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Review Article

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Xanthium strumerium L.: An Ethnomedicinal and Phytochemical Review

Showkat A. Ganie[1], Surender S. Gulia[1], Surender S. Yadav[1]*

***Corresponding author:**

S. Yadav

[1]Department of Botany, Maharshi Dayanand University, Rohtak, Haryana (India)

Abstract

Xanthium strumerium L. (Asteraceae), commonly known as "Cocklebur" is an annual herb of wastelands found in North America, Brazil, China, Malaysia and India. It has been traditionally used for its cooling, fattening, anthelmintic, digestive, and antipyretic activities. Different plant parts are predominantly used for curing malarial fever, asthma, rheumatism, leprosy, migraine, small pox and cancer. Leaves of the plant are used for the treatment of eczema, roots against high fever and fruits to treat conjunctivitis. It is also used to cure leucoderma, epilepsy, salivation, congestive heart diseases, nephritis, toxemia of pregnancy, hypertension, premenstrual tension and poisonous bites of insects. Seeds yields edible oil which is used in bladder infection. Based on ethnobotanical information it is found that plants used in folk medicine are rich in bioactive molecules. The review reveals that phytochemical constituents of wide variety have been isolated. Phytoconstituents like anthraquinone, cardenolide, leucoanthocyanin, simple phenolics (catechol) and triterpenoids were reported. Many phytocompounds like caffeic acid, isoxanthanol, xanthanol, xanthiazone, xanthanin, xanthatin etc. were isolated from the plant and proven to be biologically active. The need for review of the plant species was predominantly to answer the gaps between ethnomedicinal uses and phytochemical studies. Hence, the present review article explores the ethnomedicinal uses and phytochemistry of *X. strumerium,* which upon further research could lead to development of viable drugs for the treatment of variety of ailments. However, there is further need for toxicity and clinical trials on crude extract and isolated phytoconstituents which will help to commercialize.

Keywords: Ethnomedicine, Ethnobotany, Phytochemistry, Toxicity, Xanthium strumerium.

Introduction

Plants have been used in traditional medicine since the dawn of civilization. Particular medicinal plants must have been selected after countless treatments of hits and trials. Beneficial species were used as medicines where as non-beneficial plant species must have been discarded. The knowledge of medicinal plants has been accumulated in course of long time based on different medicinal systems *viz.* Ayurveda, Homeopathy and Unani. Documentation of traditional knowledge through ethnobotanical studies is important for conservation and utilization of biological resources. It is believed that there are about 250000 to 500000 plant species to exist in the world considering flowering and non- flowering plants, out of which approximately 50,000 plants are used in traditional medicine in one or other form. So, there is large scope for the exploration of new ethnomedicinal plant species throughout the globe. In India it is found that traditional healer's uses nearly 2500 species of plants and about 100 species are used as a regular source of medicine [1]. *Xanthium strumerium* L. is one of the medicinally important plants species. It is a common weed found in India and is called as chhota gokhru in Hindi. In many parts of India, the plant species is popularly known by "Adhasisi", as it is used in the treatment of disease "hemicrania". It is a major source of phytochemicals which are used in preparation of many herbal formulations. About 25 species of genus *Xanthium* have been recognized primarily on the basis of bur morphology [2]. The *X. spinosum* L. and *X. strumarium* L. are used medicinally in Europe, North America and Brazil. *X. canadens* is used in North America and Brazil and *X. strumarium* L. in India, China and Malaysia [3]. Only two species of *Xanthium* including *X. strumarium* and *X. indicum* are reported in India.

Botany

Distribution

The plant distribution extends from latitude 53ºN to 33ºS [4]. It is mostly found in temperate zone but also in subtropical and Mediterranean climate [4]. The species is widely distributed with an effective dispersal mechanism and high ecological amplitude. It is mainly distributed in North America, Brazil, China, Malaysia and India. The altitudinal and latitudinal limits of its distribution are determined by the interaction between climate and photoperiod [5]. In India, it is mainly found as a weed plant, especially in hotter parts of the country. It is widely distributed in Haryana along roadside, railway embankments, field edges, within cultivated fields, particularly in degraded places.

