

REVIEW ON NUTRITIONAL AND MEDICINAL PROPERTIES OF *MORINGA OLEIFERA LAM*

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## ABSTRACT

Throughout the history nutritionists and herbal medicine specialists have recognized the potential nutritional and medicinal properties and use of *Moringa* for the prevention and treatment of different diseases as well as nutritional deficiencies. It is commonly known as a 'super food' since it is rich in nutrients, antioxidants and numerous medicinally beneficial compounds. It is the tree considered as a most nutrient rich plant discovered to date. Among commoners, it has earned its name as 'the miracle tree' due to its amazing healing abilities. Various parts of this plant such as the leaves, roots, seed, bark, fruit, flowers and immature pods act as nutritive, cardiac and circulatory stimulants, antipyretic, antitumor, anti-inflammatory, antiepileptic, diuretic, antiulcer, antispasmodic antihypertensive, cholesterol lowering, antidiabetic, antioxidant, antibacterial, hepatoprotective and antifungal activities and are being employed for the treatment of different ailments all over the world. This review gives a bird's eye view mainly on the phytochemical, nutritional and medicinal properties of the plant.

**KEYWORDS:** *Moringa*, nutritional and medicinal properties.

## INTRODUCTION

Medicinal plants have been used by the mankind for thousands of years either in the pure forms or crude extracts to treat and prevent diseases. *Moringa* (horse radish tree) is one of those well-known medicinal plants that were extensively investigated over the years and used for centuries to alleviate the diseases and suffering of mankind.

Studies have shown that *Moringa* possess numerous nutritional & medicinal compounds, that used in the treatment of various common and complicated diseases. Almost all the parts of *Moringa* e.g. roots, leaves, seeds, flowers, etc have been used sometime or other in the treatment of various ailments in the indigenous system.<sup>[39]</sup> Root is carminative, stomachic, cardiac and circulatory tonic. Root bark is abortifacient. Flower is stimulant and aphrodisiac. Fruit is used in liver and spleen diseases. Leaf is effective against gastric ulcer and hypertension.<sup>[37]</sup> Seed is called 'Sweta maricha' or white pepper and have been described as acrid and pungent. It is stimulant and is given in cases of ascites resulting from enlargement of the liver and spleen.<sup>[39]</sup> Steam bark is rubefacient, vesicant and used to cure eye diseases and for the treatment of delirious patients, prevent enlargement of the spleen and formation of tuberculous glands of the neck, to destroy tumors and to heal ulcers.

The juice from the root bark is put into ears to relieve earaches and also placed in a tooth cavity as a pain killer and has anti-tubercular activity.<sup>[53]</sup>

*Moringa* is said to contain about 539 known compounds which according to traditional African and Indian medicine is said to prevent of 300 diseases and maladies. *Moringa* supplies a wide variety of nutrients in a nontoxic and easy to digest form. *Moringa* also contains these nutrients in combinations that are easy for the body to assimilate and digest. No wonder *Moringa* is considered a miracle tree with the ability to save the lives worldwide.<sup>[52]</sup>

## BOTANICAL CLASSIFICATION

Kingdom	: Plantae
Division	: Magnoliophyta
Class	: Magnoliopsida
Order	: Brassicales
Family	: Moringaceae
Genus	: <i>Moringa</i>
Species	: <i>Moringa oleifera</i> , <sup>[42]</sup>



Fig. 1: The Stem of *Moringa*.

### BOTANICAL DESCRIPTION

*Moringa* is a small, fast-growing evergreen or deciduous tree that usually grows up to 10 or 12 m in height, with a



Fig. 2: *Moringa* Leaf, Flower, Fruit & Seed.

### GEOGRAPHICAL DISTRIBUTION

*Moringa* is one of the best known and most widely distributed naturalized species of Moringaceae family. It is native of Indian, occurring wild in the sub-Himalayan regions of Northern India, and now grown in the tropics and sub-tropics. It is also widely cultivated in Africa, Cambodia, Nepal, Indonesia, Malaysia, Mexico, Central and South America, and Srilanka. Optimum leaf and pod production requires high average daily temperatures of 25-30° C (77-86° F), well-distributed annual rainfall of 1000-2000 mm (40-80 in), high solar radiation and well-drained soils. Now a days, *Moringa* and its derivatives are distributed mainly in Middle East, African and Asian countries and are still spreading to other areas.<sup>[27]</sup> *Moringa* is native to India, Arabia, and possibly Africa and the East Indies; widely cultivated and naturalized in tropical Africa, tropical America, Sri Lanka, India, Mexico, Malabar, Malaysia and the Philippine Islands.<sup>[49]</sup> *Moringa* tree is also planted all over the Bangladesh.<sup>[37]</sup>

