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Review Article

HEALTH BENEFITS, THERAPEUTIC AND PHARMACOLOGICAL PROPERTIES OF MORINGA- A REVIEW

ABSTRACT

Moringa yields at least four different edibles parts *viz.,* pods, leaves, flowers and seeds. Moringa leaves are good source of protein, β-carotene, vitamins, A, B, C and E, riboflavin, nicotinic acid, folic acid, pyridoxine, amino acids, minerals and various phenolic compounds, phytochemicals and omega 3 and 6 fatty acids. The leaves of moringa are rich in palmitic and linolenic acids whereas the seeds are predominated by oleic acid. The leaves were used to combat malnutrition, especially among infants and nursing mothers in many developing countries, particularly in India, Pakistan, Philippines, Hawaii and many parts of Africa. Pregnant women and lactating mothers use moringa leaf powder to enhance their child or children's nourishment especially in underdeveloped countries where womens are suffering from malnutrition. These natural plant phenolics present in moringa leaves could be a good source of antioxidants and antimicrobials for food and pharmaceutical industries. Perhaps using the multi mix approach of food product development more food products could be developed especially for programs on malnutrition.

Keywords: Moringa, *Moringa oleifera* Lam, Pharmacological properties, Therapeutic uses

INTRODUCTION

Moringa oleifera Lam is the most widely cultivated multipurpose tree species of a monogeneric family, Moringaceae in which immature fruits, fresh leaves and flowers are used for culinary purpose [1, 2]. The plant is also known as Drumstick, Sahjan or Sohanjana in India [3] which has different vernacular names pertaining to each region and these were listed in table 1. All plant parts of this tree have remarkable range of functional, medicinal and nutraceutical properties [4, 5]. In India and other countries, the tree is valued mainly for the tender pods which used as a vegetable [6] and it is used medicinally in Guinea, Madagascar, and Burma [7, 8, and 9]. It is referred as a "multipurpose tree" "miracle tree" or a "wonder tree" [10, 11, and 12] because of its several nutritional, pharmacological [11, 13, and 14] and industrial applications

UNDER PEER REVIEW

[10, 12, 15 and 16]. The Moringa seeds found to exhibit natural coagulants/flocculants properties, which have potential to clear turbidity in drinking water and sludge in sewage respectively [17, 18, 19 and 20].

HEALTH BENEFITS

With four times the β-carotene of carrot, moringa has a unique potential for programs dealing with avitaminosis or hypovitaminosis syndrome known as vitamin A deficiency that causes 70 percent of childhood blindness. Presence of various types of antioxidant compounds make this plant leaves a valuable source of natural antioxidants [21,22] and a good source of nutraceuticals and functional components as well [23]. Consumption of diet supplemented with moringa leaves could protect against diseases induced by oxidative stress. Many moringa nutritional supplements exist in the market including moringa dry leaf powder, capsules, nutrient shake and health booster. The moringa seed contains high quality edible oil (up to 40% by weight). In Haiti, the oil has been used as general culinary and salad oil. It resembles olive oil in its fatty acid composition [24]. Hence, moringa plant is of great potential that could be cultivated as economically profitable crop to contribute in poverty alleviation [25].

CULINARY USES

Moringa is consumed in diverse culinary preparations [26]. Almost all parts of the plant used for taste, flavor or as vegetables [27]. In South India, pod are used to prepare a variety of sambars, curries with dals, fried curries and also used to add flavor to cutlets *etc.* In West Bengal and Bangladesh, it is used in variety of dishes by mixing with coconut, poppy seeds or mustard and boiled until the moringa pods are semi-soft and consumed directly without any extra processing or cooking. In Maharastra, the pods are used in sweet and sour curries called "Aamatee". Tender moringa leaves are finely chopped and used as garnish for vegetable dishes, dals, sambar and salads [28]. The fresh succulent leaves are harvested daily for soups, sauces, or salads [25].

