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Mini Review

Silene conoidea L.: A review on its systematic, ethnobotany and phytochemical profile

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Abstract

Silene conoidea L. is a weed commonly growing in subtropical and temperate zones of western Eurasia, and some parts of the Himalayas, as a weed in various crops like wheat, barley, lentil pea, mustard and roquette. This is the first attempt to gather detailed information about this species, *viz*. distribution, taxonomy, ethno-medicines, phytochemical analysis, biological activity etc. in addition to explore its therapeutic importance for future research opportunities. A total of 114 research articles were reviewed using different sources like Scopus, Web of science, Science direct, Google scholar and PubMed. The species are used for various purposes like different biological activities against microbes, bacteria and as insecticidal. *Silene* is also important due to high contents of various chemicals compounds. Chemical extracts contain flavones, saponins, sterols and glycosides. Traditional therapeutic values of the species for treating respiratory, antioxidant, anti-diabetic and anticancer are needed to be validated through more experiments. Ethno-pharmacological and related clinical trials also has to be formulated. A research study shows that *S. conoidea* can be used as an indicator species for gold.

Keywords: ethnobotany; biological activities; phytochemical; *Silene conoidea*; taxonomy

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Introduction

Silene conoidea belonging to the family Caryophyllaceae (pink family), comprising of about 86 genera and 2,100 species throughout the world (1, 2) commonly distributed in temperate and alpine regions (3, 4, 5). The genus *Silene* is the largest one, with about 700 species, which are mostly thriving in temperate and Mediterranean regions. All the species of this genus contains secondary metabolites, such as steroids, flavonoids and saponins (1-3). As per the present circumscription, the genus includes taxa, which were previously kept under different genera, like *Coronaria*, *Cucubalus*, *Lychnis*, *Meldandrium*, *Pterocopsis* and *Viscaria*.

Silene conoidea is an annual herb and frequently found in crop fields in northern Temperate Asia, Punjab Plains (India, Pakistan), North Africa and Southeast Europe (4). The sprouts of *S. conoidea* are nutritive, containing carbohydrates, proteins and vitamins and it grows in wild form as well as green vegetable in many regions (5-7). This plant is of high medicinal value as its different parts are used as herbal medicine to treat different ailments. The whole plant is used to moisten the lungs, relieving cough, cooling the blood and stopping bleeding wounds (8).

Recent studies by the World Health Organization (WHO), confirmed that new resistance mechanisms are developed, which make the latest generation of antibiotics virtually ineffective (9). Scientific community have much interest in traditional medicinal plants and food as they have potential alternative antimicrobial activity (10, 11). Some research work has been done on the biological activity of *S. conoidea*, such as insecticidal (12), antimicrobial (13), antibacterial and allelopathic effect. Additionally, phytochemical investigations have demonstrated the presence of conoidene, glycoside and saponins (12, 14). The root of *S. conoidea* are rich in saponins with detergent properties and used traditionally to wash cloths as in other species of the family (12-14). In this article, we presented a review of systematic, biological activity, phytochemistry, cytogenetic and nutritional properties of this plant with special emphasis on its extensive uses in several traditional medicine systems. The data included in this paper, will be useful in designing imminent clinical trials and helpful in developing new medicines containing active components. The present work will highlight the importance of *S. conoidea* and will provide baseline data for the future research.

Methodology

Published papers were retrieved from different online bibliographical databases, and various key words were searched for "*Silene conoidea*" on Google Scholar, ScienceDirect Navigator, ISI Web of Knowledge, Elsevier, ResearchGate and PubMed. These key words were combined with the terms "Systematic", "Ethnobotany", "Phytochemistry" "Biological activity", "Weed" and "nutrition property" to search maximum information about the species. In the present review, we citied 114 articles from the literature related to the distribution, systematic, ethnobotany, phytochemistry, biological activity, and other aspects including, weed, effect of nitrogen and potassium and nutrition property of the species with detailed. Data were organized and tabulated using Microsoft Word. The chemical formulas of the compounds were draw on online Chem Draw software (http://chemdrawdirect-cdn.perkinelmer.com).

