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Moringa oleifera - Nutritional rich functional food

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Abstract

Moringa oleifera is a highly valued plant, which belongs to the family called Moringaceae and widely distributed in many countries of the tropics and subtropics. *Moringa oleifera* (MO) is nature's medicine cabinet and are widely used in the Indian Ayurvedic system of medicine, which is used as nutraceutical, natural energy booster as well as it increases defence against diseases. It is multipurpose tree used as vegetable, spice, source of cooking and cosmetic oil and as a medicinal plant. All parts of the tree are considered to possess medicinal properties and used in the treatment of ascites, rheumatism, and venomous bites and as cardiac and circulatory stimulant. Moringa also has a place in cosmetic products including body and hair moisturizers and conditioners. This article is mainly focused on the Phytochemical constituents, Nutritional value, safety and Pharmacological properties based on its Phytoconstituents of all the parts of *Moringa oleifera* as nutraceutical and nutritional rich food.

Keywords: *Moringa oleifera*, nutraceutical, medicinal plant, phytochemical, nutritional value

1. Introduction

Moringa oleifera is an edible plant with a wide variety of nutritional and medicinal virtues, which have been attributed to its roots, bark, and leaves, flowers, fruits and seeds [1-3]. *Moringa oleifera* is one of the vegetables of the Brassica order and belongs to the family Moringaceae. The Moringaceae is a single genus family with 13 known species [4]. Moringa is rich in nutrition owing to the presence of a variety of essential phytochemicals present in its leaves, pods and seeds. In fact, moringa is said to provide 7 times more vitamin C than oranges, 10 times more vitamin A than carrots, 17 times more calcium than milk, 9 times more protein than yoghurt, 15 times more potassium than bananas and 25 times more iron than spinach [5]. Moringa is rich in phytosterols like stigmasterol, sitosterol and kampesterol which are precursors for hormones. These compounds increase the estrogen production, which in turn stimulates the proliferation of the mammary gland ducts to produce milk. It is used to treat malnutrition in children younger than 3 years [6].

Including India, moringa is indigenous to many regions in Africa, Arabia, South East Asia, the Pacific and Caribbean Islands and South America. Traditionally besides being used as common vegetable, it is used as miracle tree to heal many ailments. For Centuries and in many cultures around the world, moringa was used medicinally to treat problems such as skin infections, anaemia, anxiety, asthma, blackheads, blood impurities, bronchitis, catarrh, chest congestion, cholera and many other illnesses. Moringa also has a place in cosmetic products including body and hair moisturizers and conditioners. It was also discovered that moringa oil was used in skin ointments ever since the Egyptian times [4].

2. Morphology

Moringa oleifera is a small, fast-growing evergreen tree that usually grows as high as 9 m, with a soft and white wood and gummy bark.

2.1 Leaves: Leaves are longitudinally cracked leaves, 30-75 cm long main axis and its branch jointed, glandular at joints, leaflets are glabrous and entire. The leaflets are finely hairy, green and almost hairless on the upper surface, paler and hairless beneath, with red-tinged mid-veins and rounded or blunt-pointed at the apex and short-pointed at the base [7].

2.2 Flowers: The fragrant, bisexual, yellowish white flowers are borne on slender, hairy stalks in spreading or drooping axillary clusters (panicles) 10-25 cm long. Individual flowers, set in a basal cup (hypanthium) ca. 3 mm long, are approximately 0.7 to 1 cm long and 2 cm broad, with five unequal yellowish-white, thinly veined, spatulate petals, five stamens with five smaller sterile stamens (staminodes), and a pistil composed of a 1-celled ovary and slender style [8].

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2.3 Fruits: The fruits are three lobed pods which hang down from the branches and are 20-60cm in length when they are dry open into 3 parts, each pod contains between 12-35 seeds.

2.4 Seeds: The seeds are round with a brownish semi permeable seed hull. The hull itself has three wings that run from top to the bottom at, 120-degree intervals. Each tree can produce between 15,000 and 25,000 seeds per year [8].

