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Review Article

Descurainia sophia (L.): a weed with multiple medicinal uses

Muhammad Khan* and Nan Wang

Department of Zoology, University of the Punjab, Quaid-e-Azam Campus,Lahore 54590, Pakistan(MK). ShiyanHigh School No. 89 South Huanghe Street Shenyang 110841, China (NW).

Abstract
Descurainia sophia (L.) is a dicot annual weed, distributed in many countries of Asia, Europe, Africa and America. In China it is distributed throughout most of the wheat producing regions and has long been used in traditional Chinese medicines to cure different ailments. It has an impressive range of medicinal uses and is a good source of proteins, amino acids, fatty acids, cholesterol, lactones, flavonoids, cardiac glycosides, aryldihydronaphthoic acid, glucosinolates and other phenolic compounds. Seeds of this plant are used to relieve cough, prevent asthma, reduce edema, promote urination and possess cardiotonic, antitumor, antipyretic, antioxidant, anti-inflammatory, diuretic, anthelmintic and analgesic activities. In addition, seeds of this plant are rich source of a variety of volatile oils.
Key words: *Descurainia sophia* L, medicinal plant, phytochemistry, cardiotonic, anticancer SariabSurkh, Thripstabaci, Chiltan-89.

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INTRODUCTION

Descurainia sophia (L.) Webb ex Prantl (flixweed), is an annual dicot weed belonging to family Cruciferae (Brassiaceae) (Li *et al.,* 2010; Khan *et al.,* 2012). It is native to Southern Europe, Asia, South Africa, South America, New Zealand (Aghaabasi and Baghizadeh, 2012) and North America (Li *et al.,* 2005).

In China, Flixweed is widely distributed throughout most of parts of wheat producing regions and is quite competitive for moisture and nutrients, reducing overall wheat yield (Li *et al.,* 2010). In Pakistan it is mainly distributed in Gilgit (Khan and Khatoon, 2008), South Waziristan (Farooq *et al.,* 2012) and Baluchistan (Marwat*et al.,* 1990). Flixweed ranges in height from 1 to 3 feet (Aghaabasi and Baghizadeh, 2012). It has a massive potential of reproduction and growth in any area, producing 75-650 seeds per plant averagely that remain viable at least for four years in the soils, making it suitable to cope with unfavourable conditions such as droughts (Conn, 1990; Li *et al.,* 2005). Seeds are very small and dark yellow or brown in color with an uneven surface in a stretched oval form. One end of seed is cut and maintains a transparent yellowish ring (Aghaabasi and Baghizadeh, 2012).

The plant has also been widely used in folk medicines. In the middle Asia, extract of aerial parts of the plant is used for various ailments, including throat diseases and as an antipyretic for measles and smallpox. The tincture has been a practice as a diuretic, anthelmintic, and hemostatic for internal hemorrhages (Li *et al.,* 2010). Seeds of flixweed are used in Chinese Traditional Medicines (TCM) to relieve cough and chest discomfort, prevent asthma, reduce edema, promote urination and treat cancer and cardiac failure (Li *et al.,* 2010; khan *et al.,* 2012). Seeds have also been reported to be used as laxative and for the alleviation of skin inflammations and excretion of ascarid and renal calculus. Flowers and leaves are used as astringent and obviator of vitamin C deficiency. Consumption of flixweed in women during pregnancy results in more successful deliveries (Aghaabasi and Baghizadeh, 2012).

Flixweed is usually combined with stephania roots and rhubarb rhizome for treating the disorders of pleural effusions, ascites, edema, scanty urination and water retention in the abdomen, fullness in the abdomen and dry mouth and tongue. It is also immingled with bitter apricot kernel and mirabilite for pleural

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*Corresponding author: khan_zoologist@ymail.com

effusion and oliguria (Hou*et al.,* 2005). So far numerous phytochemical studies have been conducted to investigate different bioactive ingredients from this herb, however no comprehensive review have been compiled from the literature embracing the efficiency of this herb in all attributes. Its miscellaneous utility in medicines motivated us to bridge the information gap and to write a comprehensive review on the medicinal, phytochemical and pharmacological attributes of this herb.

