

Exploring Knowledge about Medicinal Uses of Moringa

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Abstract: *Moringa oleifera*, originating from India, thrives in tropical and subtropical areas globally. It's often referred to as the 'drumstick tree' or 'horseradish tree.' This resilient plant can endure harsh droughts and mild frost, leading to its widespread cultivation worldwide. Its exceptional nutritional content makes every part of the tree valuable for nutritional uses.

The leaves contain a wealth of minerals, vitamins, and vital phytochemicals. Extracts from these leaves are applied in treating malnutrition and enhancing breast milk production in nursing mothers. They show promise as antioxidants, potential agents against cancer, inflammation, diabetes, and microbes. The seeds of *M. oleifera* serve as a natural coagulant, extensively utilized in water treatment. Scientific research sheds light on moringa's potential in diabetes and cancer treatment and its integration into various commercial products. This review delves into the diverse applications of moringa, spanning medicinal uses, cultivation, nutritional value, commercial aspects, and significant pharmacological properties of this remarkable tree.

In traditional medicine, various parts of the *Moringa oleifera* tree, such as leaves, seeds, bark, roots, sap, and flowers, find wide usage. Leaves and immature seed pods are incorporated into human diets as food products. Among these parts, leaf extracts demonstrate the highest antioxidant activity. Safety studies conducted in animals with aqueous leaf extracts indicate a high level of safety, with no reported adverse effects in human studies. There have been five human studies utilizing powdered whole leaf preparations of *M. oleifera*, showcasing anti-hyperglycemic (antidiabetic) and anti-dyslipidemic activities. These effects have been confirmed in animal studies using extracts and leaf powders. An increasing number of published studies highlight that aqueous, hydroalcoholic, or alcohol extracts of *M. oleifera* leaves possess various biological activities, including antioxidants, tissue protection (liver, kidneys, heart, testes, and lungs), pain relief, ulcer prevention, blood pressure regulation, radiation protection, and immune modulation.

A diverse range of polyphenols, phenolic acids, flavonoids, glucosinolates, and potentially alkaloids are thought to contribute to these effects. The standardization of products remains a challenge. Nevertheless, the outcomes of published studies involving *M. oleifera* have shown significant promise. Conducting further human studies using standardized extracts is strongly recommended to enhance understanding and reliability. © 2015 The Authors Phytotherapy Research Published by John Wiley & Sons Ltd

Keywords: *Moringa oleifera*; Miracle Tree ; Antidiabetic ; Anticancer ;Coagulant

I. INTRODUCTION

Moringa oleifera, commonly referred to as the "miracle tree," thrives across tropical and subtropical regions worldwide, believed to originate from Afghanistan, Bangladesh, India, and Pakistan. The *Moringa* family encompasses 13 species, including *M. oleifera*, *M. arborea*, *M. rivae*, *M. ruspoliana*, *M. drouhardii*, *M. hildebrandtii*, *M. concanensis*, *M. borziana*, *M. longituba*, *M. pygmaea*, *M. ovalifolia*, *M. peregrina*, and *M. stenopetala*. However, *M. oleifera* stands out for its widespread application in nutrition, biogas production, fertilizer production, and more. One exceptional trait of *Moringa* is its ability to endure drought conditions. Extensive studies highlight *M. oleifera* as one of the most cost-effective and dependable options for optimal nutrition. Virtually every part of the tree is utilized for its vital nutrients. The leaves of *M. oleifera* boast high levels of beta-carotene, minerals like calcium and potassium. Their dried form, containing around 70% oleic acid, is suitable for creating moisturizers. Powdered leaves are a common ingredient in various beverages, with "Zija" being notably popular in India. The bark is valued for its efficacy in treating ulcers,

toothaches, and hypertension. Roots have been identified for their potential in treating toothaches, helminthiasis, and paralysis. Flowers are utilized in managing ulcers, enlarged spleens, and as sources of aphrodisiacs. This tree is believed to possess remarkable abilities in combating malnutrition among infants and nursing mothers. This review aims to consolidate the most recent insights on the pharmacological activities, global research trends, toxicological assessments, phytochemical analyses, and ethnomedicinal uses of *M. oleifera*.

