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Review Article

A Review On Phytochemical And Pharmacological Significance Of Moringa Oleifera

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ABSTRACT

Moringa olifera is a gift by nature to the mankind,a traditional medicinal plant.It has numerous therapeutic, nutritional and pharmacological properties. This review focus on various pharmacological activities of Moringa olifera like antimicrobial,neuroprotective,antidiabetic,analgesic,antipyretic,antiobesity,antiasthmatic,cytotoxic and hepatoprotective activities.

INTRODUCTION

It is generally accepted that products derived from a range of herbs and plants are safe to consume,because they are a source of both multifunctional curative agents and bioactive compounds. The Food and Agriculture Organization (FAO) reported in 2024 that a large section of the world's population, especially those living in poor countries, uses herbal medicine as a preventive and therapeutic measure. Moreover, Pan et al. (2013) estimate that over 25% of synthetic medications are derived from medicinal plants. (2) The need for food has increased over the past few decades in developing countries as a way to tackle the problems of hunger and malnutrition. The vast majority of people in Asian and African countries suffer from malnutrition as a result of their diets lacking in essential nutrients. Moringa oleifera Lam. (syn. M. pterygosperma Gaertn.2n = 28) is a member of the Moringaceae family and is commonly referred to as the "drum stick" or "horseradish tree." It is an easily available, cost-effective source of essential nutrients and nutraceuticals, and it has the ability to fully treat malnutrition (Kunyanga et al. 2013). (3) Moringa is often considered an essential food during times of famine due to its tuberculate roots and resistance to dryness and drought (Padayachee

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and Baijnath 2012). (4) Nearly every component of the Moringa tree, including the roots, leaves, blossoms, green pods, and seeds, has therapeutic value in addition to being used in the production of functional foods, biodiesel, nutraceuticals, and water filtering (Saini 2015).(5) The leaves, blossoms, and young pods of this tree are used in cooking in many different nations (Stevens et al. 2013).The foliage of M. oleifera (MO) has been shown to be a rich source of minerals (Saini et al., 2014a), carotenoids (Saini et al., 2014c), polyunsaturated fatty acids (Saini et al., 2014d), phenolics and glucosinolates (Amaglo et al., 2010), ascorbic acid (Saini, 2015), and folate (Saini et al., 2016).(11) Because of its high amount of monounsaturated fatty acids in the form of oleic acid (C18:1), moringa seed oil (yield 30–40% w/w), sometimes referred to as "Ben oil," is used to produce biodiesel (Azam et al. 2005; Rashid et al. 2008).Moringa seed oil (12) is a feasible choice for biodiesel production because it meets all of the primary requirements of US, German, and European biodiesel regulations. It's crucial for business and industry because of this. The low molecular weight cationic proteins (MOCP), chitin binding protein isoforms (Mo CBP3), lectins, napins, mabinlins, and other seed proteins extracted from MO seeds are effectively characterized and used in home and commercial water purification and coagulant properties due to their strong antimicrobial and anti-hardness properties (Kansal and Kumar 2014).(13) As far as we are aware, no recent article has provided a comprehensive analysis of the coagulation and flocculation mechanisms of water coagulation proteins. Furthermore, a lot of study has been conducted to look into MOME's potential for producing biodiesel. Therefore, after reading through the literature on the possible uses of MO in biodiesel, water purification, nutrition, and nutraceuticals, it is worthwhile to compile an updated and comprehensive evaluation. This study aims to explore the potential long-term uses of MO in the household and industrial domains through an analysis of the state's water coagulation proteins, fatty acid methyl esters, biological and pharmacological properties, and bioactive content. In these situations, future directions are also determined.