Results

Distribution

Silene conoidea distributed in subtropical and temperate zone of western Eurasia, and some part of Himalayas, Afghanistan, China, India, Nepal, North Africa, Pakistan, South Europe, Iran, America, Jordan, Japan, Spain and Turkey, Northern Temperate Asia, the Punjab Plains (15-21). Chorotype of the species is Irano-Turanian and Mediterranean regions (22, 23).

Taxonomy

Annual, herbs, 20-40 cm high. Stem erect, branched, densely glandular. Leaves sessile 3-5 × ca. 0.4 cm, linear-lanceolate, base clasping at the nodes. Bract present but smaller in size. Flower in terminal, paniculate, with 3-5 flowers in lax dichasia. Pedicels densely glandular pubescent. Calyx 22-26 mm long, acute, teeth lanceolate, ca. 30-nerved. Petals pink to reddish, limb 8-9 mm long, emarginated or entire, claw 14-17 mm long. Coronal scales oblong. Capsule 11-17 mm diameter conical. Seeds dark brown, ca. 1.1 mm long, reniform, brown (24, 25).

Flowering & fruiting: Mar. - May (26); June - July (27).

Biological spectrum

Life forms are classified based on adaptation of the plants to their perennating organs to tide over the unfavorable condition. "A life form of a species is the sum of all life processes and evolved directly in response to the environment" (28). The biological spectra of the species showed that the life form of the species is therophytes and leaf size is microphylls (29, 30).

Anatomical characters

Epidermal wall of abaxial and adaxial surfaces of leaves were smooth to slightly wavy, with irregular and polygonal cells; stomata diacytic type with glandular and non-glandular hairs, stomata on both surfaces numerous; trichomes on abaxial surface 3-4-celled abundant, non-glandular, on adaxial surface glandular, 3-4-celled. The species also has different types of crystal bodies (31). The trichome characters are constant in *S. conoidea* showing variation in the ratio of glandular and eglandular trichomes on the inflorescence axis and outer calyx. The species have more trichome on the floral parts to protect them. Pedicles of *S. conoidea* with mostly glandular hairs (32). The species have some similar foliar epidermal characters with the previously published data on Caryophyllaceae (33-35). Overall, anatomical characters play important role in systematics of all plant species using different techniques (36-43).

Palynology

Silene conoidea bears 22-24 number of pores, which is a specific character, diameter of pore more than 4μm, having in thick exine with 20 and more than 20 number of pori, pore surface cristate and the

Table 1. Different types of trichome present on different part of the plants

Part of the plant	Stem	leaf	Inflores.	Pedicle	Anth.	Out.cal	Inn.cal	Cal.D	Filam.	Petals
S. conoideae	Es	Es	Es/Gs	Gs	Es	Gs	Es	Es	El	Gla

Es: eglandular short, Gs: Glandular short, El: eglandular, Gla: glabrous

surface of pollen was granulate. The species has periporate type of pollen (44). Sahreen et al. (31) mentioned that the species had reticulate surface and the number of pores ranging 32-40. Pollen of the species microrchinate-microperforate, and structure of the pollen is tectate (Table 1) (45). The palynological characters play vital role in the identification of species of the family Caryophyllaceae as well as other plant groups (46-49).

Cytogenetics

The meiotic chromosome number of *S. conoidea* was (2n=20) previously that reported (2n=24) and (n=10) previous study shows that the species has n=12 which was very similar in morphology and can only be distinguish by their petal characters. *S. conoidea* was tetraploid on the basis of x=5 47 but (21, 50) confirmed that the basic number for *Silene* was either x=10 or x=12, *Silene conoidea* was placed together with *S. conica* in section Conoimorpha Boiss. The species has the shortest chromosome as compared to *S. succulenta* (51). Cytomorphic variant *S. conoidea* exhibits intraspecific diversity in the form of different cytotypes accompanied by variation in some of the morphological features, which was (2n=20, 40) (52). *S. conoidea* has XY type of DNA. Number of copy is one, while length of base pair 6236, covered area 1(intron)-15, number of PCR fragments were 9, posterior probabilities 0.9980. *Silene conoidea* and *S. conica* represent section Conoimorpha, group together with strong support. Size of Base pair 147,896, while IR size base pair 26,828, GC content 36%, Protein 77, tRNA 30, rRNA 4 and Introns 17 (Table 2) (53).

