Research Article

Antioxidant Potential and Antimicrobial Activity of Extracts of *Sassurea Taraxacifolia (Astraceae)*

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ABSTRACT

The objective of the experiment is to evaluate antioxidant potential and antimicrobial activity of various extracts of *Sassurea taraxacifolia.* The air dried powdered plant material of *Sassurea taraxacifolia* was extracted with petroleum ether, ethyl acetate and methanol using Soxhlet's apparatus and the extracts were concentrated using rotary evaporator. All the extracts were evaluated for total phenolic content, total flavonoid content, total antioxidant capacity, reducing power, ability to scavenge various free radicals and ferrous ion chelation. The antibacterial activity of various extracts was assessed by disc diffusion method. The study revealed presence of phenolics and flavonoids in the all extracts of *S. taraxacifolia*. The phenolic content was maximum in ethyl acetate extract and lowest in the petroleum ether extract and expressed in terms of gallic acid equivalent ranged from 97 to 389 GAE/g extract. The flavonoid content expressed as rutin equivalent ranged from 51 to 189 RE/g extract. The reducing power of the extract was comparable to rutin. The extract exhibited moderate to potent DPPH radical scavenging activity with EC_{50} values ranging from 343.26 to 63.57µg/mL. ABTS radical cation scavenging ability ranged from 3976.42 to 12645.89µmol trolox equivalent/g. The extracts also exhibited fair ferrous ion chelating activity. However, extracts exhibited moderate to poor antibacterial activity with methanolic extract showing highest antibacterial activity. The results of the present study revealed the potential antioxidant potential of *Sassurea taraxacifolia.* The ethyl acetate extract was superior to methanolic and petroleum ether extract in most of the antioxidant assays. In conclusion, ethyl acetate of *Sassurea taraxacifolia* possesses fair antioxidant activity and moderate antibacterial activity.

Keywords: antioxidant, *Sassurea taraxacifolia*, phenolic, Antimicrobial

INTRODUCTION

Oxidation is a crucial process in many living organisms to produce energy for biological processes.[1] Oxygen uptake inherent to cell metabolism produces reactive oxygen species (ROS) which are continuously produced by body's normal use of oxygen in respiration and some cell mediated immune functions.[2] ROS are various forms of activated oxygen like peroxy radicals, hydroxyl radicals, superoxide anion radicals and non free radical species such as hydrogen peroxide and singlet oxygen. ROS if not scavenged by cellular processes, are capable of damaging crucial biomolecules such as nucleic acids, lipids, proteins and carbohydrates and accordingly are associated with cancer, coronary heart disease, atherosclerosis, Alzheimer's disease, diabetes mellitus, hypertension, ageing and osteoporosis.[3-5] The harmful action of these free radicals can be blocked by antioxidant substances which scavenge these free radicals and detoxify the organism.

Antioxidants are compounds that can delay or inhibit the oxidation of lipid or other molecules by inhibiting the initiation or propagation of oxidizing chain reactions.[6] Several synthetic antioxidants such as butylated hydroxyl anisole (BHA), butylated hydroxyl toluene (BHT), tert-butyl hydroquinone and propyl gallate (PG) are commercially available, however BHA and BHT have been suspected of being responsible for liver damage and carcinogenesis.[7-9] Therefore, interest in search for new effective natural antioxidants has grown over the past years.

Sassurea taraxacifolia (Family Astraceae) is a deciduous herb used in folk medicine as carminative, antiseptic and anti-inflammatory in Garhwal Himalayas, Uttarakhand, India.[10] The present paper for first time reports the antioxidant potential and antimicrobial activity of *Sassurea taraxacifolia* from the high altitude regions of Garhwal Himalayas, Uttarakhand, India. The aim of this research work was to determine the total phenolic content and total flavonoid content of the extracts of *S. taraxacifolia* and to evaluate their antioxidant potential and antibacterial activity.

MATERIALS AND METHODS

Chemicals

Sodium carbonate, gallic acid, Folin-Ciocalteu reagent, sodium nitrite, aluminum chloride, sodium hydroxide, rutin, ammonium molybdate, sodium phosphate, ferric chloride, potassium ferricyanide, trichloroacetic acid, 2, 2-diphenyl-1-picryl-hydrazyl (DPPH), potassium persulfate, 2,2′-azinobis-(3-ethylbenzothiozoline-6-sulfonic acid)-diammonium salt (ABTS), 6-hydroxy-2,5,7,8-tetramethylchroman-2-carboxylic acid (Trolox), sodium nitroprusside, ferrozine, ferrous chloride, ethylenediamine tetracetic acid (EDTA) disodium salt, butylated hydroxyl anisole(BHA) and ascorbic acid were

obtained from Himedia Chemicals or Sigma. All other reagents used were of analytical grade.

