

# A Review on Medical and Nutritional Importance of Moringa Oleifera

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## Abstract:

Moringa oleifera, belonging to the Moringaceae family, is originally from northern India and flourishes in tropical and subtropical areas. This plant is highly regarded for its abundant nutritional and medicinal benefits. It is packed with vital nutrients including proteins, amino acids, vitamins, minerals, flavonoids, and antioxidants that promote health and wellness. In this research, Moringa leaves were cultivated using precision farming techniques, harvested with drone-assisted sensing, dried using solar smart dryers, and then processed into a fine powder. Laboratory tests validated its safety regarding microbial content, nutritional value, and significant antioxidant and anticancer properties. Additionally, Moringa seed extract (MSE), which contains the bioactive compound MIC-1, demonstrated impressive anti-inflammatory and antioxidant effects by influencing Nrf2-related protective genes, even outperforming curcumin extracts. These findings highlight Moringa's promise as a natural dietary supplement and therapeutic resource, aiding in the advancement of sustainable health, nutrition, and organic poultry feed.

**Keywords:** Moringa oleifera, Nutritional value, phytochemical composition, nutrition, anti-oxidants.

## INTRODUCTION

Moringa, also called as "miracle tree," for its vital nutrients, vitamins, and medicinal properties. Nutritional biochemist with extensive experience in Western scientific research, has dedicated nearly ten years to exploring the intricate phytochemical compositions of this extraordinary plant. This detailed commentary not only offers profound insights backed by a robust collection of scholarly references but also features a well-organized table that showcases some of moringa's most notable characteristics, including its high levels of antioxidants and anti-inflammatory properties.

Moringa oleifera, also known as the drumstick tree or horseradish tree, is part of the Moringaceae family. This plant is native to the sub-Himalayan areas of India, Pakistan, Afghanistan, and Bangladesh, but it has spread to various regions in Africa, Asia, and the Americas.

All components of the Moringa plant—such as leaves, bark, seeds, flowers, and roots—are rich in essential nutrients, including proteins, vitamins, minerals, and antioxidants. The leaves stand out for their high concentrations of beta-carotene, vitamins A, C, and E, and polyphenols, providing powerful antioxidant and anti-inflammatory benefits. Research indicates that Moringa can promote liver health, decrease inflammation, and assist in preventing chronic diseases such as diabetes, heart disease, cancer, and arthritis. Additionally, it may enhance brain function, support fertility, improve digestion, and help

balance thyroid function, while also serving as a natural pain reliever and diuretic. From a nutritional standpoint, Moringa is remarkable: it contains more vitamin C than oranges, more vitamin A than carrots, more calcium than milk, more potassium than bananas, more protein than yogurt, and more iron than spinach. This makes it an essential food source for combating malnutrition, particularly for children and nursing mothers. In traditional medicine, Moringa is utilized to address hypertension, digestive problems, infections, and joint discomfort. Its seeds and extracts are also important for detoxifying and purifying water. Due to its rapid growth, drought resistance, and ability to remain nutrient-dense even when dried, Moringa presents itself as a sustainable crop and a valuable natural solution for enhancing global health.<sup>(1)</sup>

### **Enriched Description of Traditional Uses of *Moringa oleifera* in Herbal Medicine**

*Moringa oleifera* Lam., popularly known as the drumstick or horseradish tree, is a member of the Moringaceae family. It is originally from the sub-Himalayan regions of India, Pakistan, Afghanistan, and Bangladesh, and is now widely grown in Africa, Asia, and the Americas. Often referred to as the “miracle tree,” Moringa is prized for its nutritional, medicinal, and ecological advantages. Every part of the Moringa plant—leaves, bark, seeds, flowers, and roots—contains essential nutrients, including proteins, vitamins, minerals, and antioxidants. The leaves, in particular, are abundant in beta-carotene, as well as vitamins A, C, and E, and polyphenols, which provide potent antioxidant and anti-inflammatory effects. Research suggests that Moringa can promote liver health, lessen inflammation, and potentially ward off chronic illnesses such as diabetes, cardiovascular diseases, cancer, and arthritis.

