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PHARMACOLOGICAL REVIEW ON MORINGA OLEIFERA

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ABSTRACT

Moringa oleifera, also known as the "tree of life" or "miracle tree," is classified as an imoportant herbal plant due to its immense medicinal and non-medicinal benefits. Traditionally, the plant is used to cure wounds, pain, ulcers, liver disease, heart disease, cancer, and inflammation. This review aims to compile an analysis of worldwide research, pharmacological activities, phytochemical, toxicological, and ethnomedicinal updates of Moringa oleifera and also provide insight into its commercial and phytopharmaceutical applications with a motive to help further research. The scientific information on this plant was obtained from various sites and search engines such as Scopus, Pub Med, Science Direct, BMC, Google Scholar, and other scientific databases. Articles available in the English language have only been referred for review. The pharmacological studies confirm the hepatoprotective, cardioprotective, and anti-inflammatory potential of the extracts from the various plant parts. It was found that bioactive constituents are present in every part of the plant. So far, more than one hundred compounds from different parts of Moringa oleifera have been characterized, including alkaloids, flavonoids, anthraquinones, vitamins, glycosides, and terpenes. In addition, novel isolates such as muramoside A&B and niazimin A&B have been identified in the plant and have potent antioxidant, anticancer, antihypertensive, hepatoprotective, and nutritional effects. The traditional and nontraditional use of Moringa, its pharmacological effects and their pharmaceutical formulations, clinical studies, toxicity profile, and various other uses are recognized in the present review. However, several traditional uses have yet to be scientifically explored. Therefore, further studies are proposed to explore the mechanistic approach of the plant to identify and isolate active or synergistic compounds behind its therapeutic potential.

Keywords: Moringa Oleifera, Traditional Medicinal Uses, Pharmacological Activity, Phytochemistry, Phytopharmaceutical Formulation, Toxicity.

I. INTRODUCTION

In the last few decades due to exponential improve- ment in the herbal medicine field *Moringa oleifera* is popular in develop countries because it is obtained from the natural source and shows less adverse effects. Herbal drugs and their constituents play an important role in different medicinal system like unani, siddha, yoga, homeopathy, naturopathy and ayurveda. More than 70% population uses this non-allopathic system of medicine. *Moringa oleifera* is also known as horse radish tree and drum stick tree. Fig. 1 show the plant *Moringa oleifera Lam*. *Moringa oleifera* (munga) plant belonging to family moringaceae and it is native to sub – himalayan tracts of India, Pakistan, Bangladesh and Afghanistan. It is a small, fast growing, evergreen or deciduous tree. It usually grows up to 10 to 12 m in height [1]. Munga plants provide large and rare combi- nation of zeatin, quercetin, beta – sitosterol, kaemop- ferol, and caffeoylguinic acid. Vital minerals present in the *Moringa oleifera* include iron, potassium, calcium, copper, zinc, magnesium, manganese etc. Other most important and valuable species of plant *Moringa* are *M.oleifera*, *M.arborea*, *M.drouhardii*, *M. ovalifolia*, *M. longituba*, *M. rivae*, *M. borziana*, *M. corcanensis*, *M. hildebrandtii*, *M. ruspoliana*, *M. stenopetala*, *M. per- egrine*, *M .pygmaea*. Different parts of the plant such as bark, leaves, seeds, flowers, roots, and immature pods, contains large number of important phytoconstitu-ents such as terpenoids, alkaloids, tannins, steroidal aglycones and reducing sugars. Plant leaves contains essential amino acids to build strong healthy bodies. *Moringa oleifera* leaves have been used in traditional medicine system for centuries, in the ayurvedic system of medicine associated with the cure or prevention of the diseases because of its water compelling, wa- ter purification capacity and high nutritional impor- tance. Plant leaves are tiny and difficult to harvest and use a rich nutritional profile of leaves which contains times the vitamin A of carrots, 15 times the potassium of bananas, 17 times the calcium of milk, 12 times the vita- min C of oranges and 25 times the iron of spinach. Anti- oxidants galore and plant leaves of munga contains rich source of antioxidants, including beta carotene, vitamin c, quercetin and chlorogenic acid. Chlorogenic acid has been found to lower blood sugar levels

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[2]. The leaves and seeds of *Moringa oleifera Lam*. may protect against some effects of the arsenic toxicity which is especially important light of news. Contamination of ground water by arsenic has also become a cause of global public health concern. *Moringa oleifera* seeds have even been found to work bet- ter for water purification function [3]. From a digestive point of view the plant *Moringa oleifera Lam*. is highly rich in fibers that as the epoch times put it works like a mop in your intestines, to clean up any of that extra grunge left over from a greasy diet and also noteworthy are its isothio- cyanates, which have anti- bacterial activity that may help to rid your body of H. pylori, bacteria implicated in gastritis ulcers, and gastric cancer.