3. Phytochemical Constituents

Leaves: Rich in Vit. A and C, Niazirin and Niazirin three mustard oil glycosides, 4-[(4'-O acetylalpha-L-rhamnosyloxy) benzyl] isothiocyanate, Pyrrole alkaloid (pyrrolemarumine 400-O-a-Lrhamnopyranoside, 40-hydroxyphenylethanamid, (marumosides A and B) and α and γ -tocopherol [9]. Pods: The polysaccharide d-galactose, 6-O-Me-D-galactose, Dgalacturoni, acid, l-arabinose and l-rhamnose in a molar ratio of 1:1:1:1, Nitriles, an isothiocyanate and thiocarbamates [10].

Seeds: 4-(alpha-l-rhamnopyranosyloxy)-benzylglucosinolate, vitamin-E (0.01%) and Beta carotene (0.014%), Glycoside having molecular formula C15H20O7 named as moringyne [11]. Bark: Moringine And Moringinine, Phytosterols like Beta-sitosterol, Beta -sitosterone, Glucosinolates like 4-(α -L-rhamnopyranosyloxy) benzyl, glucosinolate [12]. Root: 4-(alpha-l-rhamnopyranosyloxy)-benzylglucosinolate and benzyl Glucosinolate [9].

4. Nutritional Information

Moringa trees have been used to combat malnutrition, especially among infants and nursing mothers [14]. The leaves of *M. oleifera* are rich in minerals like calcium, potassium, zinc, magnesium, iron and copper. Vitamins like beta-carotene of vitamin A, vitamin B such as folic acid, pyridoxine and nicotinic acid, vitamin C, D and E also present in *M. oleifera*. Moringa leaves also have a low calorific value and can be used in the diet of the obese [15].

The mature seeds contain 332.5g crude protein, 412.0 g crude fat, 211.2 g carbohydrate and 44.3g ash per kg dries matter. The essential amino acid profile showed deficiency of lysine, threonine and valine. The content of methionine + cysteine (43.6 g/kg protein), however, was exceptionally high and close to that of human milk, chicken egg and cow's milk [16]. Drumstick seeds contain 38.16 % oil which contain Vitamin E (0.01 %) and beta carotene (0.014%), the precursor of Vitamin A [17]. A glycoside having molecular formula C15H20O7, provisionally named as moringyne, was isolated from an acidic extract of the seeds [18]. Mono-palmitic and di-oleic triglyceride have been isolated from the benzene extract of semi-dried seeds [19]. The hexane-extracted oil content of seeds ranged from 38.00 to 42.00%. Protein, fibre and ash contents were found to be 26.50-32.00, 5.80-9.29 and 5.60-7.50%, respectively.

The mucilage from the pods designated as drumstick polysaccharide, the investigation of which revealed the presence of galactose, dextrose, xylose and sodium, potassium, magnesium, calcium salts of glucuronic acid. Contrary to the definition of mucilages, the presence of dextrose was an exception [13].

4.1 Nutritional compositions and medicinal uses of different parts of Moringa [21-35]

4.1.1 Leaves: Moringa leaves contain fiber, fat proteins and minerals like Ca, Mg, P, K, Cu, Fe, and S. Vitamins like Vitamin-A (Beta-carotene), vitamin B-choline, vitamin B1-thiamine, riboflavin, nicotinic acid and ascorbic acid are present. Various amino acids like Arg, His, Lys, Trp, Phe,

Thr, Leu, Met, Ile, Val are present. Phytochemicals like tannins, sterols, saponins, terpenoids, phenolics, alkaloids and flavanoids like quercetin, isoquercetin, kaemfericetin, isothiocyanates and glycoside compounds are present. The presence of minerals and vitamins help in boosting the immune system and cure a myriad of diseases.

