Review Article

THE PHARMACOGNOSTIC, PHYTOCHEMICAL AND PHARMACOLOGICAL PROFILE OF *Moringa Oleiferaleaves*

Asha Jyothi. V* and Nishitha. R
Sarojini Naidu Vanitha Pharmacy Mahavidyalaya, Hyderabad, India.
Email: ashajothivadlapudi@gmail.com

ABSTRACT

Moringa oleifera is popularly known as drum sticks. It is a household plant in India. Though it is a common plant consumed by a wide range of the population its other properties are not well understood until recently. Today moringa is considered a superfood worldwide owing to its health benefits and properties. The present article is a comprehensive review of the pharmacognostic, phytochemical, and pharmacological activities of moringa.
KEYWORDS:

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Moringa, Moringa oleifera, Super food, medicinal plant, Nutritional value.

INTRODUCTION:

Moringa oleifera (drum sticks) is a plant that originally comes from Africa and Asia. It's especially common in Northwestern India, where it's grown a lot. Moringa is the only type of plant in its family, called Moringaceae. [1] There are 13 different types of moringa plants, found in warm tropical and subtropical areas. They can be small like herbs or big like trees. The most commonly grown type is called Moringa Oleifera. [2] Many studies have shown that Moringa can be good for people's health. [3] The most commonly used part of the plant is the leaves, which are full of healthy nutrients like vitamins, natural plant chemicals, and antioxidants that can help protect the body and support overall health. [4] The large amount of active natural compounds in Moringa leaves may explain their healing effects. Many lab and animal studies have proven these health benefits. [5]

Different parts of the Moringa plant—like the roots, bark, gum, leaves, fruit, flowers, seeds, and seed oil—are known to have health benefits. These include helping with stomach ulcers, lowering blood sugar, reducing blood pressure, and fighting inflammation. [6]Moringa has also been shown to help improve liver and kidney function, as well as help balance thyroid hormones.[7] Moringa has also been found to support the health of the liver and kidneys, and help keep thyroid hormone levels balanced.[8] Moringa leaves can help protect the body from damage caused by harmful molecules (oxidative stress), reduce inflammation, prevent liver scarring and damage, lower high cholesterol, fight bacteria, and may even help protect against cancer and liver injury.[9] Moringa oleifera is a plant that grows in many tropical and subtropical areas around the world. It originally comes from India and Africa. [10] Silver nanoparticles (AgNPs) have a large surface area compared to their size, which makes them very reactive and useful in medical research. [11]

HISTORY:

Moringa oleifera commonly known as the drumstick tree, miracle tree, or horseradish tree, has a long and rich history of use in traditional medicine and nutrition across various cultures. [54]

Figure 1: Image showing the tree, leaves, seeds and flowers of *Moringa oleifera*.

CLASSIFICATION:

Medicinal plants are the back bone of Traditional medicine. Traditionally, the use of plant preparation as sources of drug are based on the experience and superstitions passed from generation to generation, virtually by the word of-mouth Research on medicinal plant has increased recently all over the world. [12] Moringa oleifera is a very popular plant its classification is given below.

Kingdom	Plantae
Phylum	Spermatophyta
Sub Phylum	Angiospermae
Class	Dicotyledonae
Order	Capparidales
Family	Moringaceae
Genus	Moringa
Species	Moringa Oleifera

Table 1: Classification of *moringa oleifera*.

PHARAMACOGNOSY:

Medicinal plants are highly studied for their macroscopic and microscopic characteristics for their authentication. The macroscopic and microscopic characteristics of Moringa oleifera are briefly described below in Table 2 & 3.

MACROSCOPICAL CHARACTERS: [13]

Type	Features
Size	30-60
Leaflet	Small Oval to Obovate
Color	Dark green to lighter green
Texture	Smooth, thin and delicate
Odor	Faint Characteristic
Taste	Slightly bitter and pungent
Petiole	Long and slender

Table 2: Macroscopic characters of *Moringa oleifera*

MICROSCOPICAL CHARACTERS: [14-16]

1. Epidermis: The leaf has an upper and lower epidermis, each made up of a single layer of compact, polygonal cells. Both surfaces are covered with a thin cuticle. Stomata are present on both sides are mostly paralytic in type (guard cells are accompanied by two parallel subsidiary cells).

