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Parthenium hysterophorus: A Herbal Treasure with Therapeutic Potential

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Abstract: ***Parthenium hysterophorus is a fast-growing, herbaceous, flowering, invasive, noxious weed species, native to the Americas. It is often considered a nuisance due to its aggressive growth, allergenic properties and negative allelopathic effect. However recent pharmacological studies have revealed that this plant also possesses significant medicinal properties. Rich in bioactive compounds like sesquiterpene parthenolide, flavonoids, oils and alkaloids, P. hysterophorus exhibits anti-inflammatory, antimigrain, anticancer, antimicrobial, antioxidant, and antidiabetic properties. This article aims to highlight the phytochemical composition and therapeutic potentials of Parthenium hysterophorus, while also considering the mode of action, risks and challenges associated with its medicinal use.***

Keywords: medicinal plants, bioactive compounds, therapeutic potential, pharmacological properties, invasive species

1. Introduction

Parthenium hysterophorus L., belonging to the family Asteraceae, subfamily Asteroidae (tribe Heliantheae), is an aggressive weed known for its rapid colonization and invasive nature. Their invasion causes destruction of the habitat of many plants in their surroundings as they compete for nutrients and release allelopathic chemicals in soil (Lakshmi *et al.,* 2012). *Parthenium*, known by various names as, carrot weed, gajar ghas, congress grass, Maria feverfew or famine weed, was originated in American tropics and has spread widely in Asia, Africa, and Australia, causing serious ecological, agricultural, and health problems. *Parthenium* was introduced to India in the 1950s, likely as a seed contaminant in imported wheat from the USA. Since then, it has spread rapidly across the country, becoming epidemic of allergic contact dermatitis (Mitchell and Calnan, 1978). Despite its notoriety, recent investigations have drawn attention to its potential pharmacological benefits due to the presence of various bioactive constituents (Patel, Sharma, & Chauhan, 2011). This article aims to highlight the phytochemical composition and therapeutic potentials of *Parthenium hysterophorus* along with their mode of actions, while also considering the risks and challenges associated with its medicinal use.

2. Phytochemical Profile

The medicinal and pharmaceutical potential of *P. hysterophorus* lies in its diverse phytochemical constituents (Pandey, 2009). Some of these compounds linked to various biological activities, making it a plant of interest for therapeutic applications are:

- **Sesquiterpene lactones** (notably *parthenin*): These have cytotoxic, anti-malarial, anti-inflammatory, anti-cancer and anti-parasitic effects. (Picman *et al.*, 1979; Kanchan and Jayachandra, 1980, Marimuthu *et. al.*, 2015; Kaur *et. al.*, 2021).
- **Flavonoids and phenolic acids**: Gallic acid, chlorogenic acid, ferulic acid, anisic, vanillic acid, p-caumaric acid and caffeic acid, present in *Parthenium*, are known to be antioxidants and antimicrobial agents (Swaminathan *et al.*, 1990, Panwar *et al.*, 2015).
- **Alkaloids and tannins**: Alkaloids and tannins contribute to its antimicrobial and enzyme inhibitory properties (Batish, Lavanya, Singh & Kohli, 2002).
- **Steroids and saponins**: These are involved in immune modulation and potential hormonal activity (Krishnaveni and Dhanalakshmi, 2014).
- Marimuthu *et al.*, 2015 tested the extract for the presence of various bioactive compounds by adopting standard procedures.

3. Medicinal Properties

The therapeutic potential and mode of action of *Parthenium* has been documented by various researchers:

3.1 Anti-inflammatory Activity

Studies have shown that extracts of *P. hysterophorus* suppress the expression of pro-inflammatory cytokines (IL-6, TNF-α) and inhibit COX-2 enzyme activity, reducing inflammation in experimental animal models (Kumar *et al.*, 2025).

3.2 Anticancer Properties

Phytochemicals present in *Parthenium* leaf extract showed cytotoxic activity against MCF-7 and THP-1 cell lines. (Kumar *et al*., 2013).