4.1.2 Seeds: contains oleic acid (Ben oil), antibiotic called pterygospermin, and fatty acids like Linoleic acid, linolenic acid, behenic acid, Phytochemicals like tannins, saponin, phenolics, phytate, flavanoids, terpenoids and lectins. Apart from these, fats, fiber, proteins, minerals, vitamins like A, B, C and amino acids. The presence of flavanoids gives its anti-inflammatory property. The antibiotic pterygospermin is responsible for antimicrobial properties.

4.1.3 Root Bark: Alkaloids like morphine, moriginine, minerals like calcium, magnesium and sodium. The alkaloid helps the bark to be antiulcer, a cardiac stimulant and helps to relax the muscles.

4.1.4 Flower: It contains calcium and potassium and amino acids. They also contain nectar. The presence of nectar makes them viable for use by beekeepers.

4.1.5 Pods: Rich in fiber, lipids, non-structural carbohydrates, protein and ash. Fatty acids like oleic acid, linoleic acid, palmitic acid and linolenic acid are also present. The presence of PUFA in the pods can be used in the diet of obese.

Table 1: Results of physical and chemical parameters of the extracted oil are as follows [20]:

Iodine value	68.00-71.80	
Refractive index (40 °C)	1.4590-1.4625	
Density (24 °C)	0.9036-0.9080 mg/ml	
Saponification value	180.60-190.50	
Unsaponifiable matter	0.70-1.10%	
Colour (1 in. cell)	0.95-1.10 R + 20.00-35.30 Y	
Oleic acid	78.59%	
Tocopherols (in the oil were up to)	alpha	123.50-161.30 mg/kg
	gamma	84.07-104.00 mg/kg
	delta	41.00-56.00 mg/kg
Palmitic acid	7.00%	
Stearic acid	7.50%	
Behenic acid	5.99%	
Arachidic acid	4.21%	

5. Pharmacology

Moringa oleifera Lam. (Family: Moringaceae) is a tree cultivated for different purposes such as medicine, vegetable, spice, for cooking and cosmetic oil. It is known as Drumstick in English, Saragvo in Gujarati, Soanjna in Hindi, Sajna in Bengali, Nugge in Kannada, Sigr in Malyalam, Shevga in Marathi, Shobhanjana in Sanskrit, Munaga in Telegu and Murungai in Tamil. All parts of the tree are considered to possess medicinal properties and used in the treatment of ascites, rheumatism, and venomous bites and as cardiac and circulatory stimulant.

5.1 Leaves: The leaves are rich in iron and therefore highly recommended for expectant mothers [21]. *Moringa oleifera* leaves used as an Analgesic (decrease the pain sensation) [22], Poultice of leaves is beneficial in glandular swellings [23], Phytosterols and phenolic compounds present in ethanolic and ethyl acetate extracts of leaves promote the wound healing activity [24], it is also effective in lowering blood sugar levels

within 3hrs ingestion ^[25], The methanolic and chloroform extracts of leaves of *Moringa oleifera* have shown very significant hepatoprotection against CCl₄ induced hepatotoxicity ^[26], Moringa leaf juice is known to have a stabilizing effect on blood pressure ^[27]. Ingesting drumstick leaves (β -carotene and lutein) with oil helps in improving Vitamin A nutrition and perhaps delays the onset of cataract, conjunctivitis ^[28], aqueous leaf extract of *Moringa oleifera* have beneficial effect on serum cholesterol concentration and a stimulant to thyroid functions ^[35].

5.2 Seed: extract of seed kernel of *M. oleifera* reduces the symptoms of asthma and also simultaneous improvement in respiratory functions ^[29], seeds (ethanolic, petroleum ether, solvent ether and ethyl acetate) extracts has significant antipyretic activity ^[24], few isolated bioactive compounds from the seeds were tested for antitumour promoting activity ^[11], aqueous extract of *M. oleifera* seed possesses aphrodisiac ^[36].

5.3 Root: The root extract exhibited significant anti-inflammatory activity ^[30], Moringa roots have been reported to possess hepatoprotective activity ^[31], Moringa roots are reported to be rich in antimicrobial agents ^[32], Moringa roots and leaves have been reported to possess antispasmodic activity ^[33].

