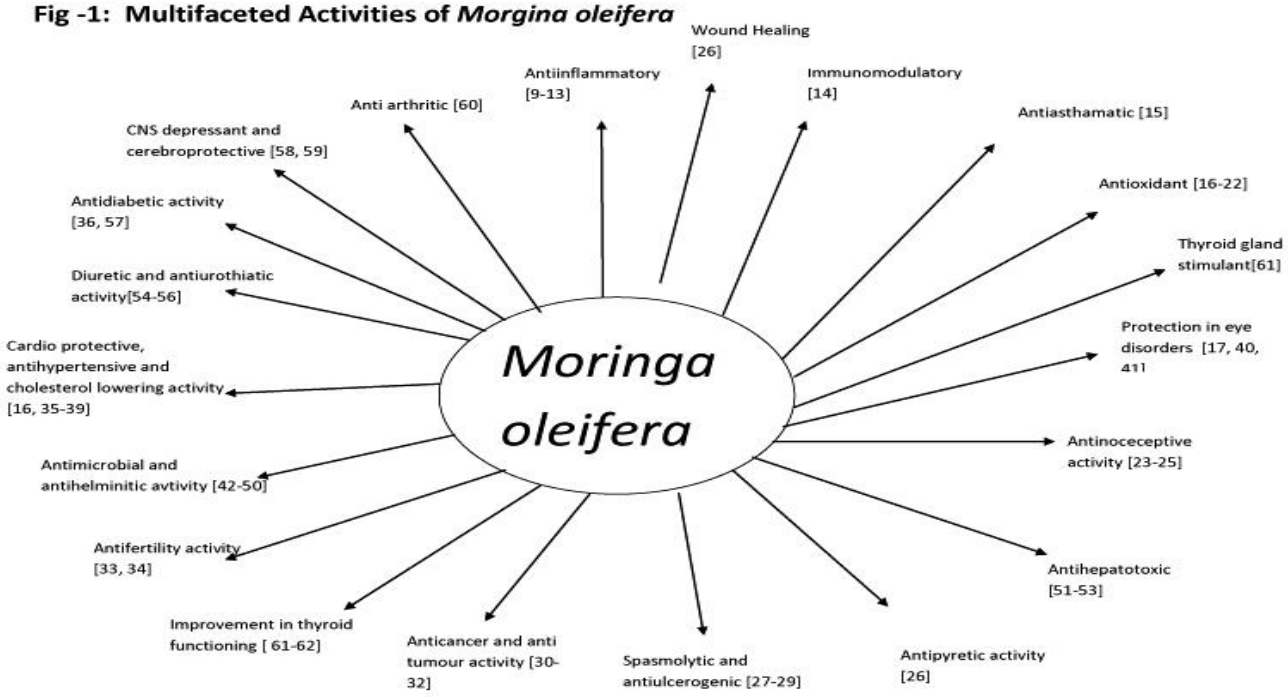
MEDICINAL PROPERTIES OF *MORINGA*

Medicinal potential of *MO* is vast (Fig-1). All parts and the components derived from plant viz. root, bark, gum, leaf, fruit pods, flowers, seed, and seed oil have been used for alleviating various ailments in traditional medicine. *Moringa* is a cornucopia of diverse activities, of which some have been reviewed below.

ANTI-INFLAMMATORY ACTIVITY

Several parts of *Moringa* plant have been shown to possess anti-inflammatory activity. Poultice of leaves

Fig -1: Multifaceted Activities of *Morgina oleifera*



helps in glandular swellings (Dubey et.al., 2013). The anti-inflammatory activity of the methanol leaf extract of *Moringa oleifera w*as demonstrated using carrageenan and histamine-induced tests (adedspo et.al., 2014). Root extract showed anti-inflammatory activity in carrageenan induced rat paw oedema (Ezeamuzie et.al., 1996). Alcohol extract of the seeds of *MO* showed anti-inflammatory activity in guinea pigs) (Mahajan et.al., 2009). Bioactive compounds present in the *M. oleifera* pods may contribute to the anti-inflammatory activity for improving the pathogenesis of inflammatory-associated chronic diseases (Muangnoi et.al., 2012).

