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Phyto-Chemistry of Congress grass (*Parthenium hysterophorus* L.) and Harmful and Beneficial effect on Human and Animals: A review

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Abstract
Parthenium hysterophorus commonly known as congers grass is a noxious weed belonging to Asteraceae family. It is native to the area surrounding the Gulf of Mexico, Central America, Southern North America, West Indies and Central South America. At present congress grass has become one of the world's seven most devastating and hazardous weeds. In India also this invasive weed is a big problem. It causes various ailments and allergies in humans as well as animals. Besides this there are some potential of this weed as insecticidal, herbicidal, fungicidal, wood preservative, anti-amoebic and also as therapeutic purpose. To assess the potential of any species especially an obnoxious weed for the welfare living beings, a complete knowledge on its beneficial as well as harmful effects are required. Therefore, this review article is an effort to document the current knowledge on harmful as well as beneficial impact of *Parthenium hysterophorus* on humans as well as animals.

Keywords: Congress grass, *Parthenium hysterophorus*, Beneficial effect

1. Introduction

The word Parthenium is derived from the Latin parthenice suggesting medicinal uses (Bailey 1960) [5]. Parthenium hysterophorus is an aggressive ubiquitous annual herbaceous weed belonging to the family Asteraceae with no economic importance unravelled till now. This erect, ephemeral herb known for its vigorous growth and high fecundity especially in warmer climates is a native of north-east Mexico and is endemic in America. It is commonly known as 'altamisa', carrot grass, bitter weed, star weed, white top, wild feverfew, the ''Scourge of India'' and congress grass. Parthenium hysterophorus is a prolific weed, producing thousands of small white capitula each yielding five seeds on maturity. It is native to the area surrounding the Gulf of Mexico, Central America, southern North America, West Indies and Central South America and now it naturalized in Australia, Bangladesh, Ethiopia, India, Kenya, Madagascar, Nepal, New Caledonia, Pakistan, Papua New Guinea, Puerto Rico, South Africa, Sri Lanka, Swaziland, Taiwan, Vietnam and the United States and is one of the world's seven most devastating and hazardous weeds. This noxious weed is often spotted on abandoned lands, developing residential colonies around the towns, railway tracks, roads, drainage and irrigation canals, etc. This weed grows luxuriantly in established gardens, plantations and vegetable crops. Due to its high fecundity a single plant can produce 10,000 to 15,000 viable seeds which can disperse and invade large areas. This alien weed is believed to have been introduced in India as a contaminant in PL 480 wheat (Public Law 480 passed in 1954 to give food grains to developing countries for eliminating starvation and malnutrition) imported from the USA in the 1950's. Presently, this invasive weed is widely prevalent in India (Singh, *et al*. 2008) [36]. Approximately two million hectares of land in India have been infested with this herbaceous menace (Dwivedi, *et al*. 2009) [13]. Looking at the multitude of harms caused by P. hysterophorus, its management is necessary to prevent future problems.

The major health hazards caused due to direct contact with plant or plant parts, living or dead, results in dermatitis in mankind. The presence of pollens in the air cause diseases like air borne contact dermatitis (Agarwal and D'Souja, 2009) [2], fever and asthma (Lonkar *et al*., 1974, Subba Rao *et al*., 1976) [23, 37]. Live stock is also allergic and susceptible to P. hysterophorus. Close contact of animal with P. hysterophorus may cause rashes on their whole body and udders. Since P. hysterophorus grows luxuriantly in many parts of the world,

it is important to explore its beneficial uses if any. The purpose of this review article is to document existing information on this obnoxious weed in terms of its potential benefit is vis a vis the harmful aspects

2. Chemical constituents of *P. hysterophorus*

Isolation and structural elucidation principles of is required to determine their chemical properties *P. hysterophorus*. Chemical analysis of *P. hysterophorus* has indicated that all its parts including trichomes and pollen contain toxins called sesquiterpene lactones (SQL). Maishi *et al.* (1998) [24] reported that *P. hysterophorus* contains a bitter glycoside parthenin, a major sesquiterpene lactone. Other phytotoxic compounds or allelochemicals are hysterin, ambrosin, flavonoids such as quercelagetin 3,7-dimethylether, 6-hydroxyl kaempferol 3-0 arabinoglucoside, fumaric acid. P-hydroxy benzoin and vanillic acid, caffeic acid, p courmaric, anisic acid, p-anisic acid, chlorogenic acid, ferulic acid, sitosterol and some unidentified alcohols. Parthenin, hymenin and ambrosin are found to be the culprits behind the menacing role of this weed in provoking health hazards (Lata *et al.* 2008) [22]. *P. hysterophorus* from different geographical regions exhibited parthenin, hymenin, coronopilin, dihydroisoparthenin, hysterin, hysterophorin and tetraneurin. A as the principal constituents of their sesquiterpene lactones (De La Fuente *et al.*1997) [10]. Gupta *et al.* (1996) identified a novel hydroxyproline-rich glycoprotein as the major allergen in *P. hysterophorus* pollen. Das *et al*. (2007) [9] examined the flowers of *P. hysterophorus* and isolated four acetylated pseudoguaianolides along with several known constituents. A novel sesquiterpenoid, charminarone, the first secopseudoguaianolide, has been isolated along with several known compounds from the whole plant by Venkataiah *et al.* (2003) [40]. Chhabra *et al.* (1999) [8] discovered three ambrosanolides from the chloroform extract of this weed.