### ACTIVE CHEMICAL CONSTITUENTS

*Moringa* contains more than about 539 bio-chemicals that are absolutely beneficial to mankind. It contains many nutrients such as essential vitamins, essential minerals, amino acids, beta-carotene, anti-oxidants, anti-inflammatory nutrients, phytochemicals and both omega-

soft and white wood and corky and gummy bark. Roots have the taste of horseradish. 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, with entire (not toothed) margins, and are rounded or blunt-pointed at the apex and short-pointed at the base. The twigs are finely hairy and green. Flowers are white, scented in large axillary down panicles, pods are pendulous, ribbed, and seeds are 3-angled,<sup>[35]</sup> Flowers fragrant, white or creamy-white, 2.5 cm in diameter, borne in sprays, with 5 at the top of the flower, stamens yellow, pods pendulous, brown, triangular, splitting lengthwise into 3 parts when dry, 30-120 cm long, 1.8 cm wide, containing about 20 seeds embedded in the pith, pod tapering at both ends, 9 ribbed, seeds dark brown, with 3 papery wings.<sup>[49]</sup>

3 and omega-6 fatty acids,<sup>[3]</sup> The review of literatures reveals various chemical constituents are present in the different parts of *Moringa* which are as follows:

#### Bark

Barks contain tragacanth like gum which possesses bassorin, beta-sitosterol & enzymes and sugars, arabinose, galactose, dextrose, glucuronic acid. There are two alkaloids, moringine and moringinine, also benil, moringinic acid, athonin and spirochin present in bark,<sup>[37]</sup> Vanillin,  $\beta$ -sitosterol,  $\beta$ -sitostenone, 4-hydroxymellin and octacosanoic acid have been isolated from the stem of *M. oleifera*,<sup>[10]</sup> Root bark contains alkaloids like morphine, moriginine, minerals like calcium, magnesium and sodium,<sup>[2]</sup> *Moringa* leaves, pods and bark contain nitrile glycosides including niaziridin & niazirin.<sup>[11]</sup>

#### Leaf

Leaves of the plant are reported to contain quercetin-3-O-glucoside and quercetin-3-O-(6"-malonyl-glucoside) and lower amounts of kaempferol-3-O-glucoside and kaempferol-3-O-(6"-malonyl-glucoside), 3-caffeoylquinic acid and 5-caffeoylquinic acid,<sup>[35]</sup> Aqueous extracts of leaves, fruits and seeds of *Moringa* contain gallic acid, chlorogenic acid, ellagic acid, ferulic acid, kaempferol, quercetin and vanillin. Phenolic acids

like gallic acid, chlorogenic acid, ellagic acid, ferulic acid and flavonoids like kaempferol, quercetin and rutin was isolated from the leaves of *Moringa* by HPLC techniques.<sup>[35]</sup>

A number of phytochemicals are present in this plant such as tannins, sterols, saponins, terpenoids, phenolics, alkaloids and flavanoids like quercetin, isoquercetin, kaempfericetin, isothiocyanates and glycoside compounds are present in the leaves of *Moringa*,<sup>[37]</sup> Leaves contains as many as 15 flavonoids including quercetin and kaempferol glycosides with malonyl, acetyl and succinoyl acylations, among which; quercetin and kaempferol glucosides and glucoside malonates. The major compounds were hexadecanoic acid, Ethyl palmitate, Palmitic acid ethyl ester, 2, 6-Dimethyl-1, 7-octadiene-3-ol, 4-exadecen-6-yne, 2-hexanone, 3-cyclohexyliden-4-ethyl-E2- Dodecenylacetate, Hi-oleic safflower oil, Safflower oil.<sup>[35]</sup>

