Indian Journal of Natural Products and Resources
Vol. 13(4), Decemebr 2022, pp. 468-473
DOI: 10.56042/ijnpr.v13i4.44111

An invasive plant *Sonchus asper* (L.) Hill: A review of its ethnopharmacology, phytochemistry, and pharmacological properties

Amrendra Nath Tripathi*, Suresh Chandra Sati and Parikshit Kumar#

Department of Botany, D.S.B. Campus, Kumaun University, Nainital 263001, Uttarakhand, India

Received 18 December 2020; revised received 01 October 2022; accepted 25 October 2022

India is well known for medicinal plants because of rich plant biodiversity. Kumaun Himalayan region of Uttarakhand state occupies a great place in having good number of medicinal plants. The uses of plants in the indigenous cultures of developing countries are numerous and diverse. In a developing country, 65% population is dependent upon traditional medicinal system. The plant based traditional medicinal system play an important role in curing the health from various diseases all over the world. The present review reveals the updated information regarding the ethnopharmacology, phytochemistry, and pharmacological properties of an invasive plant *Sonchus asper* (L.) Hill. For this study, an extensive and intensive field survey by visiting the nearby villages of Nainital district was carried out along with detailed literature survey. Multitudinous ethnic properties and pharmacological study may help in development of new drug for the treatment of cancer and infectious diseases from this plant. The documentation of isolated compounds may afford new drug entity for pharmacy sector with lesser cost and more efficacy.

Keywords: Ethnopharmacology, Invasive plant, *Sonchus asper*, Traditional uses.

IPC code; Int. cl. (2021.01)-A61K 36/00, A61K 36/28, A61P 29/00, A61P 31/00, A61P 39/00

Introduction

Medicinal plants constitute an alternative treatment in mild infectious diseases. They are possible source of new potential antibiotics to which pathogenic organisms are not tolerant[1]. The plant based traditional medicinal systems plays an important role in curing health and about 80% people of the world use traditional medicines for their primary health care[2]. Medicinal plants relevant to ethnomedicinal knowledge has been proved an important guiding tool for research in the area of new drug development[3]. Medicinal plants fulfill the need of millions of ethnic and indigenous people living in tribal and rural region. According to the data provided by Ministry of Environments and Forest and Climate Change Government of India, tribal communities in India use over 10,000 plant species for their primary health care[4,5]. India is very rich in natural resources and the knowledge of traditional medicine. There has been increasing interest of plant uses and the identification of their components with antimicrobial properties. The development of resistance in microorganisms to antibiotics and emergence of new infectious diseases create an urgent need to discover, novel, safe and effective antimicrobial drugs[6]. Although few plant species have been tested for antimicrobial properties, the majority of these have not been adequately evaluated[7]. The available literature showed that among 250,000-500,000 plant species, only a small fraction has been investigated phytochemically and a very small percentage submitted to pharmacological screening[8]. Keeping in mind the vast potentiality of ethnobotanically known invasive plant *Sonchus asper* (L.) Hill is reviewed for pharmacology.

Botanical discriptions

S. asper is an annual to perennial, erect, branched herbaceous plant (Fig. 1). It belongs to the family Asteraceae. The entire plant contains a sticky white latex; tap root short, bushy with many lateral roots; stem erect, hollow stout, unbranched or slightly branched, 30 - 150 cm tall, often reddish; may have gland- tipped hairs on upper stems; leaves alternate, ovate, 4 - 18 cm long, 0.5 – cm wide, crishped many lobed (5 to 11 lobes on each side) with fewer lobes on upper leaves[9]. Inflorescence irregularly cymose – umbellate, Involucre 15- 25 mm wide when open in

*Correspondent author
Email: amrendratripathi05@gmail.com
#Present address: Department of Botany, H.V.M. (P.G.) College, Raisi, Haridwar 247671, Uttarakhand, India

Fig. 1 — *Sonchus asper* (L.) Hill in flowering state.

flower, 9 – 14 mm height when closed over maturing achenes, Glandular hairs usually present on branches of inflorescence and involucral bracts; glands yellow or purplish. Each capitulum contains 25 -50 ligulate bisexual yellow florets. Mature achenes light brown, thin, flattened more or less winged at margins, 2.5 mm long, 1.5 mm wide with 3 or 4 -5 longitudinal ribs on each face, otherwise smooth. Pappus of numerous unbranched white bristles, 8 mm long; those of inner whorl rigid, spiny, those of outer whorl flexous, hooked at tips[10].