The authors offer contextual details and scientific evidence backing various applications. They suggest specific processing methods to maximize concentrations of relevant components. Additionally, they address claims regarding moringa products, evaluating their alignment with current scientific understanding and practical dosage recommendations for intended benefits.

Methods

The author employs a literature review methodology involving the analysis and synthesis of relevant references. This includes the selection of full-text journals and books published within the last decade, utilizing multiple databases such as PubMed, Google Scholar, Science Direct, and Cochrane. The search involves specific keywords such as diarrhea, gastroenteritis, antibacterial, antiulcer, anti-inflammation, and *M. oleifera*.

Medicinal Uses

Antidiabetic properties -

Studies have indicated that Moringa exhibits potential in managing both Type 1 and Type 2 diabetes. Type 1 diabetes is characterized by the absence of insulin production, a hormone crucial for regulating blood glucose levels. Type 2 diabetes, on the other hand, is often linked to insulin resistance. Additionally, Type 2 diabetes might stem from Beta cell dysfunction, where these cells fail to adequately sense glucose levels, leading to reduced insulin signaling and subsequently elevated blood glucose levels.



Fig – Moringa plant

Moringa oleifera, also recognized as the drumstick tree, originates from South Asia, particularly the foothills of the Himalayas in India. Over time, it has spread and acclimatized to other regions like Afghanistan, Nepal, Bangladesh, Sri Lanka, parts of South and Central America, the West Indies, the Philippines, and Cambodia. It's a petite plant, easily cultivated, with rapid growth and the unique trait of retaining its leaves during dry seasons. Its leaves boast high nutritional value, packed with amino acids, vitamins, minerals, and natural antioxidants. This information traces back to the Charaka Samhita, an ancient text dating back 5000 years, and the plant's significance in African traditional medicine is well-established. The review at hand delves into the plant's phytochemistry and its various pharmacological properties.

Analgesic, anti-inflammatory, and antipyretic activities-

Various components of this remarkable tree have demonstrated pain-relieving properties in diverse animal studies. Extracts obtained from the leaves, seeds, and bark displayed considerable pain relief effects in both central (such as the hot plate method) and peripheral models (like the acetic acid-induced writhing method), showing effectiveness that increased with dosage. Specifically, leaf extracts demonstrated pain-relief potential comparable to indomethacin, along with properties beneficial for migraine relief, all in a dosage-dependent manner. Furthermore, when applied topically, these extracts showed efficacy in alleviating neuropathic pain induced by multiple sclerosis.

The leaf extract demonstrated anti-inflammatory effects in a model inducing paw edema through carrageenan. Bark extracts exhibited anti-inflammatory properties similar to diclofenac in the same model, while reports also highlight the anti-inflammatory potential of the root. The mechanism behind these anti-inflammatory actions may involve the regulation of neutrophils and the c-Jun N-terminal kinase pathway. Active components contributing to these anti-inflammatory properties encompass tannins, phenols, alkaloids, flavonoids, carotenoids, β -sitosterol, vanillin, hydroxymellein, moringine, moringinine, β -sitostenone, and 9-octadecenoic acid.

Furthermore, the leaf extract demonstrated significant antipyretic effects in a model inducing fever via Brewer's yeast. Additionally, ethanol and ethyl acetate extracts obtained from the seeds exhibited notable antipyretic activity.

Neuropharmacological activity -

The water-based extract derived from the leaves has demonstrated its potential in shielding against Alzheimer's disease in a model induced by colchicine. This protection was evidenced through behavioral assessments using the radial Y arm maze task. The extract's effect on Alzheimer's involved alterations in brain monoamine levels and electrical activity. Another investigation utilizing the toluene-ethyl acetate fraction from the methanolic leaf extract exhibited robust cognitive enhancement (nootropic activity). Moreover, the leaf extract comprises vitamins C and E, which play a substantial role in enhancing memory among Alzheimer's disease patients.

The leaves displayed anticonvulsant effects in male albino mice in both the pentylenetetrazole and maximum electric shock models. Additionally, the aqueous root extract successfully suppressed epileptic seizures induced by penicillin in adult albino rats.