Table 2. Sequenced plastid genomes in *Silene conoidea*

Plant name	Size (bp)	IR size (bp)	GC content (%)	Gene (protein/ tRNA/ rRNA	Introns
Silene conoidea	147,896	26,828	36.0	77/30/4	17

Ethnobotanical uses

Ethnobotany, the study of how the people of an area use indigenous plants in their basic health and other needs. Ethnobotany is defined "the study of the relationship which exists between people of primitive societies and their environment" (54-57). Some of the ethnobotanical uses of the species were mentioned in literature are given below.

Fresh leaves paste are made and applied typically for skin infection (58-61). Whole plant used as emollient and used bath or as fumigant (62-65) paste of the seed and leaves applied on pimples and backache (66). Areal part of the plant also used to mixed with vegetable as well as a fodder (26, 67). Fresh plant paste is used in curing pimples and backache (59). The seed and young leaves of the plant are used in backache and applied on pimples (68). The species also used as fodder and forage (69). The root of the plant is used as emollient to wash wounds and hair, fumigant, juice used in opthalmia (70). Fresh and dried leaves of the plant cooked and used as vegetable and as stomachic (71). In combination with *Asplenium dalhousiae* Hook. and *Rubia cordifolia* L., leaves of *S. conoidea* crushed and juice obtained is applied to cure blisters (72-75). Whole plant is used to moisten the lungs, relieve cough, cool the blood and stop bleeding from wounds (8).

Phytochemical overview

The medicinal properties of *S. conoidea* have been attributed to flavonoid's glycosides. Glycoside a condensed compound obtained from sugar and non-sugar compound and may have further components, such as ring structure that are substituted and non-substituted. Key characteristic Phytochemical constituents in *S. conoidea* were conoidene, C-Glycosylflavones (76). Phytoecdysteroids were absent in *S. conoidea* (77, 78). While other species of the genus have ecdysteroids (79).

Flavonoids and Glycosides

Two new chemical compounds were isolated from *S. conoidea* C-Glycosylflavones by using butanol-soluble part of methanolic extract, these two new flavonoids and glycosides having C-C linkage between C-8 and C-1. 8-C(4-O-α-L-rhamnopyranosyl)-β-D-glucopyroanosyldiosmetin (1) and 8-C-(4-O-α-L-rhamnopyranosyl)-β-D-glucopyranosylapigenin (76). These both glycosides were extracted using HPLC and were identified by using spectroscopic. Additionally, they also study 1-2, α-spinasterol and its glycoside were also carried out for the first time.

Conoidene

R_1=β-D-Glcp-4←α-L-Phap

R_2=OH, R_3=Me

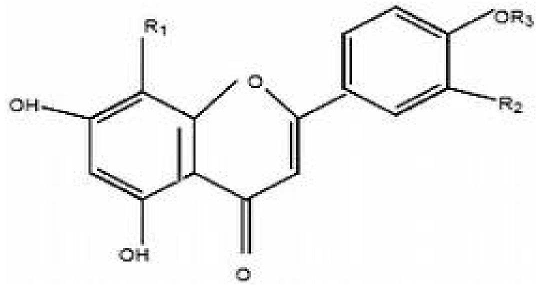

Fig. 1. chemical structure of 8(4"-O-α-L-rhamnopyranosyl)-C-β-D glycopyranosyldiosmetin isolated from *S. conoidea*

