



Moringa oleifera (Moringaceae) an in-depth review of its nutritional classification and therapeutic application

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ABSTRACT

The nutritional and various medical benefits of *Moringa oleifera* have been recognized for ages in a variety of habitats and introduced areas. A common tree in many tropical and subtropical nations is the *M. oleifera*. It belongs to the family Moringaceae. Various plant parts, including the leaves, roots, seeds, fruit, bark, flowers, and immature pods, it is used as analgesic, antioxidant, antibacterial, anticancer, antipyretic, anti-inflammatory, antiulcer, antispasmodic, diuretic, and antihypertensive properties both humans and animals can benefit from eating *Moringa* leaves. *M. oleifera* is a plant whose many components are used to make traditional human meals. Protein, vitamins A, B, and C, as well as minerals, are all abundant in *Moringa* leaves. Up to 25% of *M. oleifera* leaf is made up of crude protein. Various *M. oleifera* plant components, including leaves, fruits, immature pods, and flowers, are grown in many tropical and subtropical nations.

KEYWORDS: *Moringa oleifera*, Nutritional classification, Leaves, Fruits, Immature pods, Flowers, Phytochemistry, Traditional uses

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INTRODUCTION

The highly prized plant *M. oleifera* (Moringaceae) is found in many tropical and subtropical nations. The “Drumstick” or “horseradish” tree is a well-known name for it. There are 13 species of *Moringa* in the genus, which is found in Southwest Asia, Southwest Africa, Northeast Africa, and Madagascar. Only four of the 13 species *M. oleifera*, *M. stenopetala*, *M. concanensis* and *M. peregrine* are the subject of current research. The other species are studied less since there is little research done on naturally occurring bioactive chemicals in Madagascar and Northeast Africa, where they are indigenous (Koul & Chase, 2015). This plant’s many components are a good source of proteins, vitamins, beta-carotene, amino acids, and other phenolic, as well as a profile of significant minerals. It also contains significant amounts of potassium, calcium, vitamin C, and A. Since ancient times, the drumstick tree has been used for food and medicinal purposes. All of the plant’s components have medical uses in addition to being used to make honey from the blooms.

The most nutrient-rich plant is *M. oleifera*, popularly referred to as the “Miracle Tree” and “Mother’s Best Friend.” Leaves,

stems, flowers, fruits, seeds, roots, rhizomes, and bark are all considered herbs. *M. oleifera*, often known as the miracle tree, is used to cure several illnesses, including kidney stones, anaemia, hypertension, stress, depression, diabetes, blindness, and skin, joint, and skin-related ailments (Narina *et al.*, 2019). This plant also demonstrated the ability to support blood glucose control, cardiovascular system health, and cancer prevention while also regulating lactation in nursing mothers and delivering antioxidant, anti-inflammatory, and anti-cancer action.

Depending on the patient’s constitution, physical needs, and psychological requirements, *M. oleifera* has very important therapeutic characteristics and applications. It is typically described as a natural product that can address a variety of physical and psychological health issues by providing an energetic action, rebuilding the body’s structural integrity, and encouraging feelings of extremely positive attitudes toward life (Stohs & Hartman, 2015).

One of the most beneficial tropical trees is *M. oleifera*. Its production and management are made simple by its ease of sexual and asexual reproduction, as well as its minimal need

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for water and nutrient-rich soil after planting (Mahmood *et al.*, 2010). The addition of this plant to a farm with a bio-diverse setting may be advantageous to both the farm's owner and the local ecosystem. As of 2009 the *Moringa* tree serves a variety of purposes. It has been grown in tropical areas all over the world because of the following qualities:

1. Highly valuable as a source of sustenance for both humans and livestock due to the high protein, vitamin, mineral, and carbohydrate content of all plants.
2. A seed with high oil content (42%) that is both edible and therapeutic; a seed's coagulant that can be used to remediate wastewater.

The importance of this plant as a medicine has long been well-documented. In Indian folk medicine, the stem bark, root bark, fruit, flowers, leaves, seeds, and gum are frequently employed. When the pods and seeds are young and before they start to turn brown, they are more delicious (Abdull Razis *et al.*, 2014).

The following *Moringa* preparation ingredients have been linked to hypotensive, anticancer, and antibacterial activity: 4-(4'-O-acetyl—L-rhamnopyranosyloxy) benzyl isothiocyanate, 4-(-L-rhamnopyranosyloxy) benzyl isothiocyanate, niazimicin, pterygosperrin, and benzyl.

Fresh, cooked, or dried *Moringa* leaves that were kept in a powder form for months without refrigeration did not lose any of their nutritional content. Three times as much bioavailable iron was produced by boiling the leaves as opposed to the raw leaves.

