



PHYTO-PHARMACOLOGY OF *MORINGA OLEIFERA* ROOT: AN OVERVIEW

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ABSTRACT

Moringa oleifera Lam. (Moringaceae) is a highly valued plant, distributed in many countries of the tropics and subtropics. Moringa is best known as excellent source of nutrition and a natural energy booster. It is cultivated for various purposes like vegetable, spice, medicine, cosmetic oil. Different parts of this plant such as the flower, seed, immature pod, stem bark, leaf and root are being employed for the treatment of different ailments in the indigenous system of medicine, due to possible antihyperglycemic, antioxidant, anti-inflammatory and lipid regulating properties, anticancer, antimicrobial, anti-ulcer, anti-hepatotoxic, anti-hepatotoxic, antihypertensive, anti-hyperlipidaemic, antidiabetic, antispasmodic, antiepileptic, antipyretic, and analgesic properties. The Moringa plant provides a rich and rare combination of zeatin, quercetin, beta sitosterol, caffeoylquinic acid and kaempferol, alkaloids, flavonoids. In addition to its compelling water purifying powers and high nutritional value, *M. oleifera* is very important for its medicinal value. The present review is therefore, an effort to give a detailed survey of the literature on its nutritional and pharmacological properties and intends to provide the information on the root of *Moringa oleifera*.

Key words: Antiepileptic, *Moringa oleifera*, Moringaceae, Phytochemical constituents, Root.

INTRODUCTION:

Moringa oleifera Lam (Moringaceae) is a highly valuable plant that grows in many countries of tropics and subtropics ^[1]. It is naturally grown and cultivated throughout the plains, notably in hedges and in residential yards. There are about 13 species of Moringa, *Moringa hildebrandtii*, *Moringa rivae*, *Moringa arborea*, *Moringa drouhardii*, *Moringa peregrina*, *Moringa borziana*, , *Moringa concanensis*, *Moringa ovalifolia*, *Moringa stenopetala*, *Moringa ruspo*, *Moringa pygmaea* and and *Moringa longituba* is distributed around the world and the majority of the studies have focussed on *Moringa oleifera*, *Moringa stenopetala*, *Moringa concanensus*, *M. peregrina* ^[2]. *Moringa oleifera* is significant food source with significant potential as a natural dietary supplement in underdeveloped nations. Many Asian countries and parts of Africa ingest the blossoms, immature pods, and leaves as high nutrient

vegetables. Humans and animals in Nigeria's north and central regions^[3], as well as other countries around the world, will make the use of the leaves^[4,5,6]. It is used as an antidiabetic agent in Indian folk medicine^[7,8], and also as a tonic and aphrodisiac in Nigeria folk medicine, and also to the treatment of the intestinal worms and asthma. The genus is well-known for its wide range of applications. The seeds are used to purify water, the leaves are used as nutraceuticals, the oil can be used as a biofuel, the trunks as gum, the flowers as honey, and all the plant sections can be exploited for therapeutic purpose^[9]. It is known as the Tree of Life or the Miracle tree, however this is due to its usefulness as a food crop rather than its potential therapeutic benefit. It is called as the drumstick tree because of the morphology of the pods which are immature, also known as the horse radish tree due to flavour of the ground root preparations and the ben oil tree due to the oil derived from the seed^[10]. These trees are not influenced by the climatic conditions, and they evolve quickly in poor soil. *Moringa oleifera* is a modest deciduous tree that grows up to a height of 2.5-10 m^[11].

Moringa oleifera is a rapidly grown evergreen tree and modest, that can grow to a height of 9 m. It has a delicate and white corky wood and sticky bark, and the leaves are longitudinal, alternating, twice or three times pinnate leaf are frequently found at branch terminals. They are of 20-70 cm in length, greyish-down when young, and is having a long petiolate which contains 8-10 pairs of pinnae, with at least two pairs of opposing, elliptical leaflets, all 1-2 cm long, with glands which are present at the bases of the pinnae and petioles with a 30-75 cm long primary pivot and are joined with branches that are glandular at the joints, glabrous, and whole leaflets. The leaflets are green in colour and are finely hairy, and are almost bald at top, whiter and smooth beneath, with red touched mid-veins and pit edges, and are either adjusted and or gruff pointed on the peaks and are pointed short at the base. These twigs have such a fine hairy texture and are green in colour. Blossoms are white and pleasant, forming enormous axillary down panicle; units are pendulous and ribbed, the fruits are three lobed pods which are called as drumsticks, that hang from the branches and range in size from 20 to 60 cm. they are split into three sections when they are dried. Each pod contains at least 12 to 35 seeds with three pointed^[12,13]. It has traditionally been used to treat various ailments rather than as a dietary source.

