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WOUND HEALING ACTIVITY OF MORINGA OLEIFERA AND ALTERNANTHERA SESSILIS

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ABSTRACT

Wound healing is the process of Regeneration of cellular and anatomic continuity of tissue. After an injury, the skin and other body tissues go through a difficult healing process. Herbal remedies are powerful healers because they have antioxidant and antimicrobial qualities. The healing potential of Alternanthera sessilis and Moringa oleifera are discussed in this review. Alternanthera sessilis is a member of the Amaranthaceae family, whereas Moringa oleifera is belonging to family Moringaceae. An overview of the botanical, phytochemical, pharmacological, and therapeutic uses of Alternanthera sessilis and Moringa oleifera is provided in this review study. Which is helpful for research and development of new formulations for wound healing.

Keywords: Moringa Oleifera, Alternanthera Sessilis, Phytoconstituents, Pharmacological Activity, Wound Healing.

I. INTRODUCTION

A chemical, immunological, physical, or microbiological attack on the tissue might result in a wound that disrupts the tissue's cellular structure. The complicated and dynamic process of wound healing allows damaged tissue to resume its normal functioning. Many different plants are used to treat and promote wound healing.[1] China and India recorded their knowledge of plant medicines, or "herbals," approximately 400 years ago. Herbal remedies have an effect on the body, and how they do so depend on which plant components are present. Herbal plants can help with stamina, assist the digestive system, improve absorption, increase blood flow to the body, remove toxins, keep infections under control, and heal wounds. Worldwide, wounds are a burden for both the patient and the medical staff. Millions of individuals have both physical and mental health effects from wounds. According to the most recent statement, 6 million people have chronic wounds.[2]

II. CLASSIFICATION OF WOUNDS

The dermal layer and epidermis make up normal skin. Different kinds of wounds may affect dermal layer and epidermis. Based on their type, location, and causation, wounds can be divided into four categories. Wounds can be classified as open, closed, acute, or chronic. [3]

1. Open wound: Bleeding that is readily apparent may also occur as blood escapes the body. (2) Closed wound: Blood remains inside the body but escapes the circulatory system.
2. Acute wound: A prompt and organized healing pathway is followed. The duration of it can be 5–10 days or less than 30 days. Usually, a cut or surgical incision is the reason.
3. Chronic wound: It is impossible to treat in a timely and organized manner. Natural medicine, pressure, inadequate venous and arterial flow, burns, and vasculitis are possible causes. Here healing process takes a long time, and a proper healing does not happen overnight. Chronic wounds primarily take the form of diabetic foot ulcers. [2]

Pathophysiology of Wound Healing

Wound healing is the process of regeneration of cellular and anatomic continuity of tissue. The Process of healing is a complex one, involving the repair of damage through biochemical reactions. Blood cells, macrophages, neutrophils, and platelets are activated in response to injuries to the body. And the wounded tissues are going through various stages of regeneration. For the majority of wounds, the basic stages of wound healing are the same and include hemostasis, inflammation, proliferative, and remodeling phases.[2,4]

How Wounds Occur

A piece of body tissue is lost or destroyed as a result of a wound. A wound results from an external action that disrupts the cellular, anatomical, and functional continuity of live tissue, either with or without the underlying

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connective tissue being lost.[5] Animal bites, poisons, explosives, electric shock, blunt or sharp force injuries, and temperature changes can all result in these disorders. Anybody and everything, including big and little animals, can get injuries. Animals with wounds that expose internal organs to the environment are more susceptible to infection and slower wound healing. Skin epithelial integrity is lost as a result of wounds, either with or without connective tissue loss. Skin trauma, particularly in severe wounds, is a common clinical problem that is more challenging to treat. Wound healing is the process of attempting to repair damage to the skin. It starts with restoring damaged tissue to as close to its pre-damage state as possible. The process of shrinking the area around the wound is called wound contraction. Despite advancements in medicine, wound treatment continues to be a major global health concern. Alternatives that don't produce toxicity are therefore required. Natural products are becoming more and more significant as alternative medicine.

Numerous factors, both deliberate and inadvertent, can result in injuries. Surgery is an example of an intentional wound, whereas accidents, sharp objects, or scratches are examples of unintended wounds. When there is a body reaction to a wound, it is said to be healing. This response aids in the repair of skin structure through a number of processes, such as an inflammatory response and cell proliferation.[6]

1. MORINGA OLEIFERA

The angiospermic plant Moringa oleifera is also known as the "drumstick" or "horseradish" tree. It is one species out of the thirteen species that make up the genus Moringa. The most extensively grown of these, and a native of tropical and subtropical regions of the world, is horseradish tree i.e. Moringa oleifera. A tropical deciduous perennial dicotyledonous tree is called Moringa oleifera. In Ethiopia, it is known as "Shiferaw," while in India, it is called the horseradish tree or drumstick tree, and in Nepal, it is called "Sitalchini," Munga, Sahijan, or Saijan. [7]

Morphology and taxonomy

The tree grows quickly in sandy, loamy soils that drain well; it prefers elevations of around 500 meters above sea level. It grows to be small to medium-sized, with naturally trifoliate leaves and flowers on an inflorescence that is 10 to 25 cm long. The fruits, often called "pods," are typically trifoliate. Although the trunk usually grows straight, there are times when poor development is seen. Branches often form an umbrella-shaped canopy despite their disarray. The semipermeable hull of the brown seeds is present, and each tree produces between 15,000 and 25,000 seeds per year.[8]

1.	Kingdom	Plantae
2.	Subkingdom	Tracheobionta
3.	Super division	Spermatophyte
4.	Division	Magnoliophyta
5.	Class	Magnoliopsida
6.	Subclass	Dilleniidae
7.	Order	Capparales
8	Family	Moringaceae
9	Genus	Moringa
10	Species	Oleifera