Taxonomic Status

Kingdom	:	Plantae
Divison	:	Magnoliphyta
Class	:	Magnoliopsida
Order	:	Asterales
Family	:	Asteraceae
Genus	:	*Xanthium*
Species	:	*strumerium*

Vernacular Names

Common	:	Cocklebur
Hindi	:	Chhota- gokhru
Sanskrit	:	Arishta
Gujrati	:	Godrian
Telugu	:	Marula-matangi
Marathi	:	Ghagara

Plant description

Xanthium strumerium is an annual herb which is 20-150 cm tall with a tap root system. Stem is erect, ridged, rough-hairy, usually branched with purple spots. The cotyledon of the plant is 6.0-7.5 mm long, narrow and often persisting on older plants. Leaves of the plant are simple, sometime they are opposite at lowest node but alternate above, margin of the leaves are toothed, both surfaces rough, petiole is as long as blades. Flowers are small, unisexual and green in colour. Flowering occurs during August-September and seed mature from August to October. Fruits are hard and woody, ovoid- globose and covered with spines and it ends with two stout. It also bears two achenes and fruit becomes brown in colour after maturity. Propagation occurs through seeds.

Scope of Review

The need for review of the plant species was predominantly to answer the gaps between ethnomedicinal uses and phytochemical studies. Previous review reported by Kamboj and Saluja [6] was directed mainly at pharmacology. Hence an attempt was made to provide the complete information on ethnomedicinal uses, phytochemistry and toxicity of the species, so that it would aid for future research on this species by phytochemists, pharmacologists, clinicians, scientists, researchers and toxicologists etc. The present review highlights the ethnomedicinal uses (Table 1), qualitative phytochemistry (Table 2), phytochemicals isolated from various parts of the plant (Figure. 1a-g) and toxicological studies on various parts of the plant to provide comprehensive idea to the readers on the plant.

The information provided is from different search engines like worldwide accepted scientific database [(Scopus (http://www.scopus.com), Pubmed (http://www.ncbi.nlm.nih.gov/pubmed), Science Direct (http://www.sciencedirect.com), Springerlink (http://www.springer.co.in), Google Scholar (scholar.google.co.in) and Wiley (http://www.onlinelibrary.wiley.com)], thesis, recognized books, abstracts, conference proceedings and non-impact and non-indexed journals.

Ethnomedicinal Uses

Xanthium strumerium is one of the plant species with potential medicinal properties. Different parts of the plant are used to cure many serious human ailments (Table-1). It is a source of useful drugs exploiting the anti-cancer, immunomodulation, anti-infection, anti-hepatotoxicity, anti-arthrosclerosis, and anti diabetic activities [7]. It also possesses antibacterial [8], antiviral [9], antimalarial [10], fungicidal [11], and cytotoxic activities against cancer cell lines [12]. In Western herbalism it is used for treatment of yellow diarrhea, caused by various species of *Shigella* [13]. In traditional Chinese medicine, *X. strumarium* is used for sinusitis, headache, urticaria, emphysema. It has been used as a liniment to reduce the perspiration. It is also known for its ability to clear nasal and sinus congestion. The root of the plant has been used in treatment of high fevers, leucorrhoea and to help a woman expel afterbirth. The juice of the leaves and fruits has been useful for smallpox and paste of fruit for migraine treatment. Some other biological properties of *X. strumarium* L. have been reported, such as antiulcerogenic [14], antitrypanosomal [8], anthelmintic [15], anti-inflammatory [16,17], diuretic [18], antileishmanial, antifungal [19] and hypoglycemic actions [20]. Besides these parts, roots have anticancer properties and cause inhibition of cultured human tumor cell proliferation [21] and a significant depressant action on the central nervous system [22]. The whole plant is known to possess diaphoretic, sedative and diuretic properties.

Table 1: Ethnomedicinal profile of *Xanthium strumerium* L.