Plant Material

The plant *Sassuria taraxacifolia* was collected from Tharali, district Chamoli Garhwal, Uttarakhand, India at the height of around 11000 feet and identified from Botanical Survey of India, Dehradun, Uttarakhand, India. Freshly collected plant materials were dried under shade and the dried samples were powdered before extraction with solvents.

Solvent Extraction

The air dried powdered plant material was extracted with petroleum ether, ethyl acetate and methanol in soxhlet extractor. The extracts were concentrated by rotary vacuum evaporator and then dried. The dried extracts were used directly for the estimation of antioxidant potential through various chemical assays and determination of total phenolics, total flavonoid and antimicrobial activity assay.

Determination of Total Phenolic Content

The total phenolic content (TPC) was determined according to the method described by Mbaebie.[11] The reaction mixture was composed of 0.5ml extract, 2.5mL of the Folin-Ciocalteu's reagent (10% v/v) and 2.0mL of saturated sodium carbonate solution. The resulting mixture was vortexed for 15 sec and incubated at 40°C for 30 min for color development.

The absorbance of total phenolics was measured at 765nm. Standard gallic acid solutions were used for calibration curve and results were expressed as gallic acid equivalent per gram of extract.

Determination of Total Flavonoid Content

The 500µl extract was diluted appropriately and mixed with 1mL $NaNO_2$ (5%). After standing for 6 min, 1mL of 10% $AlCl_3$ and 10mL of NaOH (1M) were added to the mixture. The mixture was adjusted to 25mL with 70% ethanol and allowed to rest for 15 min.

The absorbance (A) was measured at 510nm, with 70% ethanol as a blank control.[6] Rutin was used as a reference standard and the total flavonoid content was expressed as rutin equivalents (RE, mg/g extract). All determinations were performed in triplicate.

Total Antioxidant Capacity

Total antioxidant activities of fractions were determined according to the method of Prieto.[12] Briefly, 0.3mL of sample was mixed with 3.0mL reagent solution (0.6M sulfuric acid, 28mM sodium phosphate and 4mM ammonium molybdate).

Reaction mixture was incubated at 95°C for 90 min under water bath. Absorbance of all the sample mixtures was measured at 695nm. Total antioxidant activity (TAOC) was expressed as ascorbic acid equivalent.

Reducing Power

The reducing power of extracts was determined according to the method by Oyaizu.[13] The different concentration of extracts (10-60µg/mL) in 1mL of solvent was mixed with 2.5mL phosphate buffer (0.2M, pH 6.6), 2.5mL of 1% potassium ferricyanide. The mixture was incubated at 50°C for 20 min and 2.5mL of 10% trichloroacetic acid was added. The reaction mixture was then centrifuged for 10 min. Further, 2.5mL of the supernatant solution was mixed with 2.5mL of distilled water and 0.5mL of 0.1% $FeCl_3$. The absorbance was measured at 700nm.

DPPH Free Radical Scavenging Activity

The antioxidant activity of the extracts was determined in terms of hydrogen donating or radical scavenging ability using the stable radical DPPH.[14] A 2mL aliquot of each solution was added to 2mL of $2x10^{-4}$mol/L ethanolic DPPH solution.

The mixture was shaken vigorously and the absorbance was measured at 517nm immediately. The decrease in absorbance was determined at 15 and 30 min until the absorbance reached a steady state (after nearly 30 min). The mixture with the addition of standard antioxidants served as a positive control. All the tests were performed in triplicate, and the inhibition rate was calculated according to the formula:

$$\% \text{ Inhibition of DPPH free radical} = \frac{(A_{blank} - A_{sample})}{A_{blank}} \times 100$$

Where, A_{blank} is the absorbance of the DPPH solution without extract or standard, A_{sample} is the absorbance of the solution in which the extract/standard was added.

ABTS Free Radical Scavenging Activity

ABTS free radical was produced by reacting 7mM ABTS aqueous solution with 2.4mM potassium persulfate in the dark for 12–16 h at room temperature. Prior to assay, this solution was diluted in ethanol (about 1: 89 v/v) and equilibrated at 30°C to give an absorbance at 734nm of 0.700 ± 0.02. The stock solution of the sample extracts were diluted such that after introduction of 10µL aliquots into the assay, they produced between 20% and 80% inhibition of the blank absorbance. After the addition of 1mL of diluted ABTS solution to 10µL of sample or Trolox standards in ethanol, absorbance was measured exactly 30 min after the initial mixing. Appropriate solvent blanks were also run in each assay and the percentage inhibition of the blank absorbance was calculated at 734nm.[15]

$$\% \text{ Inhibition of ABTS free radical} = \frac{(A_{blank} - A_{sample})}{A_{blank}} \times 100$$

Triplicate determinations were made at each dilution of the standard, and the percentage inhibition was calculated of the blank absorbance at 734nm and plotted as a function of Trolox concentration. The unit of total antioxidant activity (TAA) is defined as the concentration

of Trolox having equivalent antioxidant activity expressed as µmol/g extract.