Because of its important therapeutic benefits, M. oleifera has been a mainstay in diets all across the world since ancient times. Since ancient times, a variety of medications made from the plant used to treat a wide range of illnesses due to their ethnomedicinal qualities. Almost all parts of the plant including the leaves, pods, bark, gum, flowers, seeds, seed oil, and roots have been used to treat various illnesses. The plant can be used to cure a variety of ailments, such as diuresis, antihypertension, anti-anxiety, and anti-diarrhoea. Poultices prepared from the leaves of moringa plant have been shown to be successful in treating inflammatory disorders such as glandular inflammation, headaches, and bronchitis. It has also been shown to be useful in the treatment of diarrhoea and colitis.[9]

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The roots of moringa oleifera are typically used to cure conditions including kidney stones, inflammation, ulcers, liver ailments, and discomfort in the teeth and ears, While the pods are used to treat hepatitis and relieve joint pain. Skin infections and wounds are treated with stem bark. Gum from the plant is used in Indian traditional medicine to induce abortions and alleviate fever. The seeds have laxative properties and are used to treat bladder problems, prostate difficulties, and malignancies. It is known that they have the ability to treat arthritis by lowering inflammation and altering oxidative stress. Preparations made from the plant's leaves improve the general health of the populace as well as nursing moms and undernourished babies. The leaves have been used traditionally to cure wounds and sleeplessness. Moringa is widely used in modern times. [10]

Propagation-

Cuttings, seeds, or both can be used to grow Moringa oleifera. Its high rate of germination makes direct seeding feasible. Seeds of moringa can be planted all year long if the soil drains properly. Cuttings with a diameter of at least 4 cm and a length of 1 m can be utilized for vegetative growth. "The spacing of plants should be 15 x 15 cm or 20 x 10 cm, with conveniently spaced alleys (for example: every 4 m) to facilitate plantation management and harvests," according to the guidelines for intense leaf production. Sometimes it's quite tough to prevent illness and weed because of excessive density. In semi-intensive production, the plants are spaced 50 cm* 1 m away from one another. This requires less upkeep and yields superior results.[7]

Harvesting-

In high density farming, moringa trees can be harvested at 1.5 and 2 meters in height. To gather the leaves, cut the stems with a sharp knife or break them off of branches that are 20 to 45 cm above the ground. This process encourages the growth of additional branches. It takes up to 35 to 40 days to harvest. However, if the tree is to be harvested for fodder, it should be done every 75 days. Because they will rot quickly, the gathered leaves shouldn't be piled together. To avoid excessive water loss harvesting should done early in the morning. Since fresh leaves lose moisture quickly, they should be sold the same day they are harvested. [7]

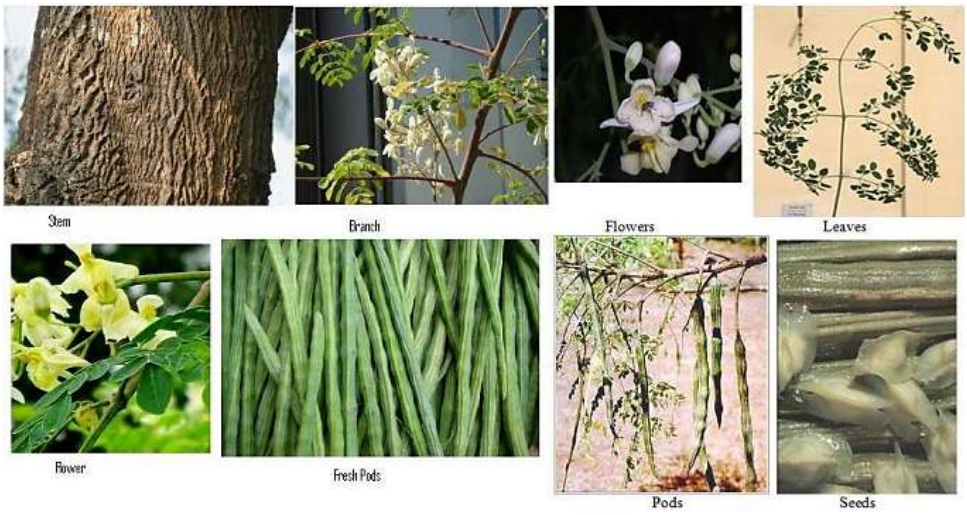

Fig 1: Various parts of moringa oleifera [11,12]

Origin and distribution

M. oleifera is indigenous to Arabia, Africa, Asia Minor, India, Pakistan, and the western and sub-Himalayan regions. However, it is currently available throughout the Caribbean Islands, North and South America, the Philippines, Cambodia, and Central America. It is currently grown all over the world's tropical and subtropical regions for a number of uses.

Cultivation condition-

Moringa oleifera which is tiny to medium-sized, deciduous or evergreen tree primarily found in Nepal's tropical foothills and certain mid hill regions. It reaches a height of 25 to 30 feet, and the best places to cultivate it are the mid-hill, Siwalik and terai area. It thrives in full daylight from zero to one thousand meters above sea level. Although moringa can withstand a wide variety of soil types, it needs neutral to slightly acidic soil (pH 6.3-5.0-7.0) for growth. Though the roots have a propensity to decay in soggy soil, the minimum and maximum annual

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rainfall requirements are roughly 250 and 3,000 millimeters, respectively. Trees can be planted on tiny hills in areas that frequently get high rainfall to promote water runoff. The plant can withstand prolonged dry spells because of its extensive taproot. The ideal temperature range for the tree is between 12 and 40 degrees Celsius, but it can withstand up to 48 degrees in the shade and a little frost. Where the soils are well-drained and the water table is consistently relatively high, it easily establishes itself in savannah and streambank environments. The plant can withstand dryness, but when it experiences constant water stress, it produces significantly less leaves. Frost does not damage it, but a freeze can bring it down to almost nothing. When clipped, it swiftly sprouts new growth from the trunk; when frozen, it grows from the ground. [7]

Phytoconstituents of Moringa oleifera-

Table 1: Phytoconstituents of moringa oleifera[13]