Botanical description:

13 species of shrubs and trees belonging to the single genus Moringaceae can be found in the Indian subcontinent (M. oleifera and M. concanensis), Kenya (M. longituba and M. rivae), northeastern and southwestern Africa (M. stenopetala), Arabia, and Madagascar (M. drouhardii and M. hildebrandtii) (Padayachee and Baijnath 2012;[Saini 2015).(14) Moringa oleifera Lam is a tropical dicotyledonous tree that grows year-round. Pale green, corky, whitish-gray bark, drooping branches, and leaves with opposing, oval leaflets are found on a brittle stem with bipinnate, or more often, tripinnate, leaves (30–60 cm long) (Pandey et al. 2011).(15) Originally from the sub-Himalayan mountains of northern India, M. Oleifera is now grown for a variety of purposes in tropical and sub-tropical climates around the world (Leone et al. 2015).(16) The global distribution of M. oleifera is shown in Fig. 1a. Fig. 1b shows the various vegetative and reproductive portions of the M. oleifera tree. (Zaku et al. 2015).(17) highlighted the plant's industrial and nutritional uses in addition to its growing techniques in a recent assessment of the MO tree's potential. Cuttings (0.2–1.0 m long) are used to propagate it for pod yield, with 1.2 and 5 m recommended tree-to-tree spacing between rows. The intended population of 1666 trees/ha is thus reached. Cuttings are planted closely apart in order to create one million trees per hectare of foliage. Saini et al. (2013) state that seed propagation is not practicable due to significant genetic variation caused by cross-pollination. The moringa tree grows best in 25–35 degrees Celsius, direct

sunlight, 500 meters above sea level, and soil that is slightly acidic to alkaline (pH 5.0–9.0). But it can tolerate significantly greater temperatures—up to 48 degrees Celsius—as well as a variety of soil kinds and environmental factorsMO seeds can be sowed soon after they reach maturity because they do not go dormant and can stay viable for up to a year. When the tree is six to eight months old, fruit starts to fall off it. It yields less fruit in the first year or two, but more in the subsequent years. (Silva et al. (2009).(19) the Brazilian genotype produced 45 tons of pods per acre on average. After three years of plantation growth, the Indian cultivar (PKM-1), grown in Argentina's subtropical northwest, produced 258 kg/ha of oil (Ayerza 2011). (20) India produces 1.1–1.3 million tons of MO fruits (pods) annually from an area of 38,000 acres, making it the world's largest grower. The state of Andhra Pradesh leads India in terms of area (15665 ha) and output, followed by Tamil Nadu (7408 ha) and Karnataka (10280 ha) (Patel et al. 2010). (21).

Phytochemical composition:

Different sections of the MO tree have been shown to contain substantial amounts of unique flavonoids, phenolic acids, and glucosinolates (Amaglo et al. 2010; Coppin et al. 2013).(22) in addition to folate (Saini et al. 2016), highly bioavailable minerals (Saini et al. 2014a), carotenoids, tocopherols, and polyunsaturated fatty acids (PUFAs) (Saini et al. 2014d, 23).(25) 4-O-(a-L-rhamnopyranosyloxy)