UNDER PEER REVIEW

THERAPEUTIC AND PHARMACOLOGICAL PROPERTIES OF MORINGA

Besides rich nutritional value, moringa also has curative and prophylactic properties [29]. Almost all the parts *viz.,* root, bark, gum, leaf, pods, flowers, seed and seed oil have been used for various ailments. Rajangam *et al.*[30] stated that the plant possess rich pharmacological properties like cardia and circulatory stimulants, anti-tumour, anti-pyretic, anti-inflammatory, anti-spasmodic, diuretic, anti-hypertensive, anti-diabetic, hepato-protective, anti-bacterial and anti-fungal properties. Enormous research and development programmes were conducted on pharmaceutical and therapeutic properties of moringa and were summarized hereunder.

1. ANTI-MICROBIAL ACTIVITY

Caceres *et al.* [13] studied the antimicrobial activities of moringa leaves, roots, bark and seeds against bacteria, yeast, dermatophytes and helminths by a disk-diffusion method. The fresh leaf juice and aqueous extracts from seeds inhibit the growth of *Pseudomonas aeruginosa* and *Staphylococcus aureus.* They inferred that no activity was demonstrated against other pathogenic *viz.,* Gram-positive, Gram-negative bacteria and *Candida albicans*. Juice from the stem bark showed antibacterial effect against *S. aureus* [31].

Dahot [32] investigated the antimicrobial activity of three fractions of moringa leaf extract against *Escherichia coli, Klebsiella aerogenes*, *K. pneumoniae, S. aureus and Basillus subtilis* and observed that all the three fractions showed strong inhibitory activity against *E. coli*, *S. aureus* and *B. subtilis.* But clear zone of inhibition was noted against *K. aerogenes* and fraction 2 showed significant zone of inhibition against *Aspergillus niger.* Similarly, Amer *et al.* [33], Renitta *et al.* [34], Peixoto *et al.* [35] and Mbikay [36] stated that aqueous and ethanol moringa leaf extract could be potential source for treatment against certain bacterial infection.

Since bacteria in water are attached to solid particles, treatment of water with moringa powder can remove bacteria up to 90 to 99% [37, 38, 39,40]. Additional treatment of water by boiling or adding chlorine is needed to render it completely safe to drink. Similarly, Shekhar *et al.* [41] tested the effect crude ethanol extract of moringa seed against *E. coli*, *Salmonella typhii*, *Vibrio cholera, Shigella dysentriae* and *Pseudomonas aeruginosa* in drinking water and inferred that moringa seed extracts had antibacterial activity against *E. coli.* Arama *et al.* [42] also tested the moringa seed extract for antibacterial activity against *Escherichia coli* (ATCC 25922),

UNDER PEER REVIEW

S. typhii and *V. cholerae* (ref. Romel Cary Blair Lot. 452610) and indicated that *V. cholerae* was the most tolerant bacteria species to moringa extract as compared to *E. coli* and *S. typhii.*

Alam *et al.* [43] investigated antibacterial activity of moringa leaf extracts against four Gram negative bacteria (*Shigella shinga, Pseudomonas aeruginosa, Shigella sonnei* and *Pseudomonas* spp.) and six gram-positive bacteria (*Staphylococcus aureus, Bacillus cereus, Streptococcus-B- haemolytica, Bacillus subtilis, Sarcina lutea* and *Bacillus megaterium*) and inferred that leaf extract exhibited inhibitory effect against all the tested Gram-negative bacteria and Gram-positive bacteria except in *S. aureus* and *S. haemolytica.* Nantachit [44]; Doughari *et al.*[45] and Prashith *et al.*[46] reported similar anti-bacterial activity of moringa against certain bacteria. Nwosu and Okafor [47]; Nikkon *et al.* [48]; Chen *et al.* [49]; Jamil *et al.* [50] and Prashith *et al.* [46] reported antifungal activity of moringa leaf extract against seven pathogenic fungi using the broth dilution and agar plate methods.