Taxonomic status[11]

Kingdom: Plantae; Phylum: Tracheophyta; Class: Magnoliopsida; Order: Asterales; Family: Asteraceae: Genus: *Sonchus* (L.); Species: *asper* (L.).

Geographic distribution

S. asper is commonly known as Spiny sow thistle. This plant is native of North Africa, Europe and west Asia. The Plant of *S. asper* has been widely distributed in the countries viz, North America, South Africa, South America, New Zealand, Australia, East Asia, Germany, France, Poland, Austria, Belgium, India, Greece, and Iran[12].

Ethnobotanical significance

S. asper has various traditional uses. The plant has been used as a tonic to purify blood and is applied on fresh injuries on wounds, cough bronchitis, and asthma[13]. It has been also used to treat ailments related with kidney and liver[14]. The roots and leaves of this plant are used in the treatment of indigestion and as a febrifuge. Its stem is used as a sedative and tonic[15]. Some species of Sonchus viz, *S.asper*, *S. oleraceus* and *S. arvensis* are regarded as sources of dietary fibre and vitamins and chiefly contribute to the food security approach of many people[16-18].

Pharmacological activities

The plant of *S. asper* (L.) has numerous medicinal uses[15]. Some important pharmacological activity reported for this plant are reviewed here under.

Antibacterial activity

The methanol and aqueous extract of *S. asper* leaf have been reported to show antibacterial activity against the pathogens tested viz., *Staphylococcus aureus*, *Escherichia coli*, *Bacillus cereus* and *Klebciella pneumonae*. However result showed more inhibitory activity against gram positive bacteria as compared to Gram negative once[12]. The essential oil of *S. asper* possess good antimicrobial activity[19,20]. The different solvent extract (Methanol, chloroform, hexane) of *S. asper* were screened for antibacterial activity against *Micrococcus sp.*, *S. aureus*, *Shigella flexineri* and *E. coli* by agar well diffusion method. The result showed that the methanol extract of this plant was more active against *S. aureus* as compared to other pathogens tested[21]. The antibacterial activity of different solvent extract (various fractions) of *S. asper* were evaluated against *E. coli, B. subtilis*, *M. luteus*, *K. pneumonae*, *S. aureus* and *P. areuginosa*. The result showed that the methanol extract represent good antibacterial potential[22]. Methanol, acetone and aqueous extract of *S. asper* and *S. oleraraceous* leaves were screened for antibacterial potential against 5 Gram-positive and 5 Gram-negative bacteria. The result revealed that the both plant extracts were active against Gram-positive strains and less towards Gram-negative strains[23]. This study also supports the facts that, in general the Gram-negative bacteria are less susceptible to antibacterial effects than the Gram-positive bacteria[24,25].

Antifungal potential

The antifungal potential of methanol and aqueous extract of *S. asper* leaves was evaluated against fungal pathogens viz., *Candida albicans* and *Aspergillus flavus*. The result showed that both fungal pathogens were resistant to both methanol and aqueous extract[12]. Different solvent and various fractions extracts of this plant were screened against 4 strains of fungi. The study showed that all the extract of all fractions of this plant exhibit antifungal activity to some extent at 200 µg/mL. However, methanol and ethyl acetate extract showed marked inhibition against *A. niger*,

while butanol, methanol, and aqueous extract showed inhibition against fungi *F. solani*[22]. The screening of antifungal activity of aerial part of *S. asper* at various concentrations (1, 2, 3, 4, and 5%) were made against fungi *Botrytis cinerea* and *Rhizoctonia solani*. The results revealed that all the applied concentrations of tested extracts showed significant antifungal potential up to 37-74%[26].