Phytochemistry

Descurainia sophia (L.) is a rich source of a variety of compounds ranging from simple sugars, amino acids and fatty acids (Hou*et al.,* 2005) to a variety of complex compounds. A number of amino acids, fatty acids and hydrocarbons (Mohamed *et al.,* 2009) have been isolated from *Descurainia sophia* (L.) (Table I). Aerial parts of *Descurainia sophia* (L.) have been reported to contain seven coumarin compounds named scopoletine, scopoline, isoscopoline, xanthtoxol, xanthtoxin, psoralene and bergaptane (Mohamed *et al.,* 2009). Seeds are rich in flavonoids and flavonoid glycosides. So far three flavonoids namely kaempferol, quercetine and isorhamnetine and fifteen derivatives of aforementioned flavonoids have been identified from seeds (Mohamed *et al.,* 2009). Artabotryside A, a flavonol glycoside has recently been isolated from seeds (Khan *et al.,* 2012). The studies on the composition of oil contents of seeds revealed the presence of more than ten fatty acids, three steroidal compounds, β-sitosterol, β-amyrine and cholesterol alongwith thirteen hydrocarbons (Mohamed *et al.,* 2009). Seeds have also provided a variety of volatile oils mainly *cis*-β-ocimene, menthol, neoisomenthyl acetate and small amount of esters, aldehydes, alcohols, phenols and ketones (Li *et al.,* 2010). Seeds have been reported to possess a unique group of compounds called descurainolide A and B, descurainin, descurainin A, descurainoside A and B and descurainoside(Sun, 2005; Sun *et al.,*2004, 2005a, b). Five phenolic compounds namely p-benzoic acid, syringic acid, isovanillic acid, p-hydroxybenzaldehyde and 4-hydroxy 3, 5-dimethoxybenzaldehyde have been isolated from the ethanol extract of the seeds of *Descurainia sophia* (L.) (Sun, 2005).

Cardiac glycosides namely strophanthidine, evomonoside, helveticoside, evobioside and erysimoside (Chen *et al.,* 1981) and some glucosinolates (predominantly gluconapin and sinigrin) and glucosinolate degradation products such as isothiocyanates, nitriles, and epithiobutane derivates have also been isolated from seeds and aerial parts of flixweed(Afsharypuor *et al.,* 1985). The structures of some selected phytochemicals from *Descurainia sophia* (L.) are shown in Figure 1.

Medicinal uses and pharmacological properties

Descurainia sophia (L.) has multiple medicinal uses which have long been recognized by a system of Traditional Chinese Medicines (TCM). The medicinal attributes and pharmacological activities especially ascribed to seeds of *Descurainia sophia* (L.) are elaborated below.

Diuretic, antiasthmatic and cardiotonic activities

The diuretic action of *Descurainia Sophia*(L.) was pointed out as early as in the beginning of the first century in Ben Cao Jing (Lu, 1987). Seeds of flixweed are reported to possess diuretic, antiasthmatic and cardiotonic activities and have been used in China in Traditional Chinese Medicines (TCM) (Hou *et al.,* 2005; Li *et al.*, 2010). *Descurainia sophia* (L.) has been used since the beginning of first century against heart failure. Its extracts are capable of strengthening the contraction function of myocardiac and reducing intravenous blood pressure (Lu, 1987; Hou*et al.,* 2005).

So far five cardiac glycosides namely strophanthidine, evomonoside, helveticoside, evobioside and erysimoside have been isolated from the seeds, of which helveticoside seems to be the most important. Pharmacological analysis demonstrated that helveticoside is a quick acting glycoside and absorbed regularly in intestine without any detoxication symptoms in liver. The diuretic action of seeds is assumed to be derived from the cardiac glycoside contents (Lu, 1987; Rao, 2002).

