

# A Review on Medicinal Constituents and Therapeutic Potential of *Moringa oleifera*

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**Abstract** *Moringa oleifera* is an old plant known for its different restorative properties referenced in Ayurveda. It has a place with the Moringaceae family. It is ordinarily named as Sainjana in Hindi and Drumstick or Horseradish tree in English. It belongs to tropical and subtropical regions. It is found in India, Philippines, South Asia, Indonesia, Central America, Africa, and Caribbean. Generally, *Moringa oleifera* has been utilized or its different restorative properties, for example, as wound healing, anti-diabetic, pain relief, anti-inflammatory, cancer prevention. All aspects of this plant contain a significant therapeutic component. Numerous basic supplements have been found in *Moringa oleifera* for example nutrients, minerals, amino acids, omega 3 and 6 unsaturated fats, antioxidants and  $\beta$ -carotene. It is a high wellspring of nutrients and minerals, leaves and pods contain bottomless measure of manganese, different minerals, for example, K, Cu, Na, Mg, Fe, Zn, Cl, P, and so forth are additionally present in *Moringa oleifera*. Different parts of *Moringa oleifera* possess a great wellspring of glucosinolates, flavonoids, phenolic compounds, polyunsaturated fatty acids, monounsaturated fatty acids and others. Different definitions are accessible in the market of *Moringa oleifera*, for example, seed oil, dried leaves powder, paste, tablet are accessible there for different uses. The present review focuses on the biological sources, phytoconstituents, toxicological studies, multipurpose uses and possible pharmacological activities carried out on *Moringa oleifera*.

**Keywords** *Moringa oleifera*, Pharmacological Activities, Phytoconstituents, Industrial Uses, Drumstick

## 1. Introduction

Plants are significant for the treatment of the ailments. In Ayurveda, different plants are referenced for their

distinctive therapeutic properties, for example, pain relief, calming, antipyretic, hostile to diabetic and so forth. *Moringa oleifera* is one of such plants utilized due its different therapeutic properties; for example, wound healing, anti-diabetic, pain relieving, cell reinforcements. *Moringa oleifera* is health restorative plant and it is very well-known in tropical and subtropical nations. Generally, *Moringa oleifera* is being utilized for its anti-inflammatory property because of its constituents found in leaves. In India, poultices of seed units have been utilized to treat glandular aggravation. Different investigations on extracts of *Moringa oleifera* seed pods, leaves, seeds done on human subjects, and animals as well as toxicity studies examined so far recommends that they are protected to use in normally used portions. *Moringa oleifera* shows pharmacological properties like anti-asthmatic, hepato-defensive, anti-fertility, anticancer, antimicrobial, cardiovascular, against ulcer, antipyretic action [1].

### Scientific Classification

Kingdom – Plantae  
Sub kingdom – Tracheobionta  
Super division – Spermatophyta  
Division – Magnoliophyta  
Class – Magnoliopsida  
Sub class – Dilleniidae  
Order – Capparales  
Family – Moringaceae  
Genus – *Moringa*  
Species – *oleifera*

### 1.1. Botanical Description

The development of *Moringa oleifera* in India is found in the most part in the southern conditions of Tamil Nadu, Kerala, Andhra Pradesh and Karnataka. India is the biggest maker of *Moringa oleifera*, with a yearly creation of 1.2 million tones of organic products from a territory of Three hundred and eighty km<sup>2</sup>. *Moringa oleifera* is developed in home nurseries and as living wall in South

Asia and Southeast Asia, where it is generally sold in neighborhood markets. In the Indonesia, it is regularly developed for its leaves which are utilized as nourishment. *Moringa oleifera* is likewise effectively developed by the World Vegetable Center in Taiwan, for vegetable research purpose. *Moringa oleifera* is an evergreen or deciduous tree which typically grows up to 10 to 12 m in tallness. Leaves are bipinnate or tripinnate fluffy, green leaves and the leaflets are upto 1-2 cm. The leaflets are bristly and practically bald on the upper surface while the twigs are furry and green. Blossoms are typically white in shading with furry stalks and individual bloom is upto 1 cm long and 2 cm wide. They are indiscriminate, fragrant and with hanging auxillary of 10 to 25 cm long. The 5 sepals are direct lanceolate type while 5 petals are thin spatulate. They encompass the 5 stamens and 5 staminodes and are reflexed aside from the least. Natural products are frequently referred as pods. They are tri-lobed cases; youthful units are green in shading. The develop pods are dark colored triangular, pendulous, and split into three sections the long way when dry 30 to 120 cm long, 1.8 cm wide natural products generation for the most part happens in March and April. Fruits possess around 26 seeds during their advancement organize. Seeds are round and caramel in shading with 1cm in distance across. It has a semi-penetrable seed frame with 3 papery wings bodies. Seeds are dark colored however can be white if portions are of low suitability. Reasonable seed develop inside about fourteen days; each tree can deliver around 15,000 to 25,000 seeds/year. Normal weight is 0.3 gm per seed [2-4].

