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PHYTOCHEMICAL COMPOSITIONS AND PHARMACEUTICAL IMPORTANCE OF XANTHIUM STRUMARIUM L

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Abstract
Xanthium strumarium L., belongs to family Asteraceae, is rich source of phytoconstituents which are being used for treatment of various life-threatening diseases. About 25 species of the plant have been recognized based on their morphology. Only two species of Xanthium including Xanthium strumarium and Xanthium indicum are reported in India that has been explored for phytochemically, and pharmacologically. Xanthium strumarium L. is the unique source of many biologically and pharmacologically important phytochemicals. Major Phytochemicals of Xanthium are steroids, alkaloids, terpenoids, saponins, tannins, flavonoids, proteins. Despite many medicinal uses, Xanthium strumarium causes many side effects like vomiting, abdominal pain, depression, paddling convulsions and even death in animals also. Induction of hepatotoxicity in human has also been reported. Pharmacological studies have generally confirmed the traditional use of extract of whole plant, root, leaves and fruits as an ailment for leukoderma, poisonous bites of insects, epilepsy, salivation, long standing cases of "malaria, rheumatism, tuberculosis, allergic rhinitis, Sinusitis, urticarial, rheumatoid arthritis, constipation, diarrhea, leprosy, lumbago, pruritus, and infections due to bacteria and fungus".

Keywords: Asteraceae, Pharmacology, Phytochemicals, Xanthium strumarium.

1. Introduction

Xanthium strumarium L., belongs to family Asteraceae, is a cocklebur or burweed which can be commonly found throughout the tropical parts of India during the month of September to November. Its common name is 'Chhota gokhru' because the shape of its fruit looks like cow's toe. It is also known as 'Aadhasisi' as this weed is used for the treatment of hemicranias. The plant is a significant source of phytochemicals, which are utilised to cure a variety of fatal diseases. Based on their morphology, about 25 species of the plant have been identified. In Europe, North America, and Brazil, *Xanthium strumarium* L. and *Xanthium spinosum* L. are used medicinally. In North America and Brazil, Xanthium canadens is utilised, while *Xanthium strumarium* is used in India, China, and Malaysia. Only two species of Xanthium, *Xanthium strumarium* and *Xanthium indicum*, have been studied from a phytochemical and pharmacological outlooks.

2. Taxonomical classification

Kingdom- Plantae
Phylum- Magnoliophyta
Class- Magnoliopsida
Order- Asterales
Family- Asteraceae
Genus- *Xanthium*
Species- *strumarium*
Scientific name-*Xanthium strumarium* L.

Vernacular names-Chota dhatura, Chota gokhuru, Ghaghra (Hindi), Shankeshwar (Marathi), Marul-Umattai (Telugu), Godrian (Gujrati), Arishta, Medhya (Sanskrit), Bhede kurro, Ghangharaa, Kaastolo, Kuch Kuche (Nepali).

3. Distribution

Worldwide: *X. strumarium* is distributed mainly in temperate zones. In countries like Australia, India, South Africa, and the America, it grow widely as weed (Love and Dansereau, 1959). India: Assam, Bihar, Odisha, Madhya Pradesh, Maharastra, Uttar Pradesh Rajasthan: Jodhpur, Bikaner, Jaisalmer, Barmer, Sikar, Naguar, Jhunjhunu, Churu, and Ganganagar (Negi *et al*., 2011).

4. Morphological features:

It is annual herb which grows upto 20-90 cm height. Stem is erect, branched, and hairy. Green, alternate, opposite, cauline leaves having 5-20 cm long and 4-16 cm wide petioles are present. Fruits are oval shaped having 2 chambered bur. These are 0.5 to 1.5 inch long and are covered with prickles.Flowers are small, unisexual, and green in color. Fruits are hard and woody, ovoid-globose and covered with spines and it ends with two stouts.

5. Phytochemical compositions.

Xanthium strumarium is the unique source of many biologically and pharmacologically important phytochemicals. Major Phytochemicals of Xanthium are steroids, alkaloids, terpenoids, saponins, tannins, flavonoids, proteins. Major phytochemicals which have been reported in *Xanthium strumarium* are- caffeic acids, xanthiazone, xanthiazone- (2-ocaffoyl)-b-D-glucopyranoside), xanthanol, isoxanthanol, tocophenol, chlorogenic caid, ferulic acid, 8-epixanthatin, 4-oxo-bedfordia, atractyloside etc. besides these, presence of many free amino acids viz. glutamic acid, alanyl-glycine, threonine, alanine, argino-mono hydrochloride, proline, valine, isoleucine, methionine have also been reported in the plant. Some important phytochemicals found in different parts (fruits, leaves, aerial parts, roots and whole plant) of *Xanthium strumarium* are summarized in table 1.

Tab.1: Important phytochemicals found in different parts of *Xanthium strumarium* L.

