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CURRENT UPDATES ON *SISYMBRIUM IRIO* LINN: A TRADITIONAL MEDICINAL PLANT

Madhurima Tiwari[1] and Prachi Bhargava[2]

[1]Institute of Biosciences and Technology, Shri Ramswaroop Memorial University, Lucknow. U.P. India
[2]Institute of Agricultural Sciences and Technology, Shri Ramswaroop Memorial University, Village Hadauri, Post- Tindola, Lucknow-Deva Road, Barabanki (U.P), India

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ABSTRACT

Sisymbrium irio Linn belonging to family 'Cruciferae' is one of the well-known plant used in Unani Thearpy. Several studies done throughout the world on '*Sisymbrium irio* L', also known as 'London Rocket' or 'Khakshi' has established that this annual herb is of tremendous medicinal benefits. This plant exhibits potential pharmacological activities such as antimicrobial, antioxidant, anti-inflammatory, analgesic, antipyretic, anticancer, detoxify spleen and liver, also used as febrifuge, expectorant, diuretic and used in the treatment of rheumatoid, voice disorders, boils, pimples, cough, and has bronchoprotective and hepatoprotective role. Various phytochemicals have been isolated scientifically from the different parts of the plants such as flavonoids, alkaloids, tannins, saponins, terpinoids, carbohydrates, phenolics compounds, fatty acids, steroids, amino acids and proteins which were found to be of 'Chemotherapeutic Interest'. This review paper summarizes the botanical description, ethnomedical, phytochemical and therapeutical role of the plant and highlighted the need of future research on this plant as a source of novel drug.

Keywords: *Sisymbrium irio* L, London Rocket, Ethnomedicinal, Phytochemicals, Therapeutical role

INTRODUCTION

Plants have shown a vital role in curing the human diseases all throughout the world. Growing identification of natural compounds or phytochemicals from medicinal plants has increased their demand for the treatment of diseases world-wide.Modern and traditional medicines utilize medicinal herbs as their integral part (Kirtikarand Basu 1994). There is a long history of 'Plant based therapies' in treating various ailments. Thesekind of therapies are comparatively harmless. Due to which modern researchers are all attracted towards natural products for the purpose of treating various challenging diseases. Some of these plant components of significance are phenolic compound, tannins, flavonoids and alkaloids. There are several reports on plants use in traditional healing in tribal areas by indigenous communities (Threlfall 1998).

Unani Medicine or 'UnaniTibb' is basically a form of traditional medicine practiced in South-Asian and Middle- East countries. Unani Therapy is among one of the authentic systems of traditional medicine in India, shown by the acronym AYUSH, i.e., Ayurveda, Yoga, Unani, Siddha and Homeopathy (Weeks 2020). It refers to a tradition of Graeco-Arabic medicine, which is based on the teachings of Roman physician Galen and Greek physician Hippocrates and was further developed into a full fleshed medical system in middle age era by Persian and Arabian physicians, it was introduced in India during the 11th-13th century in the Mughal period (Subbarayappa 2001). Along with Ayurveda it focuses on the direct use of natural plants and their by- products for the cure of ailing patients.