benzylglucosinolate, also known as glucomoringin, is the most prevalent glucosinolate found in the stem, leaves, flowers, pods, and seeds of M. oleifera (Amaglo et al. 2010).(26) The most prevalent substance in the roots is benzyl glucosinolate, sometimes referred to as glucotropaeolin. The maximum concentration of glucosinolate is found in the leaves and seeds of quercetin [kaempferol [isorhamnetin] are the flavonoids that are primarily present throughout the tree. The amounts of quercetin and kaempferol in the leaves were found to be 0.07–1.26 and 0.05–0.67 percent, respectively. The natural plant enzyme myrosinase breaks down glucosinolates enzymatically to create isothiocyanates, nitriles, and thiocarbamates. According to Anwar et al. (2007), these substances possess strong hypotensive (blood pressure lowering) and spasmolytic (muscle relaxing) qualities.Additionally, the Indian cultivars (PKM-1 and PKM-2) have shown a greater overall content of quercetin and kaempferol compared to native African samples (Coppin et al. 2013). Flavonol glycosides (glucosides, rutinosides, and malonyl glucosides) are another source of information.(28) The robust antioxidant effect of MO is due to the high concentration of these polyphenols. Recent research has examined the antioxidant, nutritional, and polyphenolic characteristics of seven important MO cultivars from Pakistan. Quercetin, apigenin, and kaempferol derivatives were discovered to be the primary flavonoids in the hydromethanolic extracts of the Moringa foliage; these flavonoids accounted for 47.0%, 20.9%, and 30.0% of the total flavonoids on average. "Pakistan Black" and Fig. 1a, which shows the global distribution of Moringa oleifera, were created by contrasting the investigated foliage's varying phenolic content with its antioxidant capacity. The globe map image was obtained from www.outline-world-map.com, a website that offers royalty-free images. distinct vegetative and reproductive portions of the M. oleifera tree: i a field-grown tree, ii a bundle of leaves, iii blossoms, and iv fruit (pod). 6:203 203% 23 It was demonstrated that "Techiman" was the most nutrient-dense cultivar when compared to other significant MO cultivars from Pakistan (Nouman et al. 2016). (29) 5-Formyl-5,6,7,8-tetrahydrofolic acid (5-HCO-H4folate; 502.1 lg/100 g DW), 5,6,7,8-tetrahydrofolic acid (H4fo late; 223.9 lg/100 g DW), 5-Methyl-5,6,7,8-

tetrahydro folic acid (5-CH3-H4folate; 144.9 lg/100 g DW), and 10-Formylfolic acid (10-HCO-folic acid; 29.0 lg/100 g DW) are the main forms of folates found in the foliage of MO. Furthermore, these forms of folate are highly bioavailable in animals, unlike other high-folate diets like those found in green leafy vegetables1. Relative bioavailability, which is calculated by contrasting the response of synthetic folic acid with that of Moringa folates, was found to be 81.9% in a test conducted on rats. According to the recommended dietary allowances (RDA), only 50% of naturally occurring folate is bioavailable. It is therefore proposed that food based on MO can be used as a major source of folate due to its significantly increased bioavailability in animals. As per (Scotti et al 2013). One of the most important water-soluble vitamins (30) is folate, which is essential for several cellular metabolisms, including the oxidation and reduction of one-carbon units. According to Williams et al. (2015), one of the worst long-term conditions and developmental abnormalities brought on by a folate shortage is neural tube defects (NTDs) during pregnancy.(31) Consequently, in order to avoid NTDs and other chronic dysfunctions, it is strongly encouraged to have a diet high in folate when pregnant.

Origin and Geographical Distribution:

The monogeneric genus Moringa of the Moringaceae family contains thirteen species: M. arborea, which is native to Kenya; M. rivae, which is native to Kenya and Ethiopia; M. borziana, which is native to Somalia and Kenia; M. pygmaea, which is native to Somalia; M. stenopetala, which is native to Kenya and Ethiopia; M. ruspoliana, which is native to Ethiopia; M. ovalifolia, which is native to Namibia and Angola; M. drouhardii, M. hildebrandi, which is native to Madagascar; M. peregrine, which is native to the Red Sea and Horn of Africa; and M. concanensis, which is native to sub-Himalayan tracts of Northern India.(32) Currently, Moringa oleifera (Figure 1) is the most studied and used of these species. This species can develop soft wood trees up to 12 meters tall and is native to the Himalayan foothills of northern India, Pakistan, and Nepal.(33) Because of its numerous uses and opportunities, farmers and scholars were formerly drawn to it. Ayurvedic traditional medicine believes that 300 diseases may be prevented by the plant Moringa oleifera, and that its leaves have been utilized for both therapeutic and preventive purposes.(34) Moreover, a study identifies Moringa as one of the species utilized by traditional Siddha healers in Virudhunagar, Tamil Nadu, India. (35) Though it was never well known in Greece or Rome, the ancient Egyptians knew the medical properties of Moringa oleifera and used it for cosmetic and skin-preparation purposes.(36) Until recently, in the 1990s, when a few researchers started investigating its potential application in water treatment for clarity, moringa oleifera was cultivated and consumed in its natural habitat. After its nutritional and therapeutic qualities were "discovered" later on, the species expanded to almost every tropical nation. After Tanzania hosted the inaugural international conference on Moringa oleifera in 2001, there have been an increasing number of conferences and research papers committed to disseminating information about the remarkable powers of this magnificent plant. This species is now known by many names, such as "mother's best friend," "natural gift," and "miracle tree." Moringa oleifera may grow in any tropical or subtropical country that meets the necessary climate requirements, which include a dry to moist tropical or subtropical environment, 760–2500 mm of annual precipitation (less than 800 mm of irrigation required), and a temperature range of 18–28 °C. Although it may grow in any type of soil, it likes moist, heavy clay soil and can tolerate temperatures as high as 2000 m.(37) "Although regarded as a non-native species, Moringa oleifera