Moringa oleifera is the most nutrient- dense plant because it contains a high proportion of amino acids, antioxidants, and anti-aging and anti-inflammatory compounds. This plant covers a range of vital minerals. Aside from just being high in potassium, vitamin A, vitamin C, and calcium, the plant also includes a variety of phytoconstituents, which includes alkaloids (moringine and moringinine), phenolics, and various procyanidins^[14]. Almost every plant part including roots, leaves, pods, flowers and seeds has been implicated in various activities. The Moringa tree has been documented since 150 BC. Moringa pods were used as a vegetable by ancient kings and queens used to beautify their skin. Moringa consumption has been documented in eighty countries and is understood in 200 languages, according to research. Moringa is widely used not only in India, but also in other cultures such as Roman, Greek, and Egyptian. The Drumstick leaf juice, also known as the Elixir drink, was offered to Mauryan warriors of India in ancient times. They claimed that this drink provided extra energy and served as a stress reliever as well as a pain reliever throughout the battle^[15].

TRADITIONAL CLAIMS:

Moringa oleifera plant has traditionally been used for the treatment of various ailments such as, it is a stimulant, and also used as an antispasmodic, diuretic and expectorant. The root of *Moringa oleifera* which is freshly collected has an unpleasant and vesicant flavour i.e it has the taste of horse-radish. It is known to be having a stimulant activity internally, antilithic, as well as a diuretic. The Gum is a mucilaginous and a bland substance. The seeds are used as astringent and stimulating. Bark of the plant works as emmenagogue and perhaps it is also an abortifacient, used as an antifungal and as well as it is having an antibacterial property. *Moringa oleifera* flowers are cholagogues, stimulants, tonics and diuretics and us beneficial for increasing bile flow. The plant has also been claimed for its us as a cardiac and circulatory tonic ^[16].

All the parts of *Moringa oleifera* plant have been claimed to be having the therapeutic use for different ailments. The traditional therapeutic uses of this plant are listed below (Table I):

Table I: Traditional claims

S.NO	PART OF THE PLANT	TRADITIONAL CLAIMS OF THE PLANT PART	AUTHORS
1	Leaf	Diarrheal, colitis, sore, infection of skin, anaemia, Dysentery, antibacterial, antimalarial, Cardiac stimulant, arthritis, hypertension, typhoid fever, swelling, Parasitic diseases, Diabetes, genio-urinary ailments, immune system booster, elicits lactation.	Silver ^[17] , Parrotta 1993 ^[18] , Anwar et al., 2007 ^[19] ; Kasolo et al., 2010 ^[20] ; Abe and ohtani 2013 ^[21] ; Popoola and obembe 2013 ^[22] ; Sivasankari et al., 2014 ^[23] ; Yabesh et al. ^[24]
2	Root	Epilepsy, helps in parturition, Tooth pain, anthelmintic, anti-paralytic	Anwar er al., 2017 ^[19] ; Popoola and obembe 2013 ^[22] , Sivasankari et al., 2014 ^[23]
3	Bark	Cough, digestive aid, stomach ache, improving the eye vision, ulcers, joint pain, anaemia, diabetes.	Teklehaymanot and Giday, 2010 ^[25] , Popoola and obembe, 2013 ^[22] Yabesh et al., 2014 ^[24]
4	Flowers	Tumours, hysteria, spleen enlargement, muscle diseases, aphrodisiac.	Anwar et al., 2017 ^[19] ; Yabesh et al., ^[24]
5	Seeds	Immune stimulant, antispasmodic, astringent	Jayavardhanan et al., 1994 ^[26] , Caceres et al., 1992 ^[27] Fuglie 1999 ^[28]
6	Oil	Gout, Acute rheumatism	Fuglie 1999 ^[28]

MACROSCOPICAL AND MICROSCOPICAL DESCRIPTION OF *Moringa oleifera* ROOT:

The roots were brown in colour (dark), with rootlets that were round, branching, and 4-8 cm long with a rough texture as shown in fig 1:

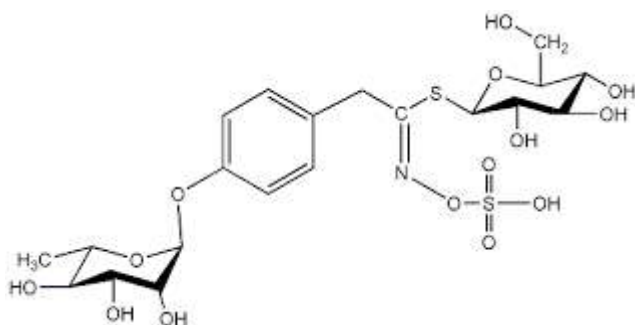
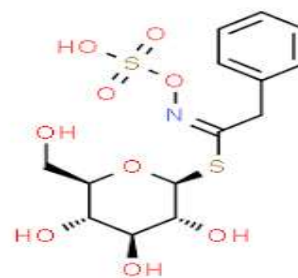


