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A Review on Cleome Gynandra

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ABSTRACT: Cleome gynandra commonly known as spider flower or "Nayivelai," is an important tropical leafy vegetable with significant ethnomedicinal value. The plant is rich in flavonoids, alkaloids, phenolics, tannins, saponins, glucosinolates, vitamins, and essential minerals. Traditionally, it has been used for the treatment of fever, gastrointestinal disorders, respiratory problems, wounds, and skin infections. Pharmacological investigations have demonstrated antioxidant, anti-inflammatory, antimicrobial, analgesic, antipyretic, antidiabetic, and wound-healing properties. Owing to its dual role as a food and medicine, Cleome gynandra holds promise as a nutraceutical plant and a potential source for novel therapeutic agents.

KEYWORDS: Cleome gynandra, Phytochemicals, Traditional uses, Pharmacological activities

I. INTRODUCTION:

Recent estimates indicate that approximately one-third of the medications currently used in clinical practice are derived from natural products[(1)]. This includes ingredients either directly isolated from natural sources, synthesized, or semi-synthesized by structural modification of their natural composites[(2)]. Herbal medicine plays a crucial role in sustaining both the health and prosperity of humanity, with a significant portion of the global population relying on herbal remedies[(3)]. The World Health Organization (WHO) reports that around 21,000 plants have been utilized for medicinal purposes, and over 50,000 plant species are employed in traditional medicine worldwide[(4)]. Cleome gynandra L. (Capparidaceae) is commonly known as 'Nalvelai' and 'Taivelai' in Tamil[(5)]. It is widely used as a medicinal plant and is distributed in different parts of India[(6)]. The plant grows abundantly as a weed in paddy fields, on roadsides, and in open grasslands, though it is not systematically cultivated[(7)]. This review highlights the botany, pharmacology, biochemistry, folkloric, and traditional medicinal applications of C. gynandra[(8)]. Traditionally, it has been utilized in folk medicine for healing purposes, particularly in wound management[(9)]. Scientific reports confirm that extracts of C. gynandra leaves possess anti-inflammatory, antimicrobial, and antioxidant activities, which contribute to effective wound repair[(10)]. These properties validate its traditional use in treating cuts, burns, and skin infections[(11)].

TOXONOMICAL PROFILE:[(12)]

Kingdom - Plantae
Subkingdom- Tracheobionta (Vascular plants).
Superdivision - Spermatophyta (Seed plants).
Division/Phylum–Magnoliophyta (Flowering plants / Angiosperms).
Class - Magnoliopsida (Dicotyledons).
Subclass – Dilleniidae.
Order – Brassicales.
Family - Cleomaceae (sometimes included in Capparaceae in older systems).
Genus- Cleome.
Species - Cleome gynandra L.
Synonyms- Gynandropsis gynandra, Cleome Africana.
Common Names -Spider plant.

ORIGIN AND DISTRIBUTION:

In India, C. gynandra is widely distributed in tropical and subtropical zones, especially in states such as Tamil Nadu, Andhra Pradesh, Maharashtra, Uttar Pradesh, and West Bengal[(13)]. It commonly grows in wastelands, roadsides, and cultivated fields during the rainy season[(14)]. The plant is well adapted to warm climates and sandy loam soils, and thrives under monsoon conditions[(15)].

MORPHOLOGICAL PROFILE:[(15-21)]

Cleome gynandra is a erect and annual herb (25-60cm tall). Its sticky, ridged stem bears glandular hairs that secrete secondary metabolites

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like alkaloids and flavonoids. These traits aid species identification and link morphology to the plant's medicinal properties and pharmacological potential.

- **LEAVES:**

Cleome gynandra leaves are widely used in food and traditional medicine. They contain flavonoids, alkaloids, and glucosinolates with strong therapeutic effects.Used to treat fevers, wounds, infections, and digestive disorders. The obtained Leaf extracts of Cleome gynandra show potent antioxidant activity.

- **STEM:**

The stem of C. gynandra contains proanthocyanidins with antioxidant and anti-cancer potential.Stem extracts show slightly less antimicrobial and antioxidant activity.Acetone extract inhibits ABTS and nitric oxide radicals effectively.These properties suggest its role in preventing inflammatory disorders.