S. No.	Plant part used	Ethnomedicinal uses	References
1.	Roots	Malarial fever, leucorrhoea, cough and asthma	[10, 23, 24]
2.	Stem	Vomiting and diarrhea	[24]
3.	Leaves	Eczema, mouth sores, pyorrhea and fever	[24-26]
4.	Fruits	Allergic rhinitis, sinusitis, rheumatism, rheumatoid arthritis, constipation, diarrhoea, leprosy and pruritis	[27]
5.	Seeds	Bladder infection, herpes and Erysipelas	[2]
6.	Whole plant	Epilepsy	[28]
7.	Whole plant	Migraine, small pox, cancer	[29]

Phytochemistry

Xanthium strumarium, is the unique source of various types of compounds having diverse chemical composition. The plant species contains wide range of phytochemicals such as steroids, alkaloids, terpenoids, triterpenoids, saponins, tannins, flavonoids, proteins and sugars [30-33]. The qualitative phytochemical screening of *X. strumarium* is presented in Table 2.

Many compounds were isolated from the plant and proven to be biologically active. Whole plant was found to contain anthraquinone, cardenolide, leucoanthocyanin, simple phenolics (catechol) and triterpenoids. Free amino acids *viz.* glutamic acid, alanyl glycine, threonine, Dl alanine, argenine mono hydrochloride, proline, valine, isoleucine and methionine were found to be present in the plant [34]. Leaves were found to contain alkaloids, anthraquinone, cardenolide, flavonoids (flavonol), leucoanthocyanin, simple phenolics (catechol) and triterpenoids. Amino acids like glutamic acid, tyrosine, alanyl glycine, glycine, glucosamine HCl, threonine, Dl alanine, argenine mono hydrochloride, proline, valine and isoleucine were found to be present in leaves. From ethyl acetate fraction and methanol extract of *X. strumarium* phenolic compounds *viz.* Caffeic acid (1a), Xanthiazone, and Xanthiazone-(2-O-caffeoyl)-b-D-glucopyranoside (1d) were isolated [2]. These compounds were identified by 1D- and 2D-NMR, Mass, UV and IR spectroscopy and chemical methods. Three new xanthanolides *viz.* xanthanol (1h), isoxanthanol (1c) and their C-4 epimers have been isolated from *X. strumerium* [35]. From fruit new thiazinedione was isolated and characterized by a combination of spectral methods [36]. Besides, the aerial parts of the plant contain sesquiterpene lactones [xanthinin (1e), xanthumin (1f), xanthatin (1g)], sulphated glycoside (xanthostrumarin, atractyloside, carboxyatractyloside), phytosterols [37, 38] and γ-tocopherols (1b) [39]. The active principles of the seeds are hydroquinone, choline and iodine [40]. The stem and leaf oil contain large amounts of monoterpenes and sesquiterpenes (d-limonene, d-carveol (-ionone, terpinolene, β-caryophyllene and *p*-cidymene) [41, 42].

Table 2: Qualitative phytochemical profile of *Xanthium strumerium*

Pt. Ether	-	+	+	+	-	+	+	+	+	**[7]**
Chloroform	+	-	+	-	+	-	-	+	+	
Methanol	+	-	+	+	+	+	+	+	-	
Distilled Water	+	-	-	-	+	+	+	+	+	[32]
Ethanol	+	-	+	-	+	+	-	-	+	**[31]**
Pt. Ether	+	+	-	-	+	+	-	-	+	**[30]**

