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## PHYTOCHEMICAL AND PHARMACOLOGICAL PROFILE OF *MORINGA OLEIFERA* LAM.

Priyanshu Jain, Nancy Jain and Umesh K. Patil \*

Department of Pharmaceutical Sciences, Dr. Harisingh Gour Vishwavidyalaya, Sagar - 470003, Madhya Pradesh, India.

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### Correspondence to Author:

**Prof. (Dr.) Umesh K. Patil**

Professor,  
Department of Pharmaceutical  
Sciences, Dr. Harisingh Gour  
Vishwavidyalaya, Sagar - 470003,  
Madhya Pradesh, India.

**E-mail:** Umeshpatil29@gmail.com

**ABSTRACT:** *Moringa oleifera*, a miracle plant, is praised for beneficial health nutrients and has potential cholesterol-lowering activity. Almost all the parts of the *Moringa oleifera* plant have potential bioactivity. The main active constituents of *Moringa oleifera* are flavonoids, alkaloids, phenols, vitamins, minerals, proteins, glycosides, Glucosinolates and Isothiocyanates, terpenes, saponins, tannins, and many more. The *Moringa oleifera* has potent activity towards various ailments such as cancer, diabetes, inflammatory, antibacterial properties, cardiovascular diseases, and many more. Hyperlipidemia is referring to the increase in the level of lipid in plasma, and that leads to cardiovascular diseases. Antihyperlipidemic activity of *Moringa oleifera* is reported to be due to phytochemicals such as flavonoids, phytosterols, and phenols. This review mainly focuses on the pharmacological role of *Moringa oleifera* in the treatment of hyperlipidemia. The present article also describes the bioactive constituents of *Moringa oleifera* and its therapeutic activity.

**INTRODUCTION:** Hyperlipidemia an abnormal elevation of excess fatty substances called lipids, largely cholesterol and triglycerides, in the blood and common risk factor for cardiovascular diseases as a person with hyperlipidemia is about twice probable to develop coronary heart disorders<sup>1, 2</sup>. The major causes are obesity, genetic diseases, dietary diseases, diabetes, etc. High lipid concentration elevates atherogenesis and leads to hyperlipidemia<sup>3</sup>. Apart from this, there are other types of hyperlipidemia, which include Hypertriglyceridemia and blended hyperlipidemia, in which both cholesterol, fatty substance (lipids), and triglycerides levels are raised.

Raised LDL-C can prompt the development of plaques inside the veins and is related to an expanded danger of atherosclerotic cardiovascular disease or ASCVD, including blockage or narrowing of the coronary arteries or stroke. As HDL-C capacities to eliminate cholesterol from the body, expanded degrees of HDL-C ( $\geq 60$  mg/dL) can help decline the danger of ASCVD<sup>4</sup>.

Hyperlipidemia demonstrates strangely raised degrees of lipids or lipoproteins in the blood because of unusual fat digestion or capacity, and it is brought about by dietary issues, obesity, hereditary ailments, for example, familial hypercholesterolemia or FH, and different ailments like diabetes<sup>5</sup>. Patients with hyperlipidemia are about twice as liable to make cardiovascular disease (CVD). Whole parts of the plant *Moringa Oleifera* Lam. are highly nutritious and medicinal. *Moringa oleifera* Lam. (Drumstick tree, Family Moringaceae) is the most significant plant largely cultivated in India.

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Among several species, *Moringa oleifera* is a current interest of research as it possesses tremendous potentials<sup>6</sup>. This plant is generally utilized as a dietary spice and contains significant pharmacological activity like anti-diabetic<sup>7</sup> hepatoprotective, anti-inflammatory<sup>8</sup> anti-asthmatic<sup>9</sup> anti-cancer<sup>10</sup> Antibacterial<sup>11</sup> antifungal activities<sup>12</sup> anti-oxidant<sup>13</sup> cardiovascular<sup>14</sup> CNS activity, anti-ulcer, wound healing<sup>35</sup> anti-fertility<sup>15</sup> anti-allergic activity, antipyretic activity and anti-epileptic<sup>16</sup>. In the Philippines, it is known as 'mother's best friend' due to its usage to increment lady's milk creation and is once in a while recommended for iron deficiency or anemia<sup>58</sup>. Many parts of *Moringa* have been accounted to be a rich source of protein, vitamin C, potassium, calcium, and b-carotene<sup>59</sup> and also serve as an abundant source of natural antioxidants and along, it increases the time span of usability of fat-containing foods because of the presence of numerous types of antioxidant agents for example flavonoids, ascorbic acid, phenolics and carotenoids<sup>60</sup>.