The powdered *Moringa* leaves showed similar outcomes. As of 2009, fast-growing softwood tree *M. oleifera* (Moringaceae) is native to Northern Indian sub-Himalayan regions. It belongs to the same genus as 13 other species and has spread widely throughout tropical and subtropical regions at altitudes of up to 2000 m. The leaves, seeds, roots, and flowers of the *Moringa* tree are all safe for ingestion by both people and animals.

The leaves are utilized in traditional medicine as well as for human and animal nutrition since they are high in protein, minerals, -carotene, and antioxidant substances. Instead, the seeds have piqued the interest of scientists since *M. oleifera* seed kernels contain a sizeable amount of oil (up to 40%) with a high-quality fatty acid composition (oleic acid > 70%) and, following refinement, considerable resistance to oxidative destruction (Gopalakrishnan *et al.*, 2016).

The nutritional and various medical benefits of *Moringa oleifera* have been recognized for ages in a variety of habitats and introduced areas. A common tree in many tropical and subtropical nations is the *M. oleifera*. Antitumor, antipyretic, anti-inflammatory, anti-ulcer, antispasmodic, diuretic, and anti-hypertensive properties are all present in cardiac and circulatory stimulants.

The other species are studied less since there is little research done on naturally occurring bioactive chemicals in Madagascar and Northeast Africa, where they are indigenous. *M. oleifera* leaves have a bitter and sweet flavor and are directed to the

stomach, spleen, and/or liver meridians (Oyeyinka & Oyeyinka, 2018). The bitter taste of *M. oleifera* leaves is also thought to have a weight-loss-promoting effect by lowering blood fat levels.

The dried *M. oleifera* powder has a milder flavour and a less bitter taste than the fresh *M. oleifera* leaves. To nourish youngsters who suffer from acute malnutrition and a lack of trace elements, *M. oleifera* leaves have a strong nutritional content. *M. oleifera* leaves help heal diseases like malaria and typhoid by lowering the body's inflammatory response. *M. oleifera* leaves can strengthen the spleen remove moisture, lower blood pressure, and preserve the liver and kidney. They can also cleanse phlegm from the hepatic meridian and reduce blood pressure (Pandey *et al.*, 2012).

Clinical applications of *M. oleifera* leaves include the treatment of catarrh, bronchitis, sore throat, headaches, and constipation. These conditions are related to an excess of Kapha, which results in a propensity to produce mucus and obstruction in the sinus and nasal passages, lungs, and colon in addition to treating and preventing many diseases. *M. oleifera* leaves are a natural supplement that promotes health and well-being on all tiers (Fahey, 2005).

The horseradish or drumstick tree, *M. oleifera*, is a tiny deciduous tree that is the most widely naturalized species of the Moringaceae family. The leaves of *M. oleifera* comprised 27.2% protein, 5.9% moisture, 17.1% fat, and 38.6% carbs. *M. oleifera* is used as a plentiful source of food and food products in many tropical and subtropical nations because to its significant intrinsic nutritional, antioxidant, and phytochemical benefits as well as its capacity to survive in a variety of climatic situations.

In comparison to other dietary products including oranges, carrots, milk, bananas, yogurts, and spinach, *oleifera* leaves have been discovered to have larger proportions of vitamins A and C, calcium, potassium, iron, and proteins (Anwar *et al.*, 2007). Humans have been seen to be protected against iron deficiency and oxidative stress by *M. oleifera* leaves. It has been stated that adding *M. oleifera* leaves as a fortificant to foods such as bread, cookies, cereal porridge, cake, yogurts, and cheese can enhance their sensory qualities and shelf life, which will increase customer satisfaction (Moyo *et al.*, 2010).

Differentiation between *Moringa* Leaves and Fruits

Leaves

The *Moringa's* leaves, which are abundant in β -carotene, proteins, vitamin C, calcium, and antioxidants, are the healthiest component. Purgative; used as a poultice to treat wounds; massaged into the temples to relieve headaches; used for piles, fevers, sore throats, bronchitis, eye and ear infections, scurvy, and catarrh; leaf juice is thought to regulate blood sugar levels; used to lessen glandular swelling.

Even though the composition of the active ingredient is still unknown, FAROOQ *M. oleifera* leaves due to the presence of many types of antioxidant components such as ascorbic acid,

flavonoids, phenolics, and carotenoids, *Moringa* leaves serve as a good source of natural antioxidants. Blood pressure is found to be stabilized by *Moringa* leaf juice (Camilleri & Blundell, 2024).