#### Flower

Flowers contain an antibiotic principle, pterygospermin and an amorphous,<sup>[37]</sup> It is rich in nine amino acids, sucrose, D-glucose, traces of alkaloids, wax, quercetin and kaempferat; the ash is rich in potassium and calcium,<sup>[53]</sup> They have also been reported to contain some flavonoid pigments such as alkaloids, kaempferol, rhamnetin, isoquercitrin and kaempferitrin.<sup>[28]</sup> Flowers are full of various amino acids; sugar such as sucrose & D-glucose, and potassium and calcium. It also contains flavonoids, alkaloids, kaempferol, rhamnetin, isoquercitrin and kaempferitrin.<sup>[10]</sup>

#### Fruit

Antihypertensive compounds thiocarbamate and isothiocyanate glycosides have been isolated from the acetate phase of the ethanol extract of *Moringa* pods,<sup>[10]</sup> *Moringa* fruits contain cytokinins.<sup>[47]</sup>

#### Seed

*Moringa* seeds contain fixed oil and fatty acids, like palmitic acid, stearic acid, behenic acid and oleic acid and 4 (L-rhamnosyloxy) benzyl isothiocyanate and an antibiotic principle,<sup>[37]</sup> Seed contains various sterols, tocopherols and fatty acids,<sup>[47]</sup> The seeds also contain Moringyne, 4-( $\alpha$ -L-rhamnosyloxy) benzyl isothiocyanate & several amino acids.<sup>[35]</sup>

#### NUTRITIONAL COMPOSITION

*Moringa* is the most nutrient rich plant yet discovered. *Moringa* possess a rich and rare combination of nutrients, amino acids, antioxidants, anti-aging and anti-inflammatory properties used for nutrition and healing. It is sometimes called "Miracle tree." Since 1998, the World Health Organization has promoted *Moringa* as an alternative to imported food supplies to treat malnutrition. Because of its potential malnutrition value *Moringa* is sometimes referred to as the Tree of life.<sup>[42]</sup> Another important point about *Moringa* that it is very

rare for the vegetable to contain all amino acids, the building blocks of proteins.<sup>[23]</sup>

The leaves, fruits, flowers and immature pods of this tree are used as a highly nutritive vegetable in many countries, particularly in India, Pakistan, Philippines, Hawaii and many parts of Africa. Different parts of *Moringa* are good sources of tocopherols.<sup>[12]</sup> The leaves of this plant are rich source of carotene. *Moringa* seems that God packed this tree with almost all the essential nutrient and made it to be pharmacy full of natural medicines in bio-available form to feed the poor of rural and barren areas.<sup>[3]</sup> With more than 90 recognized nutrients, 36 anti-inflammatories, 46 antioxidants, *Moringa* is the most enzymatically active and nutrient-dense plant known to mankind,<sup>[35]</sup> Leaf is rich in protein, vitamins and minerals,<sup>[37]</sup> *Moringa* dry leaves of contain 9 times proteins than yogurt, 10 times vitamin A than carrot, 25 times iron than spinach, 15 times potassium than bananas, 17 times calcium than milk and 7 times more vitamin C than orange. Because of rich in proteins source *Moringa* leaves are suggested by doctors, nutritionists and community health workers to cope with the problems of malnutrition worldwide.<sup>[26]</sup> Apart from vitamins and minerals *Moringa* leaves have been characterized to contain a desirable nutritional balance of minerals, amino acids, and fatty acids. Moreover, they contain various antioxidant compounds such as ascorbic acid, flavonoids, phenolics, and carotenoids.<sup>[1]</sup>

The dried powdered leaves contained 16.3 mg/100g of Vitamin A ( $\beta$ -Carotene), 2.64 mg/100g of Vitamin B1 (Thiamine), 20.5 mg/100g of Vitamin B2 (Riboflavin), 8.2 mg/100g of Vitamin B3 (Nicotinic acid), 17.3 mg/100g of Vitamin C (Ascorbic acid) and 113 mg/100g of Vitamin E (Tocopherol acetate). The leaves of *Moringa* are rich in minerals like copper, potassium, iron, magnesium, zinc and calcium. 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 *Moringa*.<sup>[45]</sup> A dry matter basis, *Moringa* leaves contained 27.2% protein, 17.1% fat, 5.9% moisture and 38.6% carbohydrates Also.<sup>[9]</sup>