3.3 Antimicrobial Activity

In *Parthenium* anti-microbial activity was attributed to the presence of terpenoids, volatile oils and flavonoids as well as amino acids, sugars and phenolic derivatives (Kaur *et al.*, 2016). Extracts of *P. hysterophorus* have shown inhibitory effects against a broad spectrum of bacterial and fungal strains including *Escherichia coli*, *Bacillus subtilis*, *Enterococcus* spp., *Staphylococcus aureus*, *Pseudomonas aeruginosa*, *Klebsiella pneumoniae*, *Enterobactor aerogenes*, *Candida albicans*, *Fusarium oxysporum*, and *Aspergillus flavus* (Khan *et al.*,2011, Malarkodi and Manoharan, 2013; Dilshad and Gupta, 2023).

3.4 Antioxidant Effects

Different assays confirm the strong free radical scavenging ability of *Parthenium hysterophorus* extracts. This property is attributed to its rich content of phenolic compounds and flavonoids, which helps in mitigating oxidative stress (Sharma, Arora, & Bansal, 2013).

3.5 Antidiabetic Potential

Experimental studies in alloxan-induced diabetic rats demonstrated that methanolic extracts of *Parthenium hysterophorus* significantly lowered blood glucose levels (Makhdoom *et al.,* 2022). The mechanism is thought to involve inhibition of α-amylase and α-glucosidase enzymes and regeneration of pancreatic β-cells (Chandrashekhar, Satyanarayana, & Pai, 2010; Kashtoh and Baek, 2023).

Besides these *Parthenium* is used **i**n traditional systems of medicine in the treatment of skin wounds and dermatitis, amoebic dysentery, muscular rheumatism, fever, diarrhoea, neurologic disorders, urinary tract infections, dysentery, malaria and as emmenagogue (Verma *et al.,* 2016; Kaur *et al.,* 2021; Kaushik *et al.,* 2024). Ethnobotanically, it is used by some tribes as remedy for inflammation, eczema, skin rashes, herpes, rheumatic pain, cold, heart trouble and gynaecological ailments. *Parthenium hysterophorus* has been found to be pharmacologically active in Psoriasis, rheumatoid arthritis, diarrhea, dysentery, urinary tract infections, malaria, psoriasis, allergies, asthma, tinnitus, nausea, vomiting, and neuralgia (Noor *et al.,* 2024).

4. Toxicity and Challenges

Despite its medicinal promise, *P. hysterophorus* poses several risks and limitations:

- **Allergic reactions**: Contact with the plant or inhalation of its pollen can cause allergic dermatitis, asthma, and hay fever (Khaket *et al.,* 2015)
- **Mutagenic and cytotoxic effects**: High concentrations can damage liver and kidney tissues due to sesquiterpene lactones (Patel, 2011; Botha *et al.,*2020).
- **Ecological harm**: Its invasive nature, aggressive growth, prolific seed production, and allelopathic effects causes displacement of native flora and toxicity to livestock (Kumar *et al.,* 2016).
- **Lack of dosage standardization**: As *Parthenium* is a weed, no established safe therapeutic range exists, increasing the risk of overdose or side effects.
- **Regulatory barriers**: Insufficient clinical data and limited toxicological profiling hinder its approval for mainstream therapeutic applications.

These factors necessitate rigorous toxicological evaluations and controlled extraction protocols.

5. Future Prospects

Continued in vivo and in vitro studies, coupled with clinical trials, are crucial for translating its pharmacological potential into safe and effective medicinal products along with development of standardized herbal formulations. *Parthenium hysterophorus* holds potential in pharmacology due to its various medicinal properties and traditional uses. Future prospects in this field include exploring its anti-diabetic, anti-inflammatory, and anti-microbial activities, as well as its role in developing new medications and enzymes.

6. Conclusion

Although long regarded as a noxious invasive weed, *Parthenium hysterophorus* has emerged as a plant of pharmacological interest with anti-diabetic, anti-inflammatory, and anti-microbial activities. With proper extraction, purification, and dosing, its bioactive compounds may serve as valuable leads in drug development. However, the toxicological concerns must not be overlooked, and more research is needed to ensure its safe therapeutic application.

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