Table 1: Chemical constituents of *P. hysterophorus*

Main groups	Constituents	References
Terpenoids	Sesquiterpene lactones: germacranolides (including parthenolide, artemorin and chrysanthemonin) guaianolides (including chrysartemin A, partholide and chrysanthemolide) and eudesmanolides (including santamarin, reynosin and magnolialide), parthenin, cornopolin, artecanin, balchanin, costunolide, epoxyartemorin.	(Parsons and Cuthbertson, 2001; Pareek *et al.,* 2011)
	α-unsaturated γ-lactones: 3-β-hydroxy- parthenolide, costunolide, 3-β- hydroxycostunolide, 8-α-hydroxyestafiatin, artecanin, two chlorinecontaining sesquiterpene lactones, 1-β-hydroxyarbusculin and 5-β-hydroxyreynosin.	(Barnes *et al.,* 2007)
Volatile oils (0.02 0.07%)	Various monoterpene and sesquiterpene components (e.g. camphor (56.9%), camphene (12.7%), p-cymene (5.2%), bornyl acetate (4.6%), tricylene, α-thujene, α-pinene, β-pinene, α-phellandrene, α-terpinene, γ-terpinene, chrysantheone, pinocarvone, borneol, terpinen-4-ol, ρ-cymen-8- ol, α-terpineol, myrtenal, carvacrol, eugenol, trans-myrtenol acetate, isobornyl 2-methyl butanoate, caryophyllene oxide, germacrene, farnesene and their esters).	(Barnes et al., 2007; Pareek *et al.,* 2011)
Amino acids	Rich in Glycine and proline and moderate amount with alanine and lysine	(Gupta *et al.,* 1996)
Amino sugars.	N-acetylgalactosamine and N-acetylglucosamine	(Gupta *et al.,* 1996)
Phenolic derivatives	Caffeic, vanllic, ferfulic, chlorogenic and anisic acids.	(Parsons and Cuthbertson, 2001)
Flavonoids	Luteolin, apigenin, 6-hydroxykaempferol 3,6 dimethyl ether, 6- hydroxykaempferol 3,6,4′-trimethyl ether (tanetin), quercetagetin 3,6- dimethyl ether, quercetagetin 3,6,3′-trimethyl ether (accompanied by isomeric 3,6,4′-trimethyl ether), quercetin, chrysoeriol, santin, jaceidin and centaureidin.	(Pareek *et al.,* 2011)
Others	8-*β*-Acetoxyhysterone C, Charminarone, 8*α*-Epoxymethylacrylyloxyambrosin, 8*α* Epoxymethylacrylyloxy-11, 13-dihydroparthenin, 8*α* Epoxymethylacrylyloxyparthenin, 2*β*-Hydroxycoronopilin, Hysterone (A, B, C, D), 1*α*, 2*β*, 4*β*-Trihydroxypseudoguaian-6*β*, 12-olide, Pyrethrin, tannins (type unspecified), melatonin, potassium chloride, protein.	(Parsons and Cuthbertson, 2001; Barnes *et al.,* 2007; Zhou *et al.,* 2011a,

3. Habit of *P. hysterophorus*

It is an annual herb, erect, up to 2 m in height; the stem is branched and covered with trichomes. Leaves are pale green, lobed, hairy, initially forming a basal rosette of strongly dissected leaves that are up to 30 cm in length, close to the soil, alternate, sessile, irregularly dissected and bipinnate, having small hairs on both the sides, resembling the leaves of carrot. The number of leaves per plant ranges from 6 to 55. Its flower head color is creamy white, about 4 mm across, arising from the leaf fork and flower comes after one month of germination. The fruit is cypsella. Each flower contains five seeds, which are wedge-shaped, black, 2 mm long with thin white scales. A large single plant produces up to 100,000 seeds in its lifecycle. Seeds do not have a dormancy period and are capable of germinating anytime when moisture is available. The highest germination rates are at temperatures ranging from 12º to o 27º C. Congress grass seeds dispersal mainly through water currents, animals and the movement of vehicles, machinery, livestock, grain, stock feed and other produce, and to a lesser extent by the wind. Persistence tests demonstrated that more than 70% of parthenium seeds buried at 5 cm below the soil surface survived for at least 2 years, whereas seeds on the soil surface did not survive for longer than 6 months. Seed viability for 20 years has also been reported.