Name of plant parts	Bioactive compounds	Class of biological compounds	References
Fruits	Sibirolide A, sibirolide B, norxanthatolide A, norxanthantolide B, norxanthantolide C, norxanthantolide D	Sesquiterpenoids	Shi *et al*., 2015
	1,5-di-O-caffeolyquinic acid, 3,4-caffeoylquinic acid methyl ester, 3,5-di-caffeoylquinic acid methyl ester, 4-O-caffeoyl quinic acid methyl ester, xanthiumnolic A, xanthiumnolic C, icariside D1, methylchlorogenate, caffeic acid ethyl ester	Phenylpropenoids	Hwang *et al*., 2016, Han *et al*., 2006, Tian *et al*., 2013, Yuan, 2014, Cheng *et al*., 2011,

			Kan *et al*., 2011, Jiang *et al*., 2017, Jiang *et al*., 2013, Jiang, 2017, pandey and Rather, 2012, Qiu *et al*., 2010 , Shi *et al*., 2015
	Laptolepisol D, dihydrodehydroliconiferyl alcohol, chushizisin E, similanol, diospyrosin, balanophoni A, fructusol A, syringaresinol	Lignanoids	Kan *et al*., 2011, Yin *et al*., 2016, Jiang *et al*., 2018
	Daucosterol, beta-sitosterol	Steroids	Kan *et al*., 2011
	Ononin, quercetin, allopatuletin, patuletin-3-glucuronide	flavonoids	Huang *et al*., 2016, Yuan, 2014
Leaves	Xanthinin, xanthumin, xanthinol, isixanthanol, xanthatin, tomentosin, desacetylxanthanol	sesquiterpenoids	Winters *et al*., 1969, McMillan *et al*., 1975, Karmakar *et al*., 2015
	Alpha-amyrin,	Triterpenoids	Kaur *et al*., 2015
	Beta-sitoserol, 14-methyl-12,13-dehydro-sitosterol-heptadeconate	steroids	Kaur *et al*., 2015, Kan *et al*., 2011
Aerial part	1beta-hydroxy-5 alpha-chloro-8-epi-xanthatin, 11 alpha,13-dihydro-8 epi-xanthatin, 4-epi-xanthanol, inusoniolide, pungiolide A	Sesquiterpenoids	Han *et al*., 2008, Mahmoud, 1998, Chen *et al*., 2013, Wang *et al*., 2013
	Lup-20(29)-en-3 beta-ol, lupenyl acetate, lupeol acetate, beta-amyrin, oleanolic acid	Triterpenoids	Cui, 2013, Wahab *et*

			al., 2012, Li and Zhang, 2016, Sultana, 2014
	Stigmasterol, beta-sitosterol-3-O-beta-D-glucopyranoside	Steroids	Ingawale *et al*., 2012, Sultana, 2014
Roots	Betulinic acid, botulin, erythrodiol	Triterpenoids	Ingawale *et al*., 2018
	N-trans-feruloyl tyramine, 9,9'-o-di-(E)-feruloyl-(-)-secoisolariciresinol	Phenylpropenoids	Kan *et al*., 2011
	Syringaresinol, 4-oxopinoresinol	Lignanoids	Ingawale *et al*., 2018, Kan *et al*., 2011
	Jatrocin B, cleomiscosin A, cleomiscosin C, Scopoletin	Coumarins	Kan *et al*., 2011
	Stigma-4-en-beta-ol-3-one, beta-sitostenone, beta- daucosterol, beta-stigmasterol, 7-ketositosterol	Steroids	Kan *et al*., 2011, Ingawale *et al*., 2018
	5-hydroxy-3,6-dimethoxy-7-methyl-1,4-naphthalenedione, 5-methyluracil, uracil	Anthraquinones and naphthoquinones	Kan *et al*., 2011, Ingawale *et al*., 2018
Whole plant	Lupeol acetate	Triterpenoids	Li and Zhang, 2016
	Isovanillic acid, xanthiazone-(2-O-caffeoyl)-beta-D-glucopyranoside	Phenylpropenoids	Li and Zhang, 2016, pandey and Rather, 2012
	Ergosterol, taraxasteryl acetate	Steroids	Li and Zhang, 2016

6. Medicinal properties of the plant

Due to presence of various important phytochemicals, parts of *Xanthium strumarium* are being used for various medicinal purposes. Many researchers have shown that various plant parts have important pharmacological activities which are summarized in Table 2.

6.1. **Larvicidal activity**

It has been reported that seed extracts in methanol of *Xanthium strumarium* show larvicidal activity against *Aedes caspius* and *Culex pipiens* with LD_{50} value of 531.07 µg/ml against 4th instart larvae of *Aedes caspius* and 502.32µg/ml for 4th instarlarvae of *Culex pipiens* (Fahd A. *et.al.*, 2017).