In view of this, various researchers have found family 'Cruciferae' also known as Brassicaceae of many applications in both commercial as well as pharmaceutical aspects as it is the important sources of oil or food products (Rahman *et al.,* 2004). It has also found its application in folk medicine (AL-Mazroa *et al.,* 2015). One of the cruciferae members named *sisymbrium* isused in treatment of rheumatoid, voice disorder inflammation etc. (AL-Jaber *et al.,* 2011). Few members also showed anti-microbial, antioxidant, analgesic and antipyretic activities (Vahora *et al.,* 1980). Researches done throughout the world revealed that this particular genus is characterized by presence of various metabolites such as, steroid, oil, anthraquinone, alkaloid and flavonoid (Al-Jaber. 2011; Al-Qudah and Abu Zarga 2010; Vahora *et al.,* 1980). *Sisymbrium irio* is one of the 90 species of the genus, which is found in various part of the world (Mabberly1997). *Sisymbrium* genus has four well known invasive species they are *S.irio*, *S.officinale, S. orientale* and *S. altissimum*.*S.irio* has been listed for official medicinal plant use in both Ayurveda and Unani therapies. Seeds of *S. irio* are utilized as Febrifuge, expectorant and against voice disorders (Ghazanfar1994 and Meyer1982). It has been reported that *S.irio* is used in the treatment of rheumatism, inflammation, antimicrobial, antipyretic, analgesic and antioxidant activity (Guil *et al.,* 2003). *S. irio* is also used in some places for dietary purposes (Montasir and Hassib1956). In a study *Sisymbrium irio* seeds were subjected to instrumental neutron activation for their elemental analysis, as a result the seeds were found to contain high levels of Iron, Manganese and sodium (Fatima *et al.,* 2012). Phytochemical analysis of the planthad shown to contain alkaloids, oils, flavonoids and glycosides (Bolus *et al.,* 1983). Different phytochemicals

such as flavonoids, glycosides, alkaloids, phenolics, carbohydrates, fats, tannis, proteins, gums, saponins and mucilage were found out by subjecting 70% ethanolic extract to various qualitative test (Trease and Evans 2002). Ten Flavonoids have been isolated from aerial parts of *Sisymbrium irio L* (Saudi Arabia) (Al-. Jaber2011). This literature review will focus on the detailed description of *Sisymbrium irio L* with its chemical components and its pharmacological applications.

Vernacular names of *Sisymbrium irio L*

The different vernacular names of the plant have been reported in the various papersand reports (Mabberley 1997; USDA, ARS 2002; Wang Zongxun *et al.,* 1996.)

Arabic	:	Khubah, Bazarulkhamkham.
Hindi	:	Asalio, Khubkalan, khubkala.
Persian	:	Khakshi, Shaftarak.
English	:	London Rocket/ Rocket mustard, Desert rocket.
Tibbi	:	Khaksi, Khubkalan.
Punjabi	:	Janglisarson, Maktrusa.
Rajasthani	:	Parjan
Sindh	:	Junglisurson
Urdu	:	Khaksi, Khubkalan
Chinese	:	Shuisuanjie.
Japenese	:	Hosoegarashi.
Spanish	:	Matacandil
Swedish	:	Vallsenap

Biological Description of the Plant

The biological description of the plant includes its taxonomic classification, geographical distribution, genetics, reproductive biology, phenology and physiology of the plant.

Biological classification of *Sisymbrium irio L*:

Domain	:	Eukaryota
Kingdom	:	Plantae
Phylum	:	Spermatophyta
Subphylum	:	Angiospermae
Class	:	Dicotyledonae
Order	:	Capparidales
Family	:	Brassicaceae
Genus	:	*Sisymbrium*
Species	:	*Sisymbrium irio*

Plant Appearance

Sisymbrium irio L is a winter annual, stiffly erect, Taprooted plant. The height of the plant is around three feet, has open, thin stem branches with pale yellow flowers. The leaves at the top portion of the plant are linear in shape and around four inches long while the lower leaves are broader than the upper leaves, and often contain lobes (Ray *et al.,* 2005) as shown in Figure 1a and b. Seeds of *S.irio* is in one series per laculeca, minute in size, oblong in shape and reddish brown in colour (Alsaffer *et al.,* 2017) shown in Figure 1c.

World-wide distribution

Sisymbrium irio is indigenous species of North Africa, temperate Asia and Europe but it has been transferred by migrants to South Africa, North America and Australia, where this species has acclimatized and became well known weed with yellow flowers, usually grown in waste areas. It was transported to the other corners of the world either by accidental transfer of the seeds or by sometimes deliberately transportations of the seeds because of their medicinal benefits (USDA-ARS2013). In relation to India, it grows in the cities of Srinagar and the ploidy of *S.irio* was reported as 2n=14, 28, 42, 56 (Khooshoo 1955; Guertin2003). The ploidy of *S.irio* is 2n=14 reported in (Flora of North America 2013).