Additionally, it may enhance brain function, boost fertility, aid digestion, and support thyroid health, while also functioning as a natural pain relief agent and diuretic. From a nutritional standpoint, Moringa stands out significantly: it contains more vitamin C than oranges, more vitamin A than carrots, higher calcium levels than milk, more potassium than bananas, greater protein content than yogurt, and more iron than spinach. These attributes make it a vital food source for combating malnutrition, particularly in children and nursing mothers. In traditional medicine, Moringa is utilized for managing hypertension, digestive problems, infections, and joint pain. Its seeds and extracts are commonly used for detoxifying and purifying water. Thanks to its rapid growth, resilience to drought, and nutrient retention even when dried, Moringa represents both a sustainable agricultural option and a promising natural solution for enhancing global health.<sup>(2)</sup>

### **Moringa Leaves A Nutritional Powerhouse:**

*Moringa oleifera* Lam., often referred to as the drumstick tree or horseradish tree, is part of the Moringaceae family. It originates from the sub-Himalayan areas of India, Pakistan, Afghanistan, and Bangladesh, but is now cultivated extensively across Africa, Asia, and the Americas. Known as the “miracle tree,” Moringa is highly regarded for its nutritional, medicinal, and ecological advantages. Every part of the Moringa plant—leaves, bark, seeds, flowers, and roots—contains essential nutrients, including proteins, vitamins, minerals, and antioxidants. Notably, Moringa leaves are rich in beta-carotene, vitamins A, C, and E, and polyphenols, which provide powerful antioxidant and anti-inflammatory benefits. Studies have indicated that Moringa can support liver function, reduce inflammation, and help mitigate chronic diseases such as diabetes, heart disease, cancer, and arthritis. It may also promote better brain function, enhance fertility, aid digestion, and balance thyroid function, while serving as a natural pain reliever and diuretic. Nutritionally, Moringa is remarkable: it has more

vitamin C than oranges, more vitamin A than carrots, greater calcium than milk, more potassium than bananas, higher protein levels than yogurt, and more iron than spinach. These qualities make Moringa an important food source for tackling malnutrition, especially among children and nursing mothers. In traditional medicine, Moringa has been used to address high blood pressure, digestive issues, infections, and joint pain. Its seeds and extracts are often utilized for detoxification and water purification. Given its rapid growth, drought resistance, and ability to retain nutrients even when dried, Moringa is not only a sustainable crop but also a promising natural remedy for advancing public health worldwide. <sup>(3)</sup>

**Nutritional composition of Moringa fresh leaves, dried leaves, and leaf powder <sup>(4)</sup>**

| Nutrients               | g/100g Plant Material |            |                 |
|-------------------------|-----------------------|------------|-----------------|
|                         | Fresh leaves          | Dry leaves | Dry leaf powder |
| <b>Protein (g)</b>      | 6.7                   | 29.4       | 27.1            |
| <b>Fats (g)</b>         | 1.7                   | 5.2        | 2.3             |
| <b>Carbohydrate (g)</b> | 12.5                  | 41.2       | 38.2            |
| <b>Fiber (g)</b>        | 0.9                   | 12.5       | 19.2            |

**Medical and Pharmacological Importance**

Moringa oleifera Lam., commonly known as the drumstick or horseradish tree, is a member of the Moringaceae family. This plant is native to the sub-Himalayan regions of India, Pakistan, Afghanistan, and Bangladesh, and has since been widely cultivated in various parts of Africa, Asia, and the Americas. Often dubbed the “miracle tree,” Moringa is cherished for its nutritional value, medicinal properties, and environmental significance. All parts of the Moringa plant—including its leaves, bark, seeds, flowers, and roots—contain a wealth of vital nutrients such as proteins, vitamins, minerals, and antioxidants. Particularly, the leaves are abundant in beta- carotene, vitamins A, C, and E, and polyphenols, providing strong antioxidant and anti- inflammatory effects. Moringa has been associated with benefits for liver health, inflammation reduction, and the prevention of chronic conditions such as diabetes, heart disease, cancer, and arthritis. It may also support cognitive function, enhance fertility, aid in digestion, and help maintain thyroid balance, in addition to acting as a pain reliever and diuretic. From a nutritional perspective, Moringa is exceptional: it boasts higher levels of vitamin C than oranges, more vitamin A than carrots, greater calcium than milk, more potassium than bananas, superior protein content compared to yogurt, and more iron than spinach. These remarkable attributes make it an invaluable resource for combating malnutrition, especially in young children and breastfeeding mothers. Traditional medicine frequently employs Moringa to treat high blood pressure, digestive disorders, infections, and joint pain. Its seeds and extracts are also used for detoxifying purposes and water purification. Given its rapid growth, drought tolerance, and ability to remain nutrient- dense even when dried, Moringa represents not only a sustainable agricultural option but also a promising natural remedy for enhancing health on a global scale. <sup>(5)</sup>



