AGRI MAGAZINE
(International E-Magazine for Agricultural Articles)
Volume: 02, Issue: 04 (April, 2025)
Available online at http://www.agrimagazine.in
©Agri Magazine, ISSN: 3048-8656

Moringa: A Green Miracle for Health

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The Indian plant *Moringa oleifera* thrives in tropical and subtropical climates worldwide. It grows well in warm regions and is sometimes referred to as horseradish or drumstick trees. Although the leaves of the *Moringa oleifera* tree contain a variety of minerals, they are increasingly widely employed as nutrients and nutraceuticals. While they have minimal anti-nutritional effects, the leaves are widely distributed in numerous advantageous substances. Among the various health advantages, drumstick leaves contain antibacterial, anti-inflammatory, anticancer, and antidiabetic properties. Along with vitamins and minerals, this vegetable is rich in phytochemicals. The review of the literature indicates that the presence of carotenoids, glucosinolates, and phytochemicals is primarily responsible for these benefits. As an essential ingredient in the creation of healthful foods, moringa is gaining popularity. Therefore, rather than the original components, the biological impact of food may be attributed to its many metabolites that can reach specific regions of action. Drumsticks are widely utilized as a health-promoting dietary component due to their strong defense against a range of illnesses and environmental contaminants.

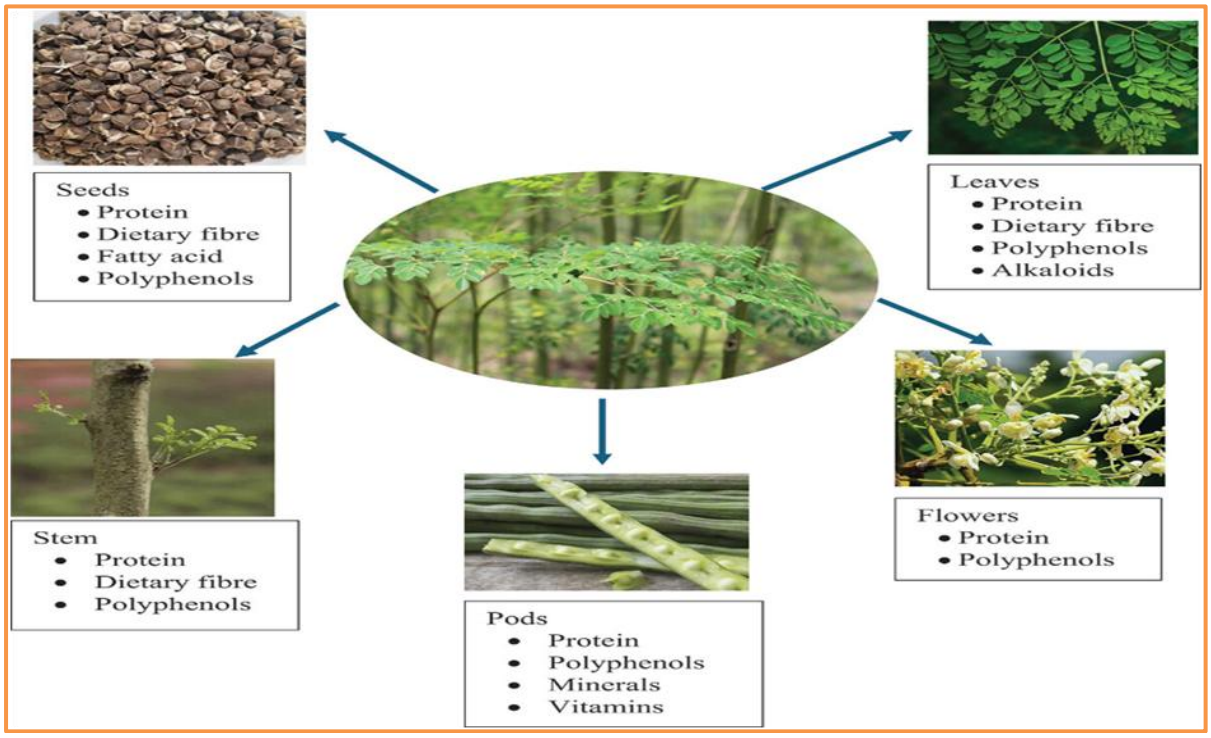
Keywords: Drumstick, Anticancer, Antidiabetic, Miracle Tree, *Moringa oleifera*, Nutritional, Health, Shevga.