N0.	Compound name	Tissue
	Flavonoids-	
1	Astragalin	Leaves
2	Quercetin-3-O-(6″-malonylglucoside)	Leaves
3	Quercetin-3-O-rhamnosylglucoside	Leaves, seeds
4	Kaempferol-3-O-(6″-malonylglucoside)	Leaves
5	Kaempferide-3-O-2″,3″-diacetylglucoside	Leaves
6	Quercetin 3-O-rutinoside	Pods
7	Quercetin 3-O-glucoside	Seeds, leaves
8	Apigenin	Leaves
9	Daidzein	Leaves
10	Genistein	Leaves
	Carbamates-	
11	Niazinin A	Pods, Leaves
12	Niazinin B	Leaves
13	Niazimicin	Leaves
14	Niazimimin A	Leaves
15	Niazimimins B	Leaves
16	S-methyl-N-thiocarbamate	Pods
17	Niazicin A	Pods
18	Marumoside A	Leaves
19	Marumoside B	Leaves
20	O-ethyl-p-hydroxy benzyl thiocarbamate	Pods
	Phenols-	
21	Cryptochlorogenic acid	Leaves
22	Gallic acid	Seeds
23	p-Coumaric acid	Seeds
24	Ferulic acid	Seeds
25	Vanillin	Seeds
26	Caffeic acid	Seeds

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27	Protocatechuic acid	Seeds
28	Cinnamic acid	Seeds
	Glucosinolates-	
29	Niazirinin	Leaves
30	Methyl-1-aminopentasulfide-5-sulfinate	Pods
31	Phenylacetonitrile	Root, bark
32	Niazirin	Seed, leaves
	Steroids-	
33	β-Sitosterol	Seeds
34	β-Sitosterol-3-O-β-d-glucopyranoside	Seeds
35	β-Sitosterone	Roots
	Carotenoids-	
36	β-Carotene	Leaves
37	Lutein	Leaves
	Others -	
38	Glycerol-1-(9-octadecanoate)	Seeds
39	N α-L-rhamnopyranosyl vincosamide	Leaves

Table 2: Phytoconstituents & Biological activity of plant Moringa oleifera [14,15]

Parts of Plant	Phytochemical constituents	Pharmacological activities
Seeds	Moringine, niazimicin, niazirin	Acts against asthma
Leaves	Niazirin, Niazirinin, Niaziminin, Niazimicin A, Niazimicin	Anticonvulsant, Antioxidant, Antihypertensive, antibacterial, anticancer
Flowers	Present some chemical constituents like as quercetin, isoquercetin, kaemopherol, kaempferitin,	Act against inflammation
Stem	Chemical constituents are extracted from stem Vanillin, beta- sitosterone	Act against inflammation
Pods	Isothiocyanate, nitrites, beta- sitosterol.	Act against inflammation & helmintics
Bark	Benzylgiucosinolate derivatives	Act against urolithiatic
Root	Some chemical constituents are extract from root are Moringine, moringinine, spirachin,also p-cymene	Antifertility

III. PHARMACOLOGICAL ACTIVITIES

1. Wound Healing and Related Activity-

An aqueous leaf extract improved the ability of albino rats to repair wounds. This is because certain sections of plant bark contain dexamethasone, and ethyl acetate extract of leaves contains phytosterols, vicenin-2, kaempferol, and quercetin, all of which are known to aid in wound healing. [14]

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According to research, flavonoids and tannins have antioxidant properties that speed up the healing of wounds. Thus, the greater content of flavonoids in the Moringa genus is primarily responsible for its strong antioxidant activity. The capacity of extracts from many plants to scavenge free radicals may be attributed to their high phenolic content. Tannins and Flavonoids in particular are phenolic chemicals that have been shown to have antibacterial properties and they helps in wound healing process. As secondary metabolites, including phenolic compounds, are bioactive, their quantity in an extract, their interaction with one another, and the quality of phenolic compounds can occasionally be linked to activity. Phenolic protein complexes provide a film that shields injured tissue from chemicals and microbes throughout the healing process and after skin burns. This film also acts as a physical barrier to the damaged tissue, preventing dehydration.

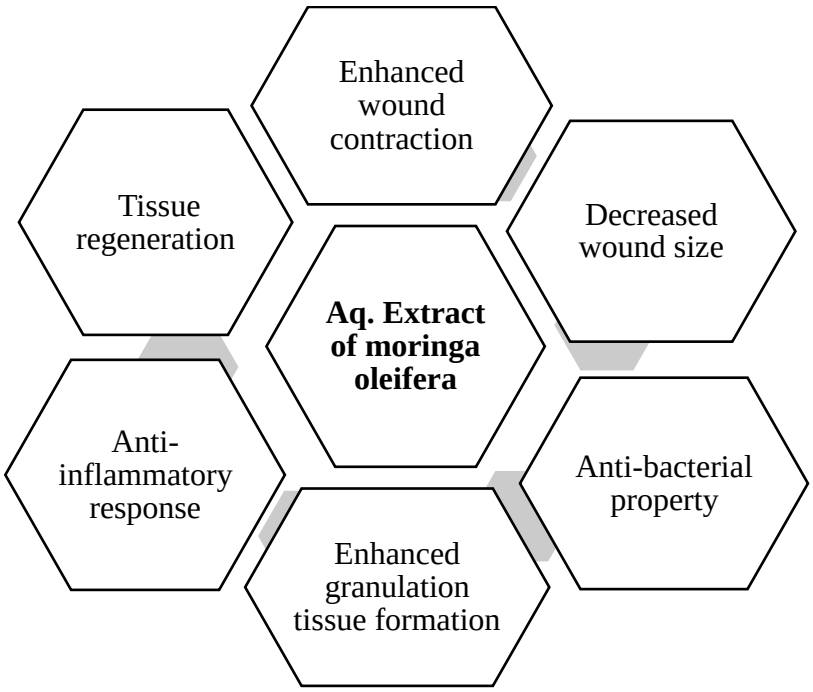

Fig 2: Wound Healing Mechanism of Moringa Oleifera [16,17]

2. Antioxidant Activity-

Moringa oleifera contains many compounds which have antioxidant activity such as flavonoids, kaempferol, qurecitin, ascorbic acid, and carotene. However, the main ingredients in the leaf component include lectins, tocopherols, and myriceti. Procyanidins were discovered in seeds. Despite the fact that there was an excess of palmitic acid, phytosterols, and 9-octadecenamide in the stem and root part Strong antioxidant and radical scavenging qualities can be found in hydrophilic and alcoholic leaf extracts as well as roots (methanolic and ethanolic). Furthermore, isoquercetin possesses the most potent antioxidant qualities. [14,18]