R_1=β-D-Glcp-4←1-α-L-Rhap
R_2=H, R_3=H

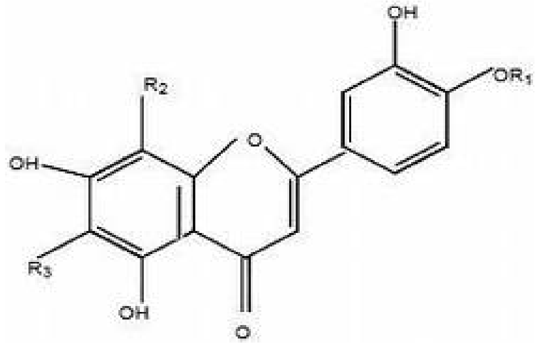

Fig. 2. Chemical compound extracted from *S. conoidea* 8 (4”-O-α-L-rhamnopyanosyl)-C-β-D-glucopyranosylapigenin

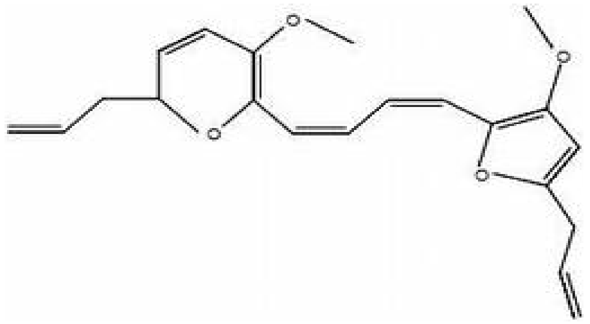

Fig. 3. Conoidene (2,2’-(1,3-butadiene-1,4-diyl) bis[3-methoxy-5-(2-propen-1-yl) furan) obtain from *S. conoidea*

Conoidene in *S. conoidea* are present; three chemical compounds were extracted from *S. conoidea* were 8(4”-O-α-L-rhamnopyranosyl)-C-β-D-glycopyranosyldiosmetin, 8 (4”-O-α-L-rhamnopyanosyl)-C-β-D-glucopyranosylapigenin and Conoidene (2,2’-(1,3-butadiene-1,4-diyl)bis [3-methoxy-5-(2-propen-1-yl) furan). The conoidene 1,4-di-[3-methoxy-5-(2-propenyl)-furan]-1,3 butadiene (1), were isolated from ethyl acetate soluble fraction of methanolic extract (14) (Fig 1, 2, 3).

Saponins and their sterol and glycoside

Silene conoidea showed the presence of saponins which are used in washing detergents property (12, 14); it also has α-Sapinasterol and α-Spinasterol-glyucoside, both are differ from each other on alkyl group (78) (Fig. 4).

α-Spinasterolglucoside R=H

α-Spinasterolglucoside R=O-β-D-Glu

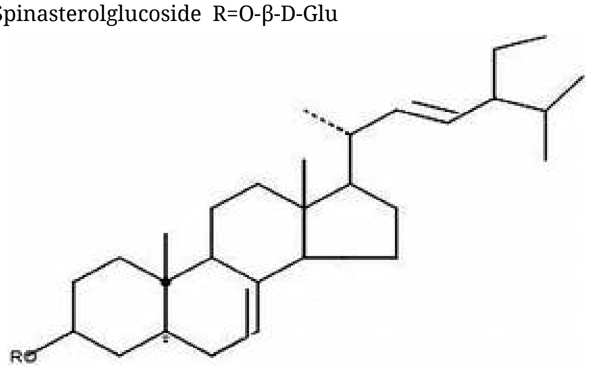

Fig 4. Structure of α-Sapinasterol and α-Spinasterolglucoside isolated from *S. conoidea*