## 2. Phytochemistry

Numerous basic supplements have been found in *Moringa oleifera* for example nutrients, minerals, amino acids,  $\beta$ -carotene, omega 3 and 6 unsaturated fats and cell

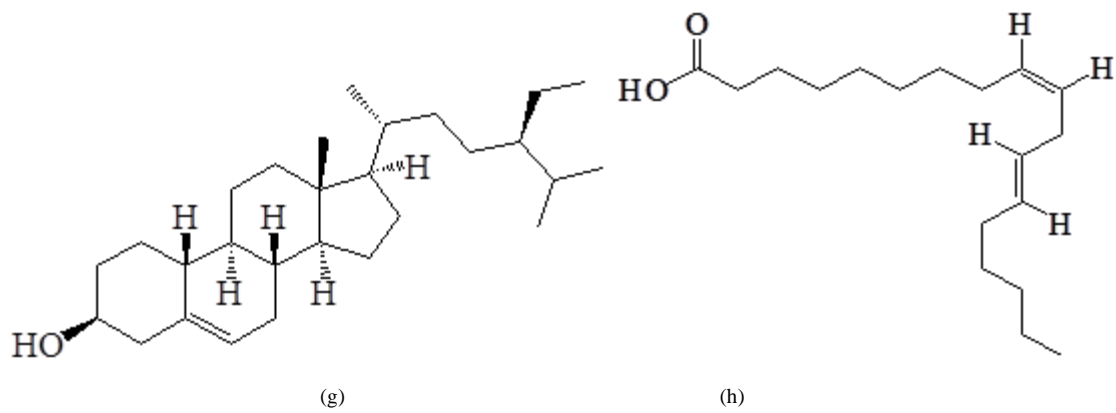
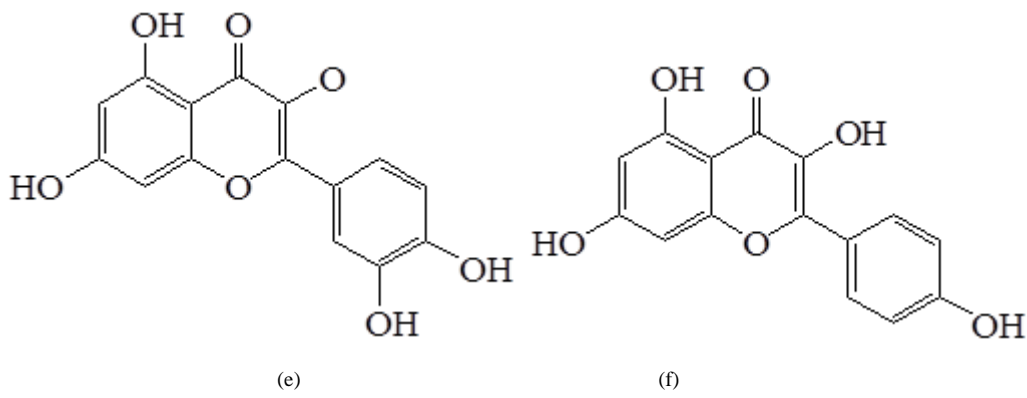
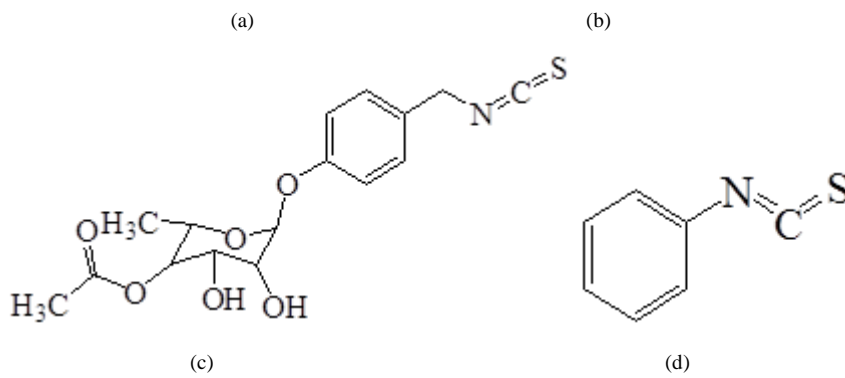
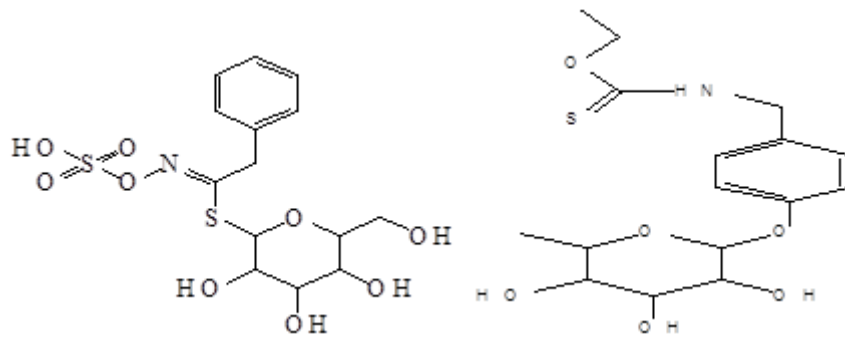
reinforcements. It is a high wellspring of nutrients and minerals, leaves and pods contain rich measure of different minerals. *Moringa oleifera* leaves are accepted as wellspring of nutrient such as carbon, chloride, potassium, beta carotene just as protein. Different parts of *Moringa oleifera* has been considered as great source of glucosinolates, phenolic acids, and flavonoids. 4-O-(a-L-rhamnopyranosyloxy)-benzylglucosinolate, one of the glucosinolates, is transcendently found in flowers, roots, stem, leaves, pods, and seeds. High content of glucosinolates are found in leaves and seeds. Glucosinolates is one of the significant parts in *Moringa oleifera* tree. It is catabolised enzymatically by plant's compound myrosinase into thiocarbamates, nitriles, isothiocyanates which are known for their solid hypertensive and spasmolytic impacts. *Moringa oleifera* have high substance of fiber in it and it is generally excellent from stomach related perspective. It contains isothiocyanates which wipes out H.pylori from the gut and is utilized in the significant sicknesses like gastritis ulcer and gastric malignancy. The *Moringa oleifera* leaves are high wellspring of omega 3 and omega 6 polyunsaturated unsaturated fats. It is elusive a plant having so a lot of gainful characteristics in its each part whether it be leaves, blooms, pods, seeds and so forth. Some chemical constituents are expressed in Table 1 [5-7].