Moreover, the ethanolic leaf extract showcased both central nervous system depressant and muscle relaxant activities as evaluated in the actophotometer and rotarod apparatuses, respectively. Furthermore, it demonstrated considerable anxiolytic effects in a dose-dependent manner as observed in the staircase test and elevated plus maze test.

Anti-cancer activity -

The alcoholic and hydromethanolic extracts derived from both leaves and fruits demonstrated a noteworthy slowdown in tumor growth kinetics in mouse melanoma tumor model studies. Additionally, the leaf extract displayed antiproliferative activity specifically on A549 lung cells. Further investigation into the impacts on factors crucial for cancer metastasis revealed that administering the leaf extract onto the chick chorioallantoic membrane resulted in a dose-dependent antiangiogenic effect. These findings underline the remarkable potential of these extracts in fighting cancer.

Figure 1 presents a visual representation of *Moringa oleifera* (MO), while Figure 2 showcases its global distribution. This plant is a reservoir of various components, with major constituents including carotenoids, tocopherols (α , γ , δ), flavonoids, phenolic acids, folate, polyunsaturated fatty acids, and an array of minerals. Table 2 lists some crucial phytoconstituents along with their structures.

A gas chromatography-mass spectrometry analysis of the plant's leaves unveiled a total of 35 compounds, with key isolates including n-hexadecanoic acid, tetradecanoic acid, cis-vaccenic acid, octadecanoic acid, palmitoyl chloride, beta-l-rhamnifuranoside, 5-O-acetyl-thio-octyl, gamma-sitosterol, and pregna-7-diene-3-ol-20-one. Notably, lutein emerged as the most abundant carotenoid present in the leafage.

Phytochemistry-

Within the plant, the radicle contains 4-(α -l-rhamnopyranosyloxy)-benzylglucosinolate and benzylglucosinolate. Roots exhibit bactericidal activity due to the presence of spirochin and anthonine. Components such as beta-sitosterone, vanillin, hydroxymellein, β -sitosterol, and octacosanoic acid are found in the plant's peduncle, while its crust comprises 4-(α -l-rhamnopyranosyloxy)-benzylglucosinolate

Physical properties -

Color Vibrancy/Texture: 5 – The powder boasts a bright green hue, vibrant with a yellow-green undertone, and possesses a very fine texture.

Smell: 5 – The aroma is reminiscent of matcha, carrying grassy and earthy notes with a hint of spice.

Flavor: 5 – The taste is subtly grassy, offering a slight touch of spice/bitterness, presenting a fresh profile akin to matcha.

Overall Impressions: This was my inaugural experience with moringa powder, and I’m still captivated by it. I appreciate its responsible cultivation within the United States, ensuring high-quality standards. The striking green color and delightful flavor have truly captured my interest.

Source Quality: Various moringa powders

Ingredient Quality: Not Specified

Approximate Price per Ounce: \$5.00

Origin Location: Texas

Additional Features: Produced by a small business operated by a moringa expert

Moringa Ingredient market –



Fig. Marketed product of moringa

The primary production and global trade of *M. oleifera* predominantly stem from India, encompassing canned produce, fresh fruits, oil, seeds, and leaf powder. India annually produces around 1.1-1.3 million tons of tender pods. According to data from Zauba.com, India exported Moringa leaf powder valued at USD 4,746,132, equivalent to 836,806 kg, from June 2013 to July 2015. Among the buyers, the United States emerged as the largest purchaser, accounting for USD 3,303,870, trailed by Germany and the United Kingdom, which imported Moringa leaf powder worth USD 364,170 and USD 162,365, respectively. The Netherlands imported Moringa leaf powder worth USD 12,594 during the same period. Conversely, Moringa *oleifera* doesn’t hold commercial significance in Bangladesh. The consumption of pods remains popular, while utilization of leaves and flowers sees limited use. To enhance local acceptance and tap into foreign markets, collaboration between government bodies and non-governmental organizations (NGOs) should be encouraged to explore export opportunities for Moringa.

This study underscores the significance of Moringa *oleifera* within the food and nutraceutical sectors and its potential to enhance human health and well-being. It delves into the present standing of Moringa *oleifera* as a dietary supplement for humans and explores future possibilities.