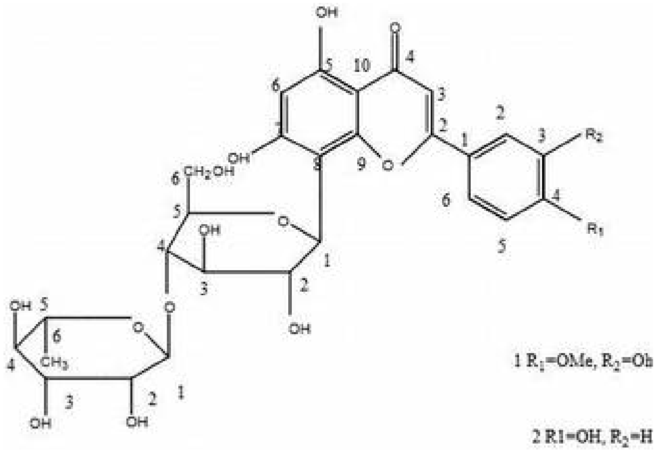

Fig. 5. Chemical structure of (C-Glycosylflavones) 8-C -(4-O-α-L-rhamnopyranosyl)-β-D-glucopyranosylapigenin and two known steroids: α-Spinasterol and α-spinosterolglucoside isolated from *S. conoidea* (67)

C-Glycosylflavones

8-C-(4-O-α-L-rhamnopyranosyl)-β-D-glucopyranosylapigenin and two known steroids:α-Spinasterol and α-spinosterolglucoside was isolated from *S. conoidea* (76) (Fig. 5).

Other compounds

The isolation of some chemical compounds from the species were Vitexin 4”-α-L-Rhamnopyrasnosyl (76).

R1 =R2 =H

R3 =β-D-Glcp-4←1-α-L-Rhap

Biogeochemical

S. conoidea possesses high concentration of gold 303 ppb, therefore the species considered indicator for gold. The species has a significant result and generates anomalies of Au and its pathfinder (80).

Heavy metals

The prepared samples by acid digestion, followed by quantification of selected trace metals by using atomic absorption spectrophotometer (Table 3, 4, 5) (81).

Table 3. Accumulation factors of trace metals (mean+SD) in *Silene conoidea*

Trace element	Fe	Zn	Cu	Mn	Cr	Cd	Pb
Value	553.5 ± 175.30	17.17 ± 8.16	2.96 ± 0.87	19.01 ± 7.55	7.71 ± 3.10	3.69 ± 1.25	3.01 ± 1.69

Table 4. Concentration (mg/kg, dry weight) of trace metals in *Silene conoidea*

Trace element	Fe	Zn	Cu	Mn	Cr	Cd	Pb	Total
Value	0.45 ± 0.18	0.40 ± 0.11	0.14 ± 0.06	0.05 ± 0.02	0.24 ± 0.12	4.99 ± 2.31	0.13 ± 0.07	6.41

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Table 5. Health risk index of trace metals (mean+SD) associated with the consumption of different

Trace element	Fe	Zn	Cu	Mn	Cr	Cd	Pb
Value	0.043	0.001	0.002	0.005	0.137	0.046	0.037

Biological activity

To manage plant diseases scientist are working on the plant extracts (82). Nowadays, natural products especially those which are extracted from plants, gaining more interest for the management of different abnormalities. These gain more importance than synthetic drugs due to negligible side effects and resistance (83). Some of the biological activities mentioned in previous literature for *S. conoidea* are given below.

Insecticidal activity

Phytoecdycteroids are analogues of insect molting hormones and their concentration in plants can reach 0.01%-3%. Their low concentrations affect insect development. E.gecdycteroid 20 hydroxyecdysone at concentration of 10-8 to 10-9 M are initiates the transformation occurring in embryogenesis and during larval development with instant metamorphosis to the adult insect 20. The potential insect deterrent activity of *S. conoidea* have been reported (66, 84). The species have the potential and also being used as insect repellent (66).