### 1. Bioactive Constituents of *Moringa oleifera*:

*Moringa oleifera*, 'a miracle tree' is praised with health beneficial nutrients and is a rich source of antioxidants, and almost all parts are considered as nutritious in traditional herbal medicine. The plant contains different minerals and vitamins<sup>16</sup>. Different parts of this plant are good source amino acid, proteins, beta-carotene, alkaloids, flavonoids, phenolics, and other phytoconstituents such as glucosinolates, isothiocyanates, tannins, and Saponins<sup>17, 18, 19, 20</sup>. The phytoconstituents of this plant offer valuable nutrients and essential chemicals that help in preventing and treating disease **Fig. 1**. There are many pieces of evidence that prove *Moringa oleifera* as a good nutritious plant and possesses beneficial effects to human. The bioactive constituents show promising pharmacological activity, which is proven in several *in-vitro* and *in-vivo* studies<sup>19</sup>.

**2.1 Polyphenols:** Flavonoids and phenolic acid are polyphenolic compounds majorly present in the dried leaves<sup>21, 22</sup> roots, flower<sup>23</sup> stem, pods, the seed of *Moringa oleifera*<sup>24, 25</sup>. Flavonoids are the secondary metabolites and are the most common phytoconstituents present in plants. They exert health benefits to the human body and prevent

many diseases. The leaves of *M. oleifera* consist of many flavonoids but Quercetin, apigenin, kaempferol, and isorhamnetin are the most abundant flavonoids with potent pharmacological activity<sup>24</sup>. The seeds of *M. oleifera* consist of  $2.900 \pm 0.0002$  (mg Quercetin equivalents / g dry matter) of flavonoids when evaluated through colorimetric analysis<sup>26</sup>. Flavonoids have reported anticancer and antioxidant activity along with anti-inflammatory, anti-allergic, anti-microbial, and many more<sup>27</sup>. Phenolic content in the *M. oleifera* leave extract is about 962.6 mg RE/g and among several phenolic compounds, Quercetin-3-O- $\beta$ -D-glucoside exerts potent antioxidant activity<sup>28, 29</sup>.

**2.2 Vitamins:** *Moringa* is the major source of several vitamins, minerals, protein, amino acid, and organic acids. Vitamins are the nutritional chemical compounds that are essential for human body<sup>30, 31</sup>. Vitamins contents in *Moringa oleifera* leaf extract was determined to be as Vitamin A, Vitamin B, and Vitamin C as - 80  $\mu$ g, - 2.324 mg, and 8.6 mg, respectively<sup>61</sup>.

In another study, Vitamin C and Beta carotene, which have potent bioactivity, act as antioxidants and maintain a balance diet, were determined to be  $6.26 \pm 0.028$  mg and  $223 \pm 5.657$  RE per 100 ml of *Moringa* leave extract<sup>32, 33</sup>.

**2.3 Glucosinolates and Isothiocyanates:** The most investigated secondary metabolites in plants are glucosinolates with bioactive and nutraceutical potentials<sup>34</sup>. *Moringa oleifera* contains two potent glucosinolates namely  $\alpha$ -4-rhamnopyranosyloxy-benzyl glucosinolate and acetyl- $\alpha$ -4-rhamno-pyranosyloxy-benzyl glucosinolate Isomer III which also possess potent bioactivity against cancerous cells<sup>34</sup>. *Moringa oleifera* also possesses an uncommon glucosinolate, namely glucomoringin, which is a potent anti-proliferative and antimicrobial agent<sup>36</sup>. Glucosinolates get converted to Isothiocyanates in the presence of enzyme myrosinase which is present in the tissues of plants and also in GIT tract of humans<sup>37, 38</sup>. Isothiocyanates are a plant constituent with antioxidants and anti-inflammatory potentials<sup>39, 40</sup>.