has garnered extensive acclaim among diverse ethnic Nigerians, who have utilized diverse applications (such as food, medication, feed, etc.)" as per an analysis on the regional applications and spatial dispersion of the plant (38) encompassing the primary agro-ecological zone in Nigeria. Currently found mostly in Middle Eastern, African, and Asian nations (39) Moringa oleifera and its derivatives are still expanding to additional regions. 2015, 16 127 Int. J. Mol. Sci.

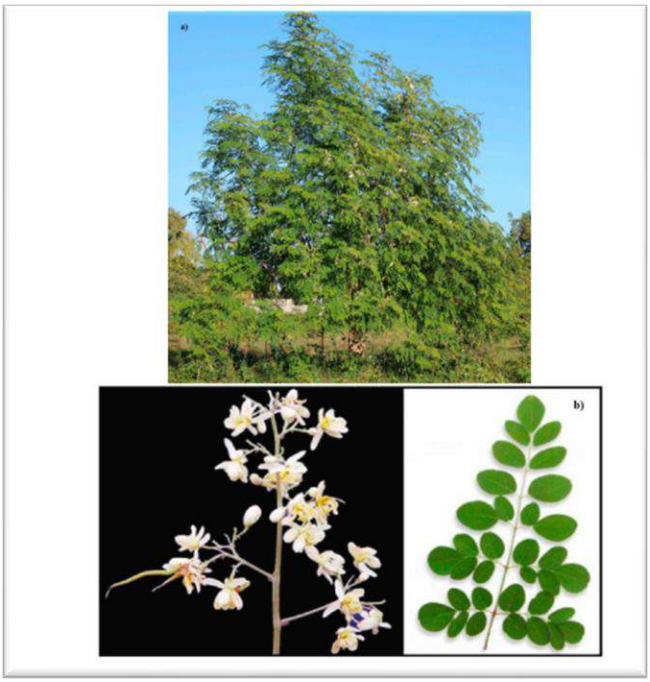

Figure shows 1: (a) A tree of Moringa oleifera; (b) Moringa flowers and leaves.

Cultivation and Production:

Cutting and seeding are the two main techniques for growing Moringa oleifera. While Sudan has historically chosen seeds, vegetative propagation is common in India, Indonesia, and other regions of West Africa. (40) Field planting is more adaptable since seedlings can be moved, even with extra work and costs, but sowing requires choosing seeds at a time when labor is scarce and seeds are easily accessible. Seeds need two weeks to germinate at a maximum depth of two millimeters. Three to six weeks after germination, or when the seedlings reach a height of around 30 cm, they can be transplanted from a nursery. (41)