Antioxidant, antitumor and anticancer activities

The seeds of flixweed are used in the treatment of some cancers in Traditional Chinese Medicines in China (Sun *et al.,* 2004; Li *et al.,* 2010; khan *et al.,* 2012). The antitumor and anticancer activities of seeds have been attributed to the presence of flavonoids; kaempferol, quercetine, isorhamnetine and their derivatives. The anticancer activity of aforementioned compounds is widely studied and has been reported to induce cell death in a variety of cancer cell lines including gliomas, colon, breast, nasopharyngeal, esophageal, gastric, lung, ovarian, hepatic, oral cavity and cervical cancer and leukaemia (Yoshida *et al.,* 1990; Mastorakos *et al.,* 1995; Donda *et al.,* 1996; Hrubec *et al.,* 1997; Kang and Liang, 1997; Teng *et al.,* 2006; Ma *et al.,* 2007; Kang *et al.,* 2010; Luo *et al.,* 2010; Vidya Priyadarsini *et al.,* 2010; Tsiklauri *et al.,* 2011). Quercetin has been shown to induce cell death through cell cycle arrest and inhibition of enzymes involved in cell proliferation and cell survival including protein kinase C, tyrosine kinase, PI-3 kinase, and ERK (Kim *et al.,* 2008).

Kaempferol has been reported to induce cell death in a variety of cancer cell lines through oxidative stress and can inhibit gene expression of VEGF, ABCC6, cMyc, HIF-1, ESRRA, AKT, ERK and Bcl-2. Various reports indicated that Kaempferol has also potential to induce apoptosis through intrinsic pathway which involves Bax and caspase-3 activation. Anticancer activity of Isorhamnetine has also been investigated through numerous mechanisms at different levels (Kang *et al.,* 2010; Luo *et al.,* 2010; Tsiklauri*et al.,* 2011).

Strophanthidin isolated from the ethanolic extract of seeds of *Descurainia sophia* (L.) has been tested for its inhibitory activity against numerous cancer cell lines which showed significant cytotoxicity towards human stomach adenocarcinoma cell line BGC-823, human breast carcinoma cell line, MDA-MB-435, prostate cancer cell line PC- 3M-1E8, hepatic carcinoma Bel-7402 and cervical cancer cell line HeLa (Sun *et al.,* 2004). Artabotryside A, a flavonol glycoside has recently been isolated from seeds which is selectively toxic to U87 glioblastoma cells as compared to normal mouse splenocytes (Khan *et al.,* 2012).

Other diverse biological activities

Descurainia sophia (L.) has also been declared to exhibit other promising diverse biological activities. Seeds and shoots' extract is effective in gas trouble, intestinal disorders and acts as a pain killer (Haq*et al.,* 2011). Seeds are also used to treat acute inflammation of pharynx, destroy bacteria, suppress cough and relieve dyspnea (Rao, 2002). A recent study on rats has documented that decoction of *Descurainia sophia* (L.) has antipyretic, anti-inflammatory and analgesic activities (Mohamed *et al.,* 2009).

Some adverse effects of Descurainia sophia (L.)

Seeds of *Descurainia sophia* (L.) have been reported to contain high concentrations of some glucosinolates (a group of sulphur containing glucosides) and their degradation products such as thiocyanates, isothiocyanates, nitriles, and epithiobutanederivates. Some glucosinolates are goitrogenic and one that is most goitrogenic is gluconapin (3-butenyl glucosinolate). This is one of the major glucosinolate isolated from seeds of *Descurainia sophia* L (136.51µg /g) (Afsharypuor *et al.,* 1985). The glucocyanate derived thiocyanates inhibit the uptake of iodine by thyroid glands and reduce the level of thyroxine T3 and T4. Low level of these thyroid hormones results in excessive secretion of thyroid stimulating hormone (TSH) which stimulates increased thyroid activity resulting in hypertrophy called goiter (David, 1976).