3. Anti-Inflammatory Activity –

There are various active constituents present in moringa oleifera leaves which are proteins, amino acids, polysaccharides, dietary fiber, phenols, flavonoids, phytosterols, glycosides and are reported to possess anti-inflammatory activity. Moringa oleifera also has anti-inflammatory properties in its root, bark, and flowers, as well as in its methanolic and aqueous extracts and ethanolic seed extract. [14]

4. Antimicrobial Activity –

Moringa oleifera exhibits antibacterial action against both gram-negative and gram-positive bacteria, it is highly effective against bacterial species. Pseudomonas aeruginosa and Staphylococcus aureus were tested against an effective M. oleifera leaf extract (Caceres, Cabrera, Morales) and 13 other bacterial species, including E. coli, S. aureus, and P. aeruginosa, which were tested against ethanol and chloroform extracts of seeds and leaves. However, Brilhante and colleagues investigated the impact of the flower and pods using ethanol and chloroform extracts against the V. vulnificus, cholera, and mimicus species. Bark ethyl acetate extract killed S. aureus, Citrobacter freundii, B. megaterium, and P. fluoescens. 4-(L-rhamnopyranosyloxy) benzyl isothiocyanate,

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methyl N-4-(L-rhamnopyranosyloxy) benzyl carbamate, and 4-(Dglucopyranosyl-1- 4-L-rhamnopyranosyloxy) benzyl thiocarboxamide are the chemical constituents of moringa oleifera which exhibits Antimicrobial activity. (14)

5. Antifungal Activity –

Moringa oleifera has been used to inhibit antifungal activities due to the presence of certain phytoconstituents. It combats a wide range of fungal species. The antifungal efficacy of ethanolic seed extracts against T. mentagrophyte, Pull has been investigated. Griseofulvin is a fungicidal chemical that can prevent the growth of fungus. It was taken out of the endophytic fungus M. oleifera species. (14,19)

6. Antiviral Activity

This native plant has been used as a herbal remedy to enhance antiviral therapies. This works against a variety of viruses, including HSV bursal adenoviruses, foot, mouth, and rhinoviruses. It also inhibits the activity of seed extract against HSV-1. Aqueous seed extract showed no anti-Newcastle disease viral action.(20) It can also be used as a medicine for those living with HIV. Nevertheless, it has been utilized to combat the Hepatitis B virus and cure HIV-related side effects. (14)

7. Antidiabetic Activity (Antihyperglycemic)-

Owing to the widespread presence of terpens and flavonins, which are crucial for activating pancreatic cells and subsequently producing insulin hormone, this is especially beneficial for diabetes mellitus, antihyperglycemic, and hypoglycemic conditions. Aspartame, flavonoids, and glucosinolates are examples of active substances that have the potential to have hypoglycemic effects. The study conducted in diabetic wistar rats which is streptozocin-induced cytotoxicity test. The results showed that ethanolic leaf extracts had a hypoglycemic action and that benzylamine, which is derived from moringaolifera leaves extract, lowers blood sugar, fat mass, cholesterol, and diabetic reactions in rats fed an elevated diet. A diluted leaf extract raised insulin levels in diabetic rats. The methanolic extract from the leaves of moringa oleifera provide protection against inflammation, reactive oxygen species (ROS), and kidney damage brought on by diabetes. (14)

8. Anti-urolithiatic Activity-

Both aqueous extracts and alcoholic extract of Moringa oleifera bark were examined for their potential to act as an anti-urolithiatic. As a result of ethylene glycol-induced urothiasis, the weight of the stone decreases. The antiuothiatic activity of moringaolifera has both restorative and protecting qualities. (14)

9. Cardio Protective Activities-

Every part of the plant is utilized to lower blood pressure and cholesterol in our bodies, as well as to stimulate the cardiovascular system.This can be attributed to the existence of heart-stimulating substances such β-sitosterol, proanthocyanidins, quercetagenin, gossypetin, and N-α-L-rhamnopyranosylvincosamide. The liver, heart, and arota of hypercholesteremic rabbits had lower cholesterol levels thanks to moringaolifera fruits. The presence of various leaf additions, including niazinin, niazimicin, niaziminin, and 4 (4′Oacetylrhamnosyloxy) benzyl isothiocyanate, has resulted in the considerable antihypertensive and hypotensive characteristics of ethanolic leaf extract. When the hypotensive activity was examined in an animal's heart, glycosidal substances such as isothiocyanate and thiocarbamate were discovered to be the primary cause of this potent hypotensive property. (14)

10. Anticancer and Antitumor Activities-

The ethanolic leaf extract has antiproliferative, antihepatocarcinoma, cytotoxic, antimyelomic, and chemoprotective properties. In addition, eugenol, isopropyl isothiocynate, and palmitic acid were discovered in the leaves and bark. (14)

11. Antiepileptic Activity and Anti-Convulsant Activity –

Methanolic leaf extracts show potent anti-convulsant properties against pentylenetetrazole at dosages of 200/400 mg/kg administered IP. Since the ethanolic extract of Moringa concanensis leaves eliminated PTZ-induced seizures and prevented MES-induced hind limb extension, it may have anticonvulsant effects through a different mechanism. (14)

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12. CNS Activity-

Compared to Alzheimer's treatment, the leaf extract may be helpful because it restores monoamine function in brain tissues. [14]

13. Anti –Fertility Activity

The antifertility function of a hydrophilic root abstract was reported to be advantageous when progesterone and estradiol di propionate were included or excluded. [14]

