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2 **HEALTH BENEFITS, THERAPEUTIC AND PHARMACOLOGICAL PROPERTIES OF**
3 **MORINGA- A REVIEW**4 **ABSTRACT** 

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

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

19 **INTRODUCTION**

20 *Moringa oleifera* Lam is the most widely cultivated multipurpose tree species of a
21 monogeneric family, Moringaceae in which immature fruits, fresh leaves and flowers are used
22 for culinary purpose [1, 2]. The plant is also known as Drumstick, Sahjan or Sohanjana in India
23 [3] which has different vernacular names pertaining to each region and these were listed in table
24 1. All plant parts of this tree have remarkable range of functional, medicinal and nutraceutical
25 properties [4, 5]. In India and other countries, the tree is valued mainly for the tender pods which
26 used as a vegetable [6] and it is used medicinally in Guinea, Madagascar, and Burma [7, 8, and
27 9]. It is referred as a “multipurpose tree” “miracle tree” or a “wonder tree” [10, 11, and 12]
28 because of its several nutritional, pharmacological [11, 13, and 14] and industrial applications

29 [10, 12, 15 and 16]. The Moringa seeds found to exhibit natural coagulants/flocculants
30 properties, which have potential to clear turbidity in drinking water and sludge in sewage
31 respectively [17, 18, 19 and 20].

32 **HEALTH BENEFITS**

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

44 **CULINARY USES**

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

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59 THERAPEUTIC AND PHARMACOLOGICAL PROPERTIES OF MORINGA 

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

67 1. ANTI-MICROBIAL ACTIVITY

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

74 Dahot [32] investigated the antimicrobial activity of three fractions of moringa leaf
75 extract against *Escherichia coli*, *Klebsiella aerogenes*, *K. pneumoniae*, *S. aureus* and *Basillus*
76 *subtilis* and observed that all the three fractions showed strong inhibitory activity against *E. coli*,
77 *S. aureus* and *B. subtilis*. But clear zone of inhibition was noted against *K. aerogenes* and
78 fraction 2 showed significant zone of inhibition against *Aspergillus niger*. Similarly, Amer *et al.*
79 [33], Renitta *et al.* [34], Peixoto *et al.* [35] and Mbikay [36] stated that aqueous and ethanol
80 moringa leaf extract could be potential source for treatment against certain bacterial infection.

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

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

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

100 2. ANTI-INFLAMMATORY ACTIVITY

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

113 3. ANTI-OXIDANT ACTIVITY

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

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

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

126 **4. ANTI-CANCER ACTIVITY**

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

134 **5. HEPATO-PROTECTIVE ACTIVITY**

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

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

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

150 **6. CARDIOVASCULAR ACTIVITY**

151 The widespread combination of diuretic along with lipid and blood pressure lowering
152 constituents makes this plant highly useful against cardiovascular disorders. According to Dahot
153 [32] moringa leaf juice known to have a stabilizing effect on blood pressure. Faizi *et al.* [82,83
154 ad 84] isolated thiocarbamate and isothiocyanate glycosides from ethanol extracts of moringa
155 leaves and inferred that these compounds are responsible for promising hypotensive activity.
156 Gilani *et al.*[85] isolated four pure compounds *viz.*, niazinin A, niazinin B, niazimicin and
157 niazinin which showed a blood pressure lowering effect. Ghasi *et al.*[86] and Mehta *et al.*[31]
158 investigated hypocholesterolemic effect of crude leaf extract of moringa and observed
159 significantly reduced serum cholesterol level but serum albumin level was increased by 15.22%.

160 Ara *et al.* [87] investigated the comparative effects of ethanol extracts of moringa leaves
161 on serum cholesterol level, serum triglyceride level, blood glucose level, heart weight and body
162 weight of adrenaline induced rats. The results of this study revealed that moringa leaves extract
163 made significant changes in each cardiovascular parameter. Limaye *et al.* [88]; Mazumder *et al.*
164 [77]; Nikkon *et al.* [48]; Ndong *et al.* [89]; Chumark *et al.* [27]; Nandave *et al.* [90]; Paliwal *et*
165 *al.*[28]; Popoola and Obembe [91] and Abe and Ohtani [92] also reported the cardio-protective
166 and hypotensive activity of ethanol extract of moringa leaves.

167 **7. ANTI-ULCER ACTIVITY**

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

173 **8. ANALGESIC, ANTIPYRETIC AND WOUND HEALING ACTIVITY**

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

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

184 **9. ANTI-DIABETIC ACTIVITY**

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

192 **10. DIURETIC AND ANTIUROLITHIATIC ACTIVITY**

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

200 **11. OTHER DIVERSE PHARMACEUTICAL ACTIVITIES**

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

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

210 **Table 1. Vernacular names of moringapertaining to different region**

Latin	:	<i>Moringaoleifera</i>
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.
<i>Bengali</i>	:	Munga ara, <i>Sajina, Sajna, Sujana</i>
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

211 [Source: Ram and Mehrotra, [117]; Roloff *et al.*, [118]; Paliwal *et al.*[28]; Mishra *et al.*,
 212 [106]; www.moringanews.org/documents/VERNACULAR.doc]

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