IMMUNOMODULATORY ACTIVITY

The immunomodulatory action of methanolic extract of Moringa oleifera (MEMO) was investigated in an experimental model of immunity. Neutrophil adhesion test, cyclophosphamide induced neutropenia and carbon clearance assay were used to study the cellular immunity. Humoral immunity was tested by lethality test in mice, immunoglobulin levels estimation in serum and indirect haemagglutination assay in animals. The study showed that MEMO stimulate both cellular and humoral immune response at lower doses (sudha et.al., 2010).

ANTI-ASTHMATIC ACTIVITY

Moringa plant alkaloid has been shown to have similarity with ephedrine in terms of its activity. Thus, it can be used in treatment of asthma. The kernels of *Mo* seed showed potential effect in the management of bronchial asthma. The patients showed significant relief in the severity of asthma symptoms in addition to the improvement in respiratory functions (Agarwal, 2008).

ANTIOXIDANT ACTIVITY

Mo has antioxidant galore (Chumark et.al., 2008 and Kumar et.al., 2013). Aqueous extracts of leaf, fruit and seed of *Mo* act as an antioxidant (Singh et.al., 2009). Methanol and ethanol extracts of Indian origin *Mo* were shown *to* have the highest antioxidant activity of 65.1% and 66.8%, respectively in a study on freeze dried *Moringa* leaves (Lalas, 2002 and Siddhuraju, 2003). Quercetin and Kaempferol have shown to possess good antioxidant activity on hepatocyte growth factor (HGF) induced Met cell migration (Labbe et.al., 2009).

Mo seed have been shown to be superiors for radical scavenging when compared to the palm oil (Ogbunugafor et.al., 2011).

ANTINOCICEPTIVE ACTIVITY

Several *Moringa* species have demonstrated analgesic activity. Ethanolic extracts of *Moringa* tender pod-like fruits were shown to possess significant analgesic activity (Rao et.al., 2008). The antimigraine potential of leaf juice alcoholic fraction of *Mo,* which is traditionally used in the treatment of migraine, was studied. The study showed that *Moringa* may be effectively used in the treatment and management of migraine (Upadhye et.al., 2012). The fresh leaf juice and ethanolic extract of the leaves of *Moringa oleifera* were administered orally at varying doses in mice and were tested for antinociceptive activities using three models: writhing induced by Acetic acid, formalin induced paw licking and tail flick test using analgesiometer. Study showed a significant antinociceptive activity of *Mo (Upadhye et.al., 2011)*.

ANTIPYRETIC ACTIVITY

Antipyretic effect of ethanol, petroleum ether, solvent ether and ethyl acetate extracts of *Mo* seeds was studied by yeast induced hyperpyrexia method in rats. Ethanol and ethyl acetate extracts of seeds had significant antipyretic activity (Hukkeri et.al., 2006).

SPASMOLYTIC AND ANTIULCEROGENIC EFFECT

Moringa root and leaves contain several compounds with Antispasmodic activity. Thus, the plant has been used in gastrointestinal motility disorder (Gilani et.al., 1994). Methanolic extract of *Mo* is also capable in protection against gastric lesions induced by acetylsalicylic acid, serotonin and indomethacin in experimental rats. It also enhances healing of chronic gastric lesions (Pal et.al., 1995). Aqueous extract of *Mo* leaves have reported to have antiulcer effect on adult Holtzman albino rats (Debnath et.al., 2007).

ANTICANCER ACTIVITY

Mo has several bioactive compounds showing antitumor activity. Niazimicin, is a bioactive compounds found in *Mo* leaves, has anticancer activity (Guevaraa et.al., 1999). *Mo* leaf extract have shown potential cytotoxic effects on human multiple myeloma cell lines (Parvathy et.al., 2007). Also, *Mo* seed extracts have effects on hepatic carcinogen metabolizing enzymes (Bharali et.al., 2003).

ANTIFERTILITY ACTIVITY

Mo plant also has pertinent antifertility activity. The root and bark aqueous extract demonstrated post-coital antifertility effect in rat and induced foetal resorption at late pregnancy (Prakash et.al., 1987). *Mo* leaf extracts were 100% abortive with doses equivalent to 175 mg/kg of starting dry material in a study analyzing anti reproductive potential of folk medicine plants (Nath et.al., 1992).