Antibacterial activity

The extracts of *S. conoidea* showed antibacterial activity against *Pseudomonas aeruginosa*, *Salmonella typhimurium*, *Staphylococcus aureus* and *S. epidermidis*. Extract of the species were made using solvent extraction (5 g) of air dried and powder material were mixed with 500 ml of various solvent like methanol, n-Hexane and ethylacetate. The supernatant was filtered using Whatman No. 4 filter paper and then concentrated to dryness at low temperature (40°C) using rotary evaporator and at last the extract were dissolved in diamethyl sulfoxide to yield 20 mg/ml of the extract (62). 0.69g extract from ethanol solvent were used, which percentage yield 3.0, they showed inhibition against bacterial strain in millimeter (85) (Table 6).

Table 6. Zone of inhibition in millimeter of *Silene conoidea* extract against the bacterial strains

Bacteria	*Staphylo-coccus epidermidis*	*Staphylo-coccus aureus*	*Salmo-nella typhimurium*	*Pseudo-monas aeruginosa*
Inhibition Against Bacteria Strains in Mm	1	2	1	10

Antimicrobial activity

Microbes cause various diseases in human beings from mild to acute and chronic. Different solvent extract of *S. conoidea* plant have been reviewed against a range of microorganisms affecting not only humans but also animals. Different plant species used in traditional medicines for the treatment of common, sore throat, fever, cold and also as aromatic incense showed anti-microbial activity in pharmacological assessments (54). Dried and powder material (50g) of the species were extracted with methanol (300ml) in a soxhlet for 10-12 hours. Solvent were removed in vacuum to give concentrated extract and the residue kept in the refrigerator until use. These residues after dilution with methanol were injected to different microorganism. Screening was performed on the plates of Mulller-Hinton Agar (Oxoid); these were sterilized for 15 min at 121°C. 20ml of this medium was added to each sterile Petri dish (approximately 20 x 100mm) and kept for 24 hours to control sterility (13) (Table 7).

Table 7. Antimicrobial activity of *Silene conoidea*

Botanical Name	*Silene conoidea*
M1	*Bacillus subtilis* (No Effect)
M2	*Candida albicans* (No Effect)
M3	*Escherichia coli* (No effect)
M4	*Klebsiella pneumonia* (No effect)
M5	*Morganella morganii* (No effect)
M6	*Pseudomonas aeruginosa* (Significant)
M7	*Salmonella typhi* (No effect)
M8	*Staphylococcus aureus* (Significant)
Part of plant	Total part

The shade dried samples of *S. conoidea* were grounded separately using electric grinder to make a fine powder. Solvent extraction (5g) of air dried and fine powder of *S. conoidea* were mixed with 500ml of three solvent methanol, n-Hexane and ethylacetate. The supernatant was filtered using Whatman No. 4 filter paper and for the concentration were dryness at low temperature (40°C). They were concentrated using rotary evaporator and at last the extract was dissolved in dimethyl sulfoxide to yield 20mg/ml of the extracts. The extracted samples were stored at 4°C in sterile airtight vials for further research. *S. conoidea* extracts were used against these microbes in vitro antibacterial activities, five gram-negative bacteria were used for the study: *Escherichia coli*, *Klebsiella pneumonia*, *Yersinia pestis*, *Shigella sonnei*, *Pseudomonas aeruginosa* and four gram-positive bacteria; *Staphylococcus aureus*, *S. epidermidis*, *Micrococcus luteus*, *Listeria monocytogenes* were also studied and one fungal strain *Candida albicans* using concentration of 20mg/ml. *S. conoidea* does not show any active activity against *Escherichia coli*, *Staphylococcus aureus*, *Shigella sonnei*, *Klebsiella pneumonia* and *Pseudominas aeruginosa*. The methanolic extract of *S. conoidea* showed activity against *Staphylococcus epidermidis* zone of inhibition were 10.6+0.57. Ethylacetate extracts show positive results against *S. epidermidis* inhibition were (13+0). Methanolic extract Inhibition activity against *Salmonella paratyphi* showed (9.6+1.15). Hexane and ethylacetate extract inhibited (9+0) mg/ml and (11+0) respectively against *Salmonella typhimurium*. The ethylacetate extract showed (11+0) inhibition against *Listeria monocytogene*. Ethylacetate extract of the species inhibition result were (13.3+0.57) (62). Antimicrobial activity of *S. conoidea* showed response against *Basillus* sp., *Escherichia coli*, *Klebsiella* sp., *Morganella morganii*, *Pseudomonas aeruginosa*, *Salmonella typhimirium* and *Staphylocoocus* sp. (86).