2. ALTERNANTHERA SESSILIS

Strong taproots support the 0.2-1 m-tall annual or perennial herb Alternanthra sessilis also known as noxious weed. The leaves are opposite, simple, 0.6–5 cm long, 0.3–1 cm wide, widely lanceolate or spatulate to nearly linear, and briefly petiolate or sessile. They have whole, glabrous or pilose (thin, fine, articulate hairs) borders, and they are attenuated at the base and apex, which is sharp blunt. The leaf axils have dense, sessile, silvery-white clusters of compressed spikes known as inflorescences. Bracts are persistent, oval, concave, and 0.3–1 mm long; bracteoles are oblong-ovate, usually not highly lacerated, and measure 1-1.5 mm in length. The 2-3 mm long, glossy, green-based, white or purplish sepals have a strong midrib and are either glabrous or have a few long hairs. The fruits are indehiscent, consisting of a tiny, flattened, 2-2.5 mm long, obcordate or obovate utricle that encloses the seed. The seeds have a disc-like shape, are lustrous, dark brown to black, and have a diameter of 0.8 to 1 mm. They react to light. To treat wounds, flatulence, nausea, vomiting, cough, bronchitis, diarrhoea, and for therapeutic, protective, or promoting objectives, a decoction is suggested as herbal treatment. Inflamed wounds can be relieved by its root. A. sessilis is used as a local remedy to treat hepatitis, tight chest, bronchitis, asthma, and other lung conditions. It is frequently combined with other medicinal plants in these mixes. Boil the leaves and shoots and drink the liquid as an antihypertensive. [21]

Fig 3: Alternanthera sessilis

Distribution-

The herb is used to cure leucorrhea, poor sperm count, and gonorrhea in the Bangladeshi district of Noakhali. Folk healers in a few Bangladeshi districts, like Faridapur and Rajbari, employ the plants to relieve excruciating pain. The plant is used to treat bleeding dysentery by the tribal people of India's Bargarh area. The herb is used by many people in the Karnataka, India's Uttra Khannada area to treat cuts, wounds, and ulcers. The herb is used by the Irula tribal people of Kalavai, Vellore district, Tamil Nadu, India, to treat hepatitis, asthama, and headaches. [21,22]

IV. TAXONOMICAL CLASSIFICATION

Domain	Eukaryote
Kingdom	Plantae
Phylum	Spermatophyta
Subphylum	Angiospermae
Class	Dicotyledonae
Order	Caryophyllales
Family	Amaranthaceae
Genus	Alternanthera
Species	Alternanthera

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Geographical distribution:

This is a pioneer species that typically thrives on disturbed areas of various wetland settings in species-rich relationships with a range of other aquatic and wetland plants. It can grow partially emergent, partially floating, or even in mats of floating vegetation in the drawdown zones of water bodies or in water up to one meter deep. It is a common plant found in flood plain wetlands, river edges, streams, canals, ponds, reservoirs, and tanks in India. There are roughly 16 species of this plant, which may be found in hotter parts of the country, on Ceylon, in damp areas, rising to an altitude of 4000 feet in the Himalayas, and in all warm countries. [23]

History/Origin-

Originating in Brazil, Alternanthera sessilis is a well-known plant in most tropical and subtropical regions of the world, where it has been grown for millennia. The ancient Greek terms "alternans" (meaning "alternating") and "anthera" (meaning "anther") are the source of the generic name Alternanthera sessilis, which refers to the alternations of pseudosaminodes and stamens. The term sessilis, which is used for flowers without pedicel, has a number of possible origins. Since Alternanthera sessilis is widely distributed throughout the old world's tropics, tropical Africa, Southern Asia, Eastern Asia, and Australia, its history is uncertain. Since many Chinese authors claim that it is native to China, it is easy to elaborate on the confusion around its native region. Alternanthera sessilis, also known as "ponannkanni-pon aggum knn nee" in Tamil, is mentioned extensively in traditional medicinal literature. In addition, it is thought in India to have cooling properties for the body and eyes. According to studies, this plant is thought to cure 96 different kinds of eye problems, reduce neuritis, and promote a healthy, disease-free life in Tamil Naddo, India. In South Africa, alternanthera sessilis is consumed as a vegetable. Sri Lankans utilize Alternanthera sessilis multiple times a week, believing it to be a large source of fiber, protein, and vitamins. It's used as a condiment in Congo and as soup in Nigeria. Because of the way its blossom resembles fish eyes, it is also known as "Matsyakshi" or "fiseyed".[24]

Botanical description: a) Macroscopic

The tap root is cylindrical, with a diameter of 0.1 to 0.6 cm, and a cream to grey color. It has multiple lateral rootlets that emerge from the main root; the fractures are short, and it lacks a distinct flavour or odour

Stem: Yellowish-brown to light-brown, herbaceous, weak, cylindrical, with spreading branches from the base; nodes and internodes distinct.

Leaf: sessile, elliptic, linear-oblong, obtuse, or subacute; taste and odor unusual.

Flower: Small axillary sessile heads with white flowers that are frequently pink in color; bracteoles around 1 cm long, oblong, and scarious; long perianth; ovate, acute, thin sepals; compressed, ovary, obcordate, style very short, capitellate; no distinct taste or odor.

Fruit: 1.5 mm long, orbicular, compressed, and with thickened borders; lacks a distinct flavor or aroma. [23]

b) Microscopic

Xylem tissues are lignified; conjunctive tissue between bundles is composed of oval, thin-walled, parenchymatous cells; pith is composed of thin-walled, round to oval, isodiametric, parenchymatous cells. The root exhibits a circular outline with five to seven layered, thin-walled, tangentially elongated and squarish, radially arranged cork cells; the secondary cortex is narrow and contains thin-walled, round or oval, parenchymatous cells; vascular bundles are radially arranged and numerous, consisting of thin-walled cells.