The leaves of the *Moringa* plant may have anticancer properties. O-Ethyl4-(α -L-rhamnosyloxy)benzyl carbamate together with 4(α -L-rhamnosyloxy)-benzyl isothiocyanate, niazimicin and 3-O-(6'-O-oleoyl- β -D-glucopyranosyl)- β -sitosterol have been tested for their potential antitumor promoting activity using an in vitro assay which showed significant inhibitory effects on Epstein-Barr virus-early antigen.

It has been suggested that niazimicin is a powerful chemopreventive agent in chemical carcinogenesis FAROOQ The state of thyroid hormones can be controlled by *Moringa* leaves. Silymarin is less effective than *M. oleifera* leaves at protecting against antitubercular-induced toxicity (Mahaveerchand & Salam, 2024).

Malaria, typhoid fever, parasite infections, genitourinary disorders, hypertension, arthritis, swellings, wounds, skin problems, and diabetes are all treated with the leaves. They are also used as heart stimulants, and contraceptive remedies, to induce breastfeeding, and to strengthen the immune system.

Additionally, it has been claimed that the leaves of *M. oleifera* contain minerals, proteins, amino acids, vitamin C, chlorophylls a and b, carotenoids, and proteins. From the leaves of *M. oleifera*, we previously reported isolating polyphenol, fatty acid, esters, and lutein.

A review of *M. oleifera* leaf cultivation, genetics, ethnopharmacology, phytochemistry, and pharmacology has been given. From the leaves of *M. oleifera*, we isolated lutein (1), -carotene (2), phytol fatty acid ester (3), polyphenol (4), chlorophyll a (5), β -sitosterol (6), triacylglycerols (7), fatty acids, fatty alcohols, and saturated hydrocarbons (Perumalsamy et al., 2024). *M. oleifera* has been linked to thyroid status regulation, radioprotective properties, and anticancer properties.

Anticancer potential

With no adverse effects on human fibroblasts, *M. oleifera* leaf extract has in vitro anticancer efficacy against human hepatocellular carcinoma, colorectal adenocarcinoma, and breast adenocarcinoma.

Potential for neuroprotection

In mice with dementia caused by conotoxin, *M. oleifera* leaves also operate as a neuroprotective and augment cognitive function (Dwivedi et al., 2023a). In response to the administration of leaf extract, lower levels of brain lipid peroxidation and higher levels of superoxide dismutase and catalase were seen.

Blindness and eye infections

Consuming *Moringa* leaves, pods, and leaf powder which have a high vitamin A content can help protect kids' eyes from

problems including night blindness and dry eyes (Klimek-Szczykutowicz et al., 2024) Table. 1.

Anti-arthritis

Acute (Turpentine oil and formaldehyde-induced arthritis) could be treated with a methanolic extract of *Moringa oleifera* stem bark (AK et al., 2024) Figure 1.

Fruits

A2058 cells treated with fruit extract from *M. oleifera* showed enhanced caspase-9 and caspase-3 activity. Additionally, it increased the phosphorylation of MAPK and the generation of ROS.

Pre-treatment with the c-Jun N-terminal kinase (JNK) inhibitor SP600125, the extracellular-signal-regulated kinase (ERK) inhibitor PD98058, or the ROS inhibitor N-acetyl-L-cysteine dramatically reduced the pro-apoptotic activity of *M. oleifera* fruit extract (Dwivedi et al., 2023b).

Together, the development of ROS production, JNK and ERK activation, and *Moringa oleifera* fruit extract are effective at causing mitochondrial death in A2058 cells.

Thus, the human melanoma A2058 cell line may benefit from the therapeutic effects of *M. oleifera* fruit extract (Nwankpa, 2024) Figure 2. In hypercholesteremic rabbits, *Moringa* fruit has been shown to reduce serum cholesterol, phospholipids, triglycerides, low-density lipoprotein (LDL), and very low-density lipoprotein (VLDL) cholesterol to phospholipid ratio, atherogenic index lipid, and reduce the lipid profile of the liver, heart, and aorta while increasing fecal cholesterol excretion. Fruit from the *M. oleifera* plant protects human melanoma A2058 cells from mitochondrial apoptosis.

Waste from the fruit shells of the *M. oleifera* plant was collected, dried, and cut into small pieces (Pareek et al., 2023). The fragments were then immersed for 24 hours in a potassium carbonate solution with a known concentration. The final mass was then cleaned with an excessive amount of water and dried for an hour at 110 °C.