- **ROOT:**

Roots of C. gynandra are used to induce labour and relieve abdominal pain.They contain alkaloids and phenolics with anthelmintic and analgesic effects.Traditionally used for intestinal worms and postpartum care.

- **SEED:**

The seeds of Cleome gynandra contains very high and rich essential oils and it have asecondarymetabolites, including glucosinolates. Traditionally, seeds are used for digestive disorders and have been incorporated in treatments for intestinal inflammation. Phytochemical studies on seeds remain limited, but preliminary data suggest their potential for modulating gut microbiota and acting as natural preservatives due to their antimicrobial action.

- **FLOWER:**

The seeds of C. gynandra are highly rich in oils and secondary metabolites, including glucosinolates. Traditionally, seeds are highly used for digestive disorders and treatments for intestinal inflammation. Phytochemical studies on seeds remain limited, but preliminary data suggest their potential for modulating gut microbiota and acting as natural preservatives due to their antimicrobial action.

- **FRUIT:**

The fruiting capsule of C. gynandra, measuring 30-150 mm in length and 2.5-5mm in width, it's a significant source of alkaloids, terpenoids, and fatty acid derivatives, particularly due to its linear, glandular-hairy surface and persistent style.

CHEMICAL CONSTITUENTS:

- **LEAVES:**

The leaves of Cleome gynandra contain flavonoids such as quercetin, kaempferol, luteolin, and naringenin, along with glycosides, tannins, phenolic compounds, carotenoids (β-carotene), saponins, and vitamin C. They also provide proteins, amino acids, and minerals like calcium, iron, and zinc[15].

- **STEM:**

The stem is reported to possess flavonoids including rutin and hesperidin, together with tannins, trace alkaloids, sterols, and triterpenes such as lupeol and β-amyrin. These compounds are largely responsible for the plant's antioxidant and anti-inflammatory properties[22,23].

- **ROOT:**

The roots yield distinctive flavonoid glycosides such as naringenin-4′-O-galactoside and dihydrokaempferol-4′-O-galactoside, as well as triterpenoids like lupeol and β-amyrin. These constituents explain the root's traditional role in wound healing, antidiabetic, and anti-inflammatory applications[15,24].

- **BARK:**

The bark (outer stem tissues), though not woody, contains triterpenoids, phytosterols, phenolic compounds, and saponins. These enhance its antimicrobial, protective, and supportive medicinal roles[22,25].

ACTIVITIES:

ANTI-INFLAMMATORY ACTIVITY:

Anti-inflammatory activity refers to the ability of a compound, extract, or drug to suppress or regulate this inflammatory process. Conventionally, synthetic drugs such as corticosteroids and non-steroidal anti-inflammatory drugs (NSAIDs) are used for management; however, their prolonged usage leads to adverse effects such as gastrointestinal irritation, renal toxicity, and cardiovascular risks[26].

Due to these limitations, research interest has shifted toward plant-based natural compounds

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which exhibit anti-inflammatory activity with minimal side effects. Medicinal plants rich in flavonoids, alkaloids, tannins, terpenoids, and phenolic compounds are reported to suppress pro-inflammatory mediators like cyclooxygenase (COX), lipoxygenase (LOX), tumor necrosis factor-α (TNF-α), interleukins (IL-1β, IL-6), nitric oxide (NO), and nuclear factor kappa B (NF-κB), thereby reducing inflammation[27].

ANTI -OXIDATANT ACTIVITY:

Oxidative stress arises when there is an imbalance between the production of reactive oxygen species (ROS) such as superoxide anions, hydroxyl radicals, and hydrogen peroxide, and the body's antioxidant defense system. Excessive ROS damages cellular proteins, lipids, and DNA, leading to the progression of chronic diseases including diabetes, cardiovascular disorders, neurodegenerative diseases, cancer, and aging-related complications[28].

Antioxidant activity refers to the ability of compounds to neutralize or scavenge free radicals, thereby preventing oxidative stress–induced cellular injury. Synthetic antioxidants like butylated hydroxytoluene (BHT) and butylated hydroxyanisole (BHA) are widely used but are associated with potential health risks and toxicity on prolonged use[29].

ANALGESIC ACTIVITY:

Analgesic activity refers to the ability of a compound, extract, or drug to reduce or block pain perception through central (acting on the brain and spinal cord) or peripheral (acting at the site of injury/inflammation) mechanisms.While effective, they are associated with adverse effects such as gastrointestinal bleeding, renal dysfunction, respiratory depression, and risk of dependence[30].

