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Medicinal uses, phytochemistry and pharmacological activities of cleome species (Cleomaceae): A review

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Abstract

This study is reviewing the medicinal uses, phytochemistry and pharmacological activities of cleome species. Ethanomedically, cleome species have used to treat a variety of diseases such as fever, flu, headaches, coughs, snakebites, nephritis, inflammation, bronchitis, diarrhoea, skin conditions, liver disorders and malarial fever symptoms. This study reviewed the previous phytochemical analysis of this plant species, its bioactive flavonoids and terpenoids, tannins, alkaloids, anthraquinones and saponins which showed to be found in the various extracts of the plant. These bioactive compounds and extracts all showed antioxidant, anti-malarial, anti-cancer, antibacterial, and hepatoprotective effect. The enormous range of medicinal applications described thus far cannot be exaggerated, despite the fact that just a few species in this genus have been studied. Given their pharmacological properties, this plant species shows potential for further analytical studies and subsequent clinical trials to advance the plants' therapeutic potential.

Keywords: Anticancer, Antimalarial, Antioxidants, Cleome gynandra, Medicinal, Pharmacological, Phytochemistry, Plants

1. Introduction

Medicinal plants are widely used in developing therapeutic medications, nutraceuticals, food supplements, and feed additives that are safe for both humans and animals. In recent years, plants have gained attention as a potential source of various medications, particularly antimicrobials, for combating multidrug-resistant bacteria (Awad et al., 2019; Hashem et al., 2019). The Cleome genus, which belongs to the Cleomaceae family, is among the largest genera, and it has been found to have medicinal and ecological significance (Moustafa et al., 2019). Plants belonging to the Cleome genus have gained recognition in traditional medicine for their effectiveness in treating stomachaches, skin allergies, and open wounds, as well as for their anticancer and hepatoprotective properties (Abdel-Kader et al., 2009; Ezzat and Motaal, 2012; Maksoud et al., 2020). Additionally, studies have revealed that shrubs of the Cleome genus possess significant anti-diabetic properties. The aqueous extract of

Cleome was found to contain a high proportion of flavonols with an activity rate of 63.3 percent, comparable to that of the synthetic medication metformin (Motaal et al., 2014).

2. Literature review

2.1. Botany and distribution

The Cleome genus belonging to the Cleomaceae family is known to be one of the largest genera. It comprises about 180-200 species that are primarily found in arid and semi-arid regions like Egypt, Libya, Syria, and Palestine (Moustafa et al., 2019). These cushion-like shrubs are known for their intricate branching stems, large oval-shaped leaves with inflated glandular hairs, and a height that ranges between 25-60 cm (El-Askary et al., 2019; Moustafa et al., 2019). In the deserts of southern Algeria, the Cleome arabica L., also known as the spider flower, thrives due to its adaptability to the harsh conditions. Although it has an unpleasant odor, it is still grazed by animals to some extent (Madi et al., 2017). Cleome gynandra L. is a wild vegetable that can be found in various provinces of South Africa (Mishra et al., 2011). It's a multi-branched annual herb that can grow up to 1.5 meters in height (Linda & Anthony, 2015).

Cleome ciliata is a digitately compound annual plant with lanceolate to obovate leaflets, typically three, sharp at their apices, and with stems that are not thorny. The plant has white, lilac, or pink flowers, and its fruit can grow up to 2.5-6 cm long (Crocker, 2000). Another annual herbaceous plant is Cleome heratensis, which blooms during the summer and autumn in warm temperate regions. It is commonly referred to as spider flowers (Pakdaman et al., 2013). Cleome viscosa is a sticky annual plant which grows as a weed in tropical areas worldwide (Tripti *et al.,* 2015). Its yellow flowers are small and have a bad odor. The plant's leaves are sudorific, vesicant, and rubefacient, while the seeds are tiny, dark brown or black, and granular (Ravi, 2015; Wael et al., 2016).