4. Threat and damage

Infestation by Parthenium degrades natural ecosystems. It aggressively colonizes disturbed sites and reduces pasture growth and depresses forage production. Its pollen inhibit fruit set in many crops. The germination and growth of indigenous plants are inhibited by its allelopathic nature. In man, the pollen grains, air borne pieces of dried plant materials and roots of parthenium can cause allergy-type

responses like hay fever, photodermatitis, asthma, skin rashes, peeling skin, puffy eyes, excessive water loss, swelling and itching of mouth and nose, constant cough, running nose and eczema. In animals, the plant can cause anorexia, pruritus, alopecia, dermatitis and diarrhea. Parthenium can taint sheep meat and make diary milk unpalatable due to its irritating odour. In India, an extensive outbreak of weed dermatitis caused by Parthenium allergy involving around 1,000 patients and including some deaths has been reported.

5. Harmful effects of *P. hysterophorus*

A. Biodiversity loss due to the *P. hysterophorus*

The invasive capacity and alleolopathic properties have rendered *P. hysterophorus* with the potential to disrupt the natural ecosystems. Very sparse or sometimes no other vegetation can be seen in *P. hysterophorus* dominated areas. It has been reported to be causing a total habitat change in native Australian grasslands, open woodlands, river banks and flood plains (Lakshmi and Srinivas 2007). These weeds rapidly invade new surroundings often replace the indigenous species and pose a serious threat to biodiversity in India. Akter and Zuberi (2009) conducted an extensive survey on invasive alien species (IAS) and their impact on different land use types viz. road side, low land, fallow land, homestead and railway track in Bangladesh. Among others, P. *hysterophorus* exhibited the ability to invade and adapt to new habitats, thereby reducing the number of indigenous plants. The more vigorous mode of reproduction and the possession of an array of secondary metabolites give the weed the status of invasive alien species.

B. Effects on Crops.

Parthenium plant contains chemicals, like parthenin, hysterin, hymenin, and ambrosin, and due to the presence of these chemicals, the weed exerts strong allelopathic effects on different crops. Parthenin has been reported as a germination and radical growth inhibitor in a variety of dicot and monocot plants (Gunaseelan, 1998). The weed affects nodulation in legumes due to inhibition of activity of nitrogen fixing and nitrifying bacteria, namely, *Rhizobium, Actinomycetes, Azotobacter,* and *Azospirillum.* Parthenium produces enormous numbers of pollens (on an average 624 million/plant), which are carried away at least to short distance in clusters of 600–800 grains, and settles on the vegetative and floral parts, including stigmatic surface, inhibiting fruit setting in crops like tomato, brinjal, beans, capsicum, and maize. In India, *P. hysterophorus* causes a yield decline of up to 40% in agricultural crops, (Khosla and Sobti 1981). The weed also acts as a collateral host for many diseases caused by viruses in crop plants.

C. Effects on Animals

Ethiopia is currently the worst affected country in the region. *P. hysterophorus* is currently considered to be the most important weed both in croplands and grazing areas by 90% of farmers in the lowlands of Ethiopia (Tamado and Millberg 2000) with sorghum yields being reduced by 97% in experimental fields with high densities of *P. hysterophorus* (Tamado *et al*. 2002). The impact of this species has also been well documented in Australia and India (Evans, 1997) where studies have revealed that P. *hysterophorus* is allelopathic and that infestations reduce crop yields and that the weed displaces palatable species in natural and improved pasture (Channappagoudar *et al.* 1990). In terms of animal husbandry it has also been reported that this noxious weed can reduce pasture carrying capacities by as much as 90% (Jayachandra 1971).

Parthenium weed is toxic to the animals which causes dermatitis, skin lesions and mouth ulcers in various animals like horses and cattle's. If an excessive amount (10–50%) of this weed is used in diet may cause harmful effects to the cattle (Narasimhan *et.al.,* 1977). Beside this it also causes anorexia, pruritus, alopecia, diarrhea and eye irritation to the dogs. The extract of parthenium also shows a significant reduction in WBC counts which weaks the immune system of the rats (Yadav *et. al*., 2010.)