2. ANTI-INFLAMMATORY ACTIVITY

Medhi *et al.* [51]; Ndiaye *et al.* [52] and Sashidhara *et al.* [53] evaluated anti-inflammatory activity of methanol and aqueous extract of moringa root bark at a dose of 750 mg/kg and observed significant inhibition of oedema development at 1, 3 and 5 hours after treatment. Mahajan *et al.* [54, 55] investigated anti-inflammatory activity from the ethanol extract of moringa seeds in toluene diisocyanate (TDI as antigen) induced asthma in Wistar rats and in guinea pigs. Anti-fibrotic study conducted by Hamza [56] indicated that moringa seed extract possessed anti-inflammatory properties against CCL4 induced liver damage [57] and fibrosis. Paliwal *et al.* [28] stated that moringa seed oil have been used for various ailments in indigenous medicine of South Asia, including the treatment of inflammation and infectious diseases along with cardiovascular, gastrointestinal, hematological and hepatorenal disorders. Moringa leaves are therefore potential source of natural antioxidants which were related to anti-inflammatory activity [13, 14, 48 and 36].

3. ANTI-OXIDANT ACTIVITY

Ashok Kumar and Pari [58] investigated antioxidant potential of moringa on hepatic marker enzymes, lipid peroxidation and antioxidants. The result of this study revealed that moringa extract and silymarin significantly decreased hepatic marker enzymes and lipid peroxidation with a simultaneous increase in the level of antioxidants. Bajpai *et al.* [59] tested

UNDER PEER REVIEW

the antioxidant activity of moringa leaves and inferred that kaempferol content is mainly responsible for this antioxidant property.

Siddhuraju and Becker [60] reported the antioxidant and free radical scavenging property of water, aqueous methanol and ethanol extracts of freeze-dried moringa leaves. The major bioactive compounds of phenolics were flavonoid groups such as quercetin and kaempferol. Various types of antioxidant compounds present in leaves and roots of moringa make this plant as a valuable source of natural antioxidants [21, 22, 27,61,62,63,64,65,66] and good source of nutraceuticals and functional components as well [15].

4. ANTI-CANCER ACTIVITY

Moringa have long been recognized by folk medicine practitioners as it has anti-tumour properties [67] and cancer prevention potential [68]. Murakami *et al.* [69] investigated the antitumor activity of moringa leaves and inferred that thiocarbamate (TC) and isothiocyanate (ITC) related compounds present in leaves are responsible for anti-tumor activity. Similarly, Aruna and Sivaramakrishnan [70]; Guevara *et al.* [71]; Bharali *et al.* [72]; Costa *et al.* [73]; Parvathy and Umamaheshwari [74]; and Ahmad *et al.* [75] also reported the anticancer activity of ethanol extract of moringa seeds and leaves.

5. HEPATO-PROTECTIVE ACTIVITY

Aqueous and alcohol extract of moringa flowers and roots possess hepato-protective activity [76] which may be due to the presence of quercetin, a well known flavonoid with hepato-protective activity. Mazumder *et al.* [77] investigated hematological along with hepato-renal functions of methanol extract of moringa root in mice and concluded that high dose at daily treatment and moderate and high dose at weekly treatment with crude extract (CE) of moringa root increased WBC count and decreased clotting time significantly. Pari and Kumar [78] evaluated hepato-protective effect of ethanol extract of moringa leaves on liver damage induced by anti-tubercular drugs such as isoniazid (INH), rifampicin (RMP), and pyrazinamide (PZA) in rats and observed oral administration of the extract showed a significant protective action against hepatic disorders.

Hepato-protective action of moringa seeds against Diclofenac (DIC) induced hepatic toxicity in male albino rats were investigated and the results of this study revealed that treatment with herbal extracts for 30 days before DIC treatment significantly reduces the indices of hepato

UNDER PEER REVIEW

toxicity induced by DIC [79]. Concomitant to this finding, Pal *et al.*[80]; Fakurazi *et al.*[81]; Hamza [56] and Paliwal *et al.*[28] also stated similar results.