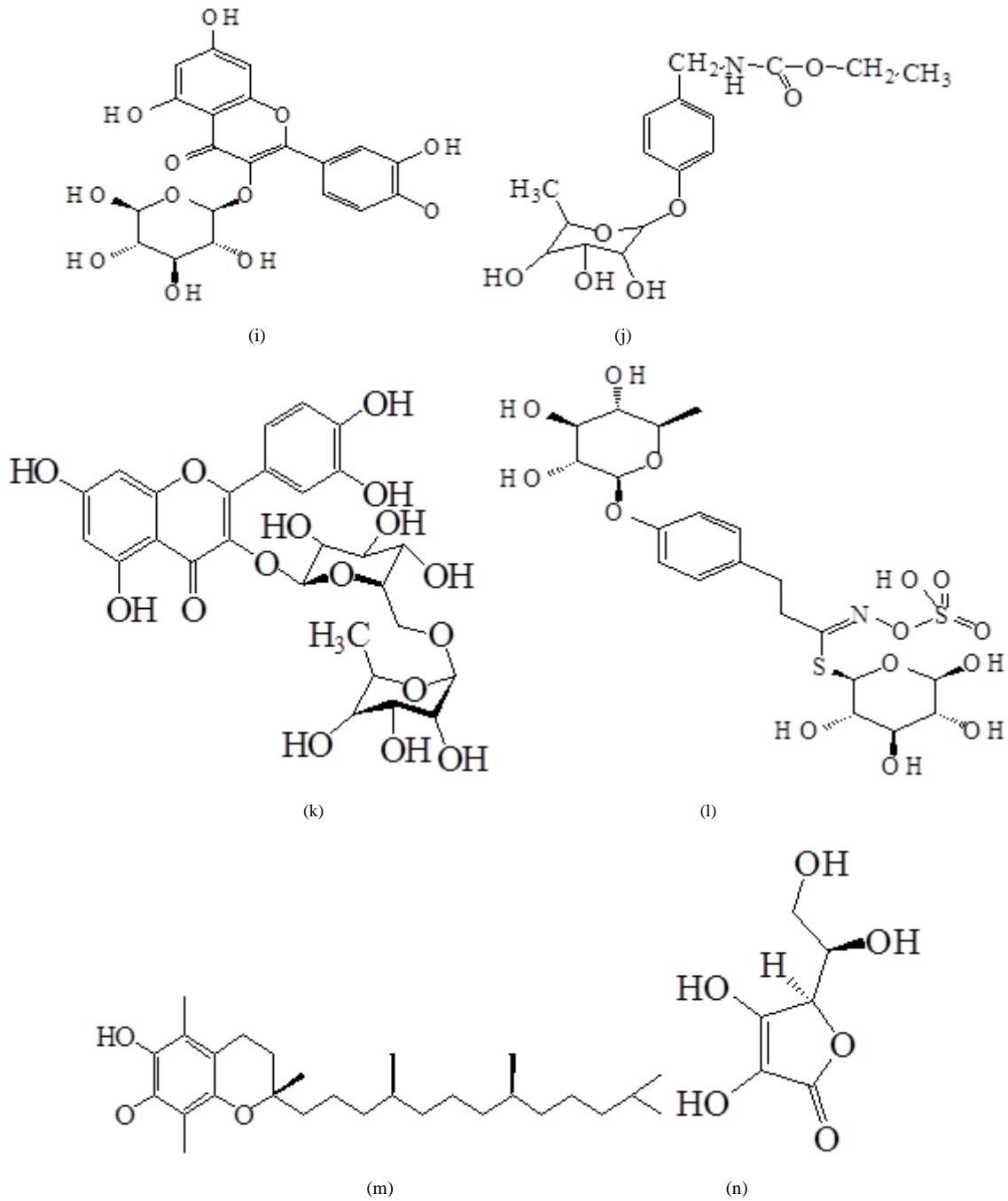
## 3. Pharmacological Activities

In Ayurveda, *Moringa* has been mentioned as the tree of god for its multiple uses to treat various diseases. From ancient times different parts of *Moringa oleifera* has been used to treat epilepsy, chronic rheumatism, dropsy, dyspepsia, fever, etc. *Moringa oleifera* possess vast pharmacological activities. Some of them are summoned in Table 2.