Introduction

Moringa oleifera is a member of the Moringaceae family, which includes fast-growing tropical deciduous plants. It has strong, tuberous roots, light green leaves, many flowering stalks with long, pendulous fruits and seeds, and many blooms. Although it is native to northern India, it is also grown in Madagascar, southwestern Asia, and southwestern and northwest Africa. It has mostly replaced conventional gardening in cities around the Pacific coast of Mexico and is primarily used for aesthetic purposes. Furthermore, plantations may be found in Bolivia, Argentina, and other countries abroad also. Other names for the Moringa plant include Mlonge, Benzolive, Horseradish tree, Mulangay, Sajna, Kelor, Saijihan, and Marango. Thirteen distinct species of *Moringa oleifera* exist **Ma *et.al.* (2020)**. It is identified by its fruit, a tall, woody pod that bears trivalent seeds with longitudinal wings and separates into two leaflets when ripe. On a rachis are the leaflets of its pinnate leaves. Bisexual and zygomorphic, the blooms are grouped in axillary panicles and include several staminodes, five sepals, five stamens, and five unequal white petals. Additionally, they have auxiliary inflorescences and pedicels. There are long stalks and tuberous roots on the plant. With a straight stem and an open crown, this tree may reach heights of 7 to 12 meters and diameters of 20 to 40 centimeters **Babu *et.al.* (2025).**

Variety of Moringa Species and Its Geographical Distribution: The family Moringaceae has only one genus, Moringa. Which are grown in all tropical and subtropical regions and found in Africa, Arabia, Southeast Asia, and South America. There are thirteen species in the Moringa genus, including (*Oleifera*, *M. arborea*, and *M. rivae*. Among others are *M. borziana*, *hildebrandtii*, *concanensis*, *ruspoliana*, *drouhardii*, and *longituba*. *M. pygmaea*, *M. ovalifolia*, *M. peregrina*, *and M. stenopetala*). The most cost-effective species for agricultural and therapeutic use are *M. oleifera Lam*. and *M. peregrina* (Forssk.) *Fiori*. This plant was brought to and successfully cultivated across the Arabian Peninsula, West Asia, and various regions of India. Eventually, it also gained naturalization in Bangladesh, the West Indies, Afghanistan, Southeast Asia, Sri Lanka, East and West Africa, Mexico, Peru, Paraguay, and Brazil. Moringa seeds can be eaten raw or roasted, but in the West, powdered seeds are frequently employed to filter out impurities and cleanse drinking water. It has been steeped for tea or used extensively in curries **Singh *et.al.* (2023)**.

Why Is Moringa known as the Miracle Tree? The potential of *Moringa oleifera*, the "Miracle tree," in terms of nutrition and nutraceuticals is widely recognized. Each of the parts of this plant, including the leaves, pods, seeds, flowers, fruits, and roots, is edible and is a staple food in tropical and subtropical nations. The numerous portions of Moringa serve as a repository for critical nutrients. The bulk of necessary amino acids are found in the 20–35% protein that makes up Moringa leaves on a dry weight basis. Minerals including calcium, potassium, zinc, iron, copper, and magnesium are also abundant in them.



Main compositions in the various vegetative parts of *M. oleifera* plant (Source: Xie *et al.* (2025)

The omega 3 and omega 6 polyunsaturated fatty acid content of Moringa plant leaves is well-known, particularly that of linolenic acid. The Moringa plant's seeds have an excellent oil content of 30–40%, which is rich in fatty acids, both saturated and unsaturated, such as oleic, palmitic, stearic, and archidic acids. A variety of other nutrients, including as proteins, dietary fiber, lipids, carbs, potassium, calcium, polyunsaturated fatty acids, and antioxidants (tocopherols), are also abundant in moringa flowers **Rizwan *et.al.* (2024)**.

Food and Supplementation from *Moringa oleifera*: Moringa supplementation showed beneficial benefits on a number of chronic inflammatory health disorders in animal trials, including metabolic syndrome, diabetes, and obesity indicators. In particular, moringa leaf powder has shown promise in lowering rabbits' blood sugar, triglycerides, total cholesterol, and low-density lipoprotein cholesterol. Moringa seed extract, which is high in isothiocyanates, has demonstrated potential in postponing the onset of type 2 diabetes in rats, indicating that it may help control diabetes.