CARDIO PROTECTIVE, ANTIHYPERTENSIVE, AND CHOLESTEROL LOWERING ACTIVITIES

Moringa Root bark contains alkaloid moringinine which through its effect on sympathetic nervous system stimulates cardiac function (Duke, 2001). The effects can also be due to the prevention of hyperlipidemia. *Mo* has been shown to prevent hyperlipidemia due to iron deficiency in male Wister rat (Ndong et.al., 2007). A study performing comparison of *Mo* leaf extract with antenolol (a selective ß1 receptor antagonist drug, used for cardiovascular diseases) reported *Mo* leaf extract as hypolipidimic, lowering body weight, heart weight, serum triglyceride level and serum cholesterol level in experimental animals (Ara et.al., 2008). Keeping simvastatin as control, antiatherosclerotic and hypolipidaemic effect of *Mo* leaves were also shown in another study (Chumark et.al., 2008). *Mo* also produces cardioprotective role in isoproterenol (ISP)-induced myocardial infarction. It was reported that *Mo* treatment plays cardio protective effects in male Wistar albino rats on biochemical enzymatic parameters including, superoxide dismutase, catalase, glutathione peroxidase, lactate dehydrogenase, and creatine kinase-MB (Farooq et.al., 2012). Several bio active compounds contained in *Moringa* leaves exert direct effect on blood pressure, and thus may be used for the stabilization of blood pressure. *Mo* compounds leading to blood pressure lowering effect includes nitrile, mustard oil glycosides and thiocarbamate glycosides present in *Moringa* leaves (Anwar et.al., 2007). *Moringa* leaves contain □-sitosterol, a bioactive phytoconstituent, having cholesterol reducing effect. This compound has been shown to decrease cholesterol level in high fat diet fed rats (Ghasi et.al., 2000).

PROTECTION IN EYE DISEASES

Vitamin A deficiency is a major cause of blindness. Consumption of *Mo* leaves, and pods and leaf powder, rich source of vitamin A, can prevent night blindness and eye problems in children. Consumption of drumstick leaves with oils can improve vitamin A nutrition and can delay the development of cataract (Pullakhandam, 2007). *Mo* as a supplementary food was highly accepted for integrated child development scheme supplementary food (ICDS-SFP) because it is enriched in vitamin A (Nambiar et.al., 2007). A Study showed retinoprotective effects *of Moringa oleifera* via anti-oxidant, anti-inflammatory, and anti-angiogenic mechanisms in streptozotocin-induced diabetic rats. *Mo* may be useful in preventing diabetes induced retinal dysfunction (Kumar et.al., 2013).

ANTIMICROBIAL AND ANTIHELMINTIC EFFECTS

Various components of *Mo* have been found to have inhibitory activity against several microorganisms.

Mo extracts also inhibit the growth of *Mycobacterium phlei* and *B. subtilis (*Eilert et.al., 1981*). Mo* Leaf extract also possess antifungal activity against *Basidiobolus haptosporus* and *Basidiobolus ranarums* (Nwosu, 1995). In a study using aqueous methanolic extract and fixed oil against microorganisms was taken up 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 type 1 (sabin vaccine). A range of antimicrobial activity was observed from sensitive for *B. stearothermophilus* to resistant for *P. aeruginosa* (Ali et.al., 2004). In Addition to antibacterial activity of *Mo* oils, anti-fungal activity has also been demonstrated (Chuang et.al., 2007). Relative comparison of antibacterial and antifungal efficiency of steam distillate of *Mo* revealed highest inhibition for *E. coli* followed by *S. aureus, Klebsiella pneumoniae, P. aeruginosa and B. subtilis.* Among fungi, *Aspergillus niger* was the most inhibited followed by *Aspergillus oryzae*, *Aspergillus terreus* and *Aspergillus nidulans (*Prashith et.al., 2010*).* Alcohol extracts 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*). Mo* aqueous extracts was found to be inhibitory against many pathogens including *Staphylococcus aureus, Bacillus subtilis, Escherichia coli,* and *Pseudomonas aeruginosa* in dose dependent (Saadabi, 2011).