Depending on the cultivar, there can be 3000–9000 seeds per kilogram, and under ideal storage circumstances (3 °C, 5%–8% moisture), 80%–90% of the seeds germination rate will occur. However, seeds that are kept at room temperature and high relative humidity lose viability; after three months, their germination rate drops to 7.5%. (42) Cutting is a better alternative if manpower is not a limitation and/or seeds are hard to come by. While Ramachandran et al. (44) claim that plants raised from seeds yield lower-quality fruits, (Animashaun et al. (43) assert that trees grown from seeds have longer roots—a plus for stability and water access—than trees grown from cuttings, which have much shorter roots. Mature trees provide hard woodcuttings (1-2 m long, 4-16 cm diameter; 45) that grow into roots in a matter of months. These cuttings are planted during the rainy season, with one third of the cuttings buried in the soil. (46) Since the tree quickly resprouts after cutting, pruning or pollarding is usually done to improve lateral branching and give the tree a bush form in order to speed the harvest. However, because there aren't many research in the literature about successful practice management of Moringa oleifera, field testing is necessary. (47) The plant's leaves and seeds are its most fascinating parts. Because of this, Moringa oleifera trees are planted with their geographical distribution planned to facilitate harvesting and the use of management techniques. A Moringa oleifera plantation can be set up in the following ways to produce leaves:

1. intense production requiring fertilization and irrigation, with harvest intervals of 35 to 45 days and spacing between 10 cm × 10 cm to 20 cm × 20 cm;
2. semi-intensive production with 50 cm × 100 cm spacing, 50–60 day harvest intervals, and recommended fertilization and irrigation;
3. incorporate into an agroforestry system with row spacing of 2-4 meters, a harvest interval

of around 60 days, and irrigation and fertilization not strictly required.

Although a great deal of diversity can be seen for a particular spatial distribution and the same cultivation management, productivity falls from intensive production to less dense spacing (agroforestry system). An intense plantation's production, for instance, can vary from 580 to 40 m/ha/year (48) depending on the season, with the cold or rainy season producing the highest yield. Additional research is required to determine the ideal spacing and harvest intervals that take into account the various climates and production systems (49) Harvesting can be done manually or mechanically. Although leaves can be plucked straight off the tree, this method results in a slower rate of regrowth. Shoots are chopped between 0.5 and 1 m above the ground. Low density plantations, often with a 2.5 × 2.5 m or 3 × 3 m triangular design, yield higher yields when producing seed. (50) Trilobite capsule fruits, also called pods, ripen approximately three months after flowering and should be gathered as soon as possible. Pods are brown in color, dry, and split longitudinally. Typically, each pod has three pale, papery leaflets around the perimeter and holds about 26 seeds with a diameter of one centimeter. Similar to leaf production, there is a great deal of variation in seed output. A single tree can yield 15,000 to 25,000 seeds, each weighing an average of 0.3 grams. (51) Early flowering cultivars can yield pods in as little as six months, while other varieties take longer to yield pods. Within six months following trimming, branches produce new pods. (52)

Harvesting techniques:

As per Table 1, the majority of farmers in Rafawa, Soura, and Djiratawa, specifically 50, 42, and 40% of them, chopped trees at a height of 0.20 meters from the ground. This was the most prepared cutting height observed among the villages. Notably, some farmers use two or three different techniques, such as cutting in the same field at a height of 0.20 meters above ground and at a height of 1.00 meters. Farmers noted that cutting at 0.20 meters above the ground prevented stump deterioration and gave agricultural crops more room to grow. This resulted in more shoots (6 to 10) and greatly increased foliage production. Research has indicated that the longest harvest intervals yielded the highest total biomass. (53) On the other hand, Lazer (54) reported that the shrubs produced their maximum yield at short cutting heights (20 and 40 cm above the ground). However, Crosby and Craker (55) reported that trees with a mean height of 19.7 cm and 150 cm, which lacked sufficient regrowth for a second harvest, were harvested at similar heights. The majority of farmers in the study area cut at 0.20 m, ground level (0 m), and 1.00 m levels. In contrast, only a small number of farmers used cutting heights of 0.5 m and 1.5 m because, as noted by Saint Sauveur (56) after cutting, trees are exposed to the elements and compete with agricultural crops for light.