Although results from a few research involving human subjects are favorable, particularly those from postprandial trials, the benefits of moringa ingestion on humans are rather excellent. In Saharawi refugees with type 2 diabetes, adding 20 g of moringa leaf powder to a traditional meal on two separate days reduced postprandial glucose levels when compared to controls; however, this had no effect on healthy people. Regarding dosage and side effects, a few studies with adults have tested moringa leaf powder given as tablet(s) with daily doses between 4.6 g - 8 g for 40 to 120 days but did not specifically report adverse or side effects **Matias *et.al.* (2025).**

Proteins and Amino Acids: Moringa's dried leaves contain 260 g/kg of crude protein, which is more than the 70 and 60 g/kg found in the shoots and stems, respectively. Additionally, it was revealed that the genuine protein content of dried moringa leaves was 87%, which was greater than the true protein contents of the shoots and stems, which were 60 and 53%, respectively **Javed *et.al.* (2024)**. *Moringa Oleifera* contains more protein and amino acids than soybeans and is a healthy source of protein since it has a special balance of essential and non-essential amino acids. Isoleucine (4.8 g/100g), leucine (9.2 g/100g), lysine (5.6 g/100g), histidine (2.2 g/100g), threonine (4.2 g/100g), valine (5.4 g/100g), and undetectable phenylalanine and tryptophan are also present in *Moringa Oleifera* leaves. While seeds contain 1.0–1.8 g of methionine, 2.3–2.9 g of isoleucine, 4.9–6.8 g of leucine, 3.5–4.1 g of phenylalanine, 2.2–4.2 g of lysine, 2.1–2.2 g of histidine, 2.5–3.0 g of threonine, 3.0–3.5 g of valine, and 2.5–8.6 g of tryptophan **Gul et.al. (2025).**

Vitamins and Minerals: Vitamins are vital and have a significant impact on how the animal body processes energy. Vitamin deficiencies are the cause of several common disorders, including rickets, scurvy, and beriberi. Moringa oleifera contains several vitamins, including vitamin A (beta-carotene), vitamin B (folic acid, pyridoxine, and nicotinic acid), vitamin C, vitamin D, and vitamin E. Consequently, processed foods made from moringa leaves or powdered moringa leaf may be a rich source of vitamins. In addition to a variety of vitamins, moringa is rich in minerals that are necessary for the growth and development of the body. Dried Moringa powder is an excellent source of calcium, which is regarded as one of the most vital minerals. Compared to milk, it has 17 times more calcium. Without that, it has 25.5–31.03 mg/kg of zinc and 2 mg/100 g of iron **Islam *et.al.* (2021)**.