**Figure: Health-promoting properties of Moringa oleifera**

### Anti-inflammatory and analgesic effect

Moringa oleifera has been highly regarded in traditional medicine for its ability to alleviate pain, reduce inflammation, and address a variety of related health issues. Recent scientific research has validated these traditional uses, revealing that the plant possesses potent anti-inflammatory and analgesic (pain-relieving) properties. The anti-inflammatory effects of Moringa can be attributed to its rich content of natural bioactive compounds, such as flavonoids, phenolic acids, isothiocyanates, tannins, and saponins. These compounds help inhibit the production of pro-inflammatory agents, including prostaglandins and cytokines (such as TNF- $\alpha$ , IL-1 $\beta$ , and IL-6), as well as enzymes like cyclooxygenase (COX) and lipoxygenase (LOX). By acting through these pathways, Moringa effectively reduces tissue inflammation, swelling, and discomfort. Studies on extracts from Moringa leaves and seeds have demonstrated their capability to decrease both acute and chronic inflammation in laboratory settings. Additionally, these extracts exhibit pain-relieving effects by affecting the pathways involved in pain transmission in both the central and peripheral nervous systems. Notably, certain compounds, including niaziminin and isothiocyanates, significantly contribute to alleviating pain and inflammation associated with tissue damage or infection. In summary, Moringa oleifera is a valuable natural source of anti-inflammatory and analgesic compounds. Its active ingredients work to modulate inflammatory responses, reduce oxidative stress, and relieve pain, making it a promising alternative to conventional synthetic medications for managing inflammatory and pain-related conditions. (6)

### Anti-cancer potential

The Moringa plant's leaves demonstrate significant potential for cancer prevention. Research has uncovered a variety of natural compounds in these leaves, including O-Ethyl-4-(L-rhamnosyloxy) benzyl carbamate, 4-(L-rhamnosyloxy)-benzyl isothiocyanate, niazimicin, and 3-O-(6-O-oleoyl-D-glucopyranosyl)-sitosterol, which may collaborate to inhibit or halt the progression of cancer cells. These compounds were extracted using different solvents such as chloroform, n-butanol, dichloromethane, and hexane after initially preparing a methanol extract. Their effects on breast cancer cells (MCF7) were evaluated using the MTS assay, while apoptosis was analyzed with Annexin V-FITC staining and confirmed through Western blot analysis of proteins like caspase 8, p53, Bax, and cytochrome. The findings indicated that the dichloromethane extract effectively killed MCF7 cancer cells with a low concentration (5  $\mu\text{g/mL}$ ) while sparing normal breast cells (MCF10A). Additionally,

this extract demonstrated the highest selectivity index (SI = 9.5), suggesting a preference for targeting cancer cells. It was found to induce early apoptosis and increase the levels of proteins critical to cell death, indicating that the induction of apoptosis is a significant mechanism through which Moringa combats cancer. Furthermore, compounds derived from Moringa have been shown to inhibit the Epstein–Barr virus early antigen (EBV-EA), which is associated with tumor growth.