Fig 1: *Moringa oleifera* root

A root transection revealed a round shape. Cork is the outermost layer, 7-12 layers wide; cork cells oriented radially and rectangular in shape. Cork cell development was not constant around the margin, but was halted at regular intervals. The cortical region is large and filled with thin, isodiametric parenchymatous cells with no intercellular space, it is interrupted by a zone of sclerenchymatous fibres confined to the outer portion. This region contains several darkly pigmented myrosin cells as well as some crystals. These crystals ranged in shape and size, comprising prismatic crystals ranging $30-40 \times 20-30$ m and stellate crystals gauging $38-48 \times 42-50$ m; a few oil globules and resinous materials were also found in cortical region. In the mature root, the endodermis and pericycle are difficult to differentiate. A vascular area with eight vascular bundles arranged in a circle. The pith is parenchymatous, with isodiametric to anisodiametric cells and also no intercellular gaps. Two mucilaginous canals separated by parenchymatous cells were visible in the very early stages of development. These mucilaginous tubes were surrounded by single-layered epithelial cells with thin walls. A few epithelial cells exhibit protuberances to inner side. The presence of sclerenchyma patches in the cortical areas of the root, stem, and petiole; mature root vessels containing a balloon-like extension of parenchyma known as tyloses; and the presence of many spheroids are all unusual anatomical features of this plant ^[29].

PHYTOCHEMICAL CONSTITUENTS OF ROOT:

In a study it has been reported that the phytochemical profile of *Moringa oleifera* root extracts found that alkaloid was not present in aqueous, 4% ethanol, or 1.5% methanol extracts. Essential oil is detected in extracts of 3,4, and 5% ethyl acetate as well as extracts of all concentrations of methanol. Except for the aqueous extract, all the extracts included saponin and phenol. Tannin was found in extracts containing 1% and 2% ethyl acetate, 1%, 2%, and 5% ethanol, along with 1% and 2% methanol. Flavonoids were found in all concentrations of ethylacetate and ethanol extracts ^[30]. Roots include more tannins and oxalates, as well as more carbohydrates, salt, arginine, lysine, and ascorbic acid ^[31]. Roots contain high concentrations of 4-(α -L-rhamnopyranosyloxy)-benzylglucosinolate and benzylglucosinolate ^[32].

A. 4-(α -L-rhamnopyranosyloxy)-benzylglucosinolate

B. Benzylglucosinolate

NUTRITIONAL CONSTITUENTS:

The proximate study of *Moringa oleifera* root has been carried out [33], and revealed that it contains 14 percentage of crude protein, 2 percent of fat, 5 percent of ash, 23 percent of crude fibre, 7 percent of moisture and 49 percent of Nitrogen Free extract, whereas the seeds of *Moringa oleifera* contains 47 percent of crude protein, 34 percent of fat, 7 percentage of moisture, and 2 percentage Nitrogen Free Extract and amino acid analysis of root of *Moringa oleifera* has revealed that the roots include Lysine is about 34.8 g/ kg protein, Histidine of 17 g/kg protein, Arginine of 18.1 g/kg protein, Aspartic acid is about 60.2 g/kg protein, Threonine is about 33.4 g/kg protein, Serine is about 35.8 g/kg protein, Glutamic acid is about 131.8 g/kg protein, Glycine is about 46.1 g/100 g protein, Alanine is about 33.4 g/kg protein, Cystine is about 25.1 g/kg protein, Valine is about 30.4 g/kg protein, Methionine is about 6.3 g/kg protein, Isoleucine is about 19 g/kg protein, Leucine is about 50.8 g/kg protein, Tyrosine is about 23.8 g/kg protein and Phenylalanine is about 38.8 g/kg protein. Also, it has been stated that the proximate study of the plants root revealed that it consists of carbohydrate 57.01%, protein 18.92%, lipids 2.74%, fibre 9.31%, moisture 4.09%, and ash 7.95% [34].

PHARMACOLOGICAL ACTIVITY:**Anti-inflammatory activity:**

The anti-inflammatory effect of a crude methanol extract of root was tested by suing the rat paw edema method and also by the rat 6-day pouch inflammatory technique. After the oral treatment, it has been reported to inhibit the carrageenan- induced rat paw edema which is done in a dose-dependent manner with an IC₅₀ of 660mg/kg. nevertheless, in the 6-day air pouch acute inflammation which has been induced by carrageenan, the extract was considerably more powerful with IC₅₀ values of 302mg/kg and 315mg/kg for the suppression of the cellular accumulation and exudation, respectively. The active principles in the roots were therapeutic both acute and chronic inflammatory disorders [35,27].