**Table 1.** The major phyto-constituents found in different parts of *Moringa* are given below

PART OF PLANT	CHEMICAL CONSTITUENTS	REFERENCES
Leaves	4-O-(a-L-rhamnopyranosyloxy)-benzylglucosinolate, quercetin, kaempferol, carotenoids, $\alpha$ -tocopherol, a-linolenic acid, linoleic acid, Palmitic acid, Ca, Fe, Niaziminin A, and Niaziminin B, three mustard oil glycosides, niaziminin, a thiocarbamate, 4(alpha-1-rhamnopyranosyloxy)-benzylglucosinolate, quercetin-3O-glucoside and quercetin-3-O-(6''-Malonyl- glucoside), Niazimicin.	[6]
Flowers	Monounsaturated fatty acids (MUFAs), ascorbic acid, protein, D-mannose, kaempferol, kaempferitin	[1]
Fruit / Seed Pods	Carotenoids, monounsaturated fatty acids (MUFAs), K, P, Cu, O-ethyl-4-(alpha-L-rhamnosyloxy) benzyl carbamate, methyl- p-hydroxybenzoate, beta-sitosterol	[8]
Roots	Benzyl glucosinolate (glucotropaeolin), Moringine, moringinine, spirachin, 1,3-dibenzyl urea, alpha- phellandrene, p-cymene, Deoxy-niazimicine.	[6]
Seeds	Oleic acid, palmitoleic acid, stearic acid, arachidic acid, Dodecanoic acid, tetradecanoic acid, hexadecanoic acid, octadecanoic	[7]
Stem	Glucomoringin, $\beta$ - sitosterone and $\beta$ - sitosterol.	[6]





**Figure 1(a-n).** (a) Benzyl glucosinate, (b) Niazimicin, (c) 4-(4'-O-acetyl-a-L-rhamnosyloxy) benzyl isothiocyanate, (d) Benzyl-isothiocyanate, (e) Kaemopherol, (f) Quercetin, (g)  $\beta$ -sitosterol, (h) Linoleic acid, (i) Quercetin-3-o-glucoside, (j) O-ethyl-4-(alpha-L-rhamnosyloxy) benzyl carbamate, (k) Rutin, (l) Glucomoringin, (m)  $\alpha$ -tocopherol, (n) Ascorbic acid.

**Table 2.** Representation of various pharmacological activities found in different parts of *Moringa oleifera* plant is described below.

Plant parts	Pharmacological activity	Findings/Outcomes	Possible phytoconstituents	References
1. <i>Moringa oleifera</i> leaves	Anti-diabetic activity	<p>a) Ethanol extract of <i>Moringa oleifera</i> leaves reduces blood glucose level, HbA1c and glycogen level.</p> <p>b) Ethyl acetate fraction of <i>Moringa</i> reversed the symptoms shown by STZ such as loss of body weight, increase in average water and food consumption.</p> <p>c) Aqueous extract of <i>Moringa oleifera</i> leaves possess dose-dependent hypoglycemic activity in normoglycemic and hyperglycemic animals.</p> <p>d) Aqueous leaf extract reduced albumin serum levels and total protein indicates the reduction of blood glucose level in diabetes treated group.</p> <p>e) Aqueous extract of leaves reduces the blood glucose level in normal rats and normalizes the level in mild, sub and severe diabetic rats.</p> <p>f) Ethanol extract of leaves reduced blood glucose level in pretreated group. As well as it decreased dose-dependently, blood glucose level in the period of 14 days. In normal rats, decline of blood glucose level has been found gradually.</p> <p>g) Aqueous extract of <i>Moringa oleifera</i> leaves was analyzed to study its effect for wound healing in STZ-induced diabetic rats. The study shown that the extract influenced the healing of the skin wounds after systemic and topical treatment.</p>	Terpenoids, quercetin, chlorogenic acid, kaempferol, flavanoids, proteins, fixed oils and fats and carbohydrates	[8] [9] [10] [11] [12] [13] [14]
2. <i>Moringa oleifera</i> leaves	Anti-convulsant activity	<p>a) The study showed that hexane and ethanol extracts of <i>Moringa</i> leaves produced delay in seizures latency. <i>Moringa</i> leaves possess anticonvulsant properties due to the complementary of the non-polar and polar constituents.</p>	Linoleic acid	[15]
3. <i>Moringa oleifera</i> leaves	Anti-depressant activity	<p>a) Alcoholic extract of <i>Moringa</i> leaves were evaluated for antidepressant activity by three animal models, forced swim test, tail suspension test and locomotor activity test. It was concluded that it possess antidepressant activity.</p> <p>b) Ethanolic extract of <i>Moringa</i> leaves were prepared to evaluate neurobehavioral properties by using open field, hole board, Y-maze, elevated plus maze and pento-barbitone induced hypnosis. The findings from this study suggested that the extract of <i>MO</i> leaves possess CNS depressant and anticonvulsant activities which possibly be mediated through enhancement of central inhibitory mechanism involving release of GABA.</p>	Quercetin, kaempferol, glucosinolates, fatty acids, isothiocyanates, hexadecanoic acid, flavonoids and phenols.	[16] [17]
4. <i>Moringa oleifera</i> leaves	Anti-inflammatory activity	<p>a) Dried and milled <i>Moringa oleifera</i> leaves were extracted with ethanol/water (4:1) followed by a series of liquid-liquid extractions. From the study it was concluded that, the extracts prepared using polar solvents had significantly higher antioxidant capacities.</p> <p>b) <i>Moringa oleifera</i> leaf extracts were tested for its antioxidant activity by two stages of maturity using standard <i>in vitro</i> models. It was concluded that <i>Moringa oleifera</i> leaves possess potent antioxidant activity. From the analysis it was revealed that there were minor differences in the antioxidant activity in the mature and tender leaves.</p> <p>c) Ethanol extracts of <i>Moringa</i> leaves against experimentally diclofenac sodium induced liver toxicity in male rats. HPLC was performed for indentifying phenolic compounds. From the results it was concluded that administration of extract improved liver and kidney functions. It has a beneficial effect against oxidative</p>	Glucosinolates, isothiocyanates, $\beta$ -carotene, $\alpha$ -tocopherol, vanillin, benzoic acid, salicylic acid, chlorogenic acid, 3,4,5 - methoxy - cinnamic acid.	[18] [19] [20] [21]