*Moringa* leaves contain fiber, fat proteins and minerals like Mg, Ca, K, P, Fe, Cu, 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 His, Arg, Trp, Lys, Thr, Phe, Leu, Ile, Met, Val are present. Phytochemicals like sterols, tannins, terpenoids, saponins, alkaloids, phenolics and flavonoids like isoquercetin, isothiocyanates, quercetin, kaempfericetin, and glycoside compounds are present (Mekonnen, 2016). *Moringa* leaves are composed of 3.65 % Calcium, 1.50 % Potassium, 0.63 % Sulphur, 0.50 % Magnesium, 0.30 % Phosphorus and 0.164 % Sodium. They also investigated the micro-element composition and found it composed of Zinc (31.03 mg/kg), Copper (8.25 mg/kg), Manganese (86.8 mg/kg), Iron 490 (mg/kg), Selenium (363.00



mg/kg) and Boron (49.93 mg/kg).<sup>[8]</sup> *Moringa* seeds contained 34.80% ether extract, 31.65% protein, 7.54% fiber, 8.90% moisture, and 6.53% ash contents.<sup>[46]</sup>

### MEDICINAL PROPERTIES OF MORINGA

*Moringa* is a versatile plant with extraordinary medicinal and therapeutic values used in alleviating and managing various disease states.<sup>[11]</sup> The presence of various important phytochemicals in *Moringa* make the plant so important for treating different ailments and have a potential of providing useful drugs of human use. All the parts and the components derived from plant viz. root, bark, gum, leaf, fruit pods, flowers, seed, and seed oil have been used for alleviating various ailments in traditional medicine. It is often referred as a panacea and can be used to cure more than 300 diseases. In this section, medicinal uses of *Moringa* leaves are reviewed.<sup>[29]</sup>

### Benefits to the breast feeding mother

*Moringa* flowers contain sucrose, D-glucose nine amino acids, alkaloid, wax, and are rich in calcium, potassium and a few flavonoids and consumption of flower juice improves the quality and flow of milk in feeding mothers.<sup>[1]</sup> In another research it is found that the leaf increases woman's milk production.<sup>[28]</sup> The leaves being rich in nutrients, pregnant women and lactating mothers use the powdered leaves to enhance their child's or children's nourishment suffering from malnutrition.<sup>[45]</sup> In the Philippine *Moringa* is known as mother's best friend, because of its utilization to increase woman's milk production and is sometimes prescribed for anemia.<sup>[47]</sup> In Africa and other developing nations used *Moringa* to overcome malnutrition especially in infants and nursing mothers.<sup>[12]</sup>

### Antimicrobial properties

*Moringa* contains alkaloids, tannins and flavonoids, which are possess anti-bacterial properties, effective against bacteria such as: *E. coli*, *S. Arous*, *P. Aeruginosa*, and *B. Cereus*.<sup>[22]</sup> Aqueous extract of *Moringa* leaves possess significant antimicrobial activity against gram positive and negative fungal species. It is active against *E coli*, *S. Aureus* and *B. Subtilis*. *Moringa* contains 4-( $\alpha$ -L-rhamnopy-ranosyloxy) benzyl isothiocyanate, which is effective against *Helicobacter pylori*.<sup>[4]</sup> *Moringa* seeds are effective against *Bacillus cereus*, *Candida albicans*, *Streptococcus faecalis*, *Staphylococcus aureus*, *Staphylococcus epidermidis*, *Bacillus subtilis*, *Pseudomonas aeruginosa*, *E.coli* and *Aspergillus niger*. *Moringa* is rich in antibiotic agent pterygospermin, which has powerful anti-bacterial and fungicidal effects.<sup>[15]</sup> A similar compound is found to be responsible for the antibacterial and fungicidal effects of its flowers.<sup>[16]</sup> The bark extract has been shown to possess antifungal and anti-tubercular activity.<sup>[50]</sup> While the juice from the stem bark showed antibacterial effect against *Staphylococcus aureus*. The fresh leaf juice was found to inhibit the growth of pathogenic microorganisms e.g. *Pseudomonas aeruginosa* and *Staphylococcus aureus*.<sup>[17]</sup>