Variety of Moringa species and it’s geographical distribution

Moringa, as a species, has been revered since ancient times due to its traditional role as a healing agent and its nutritional richness as a food source. The Moringa genus comprises 14 species, with 13 of them being extensively distributed and naturalized across various regions such as Bangladesh, Sri Lanka, Pakistan, the Arabian region, Africa,

the West Indies, Florida, South America (including Peru, Paraguay), and Brazil, as outlined in Table 1. Among these, *M. oleifera* stands out as the most widely recognized and utilized species. These Moringa species can be classified into three groups based on their trunk types.

Categories of Moringa spp.

The species listed in the plant list has undergone taxonomic validation. Among these species, *Moringa oleifera*, originally native to India and Bangladesh, has been extensively cultivated worldwide, excluding regions such as the Pacific Islands, the Caribbean, Latin America, and certain parts of Asia. Considering its widespread availability, *Moringa oleifera* was specifically selected for this study to emphasize its distinctiveness compared to other *Moringa* species. Extensive research has been conducted on this particular species (*Moringa oleifera*) since the 1970s. At present, its nutritional and medicinal significance is widely acknowledged.

Why is Moringa known as miracle tree?

The Moringa tree exhibits rapid growth, thriving from either seeds or cuttings of its branches. Its remarkable leaves, known for flourishing in poor soil and growing swiftly, contribute significantly to its allure. Moreover, this tree demonstrates exceptional resilience in arid, hot climates, showcasing drought resistance. Its leaves, fruits, flowers, and young pods are all edible, forming integral parts of traditional diets across numerous tropical and subtropical countries. Moringa's nutritional richness stems from an array of vital phytochemicals present in its leaves, pods, and seeds. Impressively, Moringa outshines other food sources, boasting seven times more vitamin C than oranges, ten times more vitamin A than carrots, seventeen times more calcium than milk, nine times more protein than yogurt, fifteen times more potassium than bananas, and twenty-five times more iron than spinach. These petite leaves pack a robust nutrient punch, surpassing eggs in protein content, surpassing spinach in iron, exceeding carrots in vitamin A, and surpassing milk in calcium.

The Moringa plant emerges as a valuable energy source with promising applications in pharmaceuticals and cosmetics, leveraging its seeds for oils beneficial in hair and skincare. Moringa seeds, rich in vitamins and minerals, display antibacterial properties and are utilized as a water purification agent. Numerous studies have highlighted the diverse benefits of Moringa seeds, showcasing their effectiveness in combating oxidative stress, reducing inflammation, regulating blood sugar levels, and managing blood pressure. For individuals grappling with malnutrition and poverty, Moringa stands out as a superfood, offering crucial nutritional alternatives.

Food and supplementation from Moringa Oleifera

In today's fast-paced world, people are increasingly health-conscious yet often compelled to opt for calorie-dense foods due to their busy schedules. Such dietary habits contribute to various health issues including obesity, high blood pressure, diabetes, and chronic diseases. Achieving a balanced lifestyle necessitates a proper diet comprising optimal levels of vitamins, minerals, polyunsaturated fatty acids (PUFAs), and more.

Moringa leaves are renowned as an excellent food source due to their high digestibility and protein-rich composition. According to Sultana and Anwar, Moringa leaves contain an array of valuable compounds including proteins, vitamins, calcium, iron, ascorbic acid, and antioxidants like carotenoids, flavonoids, and phenols. Many developing or underdeveloped countries incorporate Moringa into the diets of their children. Busani et al. highlighted that the abundance of minerals and vitamins in Moringa leaves aids in bolstering immunity against various diseases. Additionally, Moringa leaves boast a variety of amino acids. However, variations in nutrient content are common due to climatic, geographical, and environmental factors.

In recent times, Moringa leaves have found diverse uses, such as being encapsulated as medicinal powder-coated capsules, incorporated into beverages like Ziga drinks, and utilized in tea. Recognized for its nutritional prowess, Moringa has earned the moniker of the "miracle tree." Table 2 provides an overview of the nutritional profiles of Moringa fresh leaves, dried leaves, and leaf powder.