Figure 1: Plant of Moringa oleifera Lam.

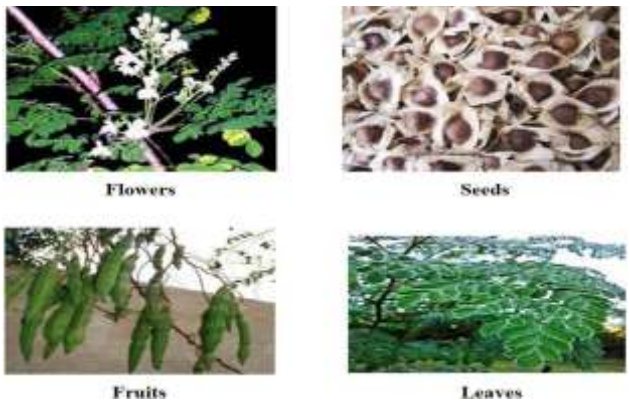

Figure 2: Parts of Moringa

Table 1: Phytoconstituents of plant *Moringa oleifera Lam* [4, 5]

Sr. No	Plant part	Extract	Phytoconstituents
1	Leaves	Aqueous and alcoholic	Niazirin and Niazirinin – nitrile glycosides,4-[(4'-O- acetylalpha- L-rhamnosyloxy) benzyl isothiocyanate, Niaziminin A, and Niaziminin B, three mustard oil glycosides, niaziminin, a thiocarbamate,4- (alpha-1- rhamnopyranosyloxy)-benzylglucosinolate, quercetin-3- O-glucoside and quercetin-3-O-(6''- Malonyl- glucoside),Niazimicin. Pyrrole alkaloid (pyrrolemarumine 400-O-a-L-rhamnopyranoside) and 40-hydroxyphenylethanamide(marumoside A and B) 4.alpha and gamma-tocopherol.2
2	Seeds	Aqueous and Hydro-alcoholic	Methionine, cysteine, 4-(alpha-L- rhamnopyranosyloxy) benzylglu- cosinolate, Moringine, benzylglucosinolate, niazimicin niazirin.
3	Pods	Hydro-alcoholic	Isothiocyanate, nitrites, thiocarbamates,O-(1heptenyloxy) propyl undecanoate, O-ethyl-4-(alpha-L-rhamnosyloxy) benzyl carbamate, methyl- p-hydroxybenzoate, beta- sitosterol .
4	Bark	Alcoholic	4-(alpha-L- rhamnopyranosyloxy) benzylgiucosinolate.

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5	Flowers	Hydro-alcoholic	D-glucose, quercetin, isoquercetin, kaemopherol, kaempferitin and ascorbic acid, protein, D-mannose.
6	Root	Alcoholic	Moringine, moringinine, spirachin, 1,3-dibenzyl urea, alpha-phellan- drene, p-cymene, Deoxy-niazimicine, 4-(alpha-L-rhamnopyranosy- loxy)benzylglucosinolate.
7	Stem	Aqueous and Hydro-alcoholic	4-hydroxyl mellein, vanillin, octacosonoic acid, beta- sitosterone and beta- sitosterol.

II. TAXONOMICAL CLASSIFICATION

- Kingdom – Plantae
- Sub kingdom – Tracheobionta
- Super Division – Spermatophyta
- Division – Magnoliophyta
- Class – Magnoliopsida
- Sub class – Dilleniidae
- Order – Capparales
- Family – Moringceae
- Genus – Moringa
- Species – oleifera
- Synonyms: The plant Moringa oleifera is known by sev- eral names throughout the world. The synonyms are given below.
- Latin – Moringa oleifera
- Sanskrit – Subhanjana,
- Hindi – Saguna, Sainjna
- Gujarati – Suragavo
- Tamil – Mulaga , Munaga
- Malayalam – Murinna, Sigru
- ·Punjabi – Sainjna, Soanjna
- Unani – Sahajan
- Ayurvedic – Haritashaaka, Raktaka, Akshiva
- Arabian – Rawag,
- French – Morungue
- Spanish – Angela, Ben, Moringa
- Chinese – La ken
- English - Drumstick tree, Horseradish tree

Morphology

Moringa oleifera is a small fast – growing evergreen or de- ciduous tree usually grows up to 10 or 12 m in height. It has spreading, fragile branches, feathery foliage of tripinnate leaves, and whitish gray bark [4].