Cleome scaposa is a 10-30 cm tall annual weed found in Arabia, Egypt, India, Pakistan, and other tropical regions. The plant has simple leaves, white or yellowish-pinkish flowers that are 3-4 mm across, and capsules that are linear and 20-30 mm long (Shaheen et al., 2013). Cleome felina Linn is a heavily branched annual plant which can grow up to 30-60 cm in height. It has 3-foliolate leaves with 10-25 mm leaflets, which are obtuse and the same length as or shorter than the petioles. The auxiliary flowers are solitary, purple or pink, with 30 filaments of stamens and long pedicels. The capsules are compressed, linear, and have sharp ends with large glabrous tubercles (Joseph et al., 2014**).**

2.2. Traditional medicinal uses

The medicinal potential of the Cleome genus has been demonstrated in various studies. Studies have reported that Cleome species have anti-inflammatory and antioxidant properties. Although only a few representatives of this genus have been studied, the therapeutic benefits reported so far are extensive. Extracts from the Cleome genus have been used to treat various conditions such as fever, cough, snake bites, nephritis, diarrhea, bronchitis, malarial fever, liver disorders and skin diseases (Chi & Hop, 2002). Cleome arabica is also known for its medicinal properties and its leaves are used traditionally in treating inflammation, scabies, and other ailments, and they are also said to have hallucinogenic properties (Baba, 2011; Tsichritzis et al., 1993).

The whole plant of Cleome gynandra has been reported to have therapeutic benefits for rheumatism, piles, malaria, and tumors. The decoction of the roots and leaves of this plant are also

applied to wounds to reduce fever, headaches, and prevent sepsis (Mule et al., 2008; Bala et al., 2011). Cleome viscosa Linn.has been used as a medicinal herb for stomachic, laxative, anthelmintic, diuretic, and skin illnesses such as itching, urticaria, and leprosy. The seeds are anthelmintic, and the juice of the leaves is beneficial in malarial fever and blood illness is used in treating ear pain; the roots are used as vermifuge and stimulant (Meda et al., 2005).

According to Jeruto et al. (2008), the Cleome species has a traditional use in Kenya for treating stomach discomfort and malaria. Cleome viscosa is also employed as a remedy for various illnesses in India (Gupta & Rao, 2012). In Egypt and Jordan, Cleome droserifolia is a notable medicinal plant that has been used for a long time to treat hyperglycemia. Its efficacy as a hypoglycemic herb has been extensively researched and proven (El-Khawaga et al., 2010).