Due to these limitations, medicinal plants have been widely investigated as natural analgesics. Phytoconstituents such as flavonoids, alkaloids, tannins, terpenoids, and saponins modulate pain pathways by inhibiting cyclooxygenase (COX), lipoxygenase (LOX), prostaglandin synthesis, and interacting with opioid receptors, thereby reducing pain sensations[31].

ANTI-CANCER ACTIVITY:

Anticancer activity refers to the ability of natural or synthetic compounds to inhibit tumor initiation, progression, or metastasis through mechanisms such as induction of apoptosis, inhibition of cell proliferation, suppression of angiogenesis, and modulation of signaling pathways. Conventional therapies such as chemotherapy, radiotherapy, and targeted therapy, though effective, are often associated with severe adverse effects, multidrug resistance, and toxicity[32].

Hence, increasing attention is given to medicinal plants as sources of safer and more effective anticancer agents. Phytoconstituents including flavonoids, alkaloids, terpenoids, tannins, and phenolic compounds exert cytotoxic effects by targeting key molecular pathways such as p53 activation, caspase cascade initiation, inhibition of NF-κB, and modulation of reactive oxygen species[33].

ANTI-FUNGAL ACTIVITY:

Phytochemicals derived from medicinal plants offer a promising alternative as natural antifungal agents. Secondary metabolites such as flavonoids, alkaloids, tannins, terpenoids, saponins, and phenolic compounds act against fungal pathogens through multiple mechanisms, including disruption of cell membrane integrity, inhibition of ergosterol synthesis, prevention of spore germination, and induction of oxidative stress in fungal cells[34].

The antifungal potential of medicinal plants rich in bioactive phytochemicals. These studies demonstrate that phytochemical-rich extracts from plant Cleome gynandracan inhibit the growth of pathogenic fungi effectively and safely, supporting their traditional therapeutic applications[35].

ANTI-BACTERIAL ACTIVITY:

Phytochemicals present in medicinal plants provide a natural source of antibacterial agents. Secondary metabolites such as alkaloids, flavonoids, tannins, terpenoids, saponins, and phenolic compounds inhibit bacterial growth by disrupting cell wall and membrane integrity, interfering with nucleic acid replication, inhibiting essential bacterial enzymes, and suppressing biofilm formation.

Due to these limitations, research has increasingly focused on medicinal plants as potential antibacterial agents. Phytochemicals such as alkaloids, flavonoids, tannins, terpenoids, saponins, and phenolic compounds inhibit bacterial cell wall synthesis, disrupt membrane integrity, interfere with nucleic acid replication, and inhibit essential bacterial enzymes[36].

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ANTI-HYPERGLYCEMIC ACTIVITY:

Anti-hyperglycemic activity refers to the ability of compounds, extracts, or drugs to lower blood glucose levels by enhancing insulin secretion, improving insulin sensitivity, inhibiting carbohydrate-digesting enzymes, or modulating glucose uptake and metabolism[37].

Medicinal plants have attracted attention as safer alternatives for diabetes management. Phytochemicals such as flavonoids, alkaloids, tannins, saponins, and phenolic compounds exhibit anti-hyperglycemic effects by stimulating pancreatic β-cells, inhibiting α-amylase and α-glucosidase enzymes, enhancing glucose uptake in peripheral tissues, and reducing oxidative stress associated with hyperglycemia[38].

ANTI-DIARRHEAL ACTIVITY:

Anti-diarrheal activity refers to the ability of compounds or plant extracts to reduce the frequency and severity of diarrhea by regulating intestinal motility, inhibiting secretion, and modulating gut microbiota[39].

Medicinal plants provide a safer alternative for managing diarrhea. Phytoconstituents such as flavonoids, tannins, saponins, alkaloids, and phenolic compounds exert anti-diarrheal effects by inhibiting intestinal hypersecretion, reducing inflammation, improving mucosal integrity, and suppressing gastrointestinal pathogens[40].

ANTI-PYRETIC ACTIVITY:

Antipyretic activity refers to the ability of a compound, extract, or drug to reduce elevated body temperature by modulating the hypothalamic thermoregulatory center and inhibiting the production of pyrogenic mediators such as prostaglandins[41].

