

Pharmacognostical, Phytochemical, Biological and Tissue Culture Studies on *Parthenium hysterophorus* Linn.: A Review

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Abstract

Parthenium hysterophorus Linn. (Asteraceae) has been labeled as a useless weed. It has been associated with skin disorders. Studies have indicated that it contains several important chemical constituents mainly histamine and sesquiterpenes. It is a rich source of sesquiterpene lactones such as parthenin, hysterin and dihydroparthenin. It has shown several prominent biological activities (including antitumor activity) in animal and human-models. Studies related to plant tissue culture and agrotechnology have also been undertaken on parthenium. The present article is an attempt to highlight the summary of studies on this 'weed'.

INTRODUCTION

Parthenium hysterophorus Linn. (Asteraceae) is considered a serious weed in several tropical and subtropical countries across the world (Anonymous, 2003). It has been associated with dermatitis and related skin disorders. It contains sesquiterpenes particularly sesquiterpene lactones such as parthenin, hysterin and dihydroparthenin.

MORPHOLOGY

P. hysterophorus is a herb reaching about 1.0 m in height. Its stem is longitudinally grooved and bears green leaves. The leaves are irregularly dissected and pubescent. The flower heads are terminal or axillary. These white flower heads are usually 0.5 mm in diameter. The fruits are broadly obovoid in shape and have dark brown colour (Anonymous, 2001).

USES IN INDIAN SYSTEMS OF MEDICINE

P. hysterophorus is used in treatment of ulcerated sores, wounds, fever, anaemia and heart troubles (Kalsi et al, 1995).

ETHNOMEDICINAL USES

The plant is used as a tonic, febrifuge, emmenagogue and as an analgesic in neuralgia. A decoction of the root finds use in treatment of dysentery (Anonymous, 2001).

PHYTOCHEMISTRY

WHOLE PLANT

Two sesquiterpene lactones; hysterin and dihydroisoparthenin; have been isolated from plants growing in Argentina and Jamaica (Picman et al, 1982). Histamine (0.585 %) is present in the aerial parts of the plant (Kamal & Mathur, 1991). Syringaresinol has also been isolated from this weed (Das et al, 1999).

Three ambrosanolides; 8-epoxymethylacryloyloxy parthenin, its 11,13-dihydro derivative and 8-epoxymethylacryloyloxy ambrosin; have been isolated from chloroform extract of the aerial parts (Chhabra et al, 1999). A novel sesquiterpenoid, charminarone (the first seco-pseudoguaianolide) has been isolated from the whole plant (Venkataiah et al, 2003).

LEAVES

Parthenin, hexacosanol, myricyl alcohol, β -sitosterol, campesterol, stigmasterol, betulin, ursolic acid, β -D-glucoside of β -sitosterol and saponin have been isolated from leaves. The saponin on hydrolysis yields oleanolic acid and glucose. The aqueous extract contains free amino acids, glucose, galactose and potassium chloride (4.8%) (Gupta et al, 1977). Methoxypseudoguaianolides viz. 13-methoxydihydroambrosin, 13-methoxydihydroparthenin and 2,13-dimethoxydihydroparthenin have been isolated from leaves (Bhullar et al, 1997). The leaves also contain parthenin, caffeic, chlorogenic, p-hydroxybenzoic, p-anisic,

vanilic, salicylic, gentisic, neo-chlorogenic and proto-catechuic acids (Anonymous, 2003). Leaves contain about 5% parthenin (Anonymous, 2003).

FLOWERS

Methanolic extract of flowers contains several constituents such as 2-hydroxycoronopilin, 8-hydroxycoronopilin, 11-H, 13-hydroxyparthenin, parthenin and coronopilin (Anonymous, 2003). Parthenin (up to 8 %) is present in capitulum (Anonymous, 2003). Four new pseudoguaianolides (hysterones A-D), parthenin, coronopilin, 2-hydroxycoronopilin and tetraneurin-A have also been isolated from the flowers (Ramesh et al, 2003). A new highly oxygenated pseudoguaianolide (8-acetoxyhysterone C), parthenin, coronopilin and hysteron C have been isolated from the flowers (Das et al, 2005).

ROOTS

Histamine (0.35 %) is present in the roots of plant (Kamal & Mathur, 1991). The roots contain parthenin, caffeic, chlorogenic, p-hydroxybenzoic, p-anisic, vanilic, salicylic, gentisic, neo-chlorogenic and proto-catechuic acids (Anonymous, 2003).

PHARMACOLOGY

Human – *Parthenium* causes allergic contact dermatitis (Anonymous, 2003).

Non-humans

Rats- The leaf extracts show depolarizing neuromuscular junctional blocking action similar to that of neostigmine (Vijayalakshmi et al, 1999).

Dog – 10% cold aqueous extract of flowers successfully elicits a hypotensive response in dogs (Anonymous, 2003).

Frog- The flower extract possesses cardiac depressant effect as concluded from experiments on perfused frog heart (Anonymous, 2003).

Aqueous extracts of flowers and leaves exert lethal effect on frog tadpoles. Phytoconstituents particularly phytotoxins present in extracts have been responsible for this action (Anonymous, 2003).

Rabbit- The flower extract has spasmogenic action in isolated rabbit duodenum (Anonymous, 2003).