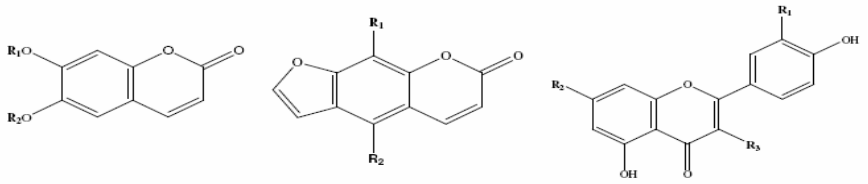
Future prospects

Up to now several phytochemical studies have been conducted on aerial parts of *Descurainia sophia* (L.) to identify and isolate various single compounds but there is a dire need to perform bioactivity guided approaches to identify and isolate new target specific compounds for various disorders.

The seed extracts have been shown to possess antipyretic, anti-inflammatory, antibacterial and analgesic activities (Rao, 2002).

Table I: Amino acids, Fatty acids and Hydrocarbons of *D. sophia* (L.).

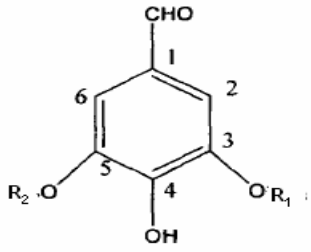
No.	Amino acids	Fatty acids	Hydrocarbons
01	Aspartic	Capric acid	Tetradecane
02	Threonine	Lauric acid	Hexadecane
03	Serine	Myristic acid	Heptadecane
04	Glutamic acid	Palmitic acid	Octadecane
05	Proline	Stearic acid	Nonadecane
06	Glycine	Oleic acid	Eicosane
07	Alanine	Linoleic acid	Henicosane
08	Valine	Linolenic acid	Docosane
09	Isoleucine	Cis-9Tetradecenoic acid	Tricosane
10	Leucine	Cis-9-Hexadecenoic acid	Tetracosan
11	Tyrosine	Eicosenoic acid	Pentacosane
12	Phenylalanine	Erucic acid	Hexacosane
13	Histidin		Octacosane
14	Lysine		
15	Argenine		



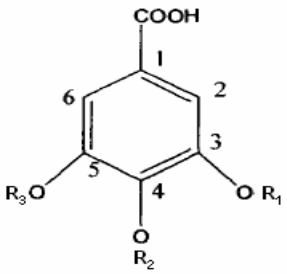
	R_1	R_2
1	H	CH_3
2	CH_3	H
3	Glucose	CH_3