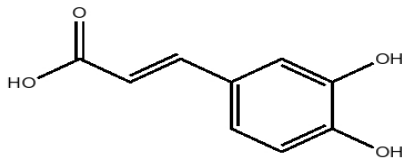

Fig. 1a: Caffeic Acid

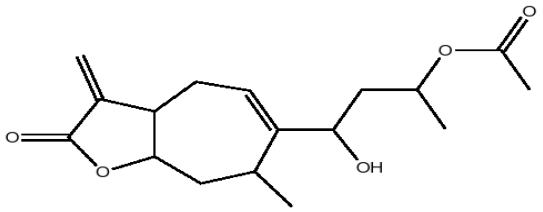

Fig. 1c: Isoxanthanol

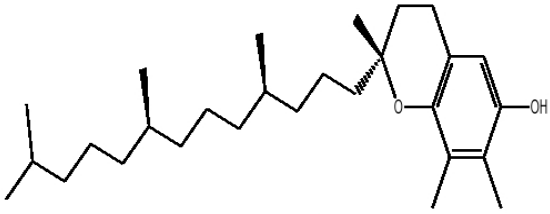

Fig.1b: Tocopherol

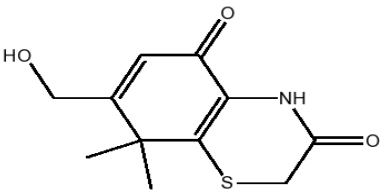

Fig. 1d: Xanthiazone

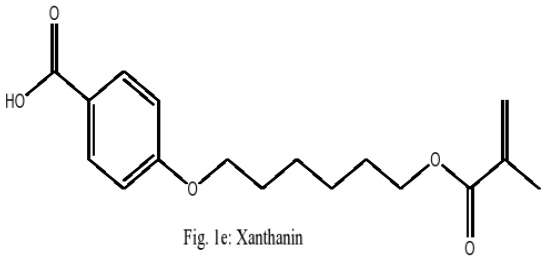

Fig. 1e: Xanthanin

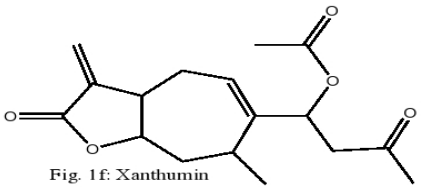

Fig. 1f: Xanthumin

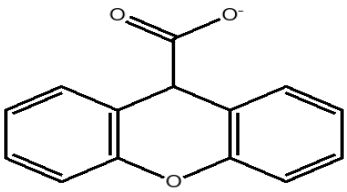

Fig. 1g: xanthatin

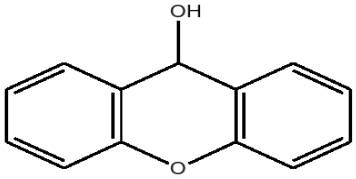

Fig. 1h:Xanthanol

Fig. 1a-1h: Phytocompounds isolated from different parts of *Xanthium strumerium*

Toxicity

Xanthium strumerium is a medicinally very important plant but it also has toxic effect on animals. Though, this plant is less toxic when mature, but its toxicity has been reported in cattle which have ingested mature plant with burs. It has been found that the seeds and seedling of the plant contain glycoside carboxy-atractyloside which can be poisonous to animals such as cattle, pigs and horses. It can cause dysfunctining in many organs and even death of animal if taken in large quantity. There is no antidote for it and supportive therapy is the mainstay of treatment [43]. There are some cases of *X. strumerium* poisoning reported in human beings. The adverse effect of plant is presented with acute onset abdominal pain, nausea and vomiting, drowsiness, palpitations, sweating and dyspnea. Some of them developed convulsions followed by loss of consciousness and also death [44]. The fruit of the plant used in Chinese herbal medicine, have the risk of high content of carboxyatractyloside in the spines [45-47]. When taken in sufficient quantity it can cause hypoglycemia and hepatic damage in animals. The mechanism of action has been proposed

to be an uncoupling of oxidative phosphorylation which is very essential process for the production of energy and normal metabolic process of a cell. Pollen grains of the plant are reported with allergic components which can cause contact dermatitis [46, 48, 49]

Conclusion

It is evident from the available literature that *Xanthium strumerium* root and fruits are the most widely used parts of the plant. Different parts of the plant species are predominantly used for curing malarial fever, asthma, rheumatism, leprosy, migraine, small pox and cancer. Anthraquinone, cardenolide, leucoanthocyanin, simple phenolics and triterpenoids are the dominant phytoconstituents of the plant. In parallel to above observations pure compounds such as caffeic acid, isoxanthanol, xanthanol, xanthiazone, xanthanin, xanthatin etc. were isolated and proven to be biologically active. Since the plant validates almost all the traditional uses, clinical trials and formulation development could be taken as future directions along with the mechanistic approach for these studies. Factors such as geographical and seasonal variation play an important role in the authentication of the chemical constituents responsible for the bioactivity can be an area of interest. An extensive research and development work should be under taken on *X. strumerium* and its products for their better economic and therapeutic utilization.

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Author contribution

SAG have collected information from different sources, prepared, designed, analyzed and interpretated the data, SSG collected data on ethnomedicinal uses and contributed in formatting and editing the manuscript, SSY have been involved in drafting the manuscript critically for important intellectual content and have given final approval of the version to be published.

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