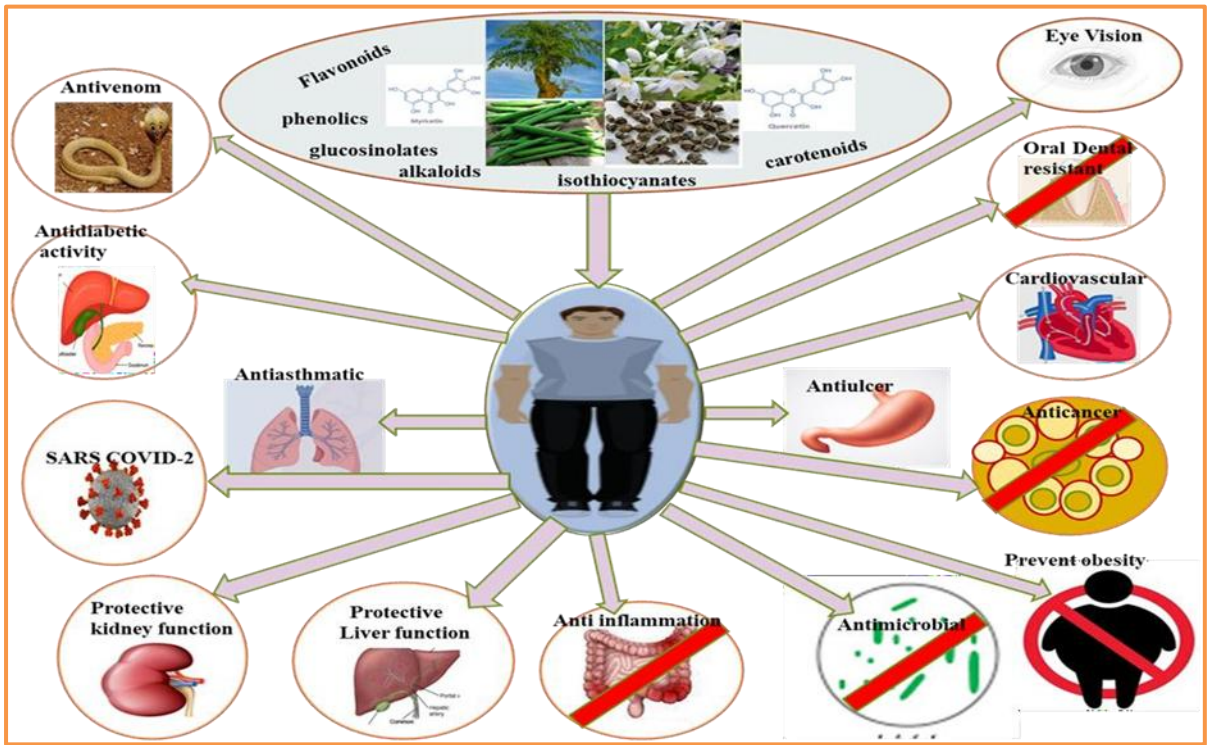
Antioxidants: In terms of antioxidants, the Moringa tree is a great source since it is more productive than traditional plant-derived alternatives. Numerous chemicals can be produced from extracts of the Moringa tree. Because moringa leaf extract contains flavonoids and phenolics, it has demonstrated antioxidant action both in vivo and in vitro. The maximum antioxidant activity is found in methanol and ethanol extracts of Indian-origin *M. oleifera* leaves, with 65.1% and 66.8%, respectively.

Medicinal Uses

Antiasthmatic Activity: *Moringa oleifera* contains anti-asthmatic properties and may decrease total WBC and histamine levels while increasing tidal volume. A clinical trial found

that after taking Moringa oleifera, pulmonary function tests improved and asthma symptoms significantly decreased. Similar to dexamethasone (2.5 mg/kg), the 100 mg/kg n-butanol fraction of the seeds inhibits airway inflammation in the guinea pig asthmatic model produced by ovalbumin **Rajizdeh *et.al.* (2024)**.

Anticancer and Antitumor Activity: The chemicals found in leaves that are thought to have anticancer properties are benzyl isothiocyanate, niazimicin, and glucosinolates. Moringa leaves contain a bioactive substance called "niazimicin," which may have anticancer properties. Seven bioactive compounds, namely, 4(α-L-rhamnosyloxy)-benzyl isothiocyanate, niazimicin, 3- O-(6′-oleoyl-β-D-glucopyranoyl)-β-sitosterol, β-sitosterol3-O-β-D-glucopyranoside, niazirin, β-sitosterol, and glycerol-1-(9-octadecnoate) had been isolated from the ethanol extract of the Moringa seed. There is evidence that benzoyl isothiocyanate is connected to cancer. BITC has been shown to produce intracellular ROS, which results in cell death. This may contribute to the effectiveness of moringa as an anticancer agent **Islam *et.al.* (2021).**



Health Benefts of *Moringa oleifera* (Source: Sivakumar *et. al.* (2024))

Antidiabetic and Wound Healing Activity: Assessments of the different medicinal plants have been conducted to ascertain their potential as diabetic treatment agents. *M. oleifera* is one of these plants that is very important. Moringa oleifera leaves have been demonstrated in studies to dramatically lower blood glucose levels in type 2 diabetes models, Wistar rats and Goto-Kakizaki (GK) rats. Furthermore, studies have shown that the moringa leaf extract efficiently reduces blood sugar levels after three hours of consumption. It is thought that dark chocolate polyphenols and other polyphenols are responsible for M. oleifera's anti-diabetic properties. Quercetin-3-glycoside, rutin, kaempferol glycosides, and other polyphenols are abundant in moringa leaves. Thus, the potential antidiabetic qualities of *M. oleifera* may be used and marketed by creating the right technology, offering a substitute for traditional diabetes drugs. The extracts (aqueous) from Moringa showed significant pro healing actions and a perfect wound healing characteristic **Thakur *et.al.* (2024).**