The sample was carbonized at 650 °C in a N₂ atmosphere in a temperature-programmable furnace Table 2. The material in the furnace was allowed to cool to room temperature while maintaining the same N₂ flow rate after carbonization. The



Figure 1: *Moringa* leaves

Table 1: Some common medicinal uses of different parts of *Moringa oleifera* (Arif et al., 2023; Azeem et al., 2023)

S. No.	<i>Moringa</i> leaves uses
1.	The effects of <i>M. oleifera</i> on stomach ulcers caused by pylorus ligation, ethanol, cold restraint, stress, and aspirin were examined.
2.	Reduction reactions in <i>M. oleifera</i> leaves contribute to the prevention of degenerative disorders like diabetes.
3.	Antidiabetic activity- Within 3 hours of consumption, Moringa leaf can reduce blood sugar levels.
4.	Hepatoprotective activity- In rats, isoniazid (INH), rifampicin (RMP), and pyrazinamide (PZA) antitubercular medicines caused liver damage that was significantly prevented by ethanolic extracts of MO leaves. The hepatoprotective activity of MO is mediated by its impact on serum levels of lipids and lipid peroxidation, as well as glutamic oxaloacetic transaminase (aspartate aminotransferase), glutamic pyruvic transaminase (alanine aminotransferase), alkaline phosphatase, and bilirubin. Additionally, albino mice exposed to CCl ₄ -induced liver injury displayed a substantial reduction in damage when exposed to methanolic and chloroform extracts of MO leaves.
5.	Antitumor activity, Thiocarbamate from MO leaves was discovered to have powerful antitumor action.
6.	HIV, Diabetes, Cardiovascular illness, Dyslipidaemia, Cardiac Enduran, Oligospermia, Osteopenia, Postmenopausal Osteoporosis, Dystonia X-linked Parkinsonism, anemia, and a lack of iron Ulcerative colitis, Type II diabetes mellitus, colorectal malignancy, liver damage, and skin cancer.
7.	Hepatoprotective, Diuretic, Antiulcer, Cardioprotective.
8.	Antibacterial, Anticancer, Antioxidant, Antidiabetic.
9.	Antibacterial, Antifungal, Antiviral, and Antiparasitic.
10.	HSV-1 and HSV-2, hepatitis C virus, influenza virus, hand, foot, and mouth disease virus, and African swine fever virus (ASFV) antiviral potential.
11.	The most frequently utilized component of the plant is its leaf. Treatments with <i>Moringa</i> leaves include those for hyperglycemia, asthma, the flu, heartburn, dyslipidemia, diarrhoea, pneumonia, scurvy, headaches, bronchitis, skin conditions, and infections of the eyes and ears. Lowers cholesterol and blood pressure in addition to acting as an anticancer. Antioxidant, antibacterial, anti-diabetic, anti-atherosclerotic, and antimicrobial agents.
12.	<i>Moringa</i> leaf extract (MLE) is employed as a medicinal agent and has a high nutritional and antioxidant value. In addition to being a powerful antioxidant, it also has bioactive chemicals that are anti-inflammatory, anticancer, antimicrobial, antitumor, antitrypanosomal (controls sleeping sickness), antiviral, antileishmanial, antidiabetic, antihypertensive, and antispasmodic.
13.	The leaves of the drumstick tree are 100% edible and rich in nutrients. They are a good source of minerals such as calcium, potassium, iron, and phosphorus as well as proteins, carbohydrates, fiber, beta-carotene, and vitamins C and B6. The protein level of dried <i>M. oleifera</i> leaf powder is comparable to that of various pulses, such as moth beans, soybeans, kidney beans, etc., which have a protein content of (22–24%) and are therefore utilized as food. Leaves are great for a regular diet because they include important amino acids such as methionine, cysteine, tryptophan, and lysine. The leaves serve as a natural antioxidant because they contain a variety of antioxidant components, including ascorbic acid, flavonoids, phenolic compounds, and carotenoids.
14.	<i>M. oleifera</i> leaves are also thought to be anti-diabetic and anti-obese. Studies have demonstrated that giving obese rats an oral dose of an ethanolic leaf extract for 12 straight weeks resulted in a reduction in body weight. The obese group of rats receiving this medication also had their insulin and blood glucose levels normalized.
15.	HIV/AIDS, UTI, thyroid, hepatic, anti-cancer, anti-hypertensive, diarrhea, dysentery, ulcer, headache, antioxidant, protein, iron deficiency, vitamin (mineral deficit, lactation enhancer, catarrh, and scurvy are among the conditions that it treats.
16.	Purgative; used as a poultice to treat wounds; massaged into the temples to relieve headaches; used for piles, fevers, sore throats, bronchitis, eye and ear infections, scurvy, and catarrh; leaf juice is thought to regulate blood sugar levels; used to lessen glandular swelling.