		<p>liver damage induced by DcNa.</p> <p>d) <i>Moringa oleifera</i> leaves extracted with methanol and dichloromethane were screened for antioxidant activity. Radical scavenging assays with 1, 1-diphenyl-2-picrylhydrazyl (DPPH) and 2,2'-azino-bis 3ethylbenzothiazoline-6-sulfonic acid (ABTS) were used to determine the antioxidant activity. The study provides evidence that <i>M. oleifera</i> leaves possess antioxidant activity.</p>		
5. <i>Moringa oleifera</i> leaves	Anti-oxidant activity	<p>a) Aqueous and ethanol extracts were prepared from leaves of Moringa. During the test, suppression in oedema was observed which may be due to the inhibitory effects on the release of histamine, 5-ydroxy tryptamine and kinin like substances which are reported to release from mast cell degradation during first hour of carrageen induced artificial paw oedema.</p> <p>b) Dried matured leaves were extracted with hexane and ethanol. The study gives the evidence of the broad spectrum of anti-inflammatory activities in the use of <i>Moringa oleifera</i> leaves polar extracts.</p> <p>c) Methanol extract of Moringa leaves was evaluated for anti-inflammatory effects by carrageen – induced paw oedema test and histamine-induced pedal oedema test. From the results, it was concluded that the methanol extract of <i>Moringa oleifera</i> leaf possesses a significant anti-oedematogenic effect on paw oedema induced by carrageen and histamine.</p>	<p>Flavonoids, tannins, saponins, terpenoids, cardiac glycosides, amino acids, <math>\alpha</math> and <math>\beta</math>-carotene, sterols, carbohydrates, alkaloids, iron, calcium, phosphorus, vitamin A and B, <math>\alpha</math>-tocopherol, riboflavin, nicotinic acid, folic acid, pyroxidine.</p>	[22] [23] [24]
6. <i>Moringa oleifera</i> leaves	Anticancer activity	<p>a) <i>Moringa oleifera</i> leaves were extracted by methanol and dichloromethane. The extract was investigated for its chemoprotective and antiproliferative activity. From the study it was concluded that, it possess antioxidant activity, as well as cytotoxic and chemoprotective properties.</p>	<p>Polyphenol, gallic acid, quercetin and kaempferol, glycosides, flavonoids</p>	[21]
7. <i>Moringa oleifera</i> leaves	Anti hyper-lipedemic activity	<p>a) Hydroalcoholic extract was prepared from Moringa leaves. From the study it was concluded that the sitosterol inhibit the absorption of dietary cholesterol.</p>	<p><math>\beta</math>-sitosterol, flavonoids, polyphenols.</p>	[25]
8. <i>Moringa oleifera</i> stem	Anti-cancer activity	<p>a) AgNPs of shade dried <i>Moringa oleifera</i> stem bark were prepared. These nanoparticles showed dose-dependent increase in the intracellular ROS production. These also affected the cell cycle for inhibiting the cell replication. AgNPs shows anti-cancer activity against HeLa cell type.</p>	<p>Phenols, <math>\beta</math>-sitosterol, caffeoylquinic acid, quercetin, kaempferol.</p>	[26]
9. <i>Moringa oleifera</i> stem	Anti-bacterial activity	<p>a) Different extracts of <i>Moringa oleifera</i> such as methanol, chloroform, ethyl acetate and aqueous were evaluated for its activity by paper disc diffusion method. All extracts irrespective of its type inhibited the growth of test pathogens to different degrees. In comparison between these extracts ethyl acetate extract have shown the maximum activity and then in decreasing order by chloroform, methanol and aqueous extracts.</p>	<p>Alkaloids, flavonoids, tannins and terpenoids.</p>	[27]
10. <i>Moringa oleifera</i> stem	Anti-ulcer activity	<p>a) Ethanol extract of root-bark of <i>Moringa oleifera</i> posses anti-ulcer, antisecretory and cytoprotective activity. <i>Moringa oleifera</i> has the potential to cure gastric ulcers and gastric mucosal lesions. It also decreases the acidity and increases the pH of gastric juice.</p>	<p>Alkaloids, carbohydrates, proteins, tannins, phenols, steroids, saponins, triterpinoids.</p>	[28]
11. <i>Moringa oleifera</i> stem	Antioxidant activity	<p>a) Crude petroleum ether, chloroform, methanolic extracts of stem of <i>Moringa oleifera</i> were tested for their antioxidant activity using DPPH radical scavenging assay method.</p>	<p>Tannins, flavonoids, steroids, alkaloids, triterpenoids, sterols, procyanidins, glycosides.</p>	[29], [30]
12. <i>Moringa oleifera</i> stem	Anti-arthritic activity	<p>a) Methanol extract of stem of <i>Moringa oleifera</i> was evaluated for anti-arthritic activity by acute and chronic models of inflammation. Different doses of Moringa significantly inhibit the inflammation and also show anti-proliferative activities.</p>	<p>Glycosides, saponins, tannins, fats and oils, steroids, triterpenoids,</p>	[31]