Antifungal activity against *Candida albicans*

The result showed inactive against antifungal activity three solvent methods were used i.e. methanol, n-Hexane and ethylacetate on fungi *Candida albicans* (62).

Allelopathic effect

Allelopathy is beneficial or harmful influence of chemical substances released by the plant species, which can suppress or promote the growth of nearby plants or microorganism. Allelopathic affect may be present in all plant organs, including root, rhizome, stem, leaves, flowers, fruits and seeds, some of which can store these compounds. The quantity and emission pathway different from species to species (87) Stem and root of *S. conoidea* inhibited the growth of wheat seedling, while the leaves are promoted growth due to allelopathy (88).

Other aspects of *Silene conoidea*

Weed

Unwanted plant which effects the crops of a specific area is known as weed (89). *Silene conoidea* growing in many crop fields is a weed used as fodder. The plant is very common weed of wheat crop (90-102). It can affect the harvest of wheat significantly (103-105). Research on ecological interpretation of weed vegetation in the summer crop fields of Anhui Province, China revealed that *S. conoidea* is a common weed in the research area (51, 106-109). It is a common weed of different crops such as, barely, mustard, roquette, lentil pea field in district Sriganganagar (110); also commonly occurring in cotton field as weed (111, 112).

Effect of Nitrogen and potassium

Using matrix culture of nitrogen and potassium can affect the morphology of *S. conoidea* vigorously. The study showed that the plant height, stem diameter, leaf length, leaf width, root length and leaf area were increased with the scope of 8.0mmol/L nitrogen level and 5.0~8.0mmol/L potassium level, they help in the growth of the plant tremendously. *S. conoidea* yield best under the condition of 8.0~12.0mmol/L nitrogen and 5.0~7.5mmol/L potassium (113).

Nutrition property

S. conoidea is a common herbaceous weed occurring in the wild. The nutrient contents were studied, the result showed that *S. conoidea* contained abundant nutrients, e.g. calcium, potassium, magnesium, iron and manganese. Heavy metal cadmium and lead were also reported but present in safe amount. Soluble sugar, vitamin C and carotene were also detected as rich in occurrence (114).

Conclusion

Silene conoidea is used in traditional medicine in different geographic areas of the world. The anatomical, palynological and cytogenetic studies attribute it a separate identity from the rest of the species of *Silene*.

This review emphasizes that the systematic, ethnobotanical, phytochemical and biological activities of *S. conoidea* emphasized its importance globally. The available research data on *S. conoidea* signifies its importance as medicinal plant in a wide range of ethnobotanical uses especially for the treatment of skin infection, backache, pimple, emollient, fumigant and as vegetable. The medicinal properties of *S. conoidea* are attributed to the presence of variety of chemicals (Fig. 1 to 5) like flavones, glycosides, conoidene etc. The increasing medicinal importance of *S. conoidea* is demanding the investigation and discovery of more potential phytochemicals. Such research works can lead to the improvement in drug system by discovering new chemicals for the welfare of humankind.

The ethno-pharmacological study of the plant is necessary to check its action for different disorders. Biological activities of plants are more important to use a specific part to check antimicrobial, insecticidal, antibacterial properties. Till date, *S. conoidea* is studied for four biological activities. Further research work will be carried out to elucidate all the possible biological activities of the species.

Authors' contributions

FU, WZ, SS and AA designed, conceived the presented ideas and wrote the manuscript; MAB and AU analyzed the data; all authors revised and approved the final version of the manuscript.

Conflict of interest

The authors have no conflict of interest.

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