The stem exhibits a single-layered epidermis with vascular bundles arranged in a ring, bicollateral, open, and endarch; the phloem is narrow with thin-walled cells traversed by phloem rays; the xylem is made up of regular elements traversed by xylem rays; the pith is distinct and contains calcium oxalate rosette crystals in some parenchymatous cells. Three vascular bundles, with xylem and phloem at their cores, make up the leaf midrib. [23]

Chemistry-

The plant known as "noxious weed," Alternanthera sessilis, is remarkably fragrant and is mostly utilized as a leafy vegetable and herb. Numerous Alternanthera sessilis ecotypes have been identified based on their flavor, taste, and other attributes. Depending on the species, Alternanthera sessilis can grow anywhere from 0.2 to 1 m in height and have leaves that range in color from white to pinkish. Although the flavor of Alternanthera sessilis

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varies widely, it often has a strong flavor. The essential oil found in the roots, leaves, and stems of Alternanthera sessilis is responsible for the plant's scent. [24]

Chemical Composition-

In addition to having a high fat content and a decent caloric value, Alternanthera sessilis also shows promise as an excellent source of minerals, vitamins A and C, and other nutrients. Dietary fibers from its leaves (approximately 12g/100g of dry matter) can dramatically lower blood glucose levels in diabetic patients when 75g of this vegetable is included in their regular diet. Although it is used as food, not many supports it because excessive use of large dosages of it might be harmful due to heavy metal contamination, such as chromium. Alternanthera sessilis fresh leaves have an 80g/100g water content, 251kJ/mol energy content, 4.7g protein/100g, 0.8g fat/100g, and 11.8g carbohydrate/100g. It has 3.2g of carbohydrate per 100g, 0.225 mg of amino acids per 100g, 2.76 mg of vitamin B1, 12.6 mg of vitamin B2, 2.1 mg of fiber per 100g, 148 mg of calcium per 100g, and 45 mg of phosphorus per 100g. It has flavonoids as well, which are known to have antioxidant qualities. It is used to treat night blindness because of the high iron and carotene content of its leaves. [24]

Phytoconstituents-

Table 3: Phytoconstituents of Alternanthera sessilis [25]

Chemical Group	Chemical compounds
Polyphenols	Vanillic acid, Catechin, Ferulic acid Epigallocatechin, Ethyl gallate Chlorogenic acid, Apigenin Daidzein, 4-hydroxybenzoic Gallic acid, Quercetin
Phytosterols	α- spinasterol stigmasterol campesterol
Triterpene	Lup-20(29)-en-3-one (Lupenone)
Alkaloid	Berberine
Diterpene	Phytol Geranylgeraniol Neophytidiene Gibberellin
Carotenoid	Astaxanthin Carotene β-carotene Zeaxanthin Violaxanthin Neoxanthin Lutein

Post-Harvest Technology-

Wild weed Alternanthera sessilis is usually not farmed. In damp, shaded areas, it grows quickly. It is easily propagated using rooted stem pieces and seeds. A typical plant produces roughly 2000 seeds. Although it is only very sparingly grown, the morning after the dew has evaporated is the ideal time to harvest. It has been noted that when grown in the morning, the plant extract and essential oil exhibit good action. There is conflicting information in the literature regarding the ideal conditions for harvesting it because it can grow in a variety of fields and soil types. Fresh leaves of Alternanthera sessilis are reported to have more varied and

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intense flavors, as well as higher vitamin contents than drier ones. It can be kept in storage for up to six months, if needed. On the other hand, dry leaves shouldn't be broken or shredded to avoid losing their vitamins and essential oil. Additionally regarded as a crucial remedy to extend Alternanthera sessilis' postharvest life is 1-methylcyclopropene (1-MCP). [24]

Processing -

Similar to other herbal plants, Alternanthera sessilis is used for a range of purposes and in a variety of ways. Apart from its raw leaves, noxious weed is also commonly processed into powdered, whole dry leaves, and essential oil extracts. It is possible to keep dried leaves or the entire plant to use it for longer periods of time than. Traditionally, alternanthera sessilis is dried by hanging bundles that have been cleaned in dry, shaded areas. Because noxious weeds darken when left out in the open for extended periods of time, it is best to dry them out as soon as possible after harvesting to avoid oxidation. It is recommended to dry at a temperature between 32°C and 40°C to prevent the loss of volatile substances like as vitamin C and A. If kept out of direct sunlight and moisture, its dried form can be kept for up to six months. There are two ways to obtain essential oil from noxious weeds: either from the leaves or the flowers. Hydrodistillation is another method that can be used to extract the essential oil from dry aerial components. It is cultivated in many subtropical and tropical regions, particularly in India and Sri Lanka, and is simple to harvest because, after one seeding, it can be harvested four times. [24]

Value Addition -

Alternanthera sessilis is a widely used for treating hepatitis, asthma, bronchitis, and lung disorders. Around the world, this plant's leaves and shoots are boiled and consumed as possible antihypertensive medications. Sometimes, Alternanthera sessilis leaves are cooked in ghee and applied to the eyes to treat various illnesses connected to the eyes. This therapeutic oil is also applied while taking a bath to provide cooling benefits to many body areas, particularly the eyes. Halitosis, piles, 96 various eye conditions, and neuritis can all be treated with it. Alternanthera sessilis dried plant is used to purify blood and treat skin problems. In addition to reducing hyperglycemia, it relieves discomfort. It is possible to make salad out of its leaves and even its blooms. It is usual practice to employ Alternanthera sessilis both in its fresh and dried forms. In Sri Lanka, Alternanthera sessilis is frequently used in the making of soap. Longer storage is also possible, but only after drying. Because of its outstanding medicinal potential, Alternanthera sessilis flowers, leaves, and fragile stems are used as a vegetable that functions as a diuretic remedy. This plant have many therapeutic properties are what make it useful for making hair oils and Kajal for the eyes. Commonly used as a garden hedging plant, Alternanthera sessilis is primarily employed in culinary medicine. [24]

Uses

Even though they are rarely consumed, a lot of herbs have a big impact on health because they are rich in antioxidants and certain mineral components. Anti-cancer, Anti-diabetic and anti-ulcer pigments are also present in certain botanicals. Although Alternanthera sessilis is useful for health, it is yet unclear how much of it needs to be consumed in order to have positive effects. Although the exact dosage of Alternanthera sessilis has not been recommended by researchers, this herb has been used historically and is still used today due to its high flavonoid and antioxidant content, which has anti-malarial, anti-diarrheal, and antioxidant potential. In addition to these ingredients, Alternanthera sessilis is a good source of vitamins and dietary fiber. In tropical and subtropical regions, it is utilized as a leafy vegetable and finds numerous uses in the food sector. Its oil is typically sold in Sri Lankan and Indian markets and has a high concentration of antioxidant agents. Because it's inexpensive and has so many uses, Alternanthera sessilis is a great addition to any kitchen. [24]