Table 2: *Moringa oleifera* Fruits/pods Uses (Khalid et al., 2023a; Muzammil et al., 2023; Yang et al., 2023)

S. No.	Disease
1	Fruits-Antidiabetic, anti-hypertensive.
2	Skin cancer, anti-hypertensive, diabetes, joint pain.
3	Joint discomfort, liver, diarrhea, and spleen issues are all treated with Moringa pods.
4	Fruits have three lobes and are frequently referred to as pods. Young pods are green and, in certain varieties, with a hint of radish coloring. Pods are triangular, brown, and split longitudinally into three pieces when dried. They are between 35 and 130 cm long and 12.8 cm wide. The pith contains about 20 sec.



Figure 2: *Moringa oleifera* Fruits

resulting carbon sample was cleaned with pure distilled water, dried at 120 °C, and then finely grinded (Jikah & Edo, 2023) (Table 3).

Description and Composition of *M. oleifera*

To increase the nutritional value of foods including bread, sauces, fish, juices, biscuits, soup, and dairy products (yogurt and cheese), *M. oleifera* leaf extract is used as a functional food ingredient. Consumer acceptance of dairy products could be impacted by the presence of *M. oleifera* leaf powder. The addition of *M. oleifera* leaf powder could improve the product's flavor acceptance (Gomes et al., 2023).

The use of *M. oleifera* leaves and extracts to improve meat quality has centered on their use as a natural antioxidant.

Since *M. oleifera* leaves are safe for consumption by both people and animals, they can be used to improve meat quality either by adding them to animal diets or by directly applying them to meat products.

Animal nutrition is known to have a significant impact on meat quality factors such as pH, color, water-holding capacity, tenderness, juiciness, flavor, and fragrance as well as the nutritional and chemical makeup of muscle tissue (Trigo et al., 2023).

Studies have examined the impact of including *M. oleifera* leaves in the meals of different meat-producing animals as a way to improve the quality and safety of the meat.

M. oleifera leaves possessed greater antioxidant capability and lipid oxidative stability Given that dietary vitamin E can

be absorbed in muscle tissue to increase lipid stability and meat quality, this may be partly related to the high vitamin E concentration in *M. oleifera* leaves (Raji et al., 2023).

Table 3: *M. oleifera* seeds have a wide range of uses in the food and agriculture industries

S. No.	Moringa seeds
1	Oil from seeds that is high in oleic acid, tocopherols, and sterols can be used as an alternative to olive oil in cooking as well as for non-food applications such as biodiesel, cosmetics, and fine industrial lubricants.
2	The seed cake can boost agricultural productivity by serving as an organic fertilizer.
3	Rats with liver fibrosis responded favorably to <i>M. oleifera</i> seed extract's anti-fibrotic properties.
4	The ability of the aqueous <i>M. oleifera</i> extracts to inhibit DNA oxidative damage as well as their antioxidant activities was investigated.
5	Infections, tumor treatment, ulcers, rheumatoid arthritis, and mineral/vitamin deficiencies.
6	Now that it has been determined that naturally occurring coagulants are safe for human health, <i>M. oleifera</i> seeds, which are edible, are highly recommended as natural coagulants.
7	According to reports, <i>M. oleifera</i> seeds have coagulation qualities that are especially suggested for usage with high-turbid water (water that has a lot of haziness or cloudiness).
8	The MO seed extract can reduce liver fibrosis. Seeds contain mutagenic 4-hydroxyphenyl acetonitrile and 4-hydroxyphenyl-acetamide.
9	Seeds, which are dried, contain β -Sitosterol, Cationic proteins, and anticoagulant properties Seed extract contains the antioxidant and anti-inflammatory compounds quercetin and chlorogenic acid.
10	Using MDA-MB-231 and HCT-8 cells for breast and colorectal malignancies, respectively, the effectiveness of <i>M. oleifera</i> seed and leaves was examined.
11	Seeds-Diuretic, Cardioprotective.
12	<i>Moringa oleifera</i> seeds had a composition of 6.53% ash, 31.65% protein, ether extract, 7.54% fiber, and 8.90% moisture.
13	Numerous studies revealed that using Moringa seed powder as a quick and easy way to clean unclean water. Crohn's illness, hyperthyroidism, rheumatism, anti-herpes-simplex virus arthritis, cramps, epilepsy, and sexually transmitted infections can all be treated with moringa seeds, which also have antibacterial and anti-inflammatory properties.
14	From a single tree, approximately 15,000 to 25,000 seeds are produced annually. The seeds are rounded and have a brownish, semi-permeable seed shell. Vitamins A and E are present in seeds in typical amounts. The seed contains polypeptides that act as coagulants and are used to clean groundwater and river water with suspended solids as well as a source of oil for the manufacturing of biodiesel. Oil known as "ben oil" is produced commercially from seeds. Oil is a valuable ingredient in perfume and hair care products due to its sweet scent and capacity to absorb and retain volatile ingredients. Between 30 and 42% of the oil in seeds is a beautiful yellow oil, and the press-cake produced as a byproduct of oil extraction has a very high protein content.
15	The round, tan, semi-permeable seeds have three papery wings and are arranged in a seed configuration. The majority of seed arrangements are brown to dark brown, although they can sometimes be white if there are insufficiently viable sections. Within a week, viable seeds begin to grow. Three white wings on the body itself move 130 times from beginning to end.