Table 1: Medicinal Uses of Cleomes species

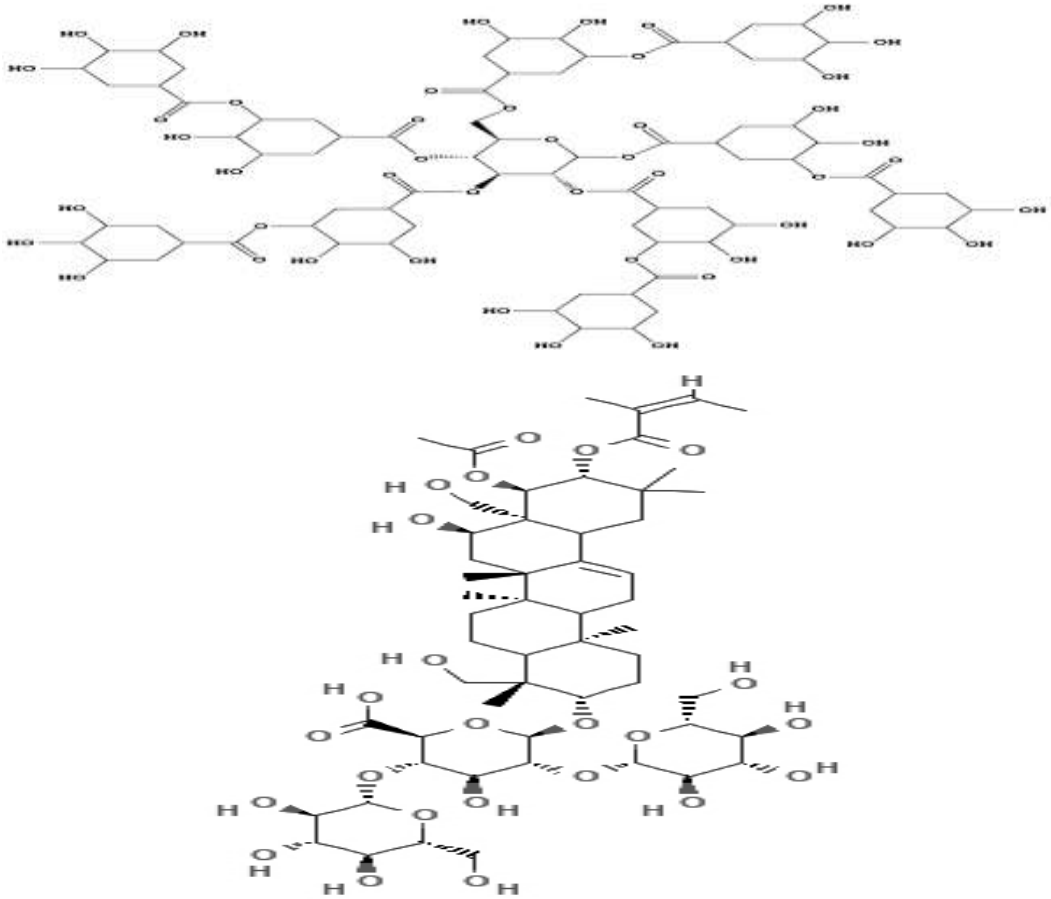
Species	Disease	Part used	Reference
Cleome Arabica	Scabbies Inflammation	Leaves	Baba, 2011; Tsichritziset al, 1993
Cleome gynandra	Rheumatism Piles, Malaria Tumor Headaches Fever	Leaves Roots Whole plant	Mule et al., 2008; Balaet al., 2011
Cleome viscose	Rheumatism Piles Malaria Tumor Vermifuge Stimulant	Leaves Roots	Mule et al., 2008; Balaet al., 2011
Cleome droserifolia	Hyperglycemia	Whole plant	Riyadh et al., 2015.

3. Phytochemistry research methodology

The ethanol extract of Cleome viscosa root contains alkaloids, flavonoids, and terpenoids, according to early phytochemical analysis (Seema et al., 2020). According to Linda and Afolayan (2015), the

various portions of Cleome gynandra contain significant amounts of phenolics, proanthocyanidins, and flavonoids. The phytochemical contents of an ethanolic extract of Cleome ciliata leaves were investigated (Umerie et al., 2012). The extract underwent phytochemical examination and was found to contain a variety of compounds, including saponins, tannins, steroids, terpenoids, alkaloids, flavonoids,, and glycosides.

In a preliminary phytochemical screening test, the extracts of Cleome Arabica from its leaves, seeds, and roots were examined for various constituents, and alkaloids, coumarins, flavonoids, saponins, tannins, and terpenoids were detected (Madi et al., 2017). According to Innocent et al (2018), phytochemical screening of *Cleome ciliata* leaves and roots, showed that the methanol leaf extract had high levels of anthraquinones and flavonoids, whereas the root had high levels of alkaloids, saponins, tannins, and terpenoids.