### Antioxidant properties

*Moringa* leaves act as antioxidant and the results of have supported the potent antioxidant activity of aqueous and ethanolic extract of leaves add one more positive attribute to its known pharmacological importance. The extract of *Moringa* possesses high phenolic content and potent antioxidant properties.<sup>[22]</sup> *Moringa* leaves have been reported to be a rich source of  $\beta$ -carotene, protein, vitamin C, calcium and potassium and act as a good source of natural antioxidants.<sup>[28]</sup> *Moringa* leaves are a good source of natural antioxidant due to the presence of various types of antioxidant compounds such as ascorbic acid, flavonoids, phenolics and carotenoids. Administration of *Moringa* extract and silymarin significantly decreased hepatic marker enzymes and lipid peroxidation with a simultaneous increase in the level of antioxidants. Aqueous extracts of leaf, fruit and seed of *Moringa* have antioxidant potential.<sup>[35]</sup>

### Antiinflammatory properties

Several parts of *Moringa* plant have been shown to possess anti-inflammatory activity. The ethanolic extract of dried seeds was tested for anti-inflammatory activity using carrageen an induced inflammation in the hind paw of mice by various workers and found to inhibit 85% of inflammation at a dose of 3mg/kg body weight, while the mature green seeds inhibited edema by 77% at the same dose. Hot water infusions of flowers, leaves, roots, seeds and bark also showed anti-inflammatory activity against carrageenan-induced hind paw edema. The seed infusion showed anti-inflammatory activity at 1000 mg/kg.<sup>[24]</sup> The root extract of *Moringa* possesses anti-inflammatory activity, in carrageen an induced rat paw edema. Alcohol extract of the seeds of *Moringa* are effective in inflammation. Anti-inflammatory action of an aqueous extract of root of *Moringa* is tested in rats using indomethacin (10 mg/kg) as standard drug and edema was induced in the rat-paw by subcutaneous injection of carrageenin. At a doses of 750 mg/kg. The *Moringa* treatment significantly inhibited the development of edema at 1, 3 and 5 hours reduction by 53.5, 44.6 and 51.1% respectively.<sup>[11,51]</sup>

### Antihypertensive properties

*Moringa* leaf juice is known to have a stabilizing effect on blood pressure. Nitrile, mustard oil glycosides and thiocarbamate glycosides have been isolated from *Moringa* leaves, which were found to be responsible for the blood pressure lowering effect. Most of these compounds, bearing thiocarbamate, carbamate or nitrile groups, are fully acetylated glycosides, which are very rare in nature. Methyl phydroxybenzoate and  $\beta$ -sitosterol investigated in the pods of *Moringa* have also shown promising hypotensive activity.<sup>[24]</sup> There are two nitrile glycosides isolated of from the ethanolic extracts of *Moringa* leaves, niazirin and niazirin and three mustard oil glycosides. Compounds such as 4-[(4'-O-acetyl-alpha-L-rhamnopyloxy) benzy l] isothiocyanate, niaziminin A and B showed hypotensive activity. In 1995 they reported six new and three synthetically

known glycosides from the ethanolic extract of the leaves of *Moringa oleifera*. Most of these compounds, bearing thiocarbamate, carbamate or nitrile groups, are fully acetylated glycosides. Thiocarbamates showed hypotensive activity. It also contains thiocarbamate and isothiocyanate glycosides. These compounds showed promising hypotensive activity.<sup>[49]</sup>

Several bioactive compounds contained in *Moringa* leaves exert direct effect on blood pressure, and thus may be used for the stabilization of blood pressure. Compounds leading to blood pressure lowering effect include nitrile, mustard oil glycosides and thiocarbamate glycosides present in the leaves.<sup>[47]</sup> The considerable amount of potassium present in the plant is important for reducing blood pressure and also increasing blood circulation, as well as preventive aid on general heart health. Beside these the presence of K, Mg, Zn and Ca reduce the effect of hypertension.<sup>[43]</sup>