Antioxidant potential

The screening of the antioxidant potential of different solvent (Methanol, n- hexane, chloroform) extracts of *S. asper* were carried out by DPPH – radical scavenging essay. The result reported that in all the solvent extract applied methanol extract showed significant antioxidant potential[21]. In an study it was revealed that the antioxidant potential of *S. asper* is due to the presence of various flavonoids contents and phenolic compounds as well[15]. Different solvent (Ethyl acetate, chloroform, hexane and methanol) extracts of this plant were evaluated for phenol contents and antioxidant potential by DPPH, ABTS and H_2O_2 radical scavenging essay. The biochemical investigation showed that presence of phenol compounds in methanol extract of this plant might be responsible for DPPH, ABTS radical scavenging capacities and reducing power[27]. The antioxidant potential of different solvent viz, 70% MeOH, 70% EtOH and hot water extracts of another species of *Sonchus* i,e, *S. oleraceus* were evaluated. The result revealed that the boiling water extract, 70% MeOH % and 70% EtOH extracts had stronger antioxidant activities from 47.1 to 56.5 µg/mL[28].

Phytochemical studies

In an experiment, it was reported that the most important bioactive components of *Sonchus* species were sesquiterpene, lactone, quinic acid esters, flavonoids, glycerate, triterpenes, steroids, coumarins and saccharides[29]. In another study, the *Sonchus* species were found to contain high levels of potassium, sodium, copper, calcium, manganese, zinc, and phosphorus. It was also shown that the species of *Sonchus* contain abundant fatty acids, viz, omega-3 polyunsaturated fatty acids, which was an important fatty acids and are reported in large scale (41.6%) in *S. asper*[30]. The carotenoid content of *Sonchus* species range from 158 to 240 mg/kg[30,31]. The chemical composition analysis of *S. eruca* and *S. asper* revealed that the bioactive compounds present in both the species comprises as – alkaloids (1.24–1.34 mg/100 g), saponins (1.46–1.76 mg/100 g), flavonoids (1.61–1.34 mg/100 g), phenols (1.32–1.44 mg/100 g), and tannins (0.02–0.061 mg/100 g)[15]. It was also suggested that the plant of *S. asper* contains rich quantity of vitamin C (33.2–22.12 mg/100 g), fiber, calcium, manganese, zinc, iron, and copper. In addition, it also bears leutiolin, leuteolin – 7 – o – β – D glucoside, apigenin – 7 – o – β – D glucopyranuronide, apigenin – 7 – o – β – D glucoronide methyl ester, germanicyl acetate, and apigenin – 7 – o – β – D glucoronide ethyl ester. The same study also reported the presence of riboflavin (0.24–0.72 mg/100 g), thiamine (0.31–0.15 mg/100 g) and niacin (0.03–0.05 mg/100 g) from the whole plant extract of *S. asper*[15].

Insecticidal potential

Ethanol and aqueous extract of *S. asper* leaf and root exhibit insecticidal activity at 1000 µg/mL. However, at the same concentration ethanol leaf extract is more potent as compare to aqueous extract[32].

Anti–inflammatory potential

The evaluation of anti-inflammatory potential of hydroalcohol leaf extract of *S. asper* and one of its major constituent, apigenin- 7 glucoside (Ap 7 G) in male mice have revealed that in tail flick, writhing and glutamate–induced paw licking tests, application of a dose of 300 mg/kg of extract exhibit significant (P <0.01) anticoncicpetive effect compared to the control group[33]. In formaline test, treatment with a dose of 100 mg/kg of extract reduced the pain source in the tonic phase compared with the control group (P <0.05). In formaline model, also naloxone (an opioid non selective antagonist) plus the extract (300 mg/kg) reduced liking and biting in mice. This study clearly demonstrate that the hydroalcohol leaf extract of *S. asper* and its constituent apigenin-7 glucoside have both anti-conciceptive and anti-inflammatory effects under certain experimental condition performed. The examination of the effects of ethyl acetate extract of aerial part of *S. asper* on nitric oxide production and prostaglandin- E_2 level in lipopolysaccharide (LPS) -stimulated RAW2647 macrophages have showed that after treatment with ethylacetate extract of *S. asper* at 100 µg/mL resulted in almost complete inhibition of nitric oxide production. This study also revealed that on the application of 25µg/mL or greater amount of ethyl acetate extract suppressed the expression of pro inflammatory enzymes and cytokines viz, iNOS, COX – 2, 1L - 1β, 1L – 6, and TNF – α drastically[34].