Other uses of the tree are: root is laxative, expectorant, diuretic, and good for inflammations, throat, bronchitis, piles, cures stomatitis, urinary discharges and obstinate asthma ^[34]. The root bark is useful in heart complaints, eye diseases, all tridosha fevers, inflammation, dyspepsia, and enlargement of spleen. The root and bark are abortifacient ^[35].

5.4 Flower & Fruits: The flowers cure inflammations and muscle diseases. The fruit cures biliousness, pain, leucoderma and tumour. The flowers, fruits and seeds cure kapha and vata. The seed cures eye diseases and head complaints. Oil is useful in leprosy ulcers and as external application for rheumatism ^[34]. The roots and seeds are prescribed for the treatment of snakebites and scorpion stings ^[35].

6. Safety & Toxicity Studies

No adverse effects were reported in any of the human studies that have been conducted to date. Several animal studies have specifically assessed the potential toxicity of various preparations on *M. oleifera*.

Moustapha ouedraogo *et al.* evaluated that the aqueous extract of *Moringa oleifera* leaves has the protective as well as reparative effects when it is given in dose of 150 and 300 mg/Kg ^[10]. The LD₅₀ *M. oleifera* root peel aqueous extract is 15.9 g/kg while that of ethanol extract is 17.8 g/kg. *M. oleifera* root peel is relatively non-toxic when given as a single dose ^[35].

Acute toxicity studies on the ethanolic extract of *M. oleifera* seed showed the seeds to possess a relatively low lethal dose (282.84 mg kg⁻¹) when administered intraperitoneally to Swiss albino mice. This result is collaborated by the result of a previous study carried out by Ferreira *et al.*, ^[36] who reported an LD₅₀ of 446.5 mg kg⁻¹ when water extract of *M. oleifera* seed was administered to mice.

However, Ajibade *et al.*, ^[37] obtained a much higher median LD₅₀ of 3873 mg/kg when they administered methanol extract of the *M. oleifera* seeds to mice. The low LD₅₀ obtained in this study may be as a result of the route of administration; unlike orally administered agents, intraperitoneally administered agents do not undergo

extensive metabolism as a result of first-pass effect. Again, orally administered agents often fail to be absorbed efficiently in the gastrointestinal tract as a result of interactions with other chemicals therein.

The non-significant effect of the extract on liver function indices in the sub-acute toxicity study implies that the extract does not exert any hepatotoxic effect upon prolonged exposure to sub-lethal doses. This result is supported by the result of Ajibade *et al.*, ^[37] who reported that the methanol extract of *M. oleifera* seed at doses of 400 and 800 mg kg⁻¹ body weight did not affect the levels of liver function enzymes and biochemicals in rats. However, they observed a marginal increase in the levels of ALT and AST at concentrations upward of 1600 mg/kg in rats. For most of the haematological parameters that were determined, there was no significant difference between the test and control subjects. However, there was a significant increase in the level of platelets of the test group administered 200 mg kg⁻¹ body weight of the extract as compared to the control group ^[37].

7. Conclusion

Moringa oleifera (Moringaceae) is commonly used as a source of food and are widely used in the Indian Ayurvedic system of medicine, which is used as nutraceutical, natural energy booster as well as it increases defence against diseases. This tree is rich in vitamin A, C, D, E, flavonoids and anthocyanins which are high in nutritional value and used as an energy booster. The leaves are rich in iron and therefore highly recommended for expectant mothers. The alkaloid-Moringine and Moringinine from bark is reported to resemble ephedrine like action and possesses anti-asthmatic property. Other Pharmacologically reported effects include anti-bacterial, antifungal, anti-inflammatory, antioxidant, anti-ulcer, cardioprotective, and antiurolithiatic activity etc. A thorough review on all these property of *Moringa oleifera* suggests that it is a "Miracle tree".

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