2. Trichomes: Unicellular, non-glandular trichomes are present, especially on the abaxial (lower) surface. These help in reducing water loss and offer protection.

3. Mesophyll: Divided into 2:

Palisade parenchyma: One or two layers of elongated, chloroplast-rich cells located beneath the upper epidermis.

Spongy parenchyma: Loosely arranged cells with intercellular air spaces that aid in gas exchange.

4.Vascular Tissues: Vascular bundles are collateral and closed (xylem and phloem lie side by side, without cambium). The xylem is located towards the upper epidermis, while phloem is oriented towards the lower side. Vascular strands are surrounded by a bundle sheath.

5.Calcium Oxalate Crystals: Prismatic and rosette types of calcium oxalate crystals are commonly found in mesophyll and parenchyma cells.

PHARMACOLOGY:

Anti-Bacterial and Anti-Fungal Efficacy: Anti bacteria is defined as substances made by bacteria that can stop the growth or kill other bacteria even in small amounts. [47] Anti-fungal agents is defined as the substances that kill or inhibit the growth of fungi including yeast and molds are used to treat fungal infections. [48] The Moringa oleifera extract greatly slowed down the growth of certain germs, showing it has strong antibacterial power. The bacteria most affected were E. coli, then S. aureus, K. pneumoniae, P. aeruginosa, and B. subtilis. [17] The Moringa extract also slowed down the growth of fungi. This was seen by the smaller size of fungal colonies on plates treated with the extract compared to untreated ones. Among the fungi tested, A. oryzae, A. terreus, and A. nidulans were the most affected. [18] The amount of essential oil in the Moringa oleifera steam extract might be the reason it can kill or stop the growth of bacteria and fungi. [19]

Antioxidant Effect: Antioxidants are defined as a molecule that inhibits the oxidation of other molecules protecting cells from damage caused by free radicals. [49] Oxidative stress plays a key role in the prognosis of the various diseases. An imbalance between the free radicals and antioxidant leads to oxidative stress. [20] Moringa contains natural plant chemicals called phenolics, which may explain its strong antioxidant effects. Tests on its extract confirmed this. Moringa pods also have other helpful compounds like glucosinolates, isothiocyanates, thiocarbamates, and flavonoids. [21] These substances help by lowering harmful molecules in the body (called ROS), removing excess metal ions, and restoring the body's natural antioxidants [22] Moringa leaves have been found to be a natural source of antioxidants, which help protect the body from damage caused by harmful molecules. [23]

Anti-Cancer Activity: Anti-cancer is defined as the substances that help, prevent inhibit or treat cancer by stopping the growth and spread of cancerous cells. [50] The Moringa Oleifera and some of its parts can kill different types of human cancer cells. [24] The moringa oleifera leaf extract effect the growth of human esophageal cancer cells. [25] The decrease in the cell survival depends on how much oil is used and the type of cell. The oil water extract from moringa oleifera seeds seems to affect cancer and healthy cells differently. It may help control cell growth and death, possibly because of tiny molecules called micro-RNA in the extract. [26]

Anti-Diabetic Activity:

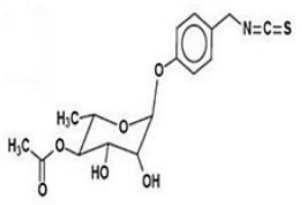
Anti-diabetic is defined as the world health organization (WHO) Diabetes is a long-term

health problem where the body as trouble using food for energy. This happens because of the body doesn't make enough insulin or cannot use it properly causing high sugar levels in the body. [51] Moringa oleifera can help fight diabetes. It leaves are good green vegetable that can help lower diabetes problems in people with the disease. [27] The water-based extract of moringa oleifera can block enzymes that raise blood sugar. It also boosts antioxidant, helps the body handle sugar better, and increases sugar absorption in yeast cells. This extract can be used as a natural medicine to help manage diabetes. [28]