Sisymbrium irio L is a polytypic plant and it grows during winters in Punjab plains. It is found in different ploidy levels such as 2n, 3n, 4n, 6n, 8n. All these races are highly effected and modified in response of changing amount of sunlight and moisture content of the soil (Khooshoo. 1955). In a study, the full chloroplast genome of *S.irio*was determined. Researchers reported the full length of chloroplast genome to be 154,001 bp. The complete chloroplast genome of *S.irio* composed of Long single copy (LSC) – 83,891bp and small single copy (SSC) – 17, 630 bp partitioned by a pair of inverted repeat (26,240 bp) regions. The complete chloroplast genome of *S.irio* encodes 112 known unique sequences containing 79 protein coding genes, 4 r-RNA genes and 30 tRNA genes (Kawanabe *et al.,* 2018). Jammu, Punjab, Northern part of Rajasthan, Delhi and western part of Uttar Pradesh (Khoshoo 1966).

Genetics of the plant

Reproductive biology

Sisymbrium irio Linn reproduces completely by seeds. It was reported that *S.irio* consists of small flowers is self-pollinated and self-compatible (Wilken and Hannah 1998). It was reported that the large plant of *S. irio* can produce approximately 9500 seeds (Guertin 2003). When the flower of *S. irio*spilts, its seeds get scattered and dropped into the ground below the parent plant.

Physiology and Phenology

In Australia, the germination of the seeds of *S. Irio* takes place from autumn to winter. The flowering occurs from late winter till the onset of spring (Herbiguide2013). In California, the seeds germinate in the month of October to March and the maturation of the plants starts from April and completes till May (Guertin 2003). While in Arizona the flowering takes place from the month of December to

Table 1: Percentage and composition of Essential oils extracted from *Sisymbrium irio*

S. No	Compound Name	Percentage
1	Dotriacontane	0.06
2	Octadecanal	1.10
3	Squalene	0.99
4	Heptacosane	3.89
5	Nonacosane	0.33
6	Docasanoic	0.60
7	1-Hexacosene	0.40
8	Octacosane	1.25
9	Dioctyladipate	25.44
10	Eicosanoic acid	0.15
11	Docasane	0.36
12	Stearic acid	2.07
13	12-Methyl–E,E– 2,13-octadecadien-1-ol	2.04
14	cis-8,11,14-Eicosatrienoic acid	6.30
15	Palmitic acid	3.45
16	Oleic acid	0.67
17	1-Eicosanol	0.39
18	3,7,11,15-Tetramethyl-2-hexadecen-1-ol	6.52
19	2,3,6-Trimethyl-1,4-naphthalenenedione	Trace
20	2-(2-Methylpropylidene)-1H-indene-1,3(2H)-Dione	0.08
21	13-Heptadecyn-1-ol	0.06
22	Methoxyeugenol	Trace
23	4-(2,4,4-trimethyl-cyclohexa-1,5-dienyl)but-3-en-2-one	0.05
24	Tetrahydrospirilloxanthin	Trace
25	5-Isopropenyl-2-methylcyclopent-1-Enecarboxaaldehyde	0.16
26	1,2–Dipalmitate glycerol	0.07
27	Deoxysericealacone	Trace
28	1,2,3b,6,7,8,-Hexahdro-6,6-dimethyl cyclopenta[1,3]cyclopropa[1,2]cyclohepten-3(3H)-one	Trace
29	8-Isopropyl-1,2,3,7-tetramethylbicyclo[5,1,0] octa-5-en-2-one	0.11
30	3_,5_-Dimethoxyacetophenone	2.54
31	Isovanillin	0.13
32	3-Methyl indole	0.05
33	o-Benzyl-L-serine	0.06
34	1,1,6-Trimethyl-1,2,3,4-tetrahydronaphthalene	0.11
35	1,1,6-Trimethyl-1,2-dihydronaphthalene	Trace
36	1,5,8-Trimethyl-1,2-dihydronaphthalene	Trace
37	Nicotine	0.06
38	p-Vinylguaiacol	0.78
39	Indole	0.22
40	p-Anisaldehyde	0.08
41	trans-z-_-Bisabolene epoxide	0.05
42	4-(2,5–Dihydro-3-methoxy phenyl)butylamine	Trace
43	Nonanal	0.07
44	β-Terpinyl acetate	0.12
45	3E-Hexenoic acid	0.05
46	Tetra acetyl-d-xylonic nitrile	Trace
47	n- Butyl isothiocyanate	2.85
48	Dimethyl sulphone	0.10