**2.4 Terpenes, Saponins and Tannins:** The saponin content of *Moringa oleifera* is about 0.67%<sup>41</sup>. Similarly, saponin content in bark, leaves, and

seed is reported to be  $1.20 \pm 0.70\%$ ,  $3.20 \pm 0.90\%$ , and  $13.65 \pm 4.56\%$ , respectively<sup>27</sup>. The saponin from *Moringa* leaves was isolated and characterized using High-performance liquid chromatography<sup>42</sup>. Terpenes and tannins are widely distributed in several plants and also occur as glycosidic form. Phytochemical evaluation of *Moringa Oleifera* also reported the presence of tannins and terpenoid compounds<sup>21, 43</sup>.

**2.5 Alkaloids:** All parts of this plant contain alkaloids in abundance ( $5.60 \pm 0.60 - 13.83 \pm 1.03\%$ ) with many therapeutic activities.

Others suggested the quantity of alkaloids as 460 mg.  $100 \text{ g}^{-1}$  of in moringa leaves extract<sup>27</sup>. The total alkaloids from *Moringa oleifera* were evaluated from anti-hypertensive activity.

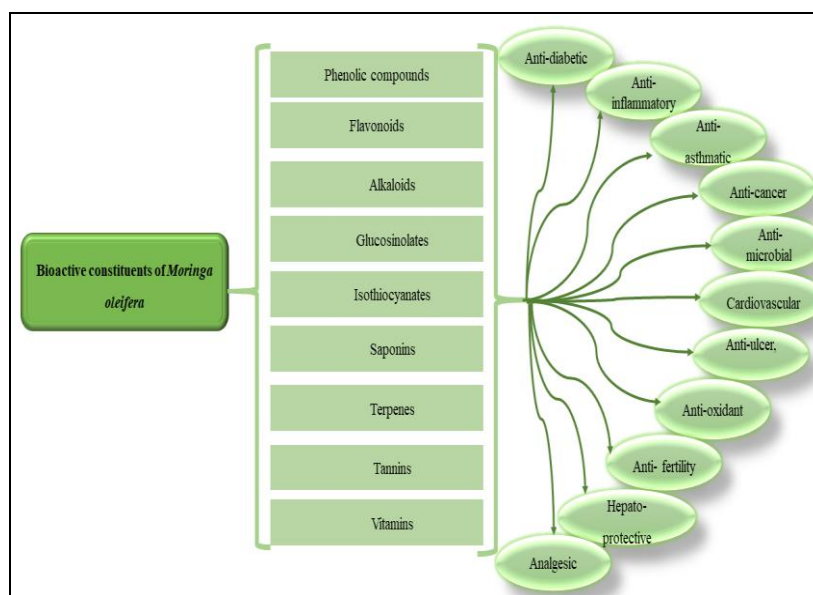


FIG. 1: BIOACTIVE CONSTITUENTS OF *MORINGA OLEIFERA* WITH ITS THERAPEUTIC USES

**3. Pharmacological Potentials of *Moringa oleifera*:** *Moringa oleifera* possess the tremendous activity and potentials against cancer<sup>44</sup>, cardiovascular diseases<sup>45</sup> diabetes<sup>46</sup>, antioxidant<sup>47</sup> antimicrobial<sup>48</sup>, and other<sup>49</sup>. Iron nanoparticles synthesized using *Moringa oleifera* fruit and leave aqueous extract were investigated for their antibacterial against *S. aureus* and *B. subtilis*, which resulted in the zone of inhibition of 15 mm showing antimicrobial potentials of *Moringa*.

Leaf extract of *Moringa oleifera* has investigated for anticancer and anti-inflammatory activity in streptozotocin-induced diabetes in the rat model. *Moringa oleifera* possesses the ability to reduce the damage caused by streptozotocin to hepatic and nephron and decrease the interleukin levels showing anti-inflammatory activity.