Anticancer potential

The security effects of the methanol extract of *S. asper* against carbon tetra chloride (CCl_4) induced oxidative stress in lungs have been examined. In this experiment the treatment of methanol extract of *S. asper* at 100 or 20 mg/kg body weight and 50 mg/kg body weight have given to male Sprague – Dawley rats orally after 48 h of CCl_4 treatment biweekly for 4 weeks. The result showed that the methanol extract of *S. asper* and rutin restored the lung content of GSH and CAT peroxidase, SOD, GSHPX, GST, GSR and quinine reductase to normal levels[35]. In an other study *S. asper* n- hexane extract was applied against $KBrO_3$ induced nephrotoxicity in rats. In this study 32 male albino rats were randomly divided in to 4 groups and the experiment was go ahead for 6 weeks. Results demonstrated that introduction of $KBrO_3$ in rats significantly reduced activities of antioxidant enzymes (P <0.01) while enhanced nuclear organizer regions (NORs) per cell and telomerase enzyme activity and lipid peroxidation, Which were notably improved by co treatment of *S. asper* n-hexane extract. This study showed that the n-hexane extract of *S. asper* contain bioactive constituents which has ability of repairing DNA fragmentation, reduces regyrophylic nucleolar organizer regions (Ag NORs), regaining telomerase enzyme activity and also other enzymes[36].

Anti-phytotoxic activity

Antiphytotoxic effects of different solvent extracts of *S. asper* were evaluated against reddish growth under control environmental condition in growth chamber. Certain parameters were also studied in this experiment. The result revealed that in all the solvent extracts methanol extract exhibited marked antiphytotoxic activity[22].

Discussion

Spiny sow thistle (*S. asper*) is an annual herbaceous plant of Asteraceae family and has been grown as pot herb since long time. The data provided here revealed that with 50 known species of *Sonchus* widely distributed in Europe, Asia and in Africa, *S. asper* (L.) Hill is officially recorded a medicinal plant. The aerial part of this plant are a rich source of protein, vitamins, essential amino acids and some minerals. They are used as a tonic to purify blood. It is applied on fresh in injuries on wounds, cough, bronchitis and asthma. They may prove beneficial to some extent to treat icterohepatitis, cancer, inflammation, rheumatism and in diarrhoea. Thus due to its various remedial properties the plant of *S. asper* has been getting attention of the medical practitioners as well as international health food industry now a days.

According to this study it has been confirmed that *S. asper* possesses variety of pharmacological properties such as antibacterial, antifungal, antioxidant, phytochemical, anti-inflammatory, anticancer and anti-phytotoxic activities. It is highly rich in omega – 3 fatty acids. The methanol extract of *S. asper* leaves shows good antibacterial activity against several bacteria viz, *E. coli*, *B. cereus*, *S. aureus*, and *K. pneumonae*, however zone of inhibition is more against Gram-positive bacteria than Gram-negative bacteria. The difference in sensitivity of Gram-positive and Gram-negative bacteria might be due to noteworthy difference in cell wall composition of Gram-negative and Gram-positive bacteria[37]. Particularly in case of Gram-negative bacteria cell is rich in lipopolysaccharide which may be a region of difference of sensitivity in Gram-positive and Gram-negative bacteria. The methanol and ethyl acetate extract of *S. asper* shows marked antifungal activity against *A. niger* while butanol and aqueous extract against *F. solani*. These results clearly demonstrate that the methanol extract of *S. asper* is active; however it shows more activity against bacterial pathogens than fungal pathogens. Several findings showed that the inhibitory effects of plant extracts against bacterial pathogens is due to their phenolic composition[38,39] and antifungal property is due to saponins[40,41].