Leaves: The leaves are bipinnate or commonly tripinnate up to 45 cm long the leaflets are hairy, green and almost hairless on the upper surface. The twigs are hairy and green, these are compound leaves with leaflets of 1 -2 cm long.

Flowers: The fragrant, bisexual, yellowish white flowers are hairy stalks in spreading or drooping axillary panicles 10 - 25 cm long. Individual flowers are approximately 0.7 to 1 cm long and 2 cm broad and five unequal yellow- ish – white, thinly veined, spathulate petals, five stamens with five smaller sterile stamens and pistil composed of a 1-celled ovary and slender style.

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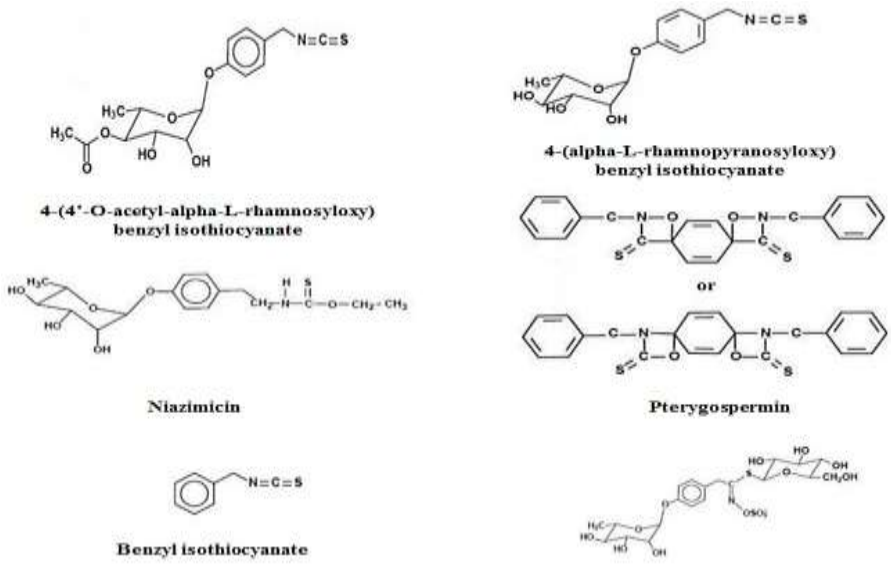

Figure 3: Structure of phytoconstituents.

Fruits: Fruits are tri – lobed capsules and are referred to pods it is pendulous, brown triangular, and splits into three parts lengthwise when dry 30 - 120 cm long, 1.8 cm wide fruits production mostly occurs in march and april. Fruit contain around 26 seeds during their development stage. Immature pods are green in color they turn brown on ma- turity.

Seeds: Seeds are round 1cm in diameter with brownish semi – permeable seed hull with 3 papery wings hulls of seed are brown to black but can be white if kernels are of low viability. Viable seed germinate within 2 weeks, each tree can produce around 15,000 to 25,000 seeds/year. Aver- age weight is 0.3 gm/seed. The parts of plant Moringa oleif- era is shown in Fig. 2.

Phytochemical constituents: Some phytochemical con- stituents of Moringa oleifera plant are found in various parts of the plant. According to the literature; these constit- uents are listed in tabular form in Table 1 and their chemi- cal structures are shown in Fig. 3.

III. PHARMACOLOGICAL ACTIVITIES

Antimicrobial and Antifungal Activity

M. oleifera ethanolic root extract contains a compound N-benzylethyl thioformate (an aglycone of deoxyniazimincin) responsible for the antimicrobial and antifungal effect toward an extensive array of microbes and fungi [44]. M. oleifera methanolic leaf extract may exert inhibition of urinary tract infections caused by Gram-negative and Gram-positive bac- teria such as Klebsiella pneumoniae, Staphylococcus aureus, Escherichia coli, and Staphylococcus saprophyticus.