It also upregulates Bcl2 level and downregulates NFK $\beta$  level proving its anti-apoptotic activity<sup>8</sup>. Antiproliferative activity of hexane fraction of crude ethanolic seed extract *Moringa oleifera* was

investigated against breast cancer cell (MCF7). The result clearly showed that it inhibits the proliferation of cancer cells and arrest the cell cycle at S and G2/M phase. Hexane fraction of crude ethanolic seed extract *Moringa oleifera* induces apoptosis, cell cycle arrest, regulates the cell death markers, and act as an anti-cancer agent<sup>10</sup>.

In a study, silver nanoparticle was incorporated in leave extract *Moringa oleifera* and this resulted in increased in cytotoxic activity against colon cancer cells and also increase in antioxidant activity<sup>44</sup>.

The antioxidant property of *Moringa oleifera* leave and fruit ethanolic and aqueous extract was evaluated through *in-vitro* and *in-vivo* assay and reported antioxidant activity at the dose of 100 mg/kg of body weight<sup>50</sup>. *Moringa oleifera* is the solution of varieties of health-related problems, having the potentials to cure many diseases and can be the future herb to be investigated for immunity booster activity especially to support COVID-19 treatment<sup>51</sup>.



FIG. 2: MEDICINAL POTENTIALS OF *MORINGA OLEIFERA*

**4. Potential Role of *Moringa oleifera* in Treatment of Hyperlipidemia:** Methanolic extract of *Moringa oleifera* leaves was investigated for hypolipidemic activity in Albino Wistar rats (150, 300 and 600 mg/kg, p.o.) taking simvastatin (4 mg/kg, p.o.) as standard for 30 days. This study showed that Methanolic extract of *Moringa oleifera* increase the excretion of fecal cholesterol and act as a hypolipidemic agent<sup>52</sup>.

In a study *Moringa oleifera*, leaf powder was incorporated in the patient's diet to evaluate its effect on LDL, total cholesterol, serum triglyceride, Bodyweight, HDL, and other. Major reduction of LDL, Total cholesterol, serum triglyceride, Bodyweight was observed with a significant increase in the level of HDL. This suggests that moringa is an anti-hyperlipidemic agent and regulates the lipid profile<sup>53</sup>. Another study on Methanolic extract of *Moringa oleifera* leaves (200 mg and 400 mg/kg) also suggested that anti-hyperlipidemic activity, when evaluated in high-fat diet-induced obesity in rats. The results indicated that *Moringa oleifera* significantly affects total cholesterol, triglycerides, body weight, and LDL along with an increase in the body temperature<sup>54</sup>. Aqueous extract of *Moringa oleifera* leaves (400 mg/kg) significantly regulates the lipid profile in the Alloxan-induced Diabetic Rats<sup>55</sup>. Phytosterols are the main component of *Moringa oleifera* which is very much responsible for lipid-lowering action. The mechanism of action involved in lowering the cholesterol is that it increases the faecal excretion of cholesterol by reducing the absorption of it. Also, it lowers the triglyceride levels in liver and plasma, both<sup>56</sup>. Another study also revealed the mechanism of phytosterol action as inhibiting the

absorption of cholesterol and increase excretion of it<sup>57</sup>. The hyperlipidemic activity of *Moringa oleifera* is well proven by many researchers. But still, the exact mechanism of action involved is not yet clear. This can be a prospective area of research for the future.

**CONCLUSION:** *Moringa Oleifera* is a potent and valuable plant with tremendous biological and therapeutic activity. It consists of numerous bioactive constituents that are potent and possess bioactivity against various ailments. The present review describes the bioactive constituents of *Moringa oleifera* with its potent therapeutic applications. This review also focuses on the potential role of *Moringa oleifera* in the treatment of Hyperlipidemia. Further, studies directed toward the detailed mechanism of action of *Moringa oleifera* constituents in the treatment of hyperlipidemia should be conducted. This updated review confirms the pharmacological activity of *Moringa oleifera*.

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