Pharmacological activities of Moringa oleifera:

1. **Antimicrobial and Anthelmintic Activities.**

Moringa oleifera leaf, flower root bark, and stem bark extracts exhibit anthelmintic and antibacterial properties. Strong antibacterial and fungicidal properties of pterygospermin have been reported (57) by Das et al. and Rao et al. in the leaf and flower, respectively.(58) The antibacterial action against E. Coli, P. aeruginosa, Enterobacter species, K. pneumoniae, S. aureus, Proteus mirabilis, Salmonella typhi A, Streptococcus, and Candida albicans was demonstrated using an ethanolic extract of seeds, leaves, and flowers.(59) Numerous studies have shown the anthelmintic activity of Moringa Oleifera flowers and leaves.(60) For instance, ethanolic extracts from the leaves of the plant have been shown to suppress the Indian earthworm Phere tima posthuma.(61)

2. Antiasthmatic Activity.

Patients with bronchial asthma showed improvement in their therapy and concomitant respiratory functions with M. oleifera seed kernel, without exhibiting any negative effects.(62)

3. Anticancer and Antitumor Activity.

Moringa leaf extracts were also significantly produce cytotoxic effects.(63)

4. Antidiabetic and Wound Healing Activity.

Reactive oxygen species, or ROS, are directly related to cell death. Numerous environmental stressors cause an excessive amount of reactive oxygen species (ROS), which progressively worsen oxidative damage and eventually kill cells.(63) Three chemicals found in leaves are thought to have anticancer properties: benzyl isothiocyanate, niazimicin, and glucosinolates. A bioactive substance from Moringa leaves called "niazimicin" demonstrated possible anti-cancer properties.(64) From the ethanol extract of the Moringa seed, seven bioactive compounds were isolated: β-sitosterol, niazimicin, 3-O-(6′-oleoyl-β-D-glucopyranoyl)-β-sitosterol, β-sitosterol 3-O-β-D-glucopyranoside, glyc erol-1-(9-octadecnoate), and β-sitosterol.(65) It has been demonstrated that benzoyl isothiocyanate and cancer are related. Studies have demonstrated that BITC generates intracellular ROS, which results in cell death. This may be among the factors contributing to moringa's effectiveness as an anticancer agent.(66) Zeatin, an antiaging cytokinin that occurs naturally in moringa plants, has been shown to have anticancer effects, be beneficial against skin and prostate malignancies, and be a potent antioxidant.(67) It is said that moringa is crucial for managing diabetes.(68) It has been found that moringa leaves have a major effect in lowering blood glucose levels right away.(69) Significant prohealing effects and ideal wound healing were demonstrated by the aqueous extracts of moringa.(70)

5. Activities that Stimulate the Heart and Circulation and Reduce Water Absorption.

The bioactive component alkaloids derived from Moringa trees have been shown to have cardiac stimulant properties.(71) to decrease fat and cholesterol.(72) to affect diuretic action (73) to stabilize blood pressure (74) to prevent hyperlipidemia (75) and to lower serum triglycerides and cholesterol. (76)

6. Analgesic Activity.

Analgesic activity was seen in several sections of Moringa plants, including the leaves, pod, roots, etc. The tail immersion method was used to find the same analgesic efficacy in the alcohol-based extract of Moringa leaves.(77) In a different study, the plant's root bark (M. oleifera) provided a considerable amount of local anesthetic action in both guinea pigs and frogs when evaluated in methanol extract.(78)

7. Antipyretic Activity.

When Moringa's antipyretic properties were tested in rats using various extracts (ethanol, petro leum ether, ethyl acetate, etc.) the seed extracts (etha nol and ethyl) had the strongest effects.(79)

8. Hepatoprotective Activity.

Moringa leaf extracts have been shown to have the properties of protection against liver damage, (80) and they also aid in the reduction of liver fibrosis.(81)

CONCLUSION:

Over synthetic drugs natural drugs are safe. They produce various pharmacological actions with zero adverse effects. Moringa olifera offers immense medicinal values.

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