The antioxidant properties of *S. asper* plant are due to the presence of phenol or flavonoid components[27]. Due to the presence of various flavonoid contents plants may show antioxidant activities, however, phenol compounds are also good antioxidant agents, which act as terminators of free radical. From the study it was clear that the plant of *S. asper* has diverse antioxidant compounds viz., catechin, carotenoids and many other phenol compounds[27]. In addition to the anti-inflammatory potential the hydroalcohol leaf extract of *S. asper* as well as one of its major constituent apigenin – 7 – glucoside (AP - 7- G) were significant[33]. From the anticancer potential point of view it is found that the methanol extract of *S. asper* and its rutin can protect the lungs against CCl_4 induced oxidative damage in rats and n-hexane extract of *S. asper* was also found effective against $KBrO_3$ induced nephrotoxicity in rats. A similar study also

suggested that the induction of $KBrO_3$ caused oxidative DNA damage in rats. Which also support these investigations[42,43]. It indicates that to some extent *S. asper* could be used as a potential resource of anticancer drug[35]. Although *S. asper* is an invasive plant species[44]. But the research carried out by scientists and nutritionists have proved it is potent nutritional and medicinal plant than any other leafy vegetables[30]. Different parts of the *S. asper* are used for different function as leaves and roots of the plant are used in indigestion and as a febrifuge. The roots of the plant act as a vermifuge and the stems are prescribed as a sedative and tonic[45].

Conclusion

The present study reviewed the botanical description, ethnopharmacological uses, active phytochemicals and pharmacological activities of *S. asper*. This plant showed therapeutic potentials however unfortunately not all but some of the pharmacological studies were conducted *in vitro*, however *in vivo* studies also needed to explore their activities in depth in animals to validate it's *in vitro* activities. This plant reveals good therapeutic potential as anticancer agent against various cell lines. Further studies must be conducted to evaluate *S. asper* anticancer activity through *in vivo* studies and clinical trials. In addition, clinical test must be held to evaluate *S. asper* in clinical efficacy for humans. The data discussed might be useful in formulating new antimicrobial drug for treatment of infectious diseases also. The isolated compounds mentioned in the review may afford new drug entity with lesser cost and more efficacy.

Acknowledgement

ANT is thankful to University Grant Commission (UGC), New Delhi, for financial support under UGC-JRF Fellowship. Thanks are also due to local people and knowledgeable persons who provided useful information about the traditional usage of *S. asper* plants in the folk remedial system.

Conflict of interest

The authors declare that they have no conflict of interest.

References

1 Fabricant D S and Farnsworth N R, The value of plants used in traditional medicine for drug discovery, *Environ Health perspect*, 2001, **109**, 69-75.

2 Diallo D, Hveen B, Mahmood M A, Belge G, Paulsen B S, *et al.*, An ethnomedicinal survey of herbal drugs of Gourma district, Mali, *Pharm Biol*, 1999, **37**, 80-91.

3 Tripathi Y C and Singh S, Prospecting phytomedicinal diversity: Threats and challenges. In *Recent progress in Medicinal plants- Plant bioactivity in traditional medicine*, vol 9, edited by D K Majumdar, J N Govil, V K Singh, R K Sharma, (USA: Studium Press LLC, Houston, Texas), 2005, 425- 441.

4 Pushpangadan P, Biodiversity and emerging benefit sharing arrangements- challenges and opportunities for India, in *Proc Natl Acad Sci* (PINSA), 2002, 297-314.

5 Uniyal A K, Singh C, Singh B, Kumar M, Tiexeria D A, *et al.*, Ethnomedicinal use of wild plants in Bundelkhand region Uttar Pradesh, India, *J Med Aromat Plant Sci Biotechnol*, 2011, **5**, 81-86.

6 Rojas R, Bustamanate B and Baur J, Antimicrobial activity of selected Peruvian medicinal plants, *J Ethanopharmacol*, 2003, **88**, 199- 204.

7 Balandrin M F, Holke J K, Wurtele E S and Bolinger W H, National plant chemicals: Source of industrial and medicinal material, *Sci*, 1985, **228**, 1154-1160.

8 Vashist H and Jindal A, Antimicrobial activities of medicinal plants- Review, *Int J Res Pharm Biomed Sci*, 2012, **3**(1), 222-230.

9 Holm L, Doll J, Holm E, Pancho J and Herberger J P, *World Weeds- Natural Histories and Distribution*, (John Willey & Sons, New York), 1997.

10 Hutchinson I, Colosi J and Lewin R A, The biology of Canadian weeds, 63- *Sonchus asper* (L.) Hill and *Sonchus oleraceous* (L.), *Can J Plant Sci*, 1984, **64**, 731-744.

11 Qureshi S J, Awan A G, Khan M A and Bano S, Taxonomic study of the genus *Sonchus* L. from Pakistan, *Online J Biol Sci*, 2002, **2**(5), 309-314.