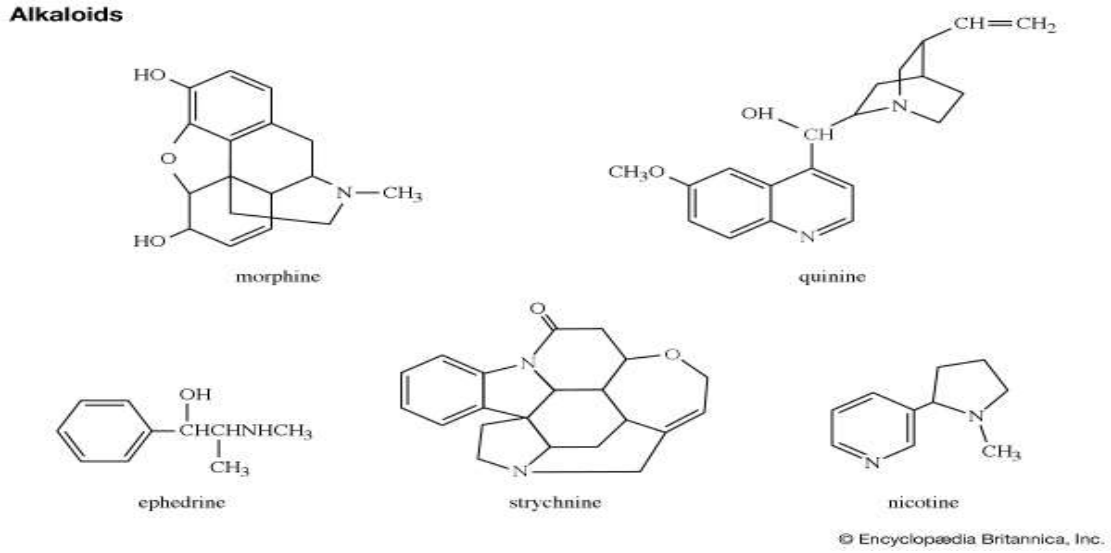


Figure.1: Compounds isolated from Cleome species

4. Pharmacological properties

4.1. Antibacterial activities

The *in vitro* antibacterial properties of an ethanolic extract of *Cleome ciliata* leaves were investigated using the agar diffusion method. Staphylococcus aureus, *Salmonella paratyphi*, and *Pseudomonas aeruginosa* were all inhibited by the extract. The flavonoid fraction of the raw sample showed effectiveness against *S.aureus*, *E.Coli*, and *K.Pneumoniae*, while the tannin fraction was only effective against Staphylococcus aureus. According to the findings, Cleome ciliata can be utilized to treat illnesses caused by the test and related organisms (Umerie et al., 2012).

Using agar-well diffusion and micro-dilution techniques, Muhaidat et al. (2015) examined the potential antibacterial activity of essential oils extracted from Cleome droserifolia and Cleome trinervia. The oils demonstrated significant growth inhibitory effects against various infections, although the degree of inhibition varied. Nonetheless, most of the microorganisms tested were suppressed. The antibacterial effects of ethanolic extracts of Cleome viscosa leaves and flowers against E. coli, Pseudomonas vulgaris, and Pseudomonas aeruginosa were examined by Abreu *et al*. (2012). According to the findings, both extracts exhibited a broad spectrum of antimicrobial activity, with the leaf extract being moderately effective against pathogenic fung**i.**

4.2. Antioxidant activities

Jean et al. (2017) examined the antioxidant potential of Cleome gynandra and found that all parts of the plant possess the ability to scavenge free radicals. The aqueous extract showed more effective results, confirming its traditional medicinal application. In a similar study, Linda and Anthony (2015) evaluated the antioxidant activities of Cleome gynandra against different radicals including ferric reducing power, ABTS diammonium salt, DPPH, and NO. The plant exhibited significant antioxidant potential attributed to its high concentration of secondary metabolites, validating its use as a natural antioxidant in traditional medicine.