49	3-Hexen-1-ol	Trace
50	2E-Hexenal	Trace
51	Isopropyl isothiocyanate	11.55
52	Isobutyl isothiocyanate	6.75
53	N-(n-propyl)acetamide	14.77

Table 2: List of Phytochemicals identified from Sisiymbrium irio.

Parts of the plant	Phytochemical isolated	References
Seeds and aerial parts	β-sitosterol, quercetin, isorhamanetin and β-sitosterol-D-glucoside.	Khan *et al.,* 1991
Aerial parts	Glucosinolates	Griftiths *et al.,* 2001
Aerial parts	Sitosteryl-6′-O-undecanoate-β-D-glucoside, (Z)-8, 11, 12-trihydroxyoctadec-9-enoic acid, apigenin-7-O—glucoside, 1,2-dipalmitoyl- 3-O-α-6‴-sulfoquinovosyl glycerol, naringenin-4′-O- glucopyranoside, -adenosine, crotanoylcosmosiin, tetracosanoic acid, apigenin, β-sitosterol, ursolic acid, -sitosterol-D-glucoside, indole-3-carboxaldehyde and indole-3-carboxylic acid.	Al-Qudah& Abu Z 2010
Aerial parts	Flavanoids (apigenin, Kaempferol-3-O -xyloside-7-galactoside, Kaempferol, apigenin-7-galactoside, apigenin-7-O-gluco(6”,1”’) rhamnoside-5-methoxide, apigenin-7-O-β-D-glucoside, apigenin-7-O-gluco(6”,1”’) rhamnoside, luteolin-7-O-glucoside, apigenin-7-O-gluco(6”,1”’) rhamnoside, apigenin-7-di-glucoside, apigenin-7-O-(6” acetyl) glucoside	Al-Jaber 2011
Aerial parts	Alkaloid(nicotine)	Alsaffer *et al.,* 2016
Aerial parts	β-sitosterol,β-sitosterol-glucoside& , stigmasterol	Al-Massarani *et al.,* 2017