The inhibitory effect of extracts from leaves, seeds, and stems of M. oleifera has been specified in various fungal strains such as Aspergillus flavus, Aspergillus terreus, As- pergillus nidulans, Rhizoctonia solani, Aspergillus niger, Aspergillus oryzae, Fusarium solani, Penicillium sclerotigenum, Cladosporium cladosporioides, Trichophyton men- tagrophytes, Penicillium species, Pullarium species [44]. M. oleifera seeds have active components 4-(alpha-L-rhamanosyloxy) benzyl isothiocyanates, which are believed to be responsible for their antimicrobial activity. The juice of Moringa leaves also showed potential against human pathogenic bacteria [43]. The methanolic leaf extract has nearly 99% inhibition against Botrytis cinerea (a necrotrophic plant fungus).

The fruit of M. oleifera contains alkaloids, flavonoids, and steroids, which have an inhibitory effect against the culture of Candida albicans by either denaturing the protein or inhibiting the germination of spores through the steroid ring they contain.

Strong inhibitory effects of moringa seed kernel extract were observed for Bacillus cereus, Staphylococcus aureus, Mucor species, and Aspergillus species. However, it was less effec- tive against P. aeruginosa and E. coli. This indicated that, except for E. coli and P. aeruginosa, moringa seed kernel extract might be utilized to treat

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infections caused by these species.

Anti-Inflammatory Activity

A significant anti-inflammatory effect was observed in different parts of M. oleifera (leaf, pods, flowers, and roots). It was observed that the isolated compound (4-[2-o-Acetyl-alpha-l-rahamnoslyloxy) benzyl] thiocynate from Moringa possessed nitric oxide inhibitory activ- ity and was subsequently found to be effective in Raw264.7 cell lines. A compound de- rived from M. oleifera roots, known as aurnatiamide acetate and 1,3-dibenzylurea, inhibited TNF-α production . Active compounds such as tannins, phenols, alkaloids, flavanoids, carotenoids β-sitosterol, vanillin, and moringin have anti-inflammatory properties [32]. The M. oleifera fruit extract blocked nuclear factor kappa B (NF κB) translocation, and the chloroform extract was found to be cytotoxic at high concentrations (500–1000 μg/mL).

M. oleifera leaves extract was used in mice for treating atopic dermatitis in human ker-atinocytes and was found to be effective in reducing the expression of mannose receptor mRNA, thymic stromal lymphopoietin, and retinoic acid-related orphan receptor γT in ear tissues.

Oxidative Stress

The results of M. oleifera were observed in methotrexate-induced mice. The study aimed to look into a probable palliative effect of M. oleifera extract on mice. The mice re- ceived the extract one week before administering methotrexate injection, and this treatment was continued for 12 days. The result showed that pretreatment with an extract of M. oleifera on mice poisoned with methotrexate could protect them from oxidative stress. The antioxidant activity of ethanolic extract M. oleifera stems exhibited a protective effect against epidermal oxidative stress injury induced by H2O2 in keratinocytes. The result displayed that the stems showed antioxidant potential, and, therefore, can be used as an excellent and preventive source in animal epidermal oxidative stress injury. The research investigated the antioxidant potential of Moringa leaves against di-clofenac sodium-induced liver toxicity in animals. The researchers concluded that the extract was significantly effective against diclofenac-induced liver toxicity and, therefore, can be considered liver protective.

M. oleifera, as an oxidative and inflammatory marker, inhibits IKBα phosphorylation, thereby preventing NFKB (nuclear factor kappa B) inhibition. It prevents the nuclear translocation and dimerization of IkBα and NFKB, thereby inhibiting the formation of inflammatory proteins such as TNFα(tumor necrosis factor), COX-2(cyclooxygenase-2), IL6(interleukin -6), and iNos(inducible nitric oxide synthase) and thereby reducing the inflammation and curing other disorders like obesity, arthritis, cancer, diabetes

IV. CONCLUSION

The plant Moringa oleifera; family Moringaceae posses broad spectrum of pharmacological activities. Also, most of the parts of plant like seeds, leaves, flowers and roots are used for treatment of various diseases. Literature reports that aqueous, ethanolic and methanolic extracts are widely used for investigation, identification, and estimation pur- pose. In future the active constituents can be isolated and formulated into suitable dosage form and delivery system. Also, in future in-vivo studies based on animal models can be done for better effect.

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