M. oleifera leaves appeared in chicken sausages following 5 weeks of chilled storage, and they had an impact on fat metabolism by lowering the intramuscular fat content without adversely impacting its tenderness sausages made with a 0.5, 0.75, and 1% addition.

Pterygosperrin, a substance that splits into two molecules of benzyl isothiocyanate and has antibacterial capabilities, is also found in the leaves of the *M. oleifera* plant.

While some research revealed that *M. oleifera* leaf extract had antimicrobial effects on raw and cooked meat, others found no significant effect on pH and bacteria counts, which may be because antimicrobial active chemicals bind to food components Figure 3.

M. oleifera leaf extracts found in meat products, may differ dramatically from in vitro results in food products. The use of inadequate inclusion levels may potentially be responsible for weak antibacterial action.

The inclusion of 0.75 and 1 g/100 g *M. oleifera* leaf extract had a substantial detrimental impact on the sensory qualities and texture of chicken sausages, but 0.50 g/100 g *M. oleifera* leaf extract was adequate to suppress lipid oxidation and microbiological growth.

The effects of *M. oleifera* inclusion on organoleptic characteristics and consumer acceptance ultimately require further study. The color improvement in layer eggs has been attributed to *M. oleifera* leaf powder (Gomes et al., 2023).

Morphology of *M. oleifera*

The tree has a corky bark, a brittle stem, and a tuberous taproot. The tree has a corky bark, a brittle stem, and a tuberous taproot.

The leaves are complex, trip innate, and pale green. They measure 30-60 cm (11.8-23.6 in) in length and have numerous



Figure 3: *M. oleifera* Powder

tiny leaflets. Greater than lateral leaflets are the lateral leaflets (Khalid *et al.*, 2023b).

The fruit pods are triangular, pendulous, and green before turning brown. When dry, they split lengthwise into three pieces.

The fruit pods are triangular, pendulous, and green before turning brown. When dry, they split lengthwise into three pieces.

The pods are 1.8 cm (0.7 in) in diameter, 1 to 4 ft (30-120 cm) long, and taper at both ends. About 10 to 20 seeds are buried in the fleshy pith of each pod (Kotsou *et al.*, 2023).

Phytochemistry

The compound family comprising glucosinolates and isothiocyanates, as well as compounds containing the simple sugar rhamnose, are all abundant in the *M. oleifera* plant. According to reports, the bark contains the alkaloids moringine and moringinine.

From the stem of *M. oleifera*, compounds such as vanillin, β -sitosterol, β -sitostenone, 4-hydroxymellin, and octacosanoic acid have been identified. It has been discovered that *Moringa oleifera* contains L-arabinose, galactose, glucuronic acid, L-rhamnose, mannose, and xylose (Ashy *et al.*, 2023).

On mildly hydrolyzing the entire gum with acid, a homogenous, degraded-gum polysaccharide composed of L-galactose, glucuronic acid, and L-mannose was produced (Islam *et al.*, 2021).

Nine amino acids, sucrose, D-glucose, traces of alkaloids, wax, quercetin, and kaempferol are all found in flowers. Ash is abundant in potassium and calcium (Ariani *et al.*, 2023).

Moringa oleifera has a wide range of beneficial effects, including galactagogues, rubefacients, diuretics, stimulants, purgatives, antibacterial, antifungal, antimicrobial, anti-inflammatory, antitumor, antioxidants, anti-aging, estrogenic, antiprogesterone, hypoglycaemic, anti-hyperthyroidism, anti-ulcer, hypocholesterolemic, antispasmodic.

They may also include alkaloids, kaempferol, rhamnetin, isoquercitrin, and kaempferitrin, among other flavonoid pigments (Meireles *et al.*, 2020).

Thiocarbamate and isothiocyanate glycosides, antihypertensive chemicals, have been identified from the acetate phase of the ethanol extract of *Moringa* pods.