Figure 1: a) *Sisymbrium irio* whole plant. b) Flower of S.irio. c) S.irio seeds

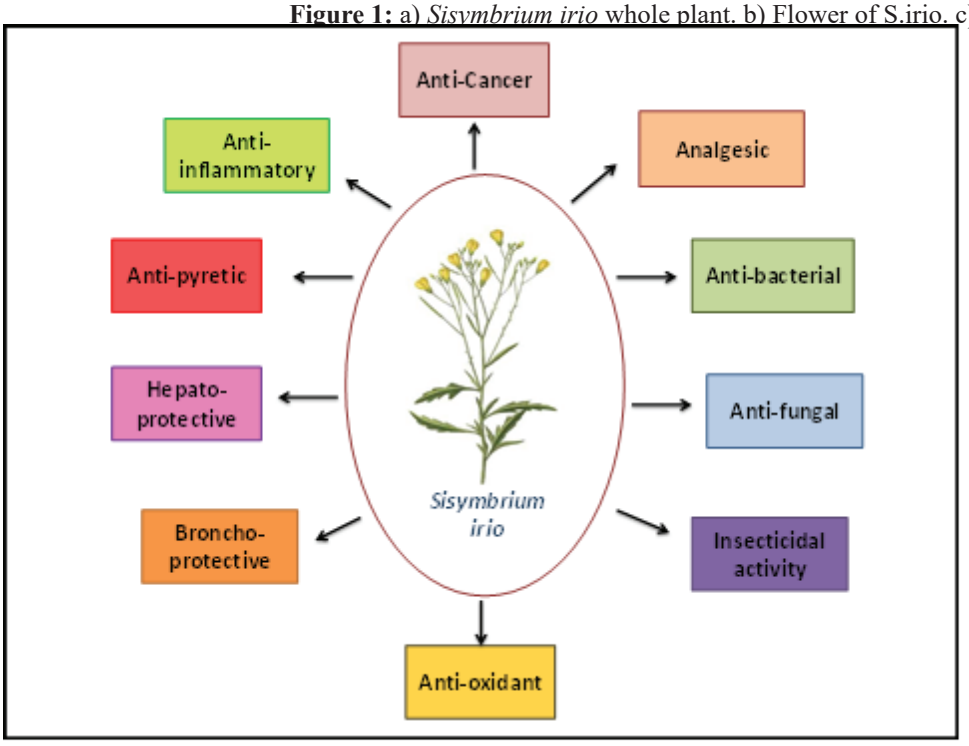

Figure 2: Pharmacological activities of *Sisymbrium irio* Linn

May, in moist soil it can flower all throughout the summer (Parker 1972; Guertin 2003). In Pakistan, the flowering of *S. irio* takes place from March to May (Flora of Pakistan 2013). The major factors affecting the germination of seeds of *S. irio* were studied by Ray and co-workers in 2005. The germination of 100 seeds was tested at different temperatures 5°C, 15°C, and 25°C respectively, and germination was found to be the best at 15°C. They also found out that the emergence of *S.irio* was best when seeds were buried at the depth of 2 mm in moist soil. The soil moisture tension should be of -0.01 to 11.2 MPa and the temperature should be between 15°C to 20°C.

As there is a little information available regarding the germination of *Sisymbrium irio*, some more information about the germination can be gathered from the closely related species *S.officinale.* For the germination of seeds in *S.officinale* nitrate and light are required, and nitrate can either be present endogenously or may be supplied exogenously to the seeds (Hilhorst and Karsson1988). It was found in the study that the seed dormancy in *S.officinale* was temperature dependent or dependent on seasonal changes. The period of seed dormancy was found to reduce at low temperature and induced at high temperature. Therefore, it was concluded that the temperature was the key factor affecting the dormancy. Desiccation, light and nitrate were the other factors found to stimulate the seed germination (Bouwmeester and Karssen1993).

Ethnomedicinal importance of *Sisymbrium irio L*

Drugs derived from plants found their utility in the modern system of medicine, through the uses of plant derived compounds as the integral part of treatment in the traditional medicine. In Unani system of medicine *Sisymbrium irio*or Khaksiis used as a famous drug for the treatment of fever. *S.irio* has been described as muqavvibadan (general tonic), daaf-humma (antipyretic)and muarriq (diaphoretic). It is known that the khaksi used to lowers the body temperature by enhancing the sweating and it also removes the unwanted particles causes diseases through the skin pores. Infusion made from leaves of the plant is used for treating throat and chest inflammation. The *S.irio* seeds are being used for past 100 years in traditional medicine, either separately or in combination with other types of unani medicines against the treatment of various diseases (Malik 2007). It has been clearly described in the famous book named "Al- Havi" that the Khaksi has anti-inflammatory and deobstruant (removes the obstructions from the vessels) activity (Zakariya Razi 1968). Itis an annual medicinal herb used for treating rheumatism, coughs, purification of liver, upper body mobbing, inflammation, irritation and injuries (Lev 2003). The seeds of the plant are used as expectorant, stimulant, restorative, tonic, used externally as poultice and also as febrifuge. *Sisymbrium irio L*of the family 'Brassicaceae' is being used in Unani Medicine since long time as antipyretic-aphrodisiac-expectorant-analgesic-antimicrobial in fever, gastric ulcer,cough, pulmonary and urinary tract infections, skin disorders and liver complaints etc (Haleem *et al.,* 2016). The seeds and the leaves of *Sisymbrium irio* are used as anti- vomiting, antipyretic, against cough and Diarrhea whereas the complete plant is used as a syrup and it is used as expectorant, laxative, diuretic, help in the digestion also used against bronchitis, laryngitis and bronchial catarrh (Shankar *et al.,* 2019).