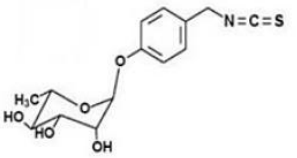
Anti Pyretic: It is defined as the substance or drug that reduces the fever by lowering the body temperature when it is abnormally high. [52] Moringa leaf concentrate showed strong fever reducing effect in a test using Brewer's yeast. Seed extract made with alcohol and vinegar like liquid also showed strong ability to lower fever. [29]

Immunomodulatory Action: It is defined as refer to the ability of a substance to modify or regulate one or more functions of the immune system either by stimulating or suppressing immune response. [53] The methanol extract of this plant boosted both antibody and cell based immune response. It also increased cell activity and growth in spleen cells. [30]

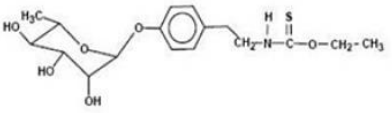
PHYTOCHEMISTRY: Moringa oleifera roots have high amounts of natural plant compounds called 4-(L-osyloxy)-benzylglucosinolate and benzylglucosinolate, which may have health benefits. [31] The term usually refers to chemicals that can affect human health or the plant's taste, texture, smell, or color, but are not essential nutrients for humans. Studying the phytochemicals in Moringa helps researchers discover many unique compounds. [32] When Moringa oleifera seeds, leaves, and roots were analysed, they were found to contain glucosinolates and phenolics, but no anthocyanidins or proanthocyanidins were found. [33]



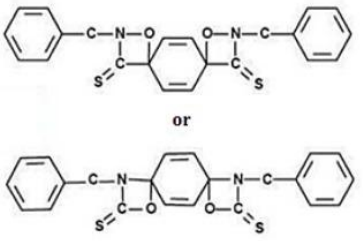
4-(4'-O-acetyl-alpha-L-rhamnosyloxy) benzyl isothiocyanate



4-(alpha-L-rhamnopyranosyloxy) benzyl isothiocyanate

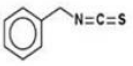


Niazimicin

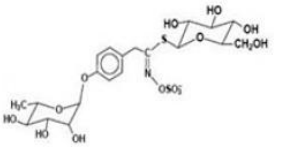


or

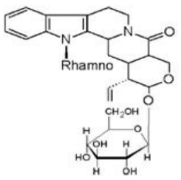
Pterygospermin



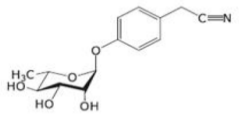
Benzyl isothiocyanate



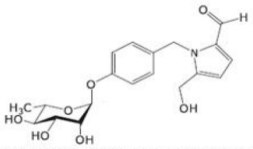
Alkaloids



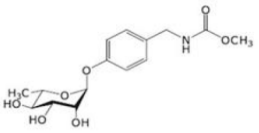
N,α-L-rhamnopyranosyl vincosamide



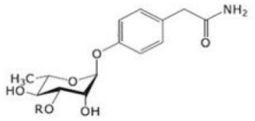
4-(α-L-rhamnopyranosyloxy)phenylacetonitrile (Niazirin)



Pyrrolemarumine 4''-O-α-L-rhamnopyranoside

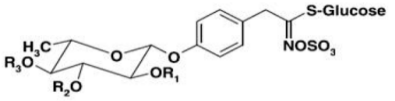


methyl 4-(α-L-rhamnopyranosyloxy)-benzylcarbamate

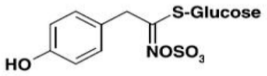


4'-hydroxyphenylethanamide-α-L-rhamnopyranoside (Marumoside A) (R = H)
4'-hydroxyphenylethanamide-α-L-rhamnopyranoside (Marumoside B) (R = D-Glucose)