			alkaloids, proteins, carbohydrates, anthraquinones.	
13. <i>Moringa oleifera</i> flower	Antioxidant activity	<p>a) Alcohol extract of dried flowers of <i>Moringa oleifera</i> was obtained by cold maceration method. Antioxidant activity of extract was evaluated by DPPH radical scavenging, showed potential radical scavenging activity.</p> <p>b) Ethanol and saline extract of <i>Moringa</i> flowers were evaluated for antioxidant activity. The antioxidant activity was stronger in ethanol extract than saline extract.</p>	Tannins, steroids, flavonoids, alkaloids, carbohydrates, glycosides, cardiac glycosides, terpenoids, polyphenols, flavonoids, alkaloids, terpenoids, tannins	[32] [33]
14. <i>Moringa oleifera</i> flower	SCAR Marker	<p>a) Methanol extract of <i>Moringa oleifera</i> flowers was used to develop SCAR marker for authentication and DNA based identification.</p>	Phenolic, flavonoid, alkaloid, terpenoids, tannins, steroids, glycosides, and anthraquinone.	[34]
15. <i>Moringa oleifera</i> fruit	Anti-diabetic activity	<p>a) Methanol extract of <i>Moringa oleifera</i> pods was evaluated for its anti-diabetic activity. It showed that extract protects <math>\beta</math>-cells against ROS-mediated damage by enhancing cellular antioxidant defenses and minimizing hyperglycemia in STZ-induced diabetes</p>	Quercetin, kaempferol, flavanoids, methyl-p-hydroxybenzoate, beta-sitosterol	[35]
16. <i>Moringa oleifera</i> fruit	Antimicrobial and Anti-fungal activities	<p>a) Methanol extract of <i>Moringa oleifera</i> fruit showed that it exhibits anti microbial activity against the tested microorganisms at different given concentrations. The fruit extract has shown mild to moderate anti-fungal activity also. The extract has shown a broad spectrum of antibacterial activity.</p>	Beta-sitosterol, carotenoids, flavonoids	[36]
17. <i>Moringa oleifera</i> fruit	Antioxidant activity	<p>a) Methanol extract of <i>Moringa oleifera</i> pods evaluated for its antioxidant activity concluded that it has promising antioxidant effects.</p> <p>b) Ethanolic extract of <i>Moringa oleifera</i> pods was evaluated for its antioxidant activity by both <i>in vitro</i> and <i>in vivo</i> analysis such as DPPH radical scavenging, FRAP, and total antioxidant activity.</p>	Polyphenols, tannins, anthocyanin, glycosides, thiocarbamates	[35] [37]
18. <i>Moringa oleifera</i> roots	Antiulcer activity	<p>a) Ethanol extract of root-bark of <i>Moringa oleifera</i> posses anti-ulcer, anti-secretory and cytoprotective activity. <i>Moringa oleifera</i> has the potential to cure gastric ulcers and gastric mucosal lesions. It also decreases the acidity and increases the pH of gastric juice.</p>	Alkaloids, carbohydrates, proteins, tannins, phenols, steroids Saponins, triterpinoids.	[28]
19. <i>Moringa oleifera</i> roots	Anti-inflammatory activity	<p>a) Methanol extract of root of <i>Moringa oleifera</i> was screened for its anti-inflammatory properties by using carrageen induced paw oedema and 6-day air pouch inflammation. The results obtained from the study concludes that the extract exhibits anti-inflammatory properties and may be useful in the treatment for both acute and chronic inflammation.</p>	Benzyl glucosinolate, quercetin, kaempferol, flavonoids, alkaloids, saponins, saccharides, glucosinolates, tannins, phenolic acids and nitrile glycosides.	[38], [39]
20. <i>Moringa oleifera</i> roots	Antimicrobial activity	<p>a) Different extracts of <i>Moringa oleifera</i> root was evaluated for its antimicrobial activity against <i>Escherichia coli</i>, <i>Staphylococcus aureus</i>, <i>Pseudomonas aeruginosa</i>, <i>Proteus mirabilis</i>, <i>Penicillium</i> sp., <i>Mucor</i> sp., <i>Aspergillus niger</i> and <i>Candida albicans</i> by disc diffusion method. Ethyl acetate extract showed broad spectrum of antibacterial activity than other extracts. Aqueous extract showed maximum activity against <i>Penicillium</i> species.</p>	Alkaloids, flavonoids, saponins, terpenoids, steroids, tannins, cardioglycosides, aminoacids and proteins	[40]