12 Upadhyay H, Kumar A, Gupta M K, Sharma A and Rahal A, Validation of medicinal values of traditionally used *S. asper* leaves for the treatment of skin ailments, *Adv Med Plant Res*, 2013, **1**(1), 29-35.

13 Koche D K, Shirsat R P, Imran S, Nefees M, Zingare A K, *et al.*, Ethnomedicinal survey of Nageria wild life Sanctuary, District Gondia (M.S) India Part-2, *Elsevier*, 2008, **12**, 532-537.

14 Zabihullah Q, Rashid A and Akhter N, Ethnobotanical survey in Kot Manzary Baba valley of Malakand Agency, Pakistan, *Pak J Plant Sci*, 2006, **12**, 115–121.

15 Hussain J, Muhammad Z, Ullah R, Khan F U, Khan I U, *et al.*, Evaluation of the chemical composition of *Sonchuseruca* and *Sonchus asper*, *J Am Sci*, 2010, **6**(9), 231-235.

16 Petropoulos S A, Fernandas A, Tzortzakis N, Sokovic M, Ciric A, *et al*., Bioactive compounds content and antimicrobial activities of wild edible Asteraceae species of the Mediterranean flora under commercial cultivation conditions, *Food Res Int*, 2019, **119**, 859-868.

17 Panfili G, Niro S, Bufano A, D'Agostino A, Fratianni A, *et al.*, Bioactive compounds in wild Asteraceae edible plants consumed in the Mediterranean diet, *Plant Foods Hum Nutr*, 2020, **75**(4), 540-546.

18 Fratianni A, D'Agostino A, Niro S, Bufano A, Paura B, *et al.*, Loss or gain of lipophylic bioactive compounds in vegetables after domestic cooking? Effect of steaming and boiling, *Foods*, 2021, **10**(5), 960.

19 Hanif M A, Al-Maskari M Y, Al-Maskari A, Al-Shukaili A, Al-Maskari A Y, *et al.*, Essential oil composition, antimicrobial and antioxidant activities of unexplored Omani basil, *J Med Plant Res*, 2010, **5**(5), 751-757.

20 Hanif M A, Al-Maskari A Y, Al-Mahruqi Z M H, Al-sabahi J N, Al-Azkawi A, *et al.*, Analytical evaluation of three wild growing Omani medicinal plants, *Nat Prod Commun*, 2011, **6**(10), 1010.

21 Mallik P, Mishra S K and Satapathy K B, Studies on the antibacterial and antioxidant activities of *S. asper* (L.) Hill and *Seseli diffusum* (Roxb, ex sm.) Sant. & Wagh, *IOSR J Pharm Bio Sci*, 2014, **9**(6), 24-27.

22 Khan R A, Khan M R, Sahreen S and Bokhari J, Antimicrobial and phytotoxic screening of various fractions of *Sonchus asper*, *Afr J Biotechnol*, 2010, **9**(25), 3883-3887.

23 Jimoh F O, Adedapo A A and Afolayan A J, Comparision of the nutritive value, Antioxidant and Antibacterial activities of *S. asper* and *S. oleraceus*, *Rec Nat Prod*, 2011, **5**(1), 29-42.

24 Grierson D S and Afolayan A J, Antibacterial activity of some indigenous plants used for the treatment of wounds in the Eastern Cape, South Africa, *J Ethnopharmacol*, 1999, **66**, 103-106.

25 Afolayan A J, Extracts from the shoots of the *Arctotis arctotoides* inhibit the growth of bacteria and fungi, *Pharm Biol*, 2003, **41**, 22-25.

26 Ejaz T, Jabreen K, Iqbal S and Naeem A, Fungistatic potential of *S. asper* against *Botrytis cinerea* and *Rhizoctoniasolani*, *Int J Biosci*, 2017, 10(1), 327-334.

27 Khan M M, Iqbal M, Hanif M A, Mahmood M S, Naqvi S A, *et al.*, Antioxidant and antipathogenic activities of *Citrus* peel oil, *J Essent Oil Bear Plants*, 2012, **15**(6), 972-979.