### Hepatoprotective properties

The seeds are given in cases of ascites resulting from enlargement of the liver and spleen. The decoction of root bark is recommended for internal administration by Chakradatta, and in the Bhavaprakasa for ascites, enlarged spleen or liver,<sup>[39]</sup> Fruits are used in affection of liver,<sup>[43]</sup> Seeds are effective in the treatment for enlargement of liver and spleen,<sup>[55]</sup> Pari & Kumar, confirmed that hepatoprotective effect of *Moringa* leaf ethanolic extract on liver damage induced by antitubercular drugs such as isoniazid (INH), rifampicin (RMP) and pyrazinamide (PZA) in rats. Oral administration of the extract showed a significant protective action made evident by its effect on the levels of glutamic oxaloacetic transaminase (aspartate aminotransferase), glutamic pyruvic transaminase (alanine aminotransferase), alkaline phosphatase, and bilirubin in the serum; lipids, and lipid peroxidation levels in liver.<sup>[37]</sup> The hepatoprotective activity of *Moringa* extract was observed following significant histopathological analysis and reduction of the level of alanine aminotransferase (ALT), aspartate aminotransferase (AST) and alkaline phosphatase (ALP) in groups pretreated with *Moringa* compared to those treated with acetaminophen alone. Meanwhile, the level of glutathione (GSH) was found to be restored in *Moringa* treated animals compared to the groups treated with Acetaminophen alone.<sup>[35]</sup> *Moringa* seed extract in rats reduced liver damage as well as symptoms of liver fibrosis.<sup>[31]</sup>

### Antidiabetic properties

*Moringa* is well known for its pharmacological actions and is used for the treatment of diabetes mellitus. *Moringa* has been shown the beneficial effect in both Type 1 and Type 2 diabetes.<sup>[37]</sup> The extract from the *Moringa* leaf has been shown to be effective in lowering blood sugar levels within 3 hrs ingestion,<sup>[35]</sup> The leaves of *Moringa* contain a significant amount of polyphenols including quercetin-3-glycoside, kaempferol glycosides,

rutin and other polyphenols which has antidiabetic activity,<sup>[3]</sup> *Moringa* leaves aqueous extract for evaluating their hypoglycemic and antidiabetic effects on fasting blood glucose (FBG), oral glucose tolerance test (OGTT) and post prandial glucose (PPG) of normal and streptozotocin (STZ) induced sub, mild and severely diabetic rats. The dose of 200 mg/kg decreases blood glucose level (BGL) of normal animals by 26.7 and 29.9% during FBG and OGTT studies respectively. In sub and mild diabetic animals the same dose produced a maximum fall of 31.1 and 32.8% respectively, during OGTT. In case of severely diabetic animals FBG and PPG levels were reduced by 69.2 and 51.2% whereas, total protein, body weight and haemoglobin were increased by 11.3, 10.5 and 10.9% respectively after 21 days of treatment,<sup>[25]</sup> Methanol extract of its dried fruit powder has produced N-Benzyl thiocarbamates, N-benzyl carbamates, benzyl nitriles and a benzyl; which prove to trigger insulin release significantly from the rodent pancreatic beta cells, and have cyclooxygenase enzyme and lipid peroxidation inhibitory activities. Hypoglycemic and anti-hyperglycemic activity of the leaves of *Moringa* may be probably due to the presence of terpenoids, which appears to be involved in the stimulation of the  $\beta$ -cell and the subsequent secretion of preformed insulin.<sup>[26]</sup>

### Anticancer properties

*Moringa* can be used as an anticancer agent. It acts as an anti-neoproliferative, thereby inhibiting the growth of cancer cells. The extracts of leaves have been proven effective as anticancer agents. Furthermore, it is suggested that the anti-proliferative effect of cancer may be due to its ability to induce reactive oxygen species in the cancer cells. Researches show that the reactive oxygen species induced in the cells leads to apoptosis,<sup>[37]</sup> In a recent study it is found that *Moringa* pod could be a potential chemopreventive agent,<sup>[18]</sup> The presence of fatty acids could have attributed to the chemopreventive effect of boild *Moringa oleifera* (bMO). In addition, the presence of niazimicin and glucomoringin which have been reported to inhibit tumour cell proliferation, were also mentioned as possible compounds contributing to the anti-colon carcinogenic effects of bMO,<sup>[18]</sup> The aqueous extract of *Moringa* leaves exhibited a dose-dependent inhibition of cell proliferation of KB human tumor (KB) cells line,<sup>[30]</sup> Both hot water and ethanolic *Moringa* leaves extracts inhibited the viability of acute myeloid leukemia, acute lymphoblastic leukemia and hepatocellular carcinoma cells.<sup>[21]</sup>

### Analgesic properties

The seed oil is used externally for relieving pain of the joints in gout and acute rheumatism. The gum has been used in the Punjab in rheumatism and as an astringent. Hakims administer the fruit in particular pains, debility of nerves and paralysis,<sup>[39]</sup> Root bark removes all kinds of pain,<sup>[43]</sup> As it contains sulfur, it is recommended for rheumatism and seed oil is used as an application to relieve the pain of gout and acute rheumatism.<sup>[55]</sup>