Compilation of Food Supplements Containing *M. oleifera* Tree Parts or Extracts

Leaves *Moringa* syrup

Boosts the immune system, slows down the ageing process, beautifies the skin, minimizes the appearance of wrinkles and

fine lines, keeps blood sugar levels in a healthy range, improves mental clarity and focus, and boosts libido.

Miracle tree Leaves

Collection of cosmetics with ingredients from *M. oleifera* tree pieces or extracts.

Natural *Moringa* tea

It is a whole food with a comprehensive nutritional profile that is naturally high in vitamins, minerals, and amino acids. Using *Moringa* regularly might help you correct any dietary imbalances you may have (Padayachee & Bajinath, 2020).

Organic supplements with *Moringa* super food capsules

Powdered *Moringa* Superfood *Moringa* Sticks Organic Iswari Leaves *Moringa* Powder The *Moringa* tree is one of the highest plant sources of vitamins and minerals because its leaves contain a wide variety of beneficial compounds.

Dry extract of drasanvi leaves Basic Nutrition: *Moringa* its active components' richness aids in regulating blood sugar levels.

Provides 5% in polyphenols and 2.5% in flavonoids. Cosmetic Substances, Product brand/name, Product information a face cream called Skin Secret Leaves is anti-aging.

Purifying and defending against the environment anti-aging face cream moisturizing environmental stressors include smoke and smog Hand lotion body fluid (Abdel-Latif *et al.*, 2022).

Properties

M. oleifera has a wide range of beneficial effects, including galactagogues, rubefacients, diuretics, stimulants, purgatives, antibacterial, antifungal, antimicrobial, anti-inflammatory, antitumor, antioxidants, anti-aging, estrogenic, antiprogesterone, hypoglycaemic, anti-hyperthyroidism, anti-ulcer, hypocholesterolemic, antispasmodic (Ercan *et al.*, 2021).

All of the plant's components have medical uses in addition to being used to make honey from the blooms.

The most nutrient-rich plant is *M. oleifera*, popularly referred to as the "Miracle Tree" and "Mother's Best Friend." Leaves, stems, flowers, fruits, seeds, roots, rhizomes, and bark are all considered herbs (Mutar *et al.*, 2021).

Plant Collection and Extract Preparation

The powder products (IITA/08/894) in sachets are offered for sale to the public commercially for dietary and medical uses.

To facilitate easy dissolution, the ground ingredients (135 g) were dissolved in warm water (2250 mL). A Buckner funnel

and Whatman's No. 1 filter paper were then used to filter it (Xiao *et al.*, 2020).

Animals

They were cared for at the University of Ibadan's Faculty of Veterinary Medicine's Experimental Animal House.

They were housed in cages similar to those used for rats, fed commercial rat cubes (produced by Ladokun and Sons Livestock Feeds, Nigeria Ltd.), and given unlimited access to bottles of fresh, clean water.

All the animals were weighed at the beginning of the experiment and then every week after that.

Acute Toxicity Study

The method was used to quantify the amount of *M. oleifera* aqueous extract. Six rats were randomly assigned to each of the five groups after they had fasted for 16 hours.

The rats in each of the 'test' groups were individually given a graded dose of the extract (400, 800, 1600, and 2000 mg/kg) corresponding to groups B, C, D, and E. This was done using a bulbed steel needle.

The only treatment given to the control group (group A) was the oral administration of distilled water (3 mL/kg) (Sultana, 2020).

Sub-acute Toxicity Study

Four groups of six rats each were formed by randomly dividing the rats into the groups.

The experimental groups, which represented groups B, C, and D, received aqueous extract at doses of 400, 800, and 1600 mg/kg, respectively, while the control group, which represented group A, got distilled water.

Using a bulbed steel needle, the extract was given orally for 21 days (Arora & Arora, 2021).

Sample Collection for Blood and Serum

For hematological research, paired blood samples from rats under diethyl ether anesthesia were drawn from their cervical cavities and placed in clean, non-heparinized bottles, where the blood was allowed to coagulate.

Hypotensive and Spasmolytic Activities

The isolation of two nitrile glycosides, niazirin and niazirinin, as well as three mustard oil glycosides, came from *M. oleifera* leaves that showed hypotensive action.

While nitrile glycosides 1 and 2 were discovered to be inactive in this regard, isothiocyanate 4 and the thiocarbamate glycosides niaziminin A and B had hypotensive action.

Determination of Hematological and Serum Biochemical Parameters

By using the traditional approach, packed cell volume (PCV) and hemoglobin concentration were measured.

According to Coles' description, erythrocyte count, total leucocyte, and leukocyte differential counts were also calculated.

The data acquired from RBC count, hemoglobin concentration, and PCV values were used to calculate the erythrocyte indices known as mean corpuscular values (MCV), mean corpuscular hemoglobin concentration (MCHC), and mean corpuscular hemoglobin (MCH).