28 Yin J, Kwon G J and Wang M H, The antioxidant and cytotoxic activities of *S. asper* (L.) extracts, *Nutr Res Pract*, 2007, **1**(3), 189- 194.

29 Helal A M, Nakamura N, EL-Askary H and Haatori M, Sesquiterpene Lactone Glucosides from *S. asper*, *Phytochem*, 2000, **53**, 473-477.

30 Guil-Guerrero J S, Gimenez-Gimenez A, Rodrguez-Garc L and Torija-lsasa M E, Nutritional composition of *Sonchus* species (*S. asper* L., *S. oleraceous* L. and *S. temerrimus* L.), *J Sci Food Agric*, 1998, **76**, 628-632.

31 Mercadante A Z and Rodriguez-Amaya D B, Carotenoid composition and vitamin A value of fruits and vegetables in common use in Egypt, *Zeitschrift Fur Ernahrungswissenchaft*, 1997, **16**, 158-162.

32 Samreen U, Ibrar M, Ullah B and Badshah B, Insecticidal activity of *S. asper* root and leaf, *Curr Opin Agric*, 2014, **3**(1), 22-25.

33 Zarei M, Mohammadi S, Sahidi S and Fallahzadeh, Effect of *Sonchus asper* and apigenin-7- glucoside on nociceptive behaviors in mice, *J Pharm Pharmacogn Res*, 2017, **5**(4), 227-237.

34 Wang L, Xu M L, Liu J, Wang Y, Hu J H, *et al.*, *Sonchus asper* extract inhibits LPS – induced oxidative stress and proinflammatory cytokine production in RAW 264.7 macrophages, *Nutr Clin Pract*, 2015, **3**(6), 579-585.

35 Khan R A, Protective effects of *Sonchus asper* against CCL_4 induced oxidative stress in the Thyroid tissue of Rats, *BMC Complem Altern Med*, 2012, **12**, 181-187.

36 Khan R A, Khan M R, Sahreen S, Sah N A, Bokhari J, *et al.*, Potassium bromate ($KBrO_3$) induced nephrotoxicity: Protective effects of n- hexane extract of *Sonchus asper*, *J Med Plant Res*, 2011, **5**(25), 6055-6060.

37 Vasney S, Vashney P, Dash S K, Gupta M K, Kumar A, *et al.*, Antibacterial activity of fruits of *Terminelia chebula* and *Terminalia belerica* against mastitie field isolates, *Med Plants*, 2012, **4**(3), 167-169.

38 Baydar N G, Sagdic O, Ozkan G and Cetin S, Determination of antibacterial effects and total phenolic contents of grape (*Vitisvinefera* L.) seed extracts, *Int J Food Sci Technol*, 2006, **41**, 799-804.

39 Rodriguez N, Amilis R, Jimenz-Ballesta R, Rufo L and Dela-Fuente V, Heavy metal content in *Erica andvalenses* an endemic plant from extreme acidic environment of Tinta river and its soils, *Arid Land Res Manag*, 2007, **21**(1), 51-65.

40 Aboba O O and Efuwape B M, Antibacterial properties of some Nigerian species, *Biochem Biophys Res Commun*, 2001, **13**, 183-188.

41 Mohanta T K, Patra J K, Rath S K, Pal D K and Thatoi H N, Evaluation of antimicrobial activity and phytochemical screening of oils and nuts of *Semicarpus anacardium*, *Life Sci Res Essay*, 2007, **2**(11), 486-490.

42 Khan M R, Rizvi W, Khan G N, Khan R A and Saheen S, Carbon tetra chloride induced nephrotoxicity in rats: Protective role of *Digeriamuricata*, *J Ethnopharmacol*, 2009, **122**, 91-99.

43 Khan N and Sultana S, Chemomodulatory effects of *Ficus racemosa* extract against chemically induced renal carcinigenesis and oxidative damage response in wister rats, *Life Sci*, 2005, **77**, 1194- 1210.

44 Seker K C, Manikandan R and Srivastava S K, Invasive-alien plants of Uttarakhand Himalaya, *Proc Natl Acad Sci* India, Sect Biol Sci, 2012, **82**(3), 375-383.

45 Ambasta S P, The Useful Plants of India, National Institute of Science Communication, CSIR, New Delhi 1992, 584.