Compositional study of the essential oil extracted from the *S. irio*

Al-Qudah and Abu in 2010 extracted and worked upon the essential oils found from the aerial parts of *Sisymbrium irio* and detailed their composition and percentage of existence. The components of oil were analysed by Gas chromatography and mass spectrometry. Experimentations elaborated that oil contained fifty-three components in total as mentioned in table 1. These 53 components represented about 97.5% of the total oil. Further it was found that 38.80 % was consisting of two Easters and seven acids, 36.41% of eleven nitrogen and sulphur containing compounds, 15 terpenoids consist of about 8.2 %, 6.3% of aliphatic hydrocarbons, 3.53% of aromatic compound, 2.5% of fatty acids and 1.17% of other components.

Phytochemicals

Phytochemicals or secondary metabolites are chemical compounds synthesized by plants through various chemical pathways. Studies have confirmed that there are many phytochemicals available which can be useful for the proper human's cell functioning (Upadhayay *et al.,* 2015; Budisan *et al.,* 2017). Some of the phytochemicals known to have medicinal properties, they mostly work in synergy, thus reduces the problem of side effects usually associated with the single synthetic drug and also eliminates the chances of developing the resistance (Briskin. 2000).

Khalil *et al.,* 2017 conducted a comparative phytochemical investigation of different *S.irio* organs in different solvent extracts. They reported the presence of Flavonoids, alkaloids, tannins, carbohydrates, triterpenoids and saponins at different amount in various extracts of *S.irio* organs. They also reported the absence of anthraquinones and cardiac glycosides in each of the extracts.

The different phytochemicals have been isolated and identified in various studies from the different parts of *Sisymbrium irio* and shown in Table 2

Pharmacological activities of *Sisymbrium irio L*

It was reported that *Sisymbrium irio* has many pharamacological applications such as antipyretic, antimicrobial, analgesic and antioxidants activities (Wanger *et al.,* 1990).*S.irio* is also used as an expectorant, for treating voice impairment, as a febrifuge (Hailu *et al.,* 2019). The plant is also used as a treatment against diseases such as rheumatism, as an anti-inflammatory agent, chest congestion, for cleaning wounds, decreases swelling and detoxifies spleen and liver (Rollins1993). *Sisymbrium irio*

produces isothiocyanates and nitriles as the degradation products of Glucosinolates. Isothiocyanates and nitriles are found to be very effective against the different kinds of diseases caused by microbes (Conrad *et al.,* 2013). There are many pharmacological activities associated with the plant which are discussed in details.

Antibacterial and antifungal activities

Crude ethanolic extracts of S. irio seeds showed antibacterial activities against both gram negative (*Salmonella typhi* and *Salmonella paratyphi A*) and gram positive (*Staphylococcus aureus*) bacterial strains (Vahora *et al.,*1980).The antimicrobial activities of the five compounds isolated from the methanolic extracts of the roots of *S.irio* was determined and found to be active antimicrobials against 3 Gram positive bacteria (*Staphylococcus aureus, Bacillus subtilis* and *B.pumilus*), Gram-negative bacteria (*Pseudomonas aeruginosa, Proteus vulgaris* and *E.coli*) and against a yeast (Candida albicans) (Khan and Asif 2000). The extracts made from seeds and leaves of *S.irio* dissolved in different solvents were tested and found to be potent against pathogenic bacterial (*Pseudomonas aeruginosa, Staphylococcus aureus, Klebsella Pneumonia, Streptococcus epidermidis, E.coli G*. and *E.coli*) and fungal strains (*Aspergillus flavus* & *Fusarium oxysporium*). The methanol extracts of both seeds and leaves showed higher antimicrobial activity than other solvent used in the study (Shabnam *et al.,* 2015). The n-hexane fraction of *S.irio* aerial parts were found to have potent cytotoxic activities against cancer cell lines, while ethylacetate and n-hexane fractions also showed marked antibacterial activities against *Clostridium perfringes, Streptococcus pyogenes* and *Salmonella enteritidis* (Al-Massarani*et al.,* 2017).The silver nanoparticles from the water extract of leaves were made using a single step procedure. The antimicrobial potential of these silver nanoparticles was tested at different concentrations against multiple drug resistance microorganism i.e *Acinetobacter baumanii* and *Psuedomonas aeruginosa.* They also showed significant antibacterial activities at low concentration of 6.25µg also (Mickymaray 2019).