6.2. **Anti-microbial activity**

Xanthine was presentin lower concentration in *Xanthium strumarium* essential oil. This phytocompound was isolated from extract of *Xanthium spinosum* L. and was found to be active against *Colltotrichum*, *T. reseum*, *B. cereus* and *S. aureus* (Ginestaa-Peris *et al*., 1994). A study showed the effectiveness of cinnamic acid against *E. coli*, *P.aeruginosa*, *S.aureus* and Salmonella sp. and MIC values were found to be 1.0 mg /ml for all the bacterial strains (Chang *et al.*, 2001). Cinnamic acid was present in *Xanthium strumarium* extracts at the range of 22- 80 mg/g dry extract (Scherer *et. al.*, 2008). So, the compounds xanthatin and cinnamic acid are responsible for the antimicrobial properties of *Xanthium strumarium*.

6.3. **Anti-oxidant activity**

In a study extracts of *Xanthium strumarium* plants were evaluated for their antioxidant and antiradical activities. IC_{50} values were found to be 0.02 mg/ml and 0.09 mg/ml for antioxidant and antiradical activities respectively. These both activities were found to be better than ascorbic acid and α-tocopherol. (Javad Sharifi Rad *et al.*, 2013).

6.4. **Anti-diabetic activity**

The dried leaves and stems of *Xanthium strumarium* L. were tested for anti-diabetic efficacy using alcoholic and water extracts. Using a 21-day streptozotozin-induced diabetes model (STZ), the anti-diabetic potency was examined. The rats with diabetes were overweight and had high levels of triglycerides, cholesterol, and blood sugar. The blood glucose level, cholesterol level, and triglyceride level could all be reduced by continuously giving animals alcoholic and water extracts orally for 21 days at doses of 250 and 500 mg/kg, respectively. After 21 days of treatment, there was some improvement in the histological appearance of pancreatic cells in the STZ-induced groups. The findings show that *Xanthium strumarium* alcohol extracts have strong anti-diabetic efficacy (Joghee Suresh *et. al*., 2014).

6.5. **Anti-arthritic activity**

In a study, it was found that extracts of *Xanthium strumarium* significantly suppress swelling and arthritic score. *Xanthium strumarium* has the potential to be regarded as a candidate for use in general therapeutics and as an immune modulatory medicine in rheumatoid arthritis. (Bing Lin *et. al.*, 2014).

Tab.2: Pharmacological activities shown by different parts of *Xanthium strumarium* L.

Name of plant part	Extract	Activity	References
Fruit	Water	Anti-cancer	Hong *et al*., 2004, Hong *et al*., 2003, Zhao *et al*., 2008, Yan *et al*., 2010, Vaishnav and George, 2015, Pan *et al*., 2013
	Water	Anti-inflammatory	An *et al*., 2004, Yeom *et al*., 2015, Huang *et al*., 2011
	Methanolic		Kim *et al*., 2005, Hossen *et al*., 2016
	Ethanolic		Park *et al*., 2015, Hasan *et al*., 2011

	Methanolic	Analgesic effect	Kim *et al*., 2005
	Ethanolic		Huang *et al*., 2011, Kepenekci and Saglam, 2015
	Methanolic	Insecticidal	Talakal *et al*., 1995, Gokce *et al*., 2011, AI-Mekhlafi *et al*. 2017
	Ethanolic	Antioxidant	Ghahari *et al*., 2017
	Methanolic		Ingawale *et al*., 2018
	Water		Huang *et al*., 2011
	Water	antimicrobial	Wang *et al*., 2016
	Ethanolic		Gahari *et al*., 2017
	Methanolic		Kim *et al*., 2002
	Water	Anti-diabetic	Kupiecki *et al*., 1974
	Methanolic		Ingawale *et al*., 2018
	Water	antilipidemic	Li et la., 2016, Li *et al*., 2017
	Water	antiviral	Liu *et al*., 2009
Leaves	Methanolic	Anti-inflammatory	Kim *et al*., 2005, Khuda *et al*., 2014
	Ethanolic	insecticidal	Talakal *et al*., 1995, Chandel *et al*., 2012
	Water		Chandel *et al*., 2012
	Ethanolic	Anti-oxidant	Kamboj *et al*., 2014
	Methanolic	Anti-microbial	Srinivas and Rajashekar, 2011, Devkota and Das, 2015, Yanar *et al*., 2011
	Water		Devkota and Das, 2015, Wang *et al*., 2016
	Ethanolic		Sharifi *et al*., 2016, Sharifi *et al*., 2015,
Aerial part	Ethanolic	Anti-cancer	Ferrer *et al*., 2016, Vaishnav and George, 2015
	Methanolic		Hossen *et al*., 2016

7. Toxicity

Despite many medicinal uses, *Xanthium strumarium* causes many side effects like vomiting, abdominal pain, depression, paddling convulsions and even death in animals also. Induction of hepatotoxicity in human has also been reported. It has been discovered that the plant's seeds and seedlings contain the glycoside carboxy-atractyloside, which is harmful to several animals, including horses, pigs, and cattle. If consumed in significant amounts, it can result in animal mortality and the dysfunction of several organs.

8. Conclusion

Many studies have been suggested that due to presence of active phytochemicasl, different parts of *Xanthium strumarium* can be used to treat various life threatening agents. The plant can be utilized as rich sources of these important phyto-constituents by pharmaceutical industries to design and synthesize new medicines of various purposes.

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