Mo flower and leaves are also capable of controlling parasitic worms (Bhattacharya, 1982). *Mo* leaves ethanolic extracts has also been reported to inhibit Indian earthworm *Pheritima posthuma (*Rastogi et.al., 2009*).*

ANTI HEPATOTOXIC ACTIVITY

Hepatoprotective activity of *Mo* has been shown in various studies. Ethanolic extracts of *Mo* leaves showed protection against antitubercular induced drugs liver damage in rats. Hepatoprotective activity of *Mo* was found to be mediated by its effect on aspartate aminotransferase), alanine aminotransferase, alkaline phosphatase, and bilirubin levels in the serum; lipids, and lipidperoxidation levels in liver (Pari, 2002). *Mo* root and flowers also possess strong hepatoprotective activity. Quercetin, a flavonoid found in *Moringa* flowers may be responsible for its hepatoprotective activity (Ruckmani et.al., 1998). Evaluation of the effect of *Mo* seed extract on liver fibrosis showed that *Mo* seed extract has the ability to reduce CCl induced liver fibrosis. Extract of *Mo* seed controls the rise of serum amino transferase activities and globulin level. *Mo* reduces liver fibrosis as shown in immunohistochemical studies (Hamza, 2010).

DIURETIC & ANTIUROLITHIATIC ACTIVITY

Diuretic activity of *Moringa* exists in its roots, leaves, flowers, gum and the aqueous infusion of seeds (Morton, 1991). Studies indicate that the root-wood of *M. oleifera* is having antiurolithiatic activity (Dubey et.al., 2013). A study reported antiurolithiatic property from the aqueous and alcoholic extract of the root bark of *Moringa oleifera (Karadi et.al., 2006)*. Both the extracts significantly lowered the urinary excretion and kidney retention levels of oxalate, calcium and phosphate.

ANTIDIABETIC ACTIVITY

Mo potential as a therapeutic agent for diabetes has been explored. In type 2 diabetic rats, MO leaves significantly reduce blood glucose concentration. Leaves are potent source of polyphenols, responsible for hypoglycemic activity (Ndong et.al., 2007). The extract from Moringa leaf decreases sugar levels in the blood within 3 h after intake (Mittal et.al., 2007).

CNS DEPRESSANT AND CEREBROPROTECTIVE

The root extract exhibited CNS depressant activity. Studies using root aqueous extract of MO on penicillin induced convulsion, locomotor behavior, brain serotonine(5-HT), dopamine (DA) and norepineprine (NE) level was studied in rats. The extract improved the imbalance between 5HT, DA, and NE (Ray et.al., 2003) . Cerebroprotective effect of *M. oleifera* leaves extract against brain damage and oxidative stress in animal model of focal ischemic stroke was studied. The study demonstrated that *Moringa oleifera* leaves extract is a potential neuroprotectant which is cheap and easy to approach (Kirisattayakul et.al, 2013).

WOUND HEALING PROPERTIES

Leaf extract was tested for analyzing wound healing capacity. Three wound models viz excision wound, incision wound and dead space were chosen. Ethyl acetate extracts (10% extract in the form of ointment) showed significant activity that is comparable with the standard vicco turmeric cream. Phytosterols and phenolic compounds present in these extracts promote the wound healing activity (Hukkeri et.al., 2006).

MISCELLANEOUS

The anti-arthritic effect of methanolic extract of *Moringa oleifera* stem bark could be observed in acute (Turpentine oil and Formaldehyde induced arthritis) and chronic (Freund's complete adjuvant induced polyarthritis in rat) model of inflammation. *Moringa oleifera* methanolic extract may be effective in the treatment of rheumatoid arthritis (Kumar et.al., 2013). The aqueous leaf extract of *Moringa oleifera* was evaluated for its ameliorative effect in the regulation of thyroidism in rat model**.** The results of this study suggest that the extract may have beneficial effect on serum cholesterol concentration and a stimulant to thyroid functions (Tabassum *et.al.*, 2013). A study showed inhibitory action of ethanolic extract *Moringa oleifera* seeds on systemic and local anaphylaxis (Mahajan, 2007).

CONCLUSIONS

Properties of Moringa oleifera are multidimensional and thus, have varied economic

applications. It's easy cultivation within unfavorable environmental condition and wide availability makes it an excellent potential for growth in economy and health & nutrition sector in a developing country like India.. Maximum yield of its various parts and constituents could be achieved to derive supplements and therapeutics of multifarious nature for human consumption. So far numerous studies have been conducted on different parts of *Moringa oleifera* and the chemical constituents, but there is a need to isolate and identify newer compounds from different parts of the tree. Further, more rigorous studies focusing on identification, characterization and commercialization of bioactive compounds of *MO* can lead to the development of remedies and prevention of several ailments.

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