The volatiles isolated through hydrodistillation from *Sisymbrium officinale* (one of the closely related species of *Sisymbrium irio*) had also showed the potential antimicrobial activity against 9 Gram negative bacteria (ampicillin resistant), 5 Gram positive bacteria and 4 fungal strains (Blazevic *et al.,* 2010).

Antioxidant activity

This plant exhibits significant antioxidant properties. A comparative antioxidant activities of different part of *S.irio* extracts dissolved in different solvent was determined. It was found out that the aqueous, butanol and ethylacetate extracts of flowers, stems and leaves showed high levels of antioxidant activities in comparison of others extracts used in the study (Khalil *et al.,* 2017).

Anticancer activity

The utility of *Sisymbrium irio* was studied for the inhibition and the treatment of cancer, can led to the development of more precise and safe way of drug discovery (Yukes&Michael 2010). The anticancerous activity of *Sisymbrium irio* is due to the presence of the phytochemical named as β-sitosterol. The β-sitosterol was isolated from the n-hexane fraction of aerial parts of the plant and showed potent cytotoxic effects against three human cancer cell lines HepG2, HCT-116, and MCF-7 (Al-Massarani*et al.,* 2017). In a *invitro* study, the effect of β-sitosterol was tested on prostate cancer cells. β-sitosterol had distorted the structural integrity of the cell membrane, thus increased the rate of apoptosis and reduced the growth rate of the cancerous cell (Von *et al.,* 1998). In a *in vivo* study it was determined that the β-sitosterolhas a potential role in the retardation of the development and the metastasis of the breast cancer cells in SCID mice (Awad *et al.,* 2000). It was reported that the ethanolic extracts of *S.irio* showed cytotoxic and phytotoxic activities (Shah *et al.,* 2013).

Isothiocyantes are the major degradation product of glucosinolates in *Sisymbrium irio*. These isothiocyantes are known to have chemopreventive potential (Gründemann and Huber 2018). They are known to inhibit the mechanism and the signaling pathways involved in the process of Carcinogenesis. Isothiocynates have been reported to prevent carcinogenesis by blocking the cell cycle progression of the cancerous cell, inhibits the transcription of repressor genes in cancer cells by preventing the activity of histone deacetylases, also inhibits nuclear translocation, affects the products of biotransformation (Ramirez *et al.,* 2020).

Antipyretic Activity

The seeds of the *S.irio* had proven to have marked Antipyretic effects. In a study the antipyretic activity of the crude ethanolic extracts of seeds of *S.irio* was investigated by using the technique that is yeast induced pyrexia in rats. The significant antipyretic effects were shown (onset: less than 1 hour, peak: at 3 hours, duration: less than 5 hours, $p < 0.05$ (Vahora *et al.,* 1980).

Analgesic effects

Analgesic is an agent to reduce pain. It has been reported that the *S.irio* has profound analgesic effects. In a study, the analgesic effects of seeds of *S.irio* were investigated. The technique of writhing in mice induced by acetic acid was used to test the analgesic activity. Ethanolic and sodium salicylate extracts made from the seeds of *S.irio* showed marked analgesic effects in comparison to other extracts used in the study (Vahora *et al.,* 1980).