Biomedical Applications -

Alternanthera sessilis is used as a plaster for wounds or sick skin, as well as a treatment for diarrhea and mild stomach ailments. It is also used in treatment of fever, skin wounds, dysentery, stomach disorders, blood vomiting, hernia snakebites, asthma and bronchitis. By powdering the leaves, it is used to treat snake bites in Senegal and India. In Taiwan it is a common folk remedy and is used to treat hepatitis, however in combination with other herbs. In addition, it is used to treat bronchitis, asthma, and lung issues. It is used to relieve headaches in Nigeria. In Sri Lanka, it is used to cure biliousness, indigestion, and a slow liver. Additionally, this

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plant has been traditionally utilized for cooling, digestion, intelligence enhancement, burning sensation, liver ailments, skin diseases, antipyretic, and general child development. Alternanthera sessilis is considered a Ramayana medicine in the Ayurvedic and Siddha medicinal systems. In the past, leaves were used to treat fever and skin conditions. It functions as a strong hepatoprotective agent. [24]

V. PHARMACOLOGICAL ACTIVITIES

Wound Healing Activity of Alternanthera Sessilis –

Leaf extracts from Alternanthera sessilis, when given to experimental animals at a dose concentration of 200µg/mL, have been shown to exhibit effective wound healing properties. On the sixteenth day after starting the medication, the wound area's contraction was assessed. The results, which showed that the scar area after complete epithelization was less than 0.0008 in the excision wound model and that the time for epithelization on the 16th day was less than 0.0008, supported the idea that it could aid in wound healing. Subsequent phytochemical studies demonstrated that the leaf extracts' ability to heal wounds was caused by sterols. sterols are the major constituent which are responsible for wound healing activity.[24]

Other activities of Alternanthera sessilis -

1 Anti-Fungal Potentials-

Using the agar well diffusion method, the antifungal activity of the leaf extract, essential oil, and component of Alternanthera sessilis was investigated. Cyrtomium falcatum, a plant pathogen, was used in tests of Alternanthera sessilis ethanol, methanol, and aqueous extract. PDA media was poured into a sterile petri plate, and it was then allowed to solidify there. Spreading the test fungal culture evenly across the media required the use of sterile cotton swabs. After creating 6 mm wells in the medium with a sterile-cork-borer, 200 microliters of each extract were placed into different walls, and the plates were incubated for 48–72 hours at 27°C–30°C. Following incubation, plates were checked for the development of a distinct incubation zone surrounding the well, which would indicate the existence of antifungal activity. Two fungal strains were resistant to Alternanthera sessilis' anti-fungal activity, suggesting that Alternanthera sessilis has good anti-fungal potential. [24]

2 Anti-Oxidant Activity-

The oil of Alternanthera sessilis is said to possess potent antioxidant properties. According to recent research, the oil may possess anti-viral, anti-cancer, anti-microbial, and anti-pyretic properties. [26] Antioxidants are essential for maintaining a healthy, balanced lifestyle, and noxious weeds can provide an excellent source of these essential chemical constituents. Despite these suggested advantages, it's important to keep in mind that using noxious weeds excessively might have detrimental effects on health because their leaves are contaminated with heavy metals like lead and cadmium. Bangladeshi traditional healers utilize Alternanthera sessilis to relieve excruciating pain. It is common practice to use noxious weed stems to relieve pain and lower high blood glucose levels in diabetic patients. One of the main causes of physical disability is injury. Wound healing has been proven to benefit from noxious weed. The phytochemical components of noxious weeds are highly diverse. These ingredients differ greatly over time, throughout cultivation, and during preservation. [24]

3 Prophylactic Agent-

It is used to treat gastrointestinal problems, dysentery, and night blindness. Strong anti-malarial effects are found in noxious weed. Noxious weed is very helpful in the healing of cuts and wounds. Antioxidant agents can be found in abundance in toxic weed. The essential oil of the noxious weed was extracted by hydro-distillation from fresh leaves, and its antioxidant capacity was assessed using GC-MS analysis. Through investigation of the noxious weed's essential oil, the presence of oxygenated sesquiterpenes, diterpenes, ketones, fatty acids, and esters was verified. Their experiments' findings revealed that harmful weeds have antioxidant properties. Noxious weed has antioxidant compounds that can help keep you healthy and lower your risk of heart disease. Toxic weed paste is used to treat snake bites, and it is thought that this plant can treat hernias. Spines and other things are being extracted from the body using a paste made from toxic plant. Noxious weed is an excellent remedy for lung problems, hepatitis, asthma, and hemorrhage control. A phytochemical analysis of the methanolic extract of Alternanthera sessilis's roots, leaves, and flowers revealed a significant flavonoid concentration. Therefore, in order to identify and measure the quercetin in the aforementioned extracts, HPTLC

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investigations were conducted using the methanol fraction. After the data were analyzed, it was discovered that Alternanthera sessilis has a sizable amount of quercetin, which is employed as a preventative measure. In addition to having qualities that are necessary for wound healing, Alternanthera sessilis is a rich source of antioxidants. Malaria has been treated using this herb. Numerous oxidant agents found in Alternanthera sessilis are helpful in preventing cardiac disorders. Additionally, it's being considered as a possible source of stress relievers. [24]

4. Anti-Cancer Activity-

Overspread of aberrant cells and unchecked proliferation result in a number of harmful illnesses that eventually cause death, including cancer. cancer can also result from internal causes including mutations, immunological disorders, and hormones. Strong anti-cancer potentials are possessed by Alternanthera sessilis, and it has been shown that Alternanthera sessilis-assisted silver nanoparticles completely inhibit human breast cancer. By apoplastic dependent mechanisms, these nanoparticles also have lethal effects on prostate cancer. program for intracellular suicides that exhibits morphological abnormalities such as cell shrinkage, oxidative stress, excessive coiling, and apoptotic biochemical reactions. The interaction between cellular proteins and silver nanoparticles may be the cause of the observed alterations in cells. If not, the extremely reactive and unstable nature of silver ions may lead them to be deionized before they reach the tumor cells. As a consequence of this experimental study, 100% growth inhibition was obtained for breast cancer cells. These findings demonstrated that concentration and duration of exposure are the primary determinants of PGAG-AgNPs' anti-proliferative actions. [24]