Cosmetic application of Moringa Oleifera seed oil

Moringa oleifera stands out as the most well-known among the 13 species belonging to the Moringaceae genus. It held immense value in ancient civilizations. Romans, Greeks, and Egyptians extracted edible oil from its seeds, utilizing it for perfumes and skincare. During the 19th century, West Indies plantations cultivated Moringa for oil export to Europe, primarily for perfumes. The oil derived from Moringa oleifera (INCI: Moringa oleifera Seed Oil) was highly regarded by ancient Egyptians for its potent healing properties against skin disorders.

Moringa Oil boasts a richness in essential fatty acids, making it an exceptional moisturizer, offering healing and soothing properties ideal for treating rough, dry skin and for therapeutic massages. Perfumers highly value this oil for its remarkable ability to absorb and retain even the most elusive fragrances, along with its impressive stability.

Pharmaceutics – Nano technology – Moringa – seed

The fatty acid composition of Moringa oil is akin to that of olive oil. This oil is lightweight and effortlessly spreads on the skin, making it an excellent choice for massage or as a carrier oil in aromatherapy. Its versatility extends to various skincare products such as creams, lotions, balms, scrubs, body oils, and hair care formulations. Moringa oil contributes occlusive and velvety emollient qualities to hair and skin formulas. The inclusion of behenic acid offers sought-after rich emollience without leaving a greasy residue.

Studies have investigated the antioxidant properties of Moringa oleifera seed oil and its application in the production of body creams. Furthermore, research has focused on formulating and assessing the sun protection factor of sunscreen cream containing Moringa oleifera Lam (from the Moringaceae family). Additionally, there are reports on the production of soap utilizing indigenous Moringa oleifera Lam seed oil.

Health benefits of Moringa

Moringa is packed with essential nutrients like beta carotene, vitamin C, calcium, potassium, iron, protein, and an array of antioxidants. Some proponents claim it to be “the most nutrient-dense plant known to date.”

Apart from its impressive nutritional content, moringa is believed to possess properties that include anti-ulcer, anti-inflammatory, anti-microbial, anti-hyperglycemic, antioxidant, and anti-cancer attributes. Human studies indicate that moringa leaf powder might benefit individuals dealing with type 2 diabetes, high cholesterol, and/or low antioxidant levels. Notably, no adverse effects were reported.

It's essential to mention that while we haven't encountered any risks associated with consuming moringa, it's advisable to consult your physician before incorporating it into your routine, especially if you're on medications or have specific health concerns. Additionally, consuming large amounts of moringa can potentially lead to digestive discomfort due to its potent nature. Starting with a ½ teaspoon serving and gradually increasing intake is recommended.

II. CONCLUSION

The comprehensive review encompasses multiple facets of *M. oleifera*, including global research, ethnopharmacology, pharmacological activities, phytochemistry, phytopharmaceutical formulations, clinical investigations, toxicology, and various other related parameters. The presence of alkaloids, phenolic acids, glycosides, sterols, glucosinolates, flavonoids, terpenes, and fatty acids contributes to the medicinal effects attributed to *M. oleifera*. Additionally, the plant is abundant in compounds like vitamins, micronutrients, and carotenoids, elevating its medicinal value and positioning it as a superfood.

Pharmacological studies showcase the plant's active constituents effectively addressing diverse diseases such as neuropathic pain, cancer, hypertension, diabetes, and obesity. However, there's a wealth of phytochemicals yet to be explored for potential therapeutic benefits. Besides its clinical utility, the plant serves as a valuable biostimulant for farmers, offering a cost-effective alternative in agricultural fields.

A literature survey underscores the extensive preclinical research conducted in recent years. Future prospects call for additional clinical investigations to explore the plant's efficacy in combatting life-threatening diseases like coronavirus outbreaks, acquired immunodeficiency syndrome (AIDS), and various cancers. Moreover, further mechanistic studies are suggested to delve into the plant's mechanisms, aiming to identify and isolate active or synergistic compounds.

In essence, *M. oleifera* lives up to its name, the “Miracle tree,” emerging as both a phytopharmaceutical and functional food. Its regular consumption holds potential in treating numerous chronic human diseases and could serve as a safer alternative for medical practitioners in managing various ailments.

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