6. CARDIOVASCULAR ACTIVITY

The widespread combination of diuretic along with lipid and blood pressure lowering constituents makes this plant highly useful against cardiovascular disorders. According to Dahot [32] moringa leaf juice known to have a stabilizing effect on blood pressure. Faizi *et al.* [82,83 ad 84] isolated thiocarbamate and isothiocyanate glycosides from ethanol extracts of moringa leaves and inferred that these compounds are responsible for promising hypotensive activity. Gilani *et al.*[85] isolated four pure compounds *viz.,* niazinin A, niazinin B, niazimicin and niazinin which showed a blood pressure lowering effect. Ghasi *et al.*[86] and Mehta *et al.*[31] investigated hypocholesterolemic effect of crude leaf extract of moringa and observed significantly reduced serum cholesterol level but serum albumin level was increased by 15.22%.

Ara *et al*. [87] investigated the comparative effects of ethanol extracts of moringa leaves on serum cholesterol level, serum triglyceride level, blood glucose level, heart weight and body weight of adrenaline induced rats. The results of this study revealed that moringa leaves extract made significant changes in each cardiovascular parameter. Limaye *et al.* [88]; Mazumder *et al.* [77]; Nikkon *et al.* [48]; Ndong *et al.* [89]; Chumark *et al.* [27]; Nandave *et al.* [90]; Paliwal *et al.*[28]; Popoola and Obembe [91] and Abe and Ohtani [92] also reported the cardio-protective and hypotensive activity of ethanol extract of moringa leaves.

7. ANTI-ULCER ACTIVITY

Pal *et al.* [80] reported that the moringa seed powder and leaves extracts have anti-ulcer and anti-gastritis activity. Moringa also has antibiotic activities against *Helicobacter pylori* which cause gastritis, gastric and duodenal ulcers [93]. Debnath and Guha [94] also reported the anti-ulcer effect of aqueous extract of moringa leaves on adult holtzman albino rats of either sex using ondansetron as standard drug.

8. ANALGESIC, ANTIPYRETIC AND WOUND HEALING ACTIVITY

Medhi *et al.* [51] and Rao *et al*. [95] investigated the methanol extract of moringa root bark in mice using acetic acid induced writhing method for analgesic activity. Rathi *et al.* [96] evaluated the wound healing property of aqueous extract of moringa leaves in male Swiss albino mice. Significant increase in wound closure rate, skin breaking strength, granuloma breaking

UNDER PEER REVIEW

strength, hydroxyproline content, granuloma dry weight and decrease in scar area was observed. Hukkeri *et al.* [97] investigated the antipyretic and wound healing activity of ethanol and ethyl acetate extracts of moringa leaves. The ethanol and ethyl acetate extracts of seeds showed significant antipyretic activity in rats; whereas ethyl acetate extract of dried leaves showed significant wound healing activity (10% extracts in the form of ointment) on excision, incision and dead space (granuloma) wound models in rats.

9. ANTI-DIABETIC ACTIVITY

Suzuki *et al.* [98] studied the anti-diabetic effect of moringa leaves on glucose tolerance in Goto-Kakizaki and Wistar rats. Moringa leaf extract significantly decreased the blood glucose in Wistar rats. Jaiswal *et al.* [99] reported anti-diabetic activity of aqueous extract of moringa leaves on glycemic control, haemoglobin, total protein, urine sugar, urine protein and body weight. Ezeamuzie *et al.* [100] and Siddhuraju and Becker [60] indicated the anti-diabetic property of moringa. Hypo-cholesterolemic and hypoglycemic properties of moringa leaves were also reported by Siddiqui and Khan [101]; Ghasi *et al.*[86] and Dangi *et al.*[102].