5. Anti-Microbial Activity-

A biological species acts as an anti-microbial agent by preventing microbial development and eliminating it. Phytochemicals with antimicrobial properties include alkaloids, quinones, tannins, phenolic acids, flavonoids, coumarins, saponins, and terpenoids. It is well established that plant-based antimicrobial components have complete therapeutic potential and can fulfill their intended role without exhibiting any of the negative effects that synthetic antimicrobials may cause. Using the highly successful disc diffusion method, the anti-microbial properties of ethanolic extracts of alternanthera sessilis were assessed. Streptococcus pyogenes, Bacillus subtilis, Salmonella typhii, and Proteus vulgaris were all successfully combatted in these experiments. When compared to ampicillin and gentamycin, two common antibiotics used as positive antibacterial controls, the antibacterial activity demonstrated a greater zone of growth inhibition. [24]

6. Anti-Inflammatory Activity-

Carrageenan-induced rat paw model is used for these studies the anti-inflammatory properties of Alternanthera sessilis aqueous and ethanolic extracts were evaluated on a range of rats. The ensuing findings revealed that Alternanthera sessilis' mode of action might be comparable to the inhibition of prostaglandin synthesis that is described as Indomethacin's anti-inflammatory mechanism in the inhibition of carrageenan-induced inflammatory processes. It was discovered that these findings had medicinal potential for treating various forms of inflammation. The suppression of the cyclooxygenase enzyme, which catalyzes the manufacture of prostaglandins and thromboxane from arachidonic acid, may have potential anti-inflammatory benefits. Sterols were identified as the cause of this activity in the Alternanthera sessilis leaf extract by phytochemical analyses.[24]

7. Anti-Diabetic Activity-

One condition that is concerningly becoming more and more prevalent globally these days is diabetes mellitus. The sharp rise in diabetes incidence worldwide over the previous 20 years has been apparent as a growing issue. Aqueous and alcoholic extracts were used for screening on both streptozotocin-induced and normal rats in order to perform qualitative and quantitative analysis in order to assess Alternanthera sessilis' potential anti-diabatic properties. In rats, the effects against diabetes and hypoglycemia were also examined. The blood glucose level was found to be lowered by alcoholic extracts of Alternanthera sessilis, from 109.32 to 71.67. The effects of the extracts were most noticeable after 4 hours and persisted for 12 hours. The overall results of the studies were very positive in that they showed that both alcoholic and aqueous extracts had the capacity to lower blood glucose levels in rats given a diabatic injection. Subsequent research indicated that the primary

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agents of this activity are triterpenoids, glycosides, and phytosterols. On the other hand, alcoholic extracts work far better than aqueous extracts. [24]

8. Anti-Pyretic Activity-

Using albino rats as test subjects, the anti-pyretic properties of Alternanthera sessilis leaf ethanolic extracts were discovered. When administered these ethanolic extracts significantly reduced normal body temperature, whereas when compared to a standard anti-pyretic drug, yeast demonstrated dose-dependent elevation in temperature. The examined animals' temperature rose when these extracts significantly reduced the amount of yeast, which is likely because they contain lupeol and β-sterols. [24]

9. Anti-Oxidant Activity-

Ant-oxidant is a type of molecule that has the ability to prevent other molecules from oxidizing. Fundamentally, oxidation is a chemical process that generates free radicals and sets off a series of events that can seriously harm cells. Certain antioxidants, such as thiols or ascorbic acid, have the power to stop chain reactions. The anti-oxidant effect of Alternanthera sessilis leaves was investigated in rat liver and kidney. The animals were given two different diets: one consisting solely of Alternanthera sessilis leaf extract and the other consisting of leaf extract plus carbon tetrachloride (CCl4). A positive control group was also given silymarin, a common antioxidant. Enzymatic antioxidants such as CAT, SOD, Px, GST, and GR were tested for their antioxidant properties. The leaves' capacity to scavenge free radicals and LPO was also investigated. The group of rats administered plant leaf extract alone had a significantly higher level of enzyme activity than the group treated with leaf extract in combination with CCl4. According to the findings, Alternanthera sessilis leaves have strong antioxidant properties. This was also contrasted with groups that were administered alcohol or alcohol combined with carbon tetrachloride, which demonstrated significantly reduced scavenging activity as a result of both oxidative stress induction and the lack of plant extract to prevent this harm. [24]

VI. CONCLUSION

Moringa oleifera leaves have anti-inflammatory, antibacterial, and antioxidant qualities and thus it has better potential to aid in and speed up wound healing. Because it is herbal in origin and has very few adverse effects, it is beneficial to human health. In addition to having a positive healing impact on various wound types, moringa oleifera may be promoting naturally occurring antibacterial compounds with possible uses in the pharmaceutical sector. Because moringa oleifera contains a high concentration of flavonoids, tannins, and anthocyanins, which may enhance its anti-oxidant, anti-inflammatory, and antibacterial qualities, it is particularly useful in therapeutic applications and in the development of novel human wound healing formulations.

There are bioactive components in A. sessilis. Numerous phytochemicals have been shown to have a variety of functions, some of which may aid in the prevention of chronic illnesses. Alkaloids, for instance, offer protection from long-term illnesses. Saponins have antibacterial and hypercholesterolemia-preventing qualities. Triterpenoids and steroids both exhibit analgesic effects. Gallic acid, which is also present in the plants, may have anti-cancer effects. Strong pro-inflammatory, antioxidant, wound-healing, analgesic, and anti-angiogenesis effects are demonstrated by the other bioactive chemicals found in the plants. During phytochemical analysis, the main components of the chloroform extract were sterols, and there have been claims that sterols are in charge of the activity that heals wounds.

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