Insecticidal Activity

Sisymbrium irio also found to exhibits insecticidal activity. In a study, the crude ethanolic extract made from the fresh

parts of the plant was tested for its insecticidal activity using rearing technique. The test organisms used in the study were *Collosobruchus analis, Rhyzopertha dominica, Sitophilus oryzea, Trogoderma granarium and Tribolium castaneum* and Permethrin was used as a standard insecticide. As a result the high insecticidal activity was found against the *Callosorbruches analis*, moderate activity against *Sitophilus oryzea and Trogoderma granarium* and the lowest activity was found against *Tribolium castaneum and Rhyzopertha dominica.*(Shah *et al.,* 2013).

Anti-inflammatory effects

Plants and their chemical constituents are used as anti-inflammatory agents in traditional medicine. The anti-inflammatory effect of crude ethanolic extract of *Sisymbrium irio* seeds were tested on albino rats (Wistar strain) using cotton pellet granuloma assay. The dose of 100mg/kg and 200mg/kg, p.o for 7days of crude extract was taken in a study, while Diclofenac and double distilled water were used as standard and control respectively. As a result, *Sisymbrium irio* seeds showed marked anti-inflammatory effects at 100-200mg/kg (Singh. 2015).

Broncho-protective role

This plant also found to have Broncho-protective role.In a study, the crude ethanolic extracts of *Sisymbrium irio* seeds at the dose of 100-200mg/kg, p.o x3days) protected the guinea pig from the bronchospasm stimulated by histamine aerosol (Singh 2015).The aqueous dry extracts from the aerial parts of the *S.officinale* were found to exhibit antimutagenic effects and myorelaxant activity as it was reported to reduce the contractions of trachea that was chemically induced in guinea pig by the leukotriene C_4 and histamine (Disotto *et al.,* 2010).

Hepato-protective Role

Sisymbrium irio is also used to detoxify liver and spleen. In a study, the ethyl acetate and the methanolic extracts of the *S.irio* had shown significant hepatoprotective activity against the liver damage induced by CCl_4 in albino rats (Alsaffar *et al.,* 2017). The liver damage induced by CCl_4 is due to the production of reactive intermediate metabolites (Tri chloro methyl radical (CCl_3•) and Tri chloro methyl peroxy radical (CCl_4OO•)) by Cytochrome P4502E1. The liver damage induced by CCl_4 is characterized by the increase concentration of the various liver enzymes such as lactate dehydrogenase (LDH), γ-glutamyl transferase (γ-GT), alkaline phosphatase (ALP), aspartate transaminase (AST) and alanine transaminase (ALT) (Srivastava *et al.,* 1990). The hepatoprotective activity of *S.irio* extracts were confirmed due to the decrease in the concentration of alkaline phosphatase (ALP), serum glutamic-pyruvic transaminase (SGPT), **b**ilirubin and serum glutamic oxaloacetic transaminase (SGOT). The hepatoprotective activity of the *S.irio* may be due to the presence of the bioactive compounds in the extracts (Alsaffer *et al.,* 2017).

In view of all these finding, it can be concluded that *Sisymbrium irio* has many pharmaceutical applications which is attributed by the presence of many bioactive compounds.

CONCLUSION

Present review paper provides vast information about the phytochemicals, ethnopharmacology, and claimed medicinal uses of the *Sisymbrium irio L.* It described the presence of various secondary metabolites such as flavonoids, triterpenoids or steroids, saponins, alkaloids, carbohydrates and tannins and absence of Anthraquinones and cardiac glycosides which are found to be of 'Chemotherapeutic Interest'. The plant found to have several activities such as anti-inflammatory, analgesic, antipyretic, antimicrobial, antioxidant, anticancer and hepato protective, may be because of the presence of investigated bioactive chemical constituents. Presence of various phytochemicals in different part of the plant needs further biological and phytochemical investigation for developing novel drug molecules and discovering other therapeutic uses.

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