21. <i>Moringa oleifera</i> roots	Anti-mutagenic activity	a) Aqueous extract of Moringa root was prepared by heat treatment. Mutagenicity was assayed by the standard Ames test. The result from this concluded that various phyto-chemicals, such as tannins, flavonoids, phenolics etc present in Moringa contribute in its anti-mutagenic activity.	Tannins, saponin, flavonoids, steroids, terpenoids, glycoside zeatin, quercetin, b-sitosterol, caffeoylquinic acid and kaempferol.	[41]
22. <i>Moringa oleifera</i> roots	CNS activities	a) Methanol extract of Moringa root was prepared by soxhlet method. Different activities were performed such as analgesic activity, effect on sleeping time, anticonvulsive activity and behavioral effect. From this study, it was concluded that the extract exhibits CNS depressant action in dose dependent manner.	Alkaloids, quercetin, kaempferol, glucosinolates, fatty acids, isothiocyanates	[42]
23. <i>Moringa oleifera</i> roots	Anti-urolithiatic activity	a) Aqueous and alcoholic extracts were prepared from Moringa root by maceration method. The aqueous and alcoholic extracts of Moringa root causes lithiasis and dissolves the preformed stones and prevents new stone formation in urinary system.	Alkaloids, pterygospermin, 2-nitrile glycosides, niaziminin, 4-(4-O-acetyl-alpha-l-rhamnosyloxy benzyl) isothiocyanate	[43]
24. <i>Moringa oleifera</i> seeds	Anti-diabetic activity	a) Moringa seed powder was investigated for its anti-diabetic activity in STZ-induced diabetic rats. The result of the study concluded that its effects are dose dependent on diabetic rats. Higher doses of Moringa seed powder have shown more anti-diabetic effect than lower doses due to the presence of more phytochemicals present in the higher dose such as glucomoringin, phenols and flavonoids.	Glucosinolates, glucomoringin, quercetin, phenols, kaempferol and chlorogenic acid	[44]
25. <i>Moringa oleifera</i> seeds	Anti-fungal activity	a) Ethanol extract of Moringa seed showed anti fungal activity against <i>Trichophyton rubrum</i> , <i>Trichophyton mentagrophytes</i> , <i>Epidermophyton floccosum</i> , and <i>Microsporum canis</i> . GC-MS analysis was done for the evaluation of chemical composition of the extract.	Oleic acid, palmitoleic acid, stearic acid, arachidic acid.	[45]
26. <i>Moringa oleifera</i> seeds	Antioxidant activity	a) Moringa seed kernel was extracted by methanol, acetone and water individually. From the result of the study it was concluded that among all the extracts, water extract of Moringa seed kernel possessed potent antioxidant activity.	4(alpha-rhamnosyloxy) benzyl isothiocyanate, 4-hydroxyphenyl-acetamide, 9-octadecenoic acid, O-ethyl-4-(alpha-l-rhamnosyloxy) benzyl carbamate, niazimicin, niazirin.	[46]



## 4. Toxicological Profile

Toxicity profile has been studied for various parts of *Moringa oleifera* such as its leaves, roots and seeds. Some of them are listed below;