Glucosinolates

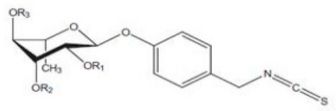


4-O-(α-L-rhamnopyranosyloxy)-benzyl glucosinolate (R1, R2, R3 = H)
4-O-(α-L-acetylrhamnopyranosyloxy)-benzyl glucosinolate Isomer 1 (R1, R2 = H; R3 = Ac)
4-O-(α-L-acetylrhamnopyranosyloxy)-benzyl glucosinolate Isomer 2 (R1, R3 = H; R2 = Ac)
4-O-(α-L-acetylrhamnopyranosyloxy)-benzyl glucosinolate Isomer 3 (R2, R3 = H; R1 = Ac)



4-hydroxybenzyl glucosinolate (sinalbin)

Isothiocyanates



4-(α-L-rhamnosyloxy)benzyl isothiocyanate (R1, R2, R3 = H)
4-(4'-O-acetyl-α-L-rhamnosyloxy)benzyl isothiocyanate (R1, R2 = H; R3 = Ac)
4-(3'-O-acetyl-α-L-rhamnosyloxy)benzyl isothiocyanate (R1, R3 = H; R2 = Ac)
4-(2'-O-acetyl-a-L-rhamnosyloxy)benzyl isothiocyanate (R2, R3 = H; R1 = Ac)

Phytochemistry- Chemical structure of bioactive compound found in moringa oleifera leaves

MEDICINAL VALUE:

Nutritional Therapeutic Value:

High in calcium, protein, vitamin A and C. [34]

Anti-Microbial Activity:

Moringa leaves exhibit antibacterial and antifungal effect against pathogens such as staphylococcus. [35]

Cholesterol Lowering: Moringa leaves have a cholesterol lowering effect similar to that of statin drugs. ([36]

MARKET VALUE:

Globally moringa market value is 9.5 billion US dollars in 2022 and is projected to reach 18.2 billion us dollars. [37]

SUMMARY TABLE-

S.NO	PLANT PART	ACTIVITY	EXTRACT	MODEL	STANDARD DRUG	DOSE	PARAMETERS	MECHANISM	STATS P-VALUE	AUTHOR, YEAR
1	Leaves	CNS depressant	Methanolic	Mice	Diazepam	100-400mg/kg	Locomotor activity	Enhancement of central inhibitory of gaba release	P<0.05	Dolly Jaiswal 2009 [38]
2	Leaves	Antiepileptic	Ethanolic	Mice	Pentylenetetrazole	100-400mg/kg	Seizure threshold	Modulation of neurotransmitter system	P<0.05	S. Sreelatha 2011[39]
3	Leaves	Anti diabetic	Aqueous	Rats	Metformin	100-400mg/kg	Blood glucose levels	Enhancement of insulin secretion	P<0.05	Adewale G. Bakre 2013 [40]
4	Leaves	Antihypertensive	Ethanolic	Rats	-	100-400mg/kg	Blood pressure	Reduction of HMG-CoA reductase	P<0.05	Woranan Kirisattayakul 2013 [41]
5	Leaves	Anticancer	Ethanolic	Human tumor	Cisplatin	0.75mg/ml	DNA fragmentation	Induction of apoptosis	P<0.05	S.Sreelatha 2011 [42]
6	Leaves	Immunomodulatory	Methanolic	Mice	-	250-750mg/kg	Leucocyte count	Enhancement of immune cell proliferatio	P<0.01	Woranan Kirisattayakul 2013 [43]
7	Leaves	Anticancer	Methanolic	Human tumor	Cisplatin	0.75mg/kg	Cell viability	Induction of apoptosis	P<0.05	Adewale G. Bakre 2013 [44]
8	Leaves	Antioxidant	Aqueous	Rats	-	100-400mg/kg	Antioxidant enzyme activity	Reduction of oxidative stress	P<0.05	Alessandro Leone 2015 [45]
9	Leaves	Antipyretic	Ethanolic	Rats	Paracetamol	100-400	Body temperature	Modulation of hypothalamic	P<0.05	Gehad A Ezzat 2020 [46]

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