BIOLOGICAL ACTIVITIES

ANTIAMOEBIAC

Antiamoebic activity of parthenin from *P. hysterophorus* has been evaluated in vitro against axenic and polyxenic cultures of *Entamoeba histolytica*. Parthenin has been found to show acute toxicity to the cultured organisms. Parthenin has activity comparable to that of metronidazole. The findings of this study suggest that parthenin may be useful in experimental hepatic amoebiasis (Sharma & Bhutani, 1988).

ANTITUMOR

Antitumor effects of methanolic flower extract of *P. hysterophorus* have been studied in mice bearing transplantable lymphocytic leukemia. Markers such as glutathione, cytochrome P-450, glutathione transferase and UDP-glucuronyl transferase in liver tissues show significant changes ultimately leading to slow development of tumors. The extract also results in increased survival of the leukemic mice (Mukherjee & Chatterjee, 1993).

TRYPANOCIDAL

Crude ethanolic extract of *P. hysterophorus* has been evaluated for in vivo and in vitro activities against *Trypanosoma evansi*. In vivo trial has revealed that the extract exerts antitrypanosomal effect at intraperitoneal doses of 100 and 300 mg/kg body weight. 1000 mg/kg dose has caused toxicity in the animals (Talakai et al, 1995).

ANTIMALARIAL

Parthenin and some of its derivatives were evaluated for antimalarial activity against a multidrug resistant strain of *Plasmodium falciparum*. Parthenin and related compounds have significant antimalarial action (Anonymous, 2003).

PLANT TISSUE CULTURE

Stem, leaf and flower explants of *P. hysterophorus* have been reportedly cultured on MS Medium supplemented with IAA, BA or kinetin hormones. Organogenesis of shoot buds from stem callus culture has been observed on MS Medium containing IAA & BA or kinetin where as the leaf callus has shown organogenesis of roots on a variety of media. Leaf callus has produced a positive patch test for delayed hypersensitivity in four patients of *Parthenium* dermatitis. This study has suggested the possibility of biosynthesis of allergenic principle(s) in leaf callus (Subramanian & Rao, 1980). Callus cultures of root, stem, petioles and leaf blades of mature plant have been screened and parthenin detected in callus cultures from all sources except roots. Coronopilin is present only in petioles and leaf blade callus cultures. This

study has confirmed that parthenin and coronopolin production is not limited to glandular trichomes (Wickham et al, 1980). A new pseudoguaianolide, dihydroparthenin has been isolated from the leaf, stem and petiole calli of *P. hysterophorus*. The calli have also been found to contain tetraeneurins A and D, hysterin, parthenin, coronopilin and ambrosin (Talwar & Kalsi, 1989).

AGROTECHNOLOGY AND OTHER NON-PHARMACEUTICAL ASPECTS

Herbicidal activity of parthenin has been evaluated on *Ageratum conyzoides* (billgoat weed) grown under in vitro conditions. The germination of *A. conyzoides* is retarded suggesting that parthenin might find use as an herbicide (Batish et al, 1997). It is reported that parthenin hinders the growth of *A. conyzoides* by altering the contents of some macromolecules and the specific activities of some enzymes (Singh et al, 2002).

Parthenium extract exhibits significant antiviral action against potato virus Y. This virus extensively damages the chilli crops. Parthenin might find use as an effective agent against potato virus Y (Anonymous, 2003).

The aqueous extracts of shoots have been evaluated for antifungal activity against three fungi viz., *Drechslera tetramera*, *Aspergillus niger* and *Phoma glomerata*. Lower concentrations (10, 20 and 30% extract) exhibit antifungal activity whereas higher concentrations are devoid of any such activity. Hence, the lower concentrations of extracts might find use as antifungal agent (Bajwa & Khalid, 2003).

The cold and hot water leaf extracts have been evaluated against *Pythium aphanidermatum* wherein they show 50.5% and 48.3% inhibition respectively (Anonymous, 2003).

The germination of freshly harvested seeds can be effected by the exposure time of light. There is an increase in germination rate from 8% in the dark to 68% in light. It indicates that light plays a major role in growth of plant from seeds (Pandey & Palni, 2005).

Gall induction by *Epiblema strenuana* results in a range of morphological and physiological changes in *Parthenium*. These effects have been evaluated in the rosette (young), pre-flowering (mature), and flowering (old) stages. Gall induction reduces the leaf-water potential, especially in flowering stage plants. In young and mature stage plants, galling reduces photosynthetic rates considerably. It means that *E. strenuana* has the potential to regulate *P.*

hysterophorus (Florentine et al, (2005). *Epiblema strenuana* Walker (Lepidoptera: Tortricidae) induced stem galls of *Parthenium hysterophorus* result in the stress metabolism in plant, implying that *E. strenuana* may find use as biological control agent. (Raman et al, 2006)

Parthenium hysterophorus L can be affected by cell-free culture filtrate of *Phoma herbarum* FGCC 75. *P. herbarum* shoot, detached leaf and seedling contain 3-nitrophthalic acid which acts as a phytotoxin against *P. hysterophorus*. This constituent has a potential to be developed as a chemical control tool for this weed (Vikrant et al, 2006).

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