The difference between total protein and albumin was used to produce globulin. Described how to measure aspartate aminotransferase (AST), alkaline phosphatase (ALP), and alanine aminotransferase (ALT) using a photoelectric colorimeter, GGT activity using a 747/737 BM/Hitachi autoanalyzer 2016 ALEXANDRO (Dzuvoor *et al.*, 2022).

Histopathology

All of the animals' testicles, livers, and kidneys were preserved in 10% buffered formalin in clearly marked vials.

The normal processing and paraffin wax embedding of tissues. Haematoxylin and eosin staining were used to cut sections of 5 thickness, which were then viewed under a light microscope.

Statistic Evaluation

The mean and standard deviation were used to express the results (S.D.). The Statistical Analysis System (SAS, 1999) program was used to perform a one-way analysis of variance (ANOVA) when appropriate and Duncan's Multiple Range test to identify sample differences (Goswami *et al.*, 2023).

Traditional Uses

The Moringa tree is widely used in medicine as a therapeutic and prevention measure. Many nations employ its bark, sap, roots, leaves, seeds, oil, and flowers in traditional medicine.

Traditional medicine is used to treat stomach aches, catarrh, cancer, gastric ulcers, skin conditions, nervous disorders, diabetes, fatigue, increased lactation, hay fever, impotence, edema, cramps, hemorrhoids, headaches, sore gums, as well as to strengthen the liver, gallbladder, digestive, respiratory, and immune systems.

Additionally, it strengthens and cleans the blood. Conjunctivitis is treated with an eye wash made from an infusion of leaves. Drumstick-leaf soup is highly advantageous for the natural prevention of tuberculosis, bronchitis, and asthma.

The herbal remedy for cholera, diarrhea, dysentery, jaundice, and colitis is a mixture of fresh leaf extract, one teaspoon of honey,

and a glass of gentle coconut water. A natural remedy for dysuria and a high urine acidity level is fresh drumstick leaf extract blended with cucumber or carrot juice (Su & Chen, 2020).

MATERIAL AND METHODS

While *M. peregrina* was procured from a demonstration farm in the Southern Region of the Kingdom of Saudi Arabia, *Moringa oleifera* leaves, cake, and oil came from a demonstration farm in Khartoum North, Sudan.

Analytical grade petroleum ether (40-60 °C; Merck, Darmstadt, Germany) was available. Tert-butyl methyl ether and heptane were of HPLC quality (Merck, Darmstadt, Germany). CalBiochem (Darmstadt, Germany) provided the standard compounds for tocopherol and tocotrienol that were acquired.

RESULTS AND DISCUSSION

After receiving the extract for a few hours, the animals eventually start acting normally. The plant is safe for eating and for use as a medicine at a level of 2000 mg/kg. According to the acute toxicity study conducted on rats.

Contrarily, the 800 mg/kg dose significantly reduced the levels of hemoglobin and red blood cell counts, whereas the other 2 doses had only a small effect. The study concluded that if animals are exposed to the plant for an extended period, it may cause some degree of anemia.

Due to the presence of isothiocyanate-producing glycosides, the effects of this plant extract on the hematological parameters have undergone a variety of alterations. Glycosides are ethers that connect a sugar to the aglycone toxin. The glycoside or aglycone can be poisonous on its own. Cyanogenic glycosides are among the glycosides.

The poisonous characteristics of Cyanogenic glycosides like linamarin are generally thought to be caused by the hydrocyanic acid that is produced from the glycosides by the action of an enzyme complex. As of 2009, *M. oleifera* has pharmacological characteristics in its leaf, seed, flower, bark, pod, and root, among other components.

Only the flower (aqueous and ethanol), leaf (ethanol), and bark (ethanol) extracts contained the seven phytochemical components. Better solvents like ethanol can extract both organic and inorganic elements from plants.

CONCLUSION

One of the most popularly grown species in the family Moringaceae, *M. oleifera* is a significant medicinal plant. For various human illnesses, leaves, bark, roots, stems, buds, flowers, etc. have been employed. *M. oleifera* fruit shell waste activated carbon has been researched the information gathered during this research demonstrates that activated carbon made from the waste of *M. oleifera* fruit shells is an efficient and

reasonably priced adsorbent for the removal of AB 92 from aqueous solution. *M. oleifera* stems, seeds, and leaves; pointing to the possibility that using *M. oleifera* in food products and diets may enhance consumers' nutritional status and wellbeing, particularly women who are pregnant or nursing. Similar knowledge is limited to the nutritional makeup of other important plant parts, such as the flowers, pods, and roots.

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