	R_1	R_2
4	H	H
5	OH	H
6	OCH_3	H
7	H	OCH_3

	R_1	R_2	R_3
8	H	OH	OH
9	OH	OH	OH
10	OCH_3	OH	OH



	R_1	R_2
11	H	H
12	CH_3	CH_3



	R_1	R_2	R_3
13	H	OH	H
14	OH	CH_3	H
15	CH_3	OH	CH_3

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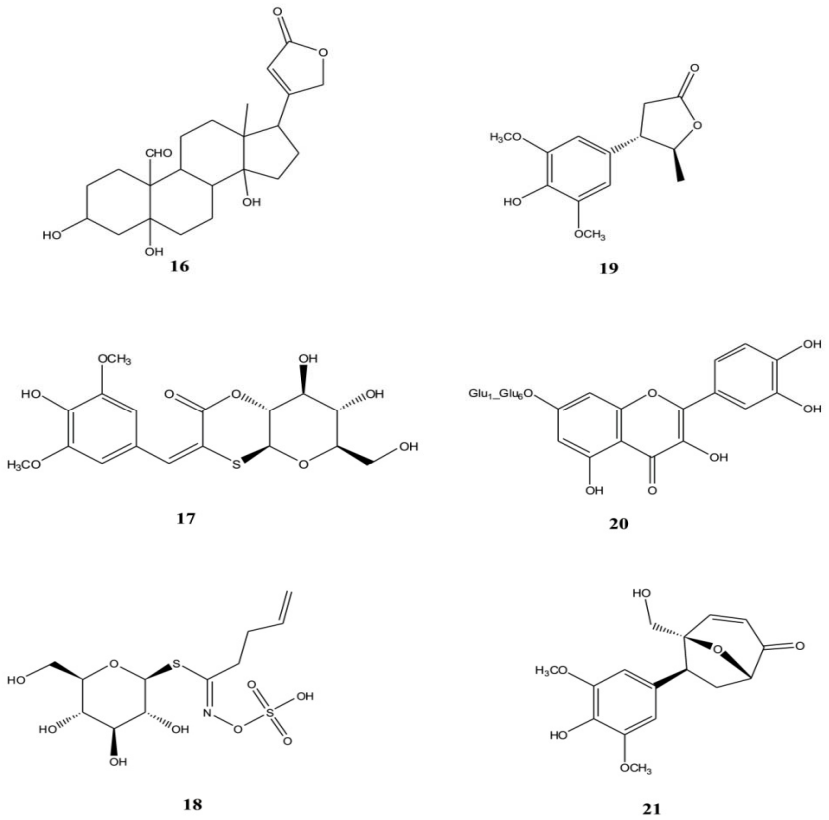

Figure 1: Structures of selected phytochemicals from *Descurainia sophia* (L)
1. Scopoletin, 2. Isoscopoletin, 3. Scopoline, 4. Psoralene, 5. Xanthotoxol, 6.Xanthotoxin, 7. Bergapten, 8. Kaempferol, 9. Quercetin, 10. Isorhamnitine, 11. p-hydroxybenzaldehyde, 12. 4-hydroxy-3, 5-dimethoxybenzaldehyde, 13. p-benzoic acid, 14. Isovanillic acid, 15. Syringiccaid, 16.Strophantidin, 17. Descurainoside, 18. Gluconapin, 19. Descurainolide A, 20. Descurainoside A, 21. Descurainin

Therefore, it is important to identify and isolate bioactive constituents from the seeds in order to understand their antipyretic, antibacterial and anti-inflammatory mechanism in a better way. Since plants are a huge reservoir of natural products and offer a diversity and complexity of novel chemical structures and biological activities. This aspect demands a systematic chemical investigation of *Descurainia sophia* (L.) for new value-added products with useful medicinal and chemical properties. Seeds of *Descurainia sophia* (L.) have been used to treat some cancers in Traditional Chinese Medicines (Li *et al.,* 2010). So far only a few flavonoids with anticancer activity have been isolated from the seeds. Therefore, extensive studies should be conducted to identify new compounds from the seeds, which have possible antitumor promoters as well as tumor inhibitory properties.

The seeds of *Descurainia Sophia* (L.) have been shown to contain high concentrations of some goitrogenicglucosinolates. So far no bioactive constituents with antipyretic, anti-inflammatory, antibacterial and antiasthmatic activities have been identified in the seeds, however, seed extracts have been shown to possess these properties. In the light of above findings, extensive studies are recommended to be conducted in order to identify bioactive constituents to treat various ailments instead of

using herb extract to offer a safer clinical approach.

Some studies on oil contents of *Descurainia sophia* (L.) have revealed that seeds of this species are rich source of oil contents with 76.65% polyunsaturated fatty acids and 53.7% linolenic acid (Lieth et al., 2003). Linolenic acid is an unsaturated fatty acid important for industrial uses. Thus detailed studies are required to examine agronomic parameters of this plant for industrial uses.

On account of its multiple uses, *Descurainia sophia* (L.) demands to be widely cultivated in most of the areas where climatic conditions favor its optimum growth to achieve maximum yield of its seeds to derive the maximal amount of goods of a multifarious nature for the welfare of humanity.

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*Corresponding author: khan_zoologist@ymail.com