Jehan et al. (2018) investigated the antioxidant activity of crude fractions from the aerial parts of Cleome amblyocarpa and Cleome ramosissima. The extracts were evaluated using various antioxidant assays including DPPH, ABTS+, MCA, and O-2 scavenging tests. The butanol extracts

from both species showed the highest antioxidant activity, and significant levels of TPC and TFC were observed. Furthermore, Mohammed *et al.* (2019) utilized an 80 percent methanolic extract to examine the antioxidant effects of Cleome heratensis. According to the findings, the aerial part of the plant extract demonstrated remarkable natural antioxidant activity through spectrophotometric techniques.

4.3. Antimalarial activities

In a 2016 study, Elufioye and Onoja explored the anti-malarial potential of Cleome viscosa's methanolic extract and its fractions (n-hexane and ethyl acetate) against early, established, and residual malaria infections in mice. The anti-malarial activity of the extracts was tested in vivo on mice that were infected with the chloroquine-sensitive Plasmodium berghei NK-65 strain. The methanolic extract and the partitioned fractions of Cleome viscosa exhibited significant ($p<0.05$) dose-dependent anti-malarial activity, indicating its potential use in the treatment of malaria.

Using white albino mice, John et al. (2016) tested the combined methanol and ethyl acetate extracts of Cleome gynandra for anti-malarial efficacy in vivo against Plasmodium berghei NK65. The findings demonstrated that the plant had anti-malarial properties, indicating that it could be used as a traditional medicine to treat malaria.

4.4. Anticancer activities

Using different human cancer cell lines, Chafia et al. (2013) evaluated the capacity of methanol extracts from Cleome Arabica leaves to prevent tumor growth. Their finding indicated that the extracts had significant anticancer properties against all cell lines tested.

In a separate study, the anticancer properties of Cleome felina were evaluated using the 3-(4,5-dimethylthiazol-2-yl)-2,5-diphenylterttrazolium bromide (MTT) assay on HepG2 (a human hepatocellular liver carcinoma cell line). The study measured the percentage of cell growth inhibition induced by the Cleome felina extract compared to DMSO-treated control cells. The findings revealed that the plant extract has the capability to reduce HepG2 cell viability in a dose-dependent way (Joseph et al., 2014).

4.5. Other pharmacological activities

The potential hepatoprotective effects of Cleome viscose and Cleome chelidonii leaves and stems were examined against carbon tetrachloride (CCl4)-induced liver toxicity in rats, both in vitro and in vivo, using n-hexane, ethyl acetate, and methanol extracts, as well as isolated compounds. The study by Nhat et al. (2021) reported significant hepatoprotective effects of the plant extracts in vitro on HepG2 cells.

Table 2: Pharmacological Activities of *Cleome Species*

Species	Part used	Solvent	Pharmacological properties	Reference
Cleome ciliate	Leaves	EtOH	Antibacterial	Umerie *et al.*, 2012
*Cleome droserifolia*and *Cleome trinervia*			Antibacterial	Catherine et al., 2022.
Cleome viscose	Leaves Roots	EtOH	Antibacterial	Catherine et al., 2022.
Cleome Arabica	Leaves	MetOH	Anticancer	Catherine et al., 2022.
Cleome viscose	Whole plant	MetOH	Antimalaria	Elufioye and Onoja 2016
Cleome ramosissima	Aeriel part	ButOH	Antioxidant	Anup et al., 2022
Cleome amblyocarpa	Ariel part	ButOH	Antioxidant	Anup *et al.*, 2022
Cleome viscose	Leaves and Flowers		Antibacterial	Anup *et al.*, 2022
Cleome viscosa	Leaves	n-hex	Hepatoprotective	Nhat *et al.*, 2021
Cleome chelidonii	Stem	MetOH	Hepatoprotective	Nhat *et al.*, 2021

6. Conclusions

The wide therapeutic value of the Cleome species for medicinal applications, phytochemistry, and pharmacological activity has been discussed in this paper. It is worthy of note that a little is known about the Cleome family, as only a few members of the species have been investigated for medical and pharmacological purposes. Further toxicological and clinical investigations are needed to promote these plants' medicinal potential, given their pharmacological properties.

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