10. DIURETIC AND ANTIUROLITHIATIC ACTIVITY

Morton [103] and Caceres *et al.* [13] reported diuretic activity of hot water infusions of flowers, leaves, roots, seeds and stalks or bark of moringa. The diuretic components present in these plant parts play a complementary role in lowering blood pressure. Karadi *et al.*[104,105] reported anti-urolithiatic property of aqueous and alcohol extract of moringa root bark and inferred that both the extracts significantly lowered the urinary excretion and kidney retention levels of oxalate, calcium and phosphate. Moreover, elevated serum levels of urea nitrogen, creatinine and uric acid were significantly reduced by these extracts.

11. OTHER DIVERSE PHARMACEUTICAL ACTIVITIES

Moringa has been reported to exhibit other diverse beneficial activities. The plant has also been used for the treatment of ascites, rheumatism [22], venomous bites [106] and CNS depressant [100, 107,108]. The seed extract have been reported to be administered nasally to control the diseases like rhinitis and the dried seeds used successfully as an ‘anti-allergic’ agent by the ayurvedic practitioners [109,110]. Additionally, the leaves have been reported for its radio-protective [111,112] and anthelmintic activity [113,114]. Moringa roots have been reported to possess anti-spasmodic activities [13,115,102] which helps for the management of

UNDER PEER REVIEW

gastrointestinal motility disorders. Aqueous leaf extract of moringa regulate "thyroid hormone" and can be used to treat hyperthyroidism [80,116].

Table 1. Vernacular names of moringapertaining to different region

Latin	:	*Moringaoleifera*
Sanskrit	:	Danshamula, Shobhanjana, SigruShobhanjan, Sobhanjana, sigruh
Arabian	:	Rawag
French	:	Moringe à graineailée, Morungue
Spanish	:	Ángela, Ben, Moringa
Portuguese	:	Moringa, Moringueiro
Chinese	:	La ken
English	:	Drumstick tree, Horseradish tree, Radish tree, Ben oil tree, Mother's Best Friend, West Indian ben.
Tamil	:	Morunga, Murungai, Murunkak-kai.
Telugu	:	Mulaga, Munaga, Tella-Munaga, Sajana,
Kannada		Guggala, mochaka, nugge, moxing
Malayalam	:	Sigru, Moringa, Muringa, Murinna, Morunna
Punjabi	:	Sainjna, Soanjna
Unani	:	Sahajan
Ayurvedic	:	Akshiva, Haritashaaka, Raktaka, Tikshnagandhaa
Hindi/ Orissa	:	Munga ara, Shajmah, Shajna, Segra, Mungna, sahjan, saijna, sanjna, Soanjana, Soajna, Sohajna.
Gujarati	:	Midho-saragavo, Saragavo, Saragvo, Suragavo, segto, seyla.
Bengali	:	Munga ara, *Sajina, Sajna, Sujana*
Kanarese	:	Nugga egipa, Nugge, Noogay, Nuggi Mara
Kol	:	Mulgia, Munga ara, Mungna
Kumao – Himalayanregion	:	Sunara
Konkani/Goa	:	Moosing, Mosing
Marathi	:	Sujna, Shevga, Shivga, Achajhada, shevgi
Modesia/W. Bengal	:	Mangnai
Monghye/Punjab	:	Sejana
Oriya	:	Munigha, Sajina, Munika, Sojina, Sojaba
Punjabi	:	Sanjna, Senjna, soanjna
Rajasthan	:	LalSahinjano
Sindhi	:	Swanjera
Teling	:	Morunga, Morungai
Urdu	:	Sahajna
Central provinces	:	Mulaka, Saihan
Western region	:	Sundan

[Source: Ram and Mehrotra, [117]; Roloff *et al*., [118]; Paliwal *et al.*[28]; Mishra *et al*., [106]; www.moringanews.org/documents/VERNACULAR.doc***]***

UNDER PEER REVIEW

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UNDER PEER REVIEW

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UNDER PEER REVIEW

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UNDER PEER REVIEW

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UNDER PEER REVIEW

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