Niazimicin has been recognized for its role in inhibiting cancer development. Moringa seed extracts also displayed benefits, such as enhancing antioxidant activity, preventing skin tumors in mice, and aiding liver enzymes in detoxifying harmful carcinogens. Animal studies illustrated improvements in mice with *Staphylococcus aureus* skin infections when treated with a combination of Moringa seed ointment and neomycin. Compounds like niaziminin, a thiocarbamate from the leaves, were identified as blockers of virus activation induced by tumor promoters. Additionally, 4-[(4-O-acetyl-L-rhamnosyloxy) benzyl isothiocyanate] was effective in halting tumor-promoter-induced virus activation, underscoring the importance of isothiocyanates in cancer prevention. Moringa seed extracts were also evaluated for their anti-inflammatory properties. When administered to mice with carrageenan-induced paw inflammation, the extracts reduced swelling. Fractions extracted with butanol, water, and hexane exhibited anti-inflammatory effects, although the ethyl acetate fraction unexpectedly increased inflammation and showed signs of toxicity. The crude ethanol extract also inhibited TPA-induced EBV-EA, suggesting its potential in tumor formation prevention. Chronic diseases are often associated with elevated levels of inflammatory molecules and reactive oxygen species (ROS). Addressing these pathways can be crucial for managing inflammation and oxidative stress. Given that conventional anti-inflammatory medications can have adverse effects, Moringa oleifera emerges as a natural alternative. Its seeds harbor a range of bioactive compounds, including nitriles, glycosides, glucosinolates, isothiocyanates, carbamates, and thiocarbamates, all of which exhibit robust antioxidant and anti-inflammatory characteristics.<sup>(7)</sup>

### Phytochemical Constituents

The leaves of the Moringa plant have shown considerable promise in cancer prevention. Studies have revealed various natural compounds within the leaves, such as O-Ethyl-4-(-L-rhamnosyloxy) benzyl carbamate, 4-(-L-rhamnosyloxy)-benzyl isothiocyanate, niazimicin, and 3-O-(6-O-oleoyl-D-glucopyranosyl)-sitosterol. These compounds may work synergistically to either inhibit or halt the proliferation of cancer cells. Different extraction methods using solvents like chloroform, n-butanol, dichloromethane, and hexane were applied to obtain these compounds from an initial crude methanol extract. The impact on breast cancer cells (MCF7) was assessed using the MTS assay, while the process of apoptosis was evaluated using Annexin V-FITC staining and validated with Western blot analysis of protein markers, including caspase 8, p53, Bax, and cytochrome. The results indicated that the dichloromethane extract was particularly effective in eradicating MCF7 cancer cells at a low concentration (5 µg/mL) while exhibiting minimal effects on normal breast cells (MCF10A). This extract also demonstrated the highest selectivity index (SI = 9.5), highlighting its potential to specifically target cancer cells.

It prompted early apoptosis and increased the levels of crucial proteins related to cell death, suggesting that inducing apoptosis is a major mechanism by which Moringa combats cancer. Additionally, Moringa compounds have been shown to suppress the Epstein–Barr virus early antigen (EBV-EA), which is associated with tumor growth. Niazimicin has been identified as contributing to the prevention of cancer

development. Extracts from Moringa seeds also have shown advantages, such as enhancing antioxidant activity, inhibiting skin tumor formation in mice, and supporting liver enzymes in detoxifying harmful carcinogens. Animal studies revealed that mice with skin infections caused by *Staphylococcus aureus* showed improvement when treated with a mixture of Moringa seed ointment and neomycin. Compounds such as niaziminin, a thiocarbamate extracted from the leaves, were found to inhibit virus activation triggered by tumor promoters. Similarly, 4-[(4-O-acetyl-L-rhamnosyloxy) benzyl isothiocyanate] effectively prevented virus activation induced by tumor promoters, underscoring the important role of

isothiocyanates in cancer prevention. Moringa seed extracts were further examined for their anti-inflammatory properties. In trials with mice experiencing paw inflammation due to carrageenan, these extracts helped reduce swelling. The fractions obtained through butanol, water, and hexane exhibited anti-inflammatory effects, while the ethyl acetate fraction surprisingly led to increased inflammation and potential toxicity. The crude ethanol extract also inhibited TPA- induced EBV-EA, emphasizing its potential for preventing tumor formation. Chronic diseases are often related to elevated levels of inflammatory markers and reactive oxygen species (ROS). Targeting these pathways is vital for managing inflammation and oxidative stress. As conventional anti-inflammatory medications can lead to side effects, *Moringa oleifera* offers a natural alternative. Its seeds are rich in a variety of bioactive compounds, including nitriles, glycosides, glucosinolates, isothiocyanates, carbamates, and thiocarbamates, all known for their potent antioxidant and anti-inflammatory properties. <sup>(8)</sup>