### Cardiac stimulant properties

All parts of *Moringa* are somewhat cardiac stimulant. Moringinine, an alkaloid of root bark of *Moringa* is considered as cardiac stimulant,<sup>[49]</sup> *Moringa* leaf extract showed hypolipidemic, prevent Cardiomegaly, body weight, serum cholesterol level and serum triglyceride level on experimental animals,<sup>[7]</sup> It has cardioprotective effects in male Wistar albino rats in isoproterenol-induced myocardial infarction,<sup>[3]</sup> Root bark contains alkaloid moringinine which through its effect on sympathetic nervous system stimulates cardiac function. The effects can also be due to the prevention of hyperlipidemia,<sup>[49]</sup> It has been shown to prevent hyperlipidemia due to iron deficiency in male Wister rat. *Moringa* plays cardioprotective effects in male Wistar albino rats on biochemical enzymatic parameters including, superoxide dismutase, catalase, glutathione peroxidase, lactate dehydrogenase, and creatine kinase-MB.<sup>[53]</sup>

### Antiasthmatic properties

Moringine is an alkaloid of *Moringa* resembling in action with ephedrine is used for asthma,<sup>[3]</sup> The seed kernel of *Moringa* is effective against bronchial asthma. The study validated a significant decrease in the sternness of asthma and coexisting respiratory function improvement.<sup>[23]</sup>

### Beneficial for eye vision

Leaves and pods consumption is effective against eye problems and helpful in preventing night blindness,<sup>[3]</sup> Vitamin A deficiency was improved and cataract development was delayed by ingestion of leaves. Eating *Moringa* leaves, pods and leaf powder which contain high proportion of vitamin A can help to prevent night blindness and eye problems in children,<sup>[14]</sup> Ingesting drumstick leaves (Beta-carotene and leutin) with oil helps in improving vitamin A nutrition and perhaps delays the onset of cataract. Also the juice can be instilled into eyes in cases of conjunctivitis.<sup>[35]</sup>

### Diuretic & Antiurolithiatic properties

Extracts of *Moringa* were administered orally in rats and diuretic activity is determined by urine output in metabolic cages,<sup>[35]</sup> It is proved that oral administration of aqueous and alcoholic extract of *Moringa* significantly reduced the elevated urinary oxalate, showing a regulatory action on endogenous oxalate synthesis. The increased deposition of stone forming constituents in the kidneys of calculogenic rats was also significantly lowered by curative and preventive treatment using aqueous and alcoholic extracts. Antiurolithiatic property from the aqueous and alcoholic extract of the root barks of *Moringa*. Both the extracts significantly lowered the urinary excretion and kidney retention levels of oxalate, calcium and phosphate.<sup>[19]</sup>

### Neurological properties

*Moringa* supports brain health and cognitive function because of its antioxidant and neuro-enhancer activities.

It's also been tested as a treatment for Alzheimer's disease with favorable preliminary results. Its high content of vitamins E and C fight oxidation that leads to neuron degeneration, improving brain function. It's also able to normalize the neurotransmitters serotonin, dopamine, and nor-adrenaline in the brain, which play a key role in memory, mood, organ function, responses to stimulus such as stress and pleasure, and mental health, for example in depression and psychosis.<sup>[54]</sup>

### SIDE EFFECT

Leaf juice in large doses produces vomiting. It may produce local allergic reaction like blister when applied locally. In large doses it may causes abortion; hence during pregnancy should be taken carefully. It also may produce harmful effects in individuals with warm temperature & individual who are sensitive to the plant.<sup>[36]</sup>

### CONCLUSION

The extensive survey of literature revealed that *Moringa* is an important medicinal plant with diverse pharmacological spectrum. *Moringa* is widely used in alternative systems of medicine all over the world. The vast study proved the plant has various important nutritional & medicinal constituents, which were found to be responsible for many of the pharmacological activities. *Moringa* is providing significant role in prevention and cure of diseases, and to improve the nutritional standard of mankind from the time immemorial. Further evaluation needs to be carried out in order to explore the concealed areas and their practical clinical applications, which can be used for the welfare of the mankind.

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