D. Effects on Human Beings.

The common allergens found in this weed are parthenin, coronopilin, tetraneuris, and ambrosin which cause various allergies like contact dermatitis, hay fever, asthma, and bronchitis in human beings (Wiesner *et.al,*. 2007).

6. Clinically the parthenium dermatitis is of five types, as discussed below.

1. The classical pattern also known as airborne contact dermatitis and affects the face, especially eyelids and/or neck, V of chest, cubital, and popliteal fossae.
2. The chronic actinic dermatitis (CAD) pattern involves the exposed areas such as forehead, rim of ears, cheeks, nape of neck, dorsae of forearms, and hands as lichenified papules, plaques, or papulonodules with relative sparing of nonsun exposed areas such as eyelids, retroauricular areas and undersurface of chin and depth of the skin folds.
3. The mixed pattern (combination of classical and chronic actinic dermatitis pattern) manifests as scattered infiltrated scaly papules over the exposed parts and dermatitis over eyelids, flexures of extremities and neck.
4. The photosensitive lichenoid eruption pattern presents with pruritic, discrete, flat, violaceous papules, and plaques over sun-exposed parts such as forehead, ears, cheek, upper chest, and back, extensor aspect of forearms and dorsae of hands stimulating photosensitive lichenoid eruptions.
5. The prurigo nodularis like pattern presents as multiple hyperkeratotic papules and nodules over extremity with characteristic histopathologicm features similar to prurigo nodularis. (Aneja, 1991 and Sharma *et.al.,* 2013).

7. Beneficial uses of *P. hysterophorus*

A. *P. hysterophorus* used as a Traditional Medicinal plant

It is believed that it has been migrated accidentally from USA to India in mid 1950's, and is now considered as an obnoxious weed in our country. (Rao 1956). The adverse effects of this weed have been well documented with regard to health of human being and animals. It causes serious effects like asthma, bronchits, dermatitis, and hay fever in men and livestocks. Despite this problem it has also been used in industry for its noxious, insecticidal, nematicidal and herbicidal properties (Sastri and Kavathekar 1990). Besides this it is also use for composting.

The decoction of root is used in curing of amoebic dysentery. The sub-lethal doses of parthenin extract help in reducing cancerous activity in the cell of mice. It is also reported as promising remedy against hepatic amoebiasis (Sharma and Bhutani, 1988) and used in pharmacologically active against neuralgia and certain types of rheumatism. In the Caribbean and Central America, it is applied externally on skin disorders

and a decoction of the plant is often taken internally as a remedy for a wide variety of ailments. In Jamaica, the decoction is used as a flea repellent both for dogs and other animals. The toxic chemical recovered by Parthenium i.e. Parthenin damage to human leucocyte chromosomes and form polychromatic erythrocytes in mice (Dominguez and Sierra, 1970).

B. Herbicidal

Pure parthenin as well as extract of different parts of *P. hysterophorus* show phytotoxic effects on many aquatic (Pandey, 1996) as well as terrestrial weeds (Khosla *et al*., 1980; Kumari, 1990; Acharya and Rahman, 1997). The sesquiterpene lactone parthenin has received most attention regarding allelopathy or potential herbicidal properties of the plant (Duke *et al*., 2007).

C. Antifungal:

Antifungal potential of different extracts of *P. hysterophorus* against human pathogenic fungi were investigated by Rai and Upadhyay (1990) and Rai (1995). The dermatophytes and other fungal pathogens have been found to be sensitive to sesquiterpene lactones which are present as active agent in Asteraceous plant *P. hysterophorus* (Rai *et al*., 2003).

D. Antiamoebic 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 metronidazol (Sharma and Bhutani, 1988).

8. Conclusion

P. hysterophorus is a great source of terpenoids, volatile oils and flavonoids as well as amino acid, sugars and phenolic derivatives, Caffeic acid, Vanillic acid, Anisic acid, Panisic acid, Chlorogenic acid and parahydroxy benzoic acidare. Parthenolide (the major sesquiterpene lactone), parthenin and different solvent extracts showed significant analgesic, anti-inflammatory and antipyretic activities. Its extracts and constituents showed both beneficial and harmful effects on human and animal such as anticancer, pesticidal, antimicrobial, allelopathic, allergic, lervicidal, ovicidal, herbicidal etc. However, as *P. hysterophorus* is a toxic plant, further scientific researches and investigations are essential to establish it as a standard medicinal plant.

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