### Discussion / Future Prospects

*Moringa oleifera*, commonly known as the drumstick tree, is celebrated for its exceptional nutritional, medicinal, and ecological advantages. Almost every part of this plant—leaves, seeds, pods, bark, and roots—harbors important bioactive compounds including vitamins, minerals, flavonoids, and phenolic acids, which contribute to its antioxidant, anti-inflammatory, antimicrobial, antidiabetic, and anticancer properties. Emerging research underscores Moringa's promise as a functional food and a natural remedy, especially in managing metabolic disorders and purifying water through proteins extracted from its seeds. Nonetheless, challenges such as standardization, dosage determination, and clinical validation are still present, as most studies are based on *in vitro* or animal research. Future investigations should focus on establishing standardized extraction techniques and ensuring consistent quality control to fully unlock the potential benefits of Moringa.

### Conclusion and Future Scope of *Moringa oleifera*

*Moringa oleifera*, is a highly valuable plant known for its exceptional nutritional and medicinal properties. Its leaves, seeds, pods, and roots provide essential nutrients, including quality proteins, vitamins, and minerals, alongside diverse phytochemicals responsible for antioxidant, anti-inflammatory, and antimicrobial effects. These attributes make Moringa an important tool in addressing malnutrition, boosting immunity, and supporting sustainable health and food systems. However, research on Moringa is still developing. Variations in cultivation, environmental factors, and extraction methods affect its composition and efficacy. Most findings are based on laboratory and animal studies, highlighting the need for well-designed

Clinical trials to determine safety, dosage, and mechanisms of action. Future applications of Moringa extend to medicine, nutrition, agriculture, and industry. Its bioactive compounds show potential in

producing nutraceuticals and natural therapeutics for chronic diseases, while it's adaptability supports sustainable farming, reforestation, and eco-friendly product development. Advancing its full potential will require collaboration among scientists, farmers, and industry stakeholders, along with standardized cultivation and quality practices. With continued research, *Moringa oleifera* could become a cornerstone of global health, nutrition, and environmental sustainability.

### References:

1. Anwar, F., Latif, S., Ashraf, M., & Gilani, A. H. *Moringa oleifera*: A food plant with multiple medicinal uses. *Phytotherapy Research*. (2007), 21(1), 17–25.
2. Fahey, J. W. *Moringa oleifera*: A review of the medical evidence for its nutritional, therapeutic, and prophylactic properties. Part 1. *Trees for Life Journal*, (2005). 1(5), 1–15.
3. Kasolo, J. N., Bimenya, G. S., Ojok, L., Ochieng, J., & Ogwal-Okeng, J. W. Phytochemicals and uses of *Moringa oleifera* leaves in Ugandan rural communities. *Journal of Medicinal Plants Research*, (2010). 4(9), 753–757.
4. Olagbemide P. T., Alikwe P. C. Proximate analysis and chemical composition of raw and defatted *Moringa oleifera* kernel. *Advances in Life Science and Technology*. 2014;24:92–99. [Google Scholar]
5. Kasolo, J. N., Bimenya, G. S., Ojok, L., Ochieng, J., & Ogwal-Okeng, J. W. Phytochemicals and uses of *Moringa oleifera* leaves in Ugandan rural communities. *Journal of Medicinal Plants Research*, (2010). 4(9), 753–757.
6. Mahmood, K. T., Mugal, T., & Haq, I. U. *Moringa oleifera*: A natural gift—A review. *Journal of Pharmaceutical Sciences and Research*, (2010), 2(11), 775–781.
7. Newman DJ, Cragg GM, Snader KM: Natural products as sources of new drugs over the period 1981–2002. *J Nat Prod*. 2003, 66: 1022-1037. 10.1021/np030096l. Article CAS PubMed
8. Leone A, Spada A, Battezzati A et al Cultivation, genetic, ethnopharmacology, phytochemistry and pharmacology of *Moringa oleifera* leaves: an overview. (2015) *Int J Mol Sci* 16:12791– 12835. doi:10.3390/ijms160612791 Article CAS Google Scholar