Cardiac and Circulatory Stimulant and Antidiuretic Activities: *M. oleifera's* freeze-dried alcoholic and aqueous extract shown cardioprotective effects in animal models that were given isoproterenol to induce myocardial infarction. Rats with myocardial necrosis brought on by isoproterenol showed substantial antioxidant benefits from butanol extract. Additionally, it was shown that the chemical N-α-rhamnopyranosyl vincosamide helps to

considerably lower inflammation and cardiac necrosis. Moringa leaves had a protective effect on hypertensive rats, resulting in a considerable reduction of cholesterol levels. This action was caused by the active ingredients niazirmin A, niazirimin B, and niazimincin. Different parts of M. oleifera (leaves, pods, flowers, and roots) showed a notable anti-inflammatory impact. An isolated chemical from Moringa (4-[2-o-Acetyl-alpha-lrahamnoslyloxy) benzyl] thiocynate was discovered to be efficient in cells after exhibiting nitric oxide inhibitory action. A substance called aurnatimide acetate and 1,3-dibenzylurea that is extracted from M. oleifera roots prevents the synthesis of TNF-α **Sivakumar *et. al.* (2024)**.

Phytochemical Constituents of Moringa oleifera from Different Parts of the Plant: Carotenoids, tocopherols, polyunsaturated fatty acids (PUFAs), highly accessible minerals, folate, and distinct glucosinolates have all been shown to be abundant in various portions of the moringa tree. In the stem, leaves, flowers, pods, and seeds 4-O-(a-L-rhamnopyranosyloxy)-benzyl glucosinolate (glucomoringin) is the most abundant glucosinolate. However, the most noticeable substance in the roots is benzyl glucosinolate, also known as glucotropaeolin. The leaves and seeds have the most glucosinolate concentration **Saini *et.al.* (2016).**

Moringa Incorporation in Various Food Products

The nutritious content of different baked goods is increased by the addition of *M. oleifera* powders. According to a study, adding its flower extract to cooked chicken nuggets significantly increased their protein, ash, emulsion stability, cooking yield, dietary fiber, and total phenolic content. P, Ca, K, and Fe contents were significantly raised when seed powders were added to the new functional yoghurt. At the same time, the antibacterial properties were significantly enhanced, whereas Mg and Zn contents were significantly decreased. Moringa sprout powders have been proven to enhance the nutritional and functional qualities of fettuccini pasta by raising its thiamine, fiber, riboflavin, γ-aminobutyric acid, fat, protein, glucosinolates, and mineral contents **Xu *et.al.* (2024)**.

Market Trends

Since 2020, the COVID-19 epidemic has contributed to a boom in the moringa industry. increased health consciousness following the epidemic. has led to a rise in the market for moringa products, particularly in the contemporary world. The moringa tree's natural location in the India-Pakistan area is the main reason why the Asia-Pacific region leads the moringa market. India is a significant manufacturer in the world and commands a large portion of the market. Moringa seed oil (Ben oil), moringa leaf powder, moringa seeds, and moringa drumsticks are among the several moringa goods that the nation exports in large quantities. India produces 2.2 million tons of tender fruits a year on about 43,600 hectares, according to the Agri-Exchange data.

The worldwide moringa market grew significantly, hitting US$ 4.63 billion in 2016 and then US$ 5.8 billion in 2018, according to estimates from Market Research Future (MRFR). With a projected market value of US$ 9.4 billion by 2028, representing a compound annual growth rate of 9.2%, projections show a continuous increasing trend. Notably, Asian nations account for 35.3% of the worldwide moringa industry as of 2018, making them crucial contributors. Australia, China, India, and New Zealand are the top producers of moringa in Asia Pacific, and they all make substantial contributions to the worldwide moringa industry.

Conclusion

In conclusion, *Moringa oleifera* holds immense potential as a nutrient-rich food source with significant health benefits. Despite its growing use in certain regions, its full potential as a food supplement and fortification ingredient remains largely untapped. Expanding research on its bioactive compounds, nutritional value, and functional applications could lead to the development of innovative food products aimed at combating malnutrition and promoting

overall health. By harnessing its benefits, Moringa could become a vital component in addressing global nutritional challenges and lifestyle-related diseases.

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