Medicinal plants have been widely explored as natural antipyretic agents with fewer side effects. Phytochemicals such as flavonoids, alkaloids, tannins, terpenoids, and saponins exert antipyretic effects by suppressing the synthesis of prostaglandins, reducing cytokine production, and modulating inflammatory responses[42].

WOUND HEALING ACTIVITY:

Wound healing activity refers to the ability of compounds or plant extracts to accelerate tissue repair, reduce infection, enhance collagen synthesis, and promote epithelialization[43].

Medicinal plants offer an effective alternative for wound management due to their bioactive compounds such as flavonoids, tannins, saponins, alkaloids, and phenolics. These phytochemicals stimulate fibroblast proliferation, angiogenesis, collagen deposition, and antimicrobial defense, thereby promoting faster and more efficient wound repair[44].

REVIEW ON CLEOME GYNANDRA BASED ON THE ACTIVITY:[45-55]

PLANT PART	EXTRACT TYPE	PHYTOCHEMICAL CONSTITUENTS	REPORTED ACTIVITIES/USES
LEAVES	Aqueous extract	Phenolic acids, Tannins, Saponins, Vitamin C.	Anti-diarrheal, Antipyretic, Wound healing, Traditional tonic.
LEAVES	Ethanolic extract	Flavonoids (quercetin, rutin, kaempferol), Alkaloids, Terpenoids	Anti-inflammatory, Analgesic, Antimicrobial, Antioxidant.
LEAVES	Methanolic extract	Flavonoids, Triterpenoids, Glycosides, Carotenoids, Tocopherols.	Antidiabetic, Anticancer potential, Hepatoprotective, Antioxidant.

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SEEDS	Oil extract	Fixed oils (linoleic, oleic, palmitic acids), Sterols, Proteins.	Skin care, Antimicrobial, Nutritional (rich in essential fatty acids and proteins)
SEEDS	Methanolic extract	Phenolics, Amino acids, Sterols.	Antimicrobial. Antioxidant.
SEEDS	Petroleum ether extract	Fatty acids, Sterols.	Antimicrobial and Nutritive role.
ROOTS	Decoction (aqueous)	Alkaloids, Glycosides, Saponins, Phenolics.	Fever reduction, Stomach disorders, Cough, Asthma.
ROOTS	Ethanolic extract	Alkaloids, Tannins, Saponins.	Anthelmintic, Anti-inflammatory.
FLOWERS/AERIAL PARTS	Ethanolic extract	Flavonoids, Terpenoids, Phenolics.	Antifungal (effective against dermatophytes), Antimicrobial.
FLOWERS/AERIAL PARTS	Methanolic extract	Flavonoids, Phenolics	Wound healing, Antioxidant.
STEM	Aqueous extract	Tannins, Alkaloids.	Digestive aid, Supportive therapy
STEM	Methanolic extract	Flavonoids, Tannins, Phenolics.	Antioxidant, Antimicrobial/
WHOLEPLANT	Aqueous/Alcoholic extract	Mixed phytochemicals-Flavonoids, Terpenoids, Alkaloids, Tannins, Phenolics, Vitamins.	General health tonic, Antioxidant, Antimicrobial, Anti-tumor, Antidiabetic.

II. CONCLUSION:

Cleome gynandra is a versatile medicinal and nutritional plant widely distributed across tropical and subtropical regions of India. Its stems, roots, leaves, seeds, flowers, and fruits are rich in bioactive compounds such as flavonoids, alkaloids, glucosinolates, proanthocyanidins, terpenoids, and essential oils. These phytochemicals confer potent antioxidant, antimicrobial, anti-inflammatory, analgesic, and anticancer activities. Traditional uses, including treatment of fevers, wounds, digestive disorders, intestinal worms, and postpartum care, are supported by pharmacological studies, particularly the strong antioxidant and antimicrobial potential of its leaves, stems, and seeds.

Despite promising preliminary studies, several parts of the plant, especially seeds and flowers, remain underexplored. Future research could focus on detailed phytochemical profiling, mechanistic studies, and clinical validation to unlock the full therapeutic potential of C. gynandra. Further investigations may also explore its wound healing and antipyretic activities, which could expand its applications in modern herbal medicine.

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