Anti-fertility activity:

The estrogenic, antiestrogenic, progestational and antiprogestational properties of *Moringa oleifera* roots aqueous extract were examined and was found that the activation of uterine histoarchitecture aided the estrogenic activity. The extracts antifertility appears to be attributable to a combination of factors [36].

Antioxidant activity:

In an analysis, performed with several solvent extracts with *Moringa oleifera* roots and demonstrated that different solvent extracts produce different antioxidant activity, with methanolic extract is the best suited solvent for the extraction of the bioactive components as well as for the extraction the antioxidants, it has been found that the various bioactive

components present in the root are α -tocopherol, flavonoids, triterpenoids, saponins, alkaloids, phenols, and glutathione. It has also been reported that *Moringa oleifera* root has shown significant activity of radical scavenging activity of the different extracts as well as by reducing hydroxyl radicals along with the inhibition of microsomal LPO activities. The study indicated that DNA is protected against hydroxyl radical-induced damage^[37].

Central Nervous system (CNS):

Gupta et al., 1999^[38], found out that methanolic extract of the root prolonged sleep time produced by a variety of CNS depressants, including diazepam, meprobamate and pentobarbitone. *Moringa oleifera*'s modulation of 5-hydroxytryptamine pathways may be responsible for this central depressive impact (Ray et al., 2004)^[39]. The plant extract promoted the analgesia which was induced by pethidine and morphine while suppressing the convulsions which are induced by strychnine and Leptazol (Gupta et al., 1999). Ray et al., (2003)^[40] demonstrated that aqueous extracts of the root suppressed penicillin-induced convulsions in rats administered chronically^[38,39,40].

Antihepatotoxic activity:

It has been reported that aqueous extract and alcoholic extract of the *Moringa oleifera* root and flower has exhibited the antihepatotoxic effectiveness in treated rats to acetaminophen-induced hepatotoxicity^[41], and also been reported, an outcome related to the plants ability to restore/increase glutathione levels in liver^[42].

Antiuro lithiatic activities:

Caceres et al., 1992^[27] reported that the plants root, leaves, flowers, seeds and gum are all diuretic. Karadi et al.,^[43] investigated the antiuro lithiatic activity of ethanolic extract of *Moringa oleifera* root also with aqueous root extract of *Moringa oleifera* in Wistar albino rats and found that it is having the antiuro lithiatic property.

Antimicrobial activities:

Previous research has demonstrated that the seeds, flowers, leaves, root and stem bark of *Moringa oleifera* possess antibacterial action against a wide variety of bacteria and fungus. It has been found that the active microbial compounds in the seed and root have been identified as 4-(-L-rhamnosyloxy) benzyl isothiocyanate, which has been shown to be bactericidal against *Mycobact. Pheli* and *B. subtilis*^[44]; and 4-(D-Glucopyranosyl-1,4-L-rhamnosyloxy)-benzyl thiocarboxamide, which has also been reported to be bactericidal against *S. dysenteriae*, *B. cereus*, *E. coli*, and *S. typhi*^[45].

Hypotensive activity:

The hypotensive activity of *Moringa oleifera* roots non-polar extracts and fractions of its roots, along with their chemical profile, were investigated by GC-MS, and found that the Petroleum ether and Dichloromethane extracts of *Moringa oleifera* roots reduced mean arterial blood pressure (MABP) significantly, when compared with control. It has been reported that GC-MS analysis of both the petroleum ether and dichloromethane extracts have been identified 74 compounds and the major constituents among them are various hydrocarbons, fatty acids, esters, alcohols, isothiocyanates, steroids, trephenyl and sulphur containing compounds were methyl hexadecanoate, stigmastan-3,5, diene, methyl 14-hydroxy -5- tetradecanoate, 11 diphenyl undecane and cyclopentanyl hexadecane. However, more research is necessary to confirm the bioactivity, particularly in a hypertension paradigm, which will assist in determining the simultaneous activity of these components as well as their potential in the treatment of hypertension^[46].

Anticancer activity:

Drumstick tree (*Moringa oleifera*) roots seemed to have active compounds that were easily extracted in the ethanolic solvent and could be employed as natural anticancer medications, it has been found that *in vitro*, they were effective against leukaemia cells. The extracts metabolites will be studied, as will their role in cancer cell eradication. These studies strongly support the significance of the roots as a source of high value metabolites ^[47].

Future prospects:

Several studies have been undertaken to assess traditional usage of moringa species, and all of these investigations have supported the traditional claims. However, there are a plethora of traditional uses that have yet to be investigated like the CNS stimulant other than the epileptic activity and some other activities like hypotensive activity which needs to be studied clearly and the unknown compounds has to be identified as well as the mechanism of actions of the known compounds can be used for other activities are yet to be determined. As a result, more research is required to fully exploit *Moringa oleifera*'s root numerous applications.

Conflicts of Interest:

Authors Declare no conflicts of interest.

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