- Acute toxicity of *Moringa oleifera* dried leaf powder at 2000 mg/kg was studied on Sprague Dawley rodents according to OECD Guidelines 423. Animals watched for every hour, in its underlying period for 14 days and no unfriendly responses were seen, for an additional 7 days. From the examination it was demonstrated that oral administration of dried *Moringa oleifera* leaves powder upto 2000 mg/kg indicated no adverse impacts and its LD50 saw as more than 2000 mg/kg [47].
- Acute and chronic poisonous quality of the aqueous extract of *Moringa oleifera* leaves were contemplated by oral administration. Acute toxicity was induced by directing 10 g/kg. This portion gave no indications of antagonistic responses in mice. In chronic lethality study, eighty Wistar rats were isolated into four groups having 10 creatures in each gathering per sex. Group 1 was the control group and Group 2 to 4 were given 10, 100, 1000 mg/kg/day for a half year. The outcomes from chronic toxicity examination uncovered that on various portions given to various groups, no change was seen by and large wellbeing status of rodents [48].
- Ethanol concentrates of *Moringa oleifera* leaves were surveyed for acute toxicity studies. Two groups, each with 6 creatures were made, for both, rats and rabbits. The concentrate was infused by intraperitoneal route with 150 mg/ml in like clockwork till death of the creatures happened. The outcome uncovered that LD50 for rats was 6616.67 mg/kg body weight and for rabbits was 26043.67 mg/kg body weight [49].
- Sub-chronic toxicity study of *Moringa oleifera* leaf powder was assessed. For the examination, 1000 mg/kg per oral every day was administered to mice for ninety days. In the investigation, no change was seen in clinical or net pathology over a drawn out incessant presentation of 90 days[50]
- Acute toxicity study of *Moringa oleifera* roots was dictated by giving a solitary oral portion to mice and watched for 24 h. The LD50 of ethanol extricate was 17 g/kg and that of watery concentrate was 15 g/kg. Both the concentrates are generally non-poisonous when given in a solitary portion [51].
- Toxicity profile of *Moringa oleifera* leaves and seeds were concentrated to watch the consequences for fundamental organs of Wistar rodents. Methanol concentrates of leaves and seeds were arranged and controlled orally in portions 100, 200, 400 and 1000 mg/kg to 8 gatherings containing 5 rodents for each gathering for 28 days. Histopathological changes were seen in the heart, liver, lungs, spleen and kidneys

of rodents treated with the concentrates at all dosages tried. Some other physical changes like fomentation, disarray and confusion were seen at the most elevated portion tried (1000 mg/kg) of the seed extricate [52].

## 5. Therapeutic & Industrial Significance

*Moringa oleifera* has demonstrated its flexibility in different fields other than its therapeutic properties. Different reports are there to demonstrate its multipurpose uses of a large portion of the parts of plant for example, nourishment, pharmaceutical, and restorative, mechanical, horticultural. In an investigation, it was demonstrated that, there is an enormous degree in charge of contamination by planting *Moringa oleifera* trees on huge scales, as it stores a lot of carbon in them. *Moringa oleifera* tree assumes a significant job in environmental change alleviation [53]. *Moringa oleifera* have natural coagulant activity [54]. Research facility ponders have indicated that *Moringa oleifera* seed have successful coagulative properties and are non-dangerous in nature. It has been utilized as essential coagulant for water treatment as water filtration and expel upto 99% of microscopic organisms [55].

In another examination, *Moringa oleifera* has been utilized as fish preservative. The protein protease inhibitor got from *Moringa oleifera* has extension to turn into a perfect up-and-comer in safeguarding of fish against proteolysis [56]. It is additionally a significant part in culinary world. Other than nourishment additive it is likewise used to season different Indian curries, particularly in South India [4]. *Moringa oleifera* seeds could be utilized as a more affordable biosorbent for the evacuation of cadmium (Cd) from fluid media. Fluid arrangement of *Moringa oleifera* contains heterogeneous complex blend with different functional groups. These amino acids establish physiologically dynamic group of binding agents, which works even at low fixation, in view of its capacity to associate with metal particles to expand the sorption of metal particles [57]. In different investigations it has been demonstrated that leaves seeds and blossoms of *Moringa oleifera* have ovicidal, larvicidal and insecticidal potential against the vectors of the species *Anopheles stephensi* and *Aedes aegypti* [58].

*Moringa oleifera* has demonstrated its potential in biogas creation. The seed cake powder got from hexane concentrate of *Moringa stenopetala* was broke down for biogas generation. Biogas plant could add to wipe out waste issues from businesses having natural waste. This biogas plant can give modest vitality to that industry, or can likewise give this vitality to deal for e.g., vehicles. Not just this, biogas plant delivers a condensation that can be magnificent compost, and which can be sold for example to ranchers. Supplanting substance composts with this bio manure will add significant minerals to the dirt and in this

way add to build the richness of cultivated land. In restorative industry likewise, *Moringa* is exceptionally esteemed. It is best for back rub and fragrance based treatment applications. Its oil contains hostile to maturing properties which humors it in different scopes of items for example against maturing creams, fragrance based treatment oils, knead oil, scents and antiperspirants [59]. The recuperating properties of *Moringa* oil were recorded by old societies. *Moringa* oil has uncommon oxidative strength which may clarify why the Egyptians put containers of *Moringa* oil in their tombs. *Moringa* oil is high in oleic corrosive and spreads effectively on the skin [60].

## 6. Conclusions

The multi advantages of *Moringa oleifera* plant made it "Marvel plant" of nature. It's the most modest plant with conveying potential in each perspective industry, beautifying agents, wholesome advantages, and agribusiness; and so on the vast majority of the parts of plant like seeds, blooms, leaves, and roots are utilized for treatment of different infections. Research reports that ethanolic, aqueous and methanolic extracts are broadly utilized for examination, identification, and estimation reason. *Moringa oleifera* plant is reasonable and modest to develop and grow in Asia. *Moringa oleifera* could be developed in contamination inclined and to control the climatic changes. In future the dynamic constituents can be disengaged and detailed into reasonable dose structure and conveyance framework and *in-vivo* examines dependent on creature models should be possible for better impact. Because of its different pharmacological uses this plant holds various promising moieties for separation of constituents and future clinical examinations.

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