Ferrous ion Chelation

The chelating activities of extracts on Fe^{2+} were estimated based on the decrease in the maximal absorbance of the iron (Fe^{2+})–ferrozine complex.[16] 1mL of extracts/standard was incubated with 0.5mL of ferrous chloride (1.0mmol/L). The reaction was initiated by the addition of 1mL of ferrozine (5.0mmol/L), and the total reaction volume was adjusted to 4mL with ethanol. After the mixture had reached equilibrium (10 min), the absorbance was measured at 562nm. The negative control was prepared without the extract and EDTA was used as the positive control. The chelating activity of the extract on Fe^{2+} was calculated as follows:

$$\text{Chelating activity (\%)} = \left[\left(\frac{A_{control}}{A_{sample}}\right) - 1\right] \times 100$$

Antimicrobial Activity

Bacterial cultures of *Salmonella thyphi, Escherichia coli, Staphylococcus aureus and Bacillus subtilis* used in this study were from clinical samples at HNB Garhwal University (A Central University), Srinagar Garhwal, Uttarakhand, India. The susceptibility tests were performed by Mueller Hinton agar-well diffusion method. The bacterial strains grown on nutrient agar at 37°C for 18 h were suspended in a saline solution (0.9%, w/v NaCl) and adjusted to a turbidity of 0.5 Mac Farland standard (10^8 CFU/mL). To obtain the inocula, these suspensions were diluted 100 times in Muller Hinton broth to give 10^6 colony forming units (CFU)/mL.

The extracts were dissolved in their respective solvents to obtain final concentration of 250µg/mL. The sterile discs (6mm) were impregnated with 10µL of the extracts. Petri plates were prepared with 20mL of a Mueller Hinton agar (Hi Media Chemicals). Each Petri plate was inoculated with 15µL of each bacterial suspension (10^6 CFU/ml). After drying, 6mm diameter discs soaked with 10µL of the different extracts were placed on the agar.

Discs containing Ofloxacin (5µg/disc) were used as positive controls and solvents as a negative control. The plates were incubated for 24 h at 37°C and at 44°C for *Escherichia coli* because this bacterium is thermo resistant. The diameters of the inhibition zones were evaluated in millimeters. The extract inducing inhibition zone ≥ 3 mm around disc were considered as antibacterial.

All tests were performed in triplicate and the bacterial activity was expressed as the mean of inhibition diameters (mm) produced.

Statistical Analysis

Experimental results are expressed as mean ± SD of three measurements. *P* values <0.05 were regarded as significant and *P* values <0.01 very significant.

RESULTS AND DISCUSSION

Total Phenolic Content

Plants are potential sources of natural antioxidants because they contain phenolic compounds such as phenolic acids, flavonoids, tannins, and phenolic diterpenes. The presence of phenolic compound in the extract was determined by Folin-Ciocalteu method. This method is based on the principle that oxidation of phenol by molybdotungstophosphoric reagent yield a colored product that can be estimated by measuring absorbance at 765nm.[17] Gallic acid was used as reference standard and the phenolic content of the extracts was expressed in mg Gallic acid equivalents per gram of extract (Figure 1). The highest amount of phenolic content was found in the ethyl acetate extract followed by methanolic and the petroleum ether extract of *S.taraxacifolia*. The mean of the total phenolic content per gram of extract of ethyl acetate extract (389.1 ± 13.2 mg GAE/g) was found to be higher than that of methanolic (294 ± 11.7 mg GAE/g) and petroleum ether extract (97.6± 8.9 mg GAE/g).

Total Flavonoid Content

Phenolic compounds include a wide range of substances which possess in common an aromatic ring bearing one or more hydroxyl substituents. Flavonoids form the largest group within phenolic compounds which also include tannins, stilbenes, curcuminoids, coumarins, lignans and quinines. Flavonoid as a group possesses a wide range bioactive capacities including antioxidant activity.[18] The determination of total flavonoid content using aluminum chloride is based on the formation of stable complex between aluminum chloride and keto and hydroxyl groups of flavonoids. The total flavonoid content of the extracts of *S. taraxacifolia* is expressed as rutin equivalents in mg/g extract (Figure 2). Rutin, a lipid-soluble analogue of flavonoids, was used as a reference antioxidant compound. The flavonoid content in the various extracts ranged from 51 to 189 mg RE/g. The ethyl acetate extract showed highest amount of flavonoids whereas the petroleum ether extract the least. Flavonoids are reported to be responsible for antioxidant activity owing to the presence of hydroxyl groups in their chemical structure. The high amount of flavonoids in the extract indicated the possible antioxidant potential of the extracts.

Total Antioxidant Capacity

Total antioxidant capacity is often related to the presence of phenolic content. The determination of total antioxidant capacity by phosphomolybdenum method involves reduction of molybdenum VI (Mo^{6+}) to form a green phosphate/Mo^{5+} complex at acidic pHs which was then estimated by measuring absorbance at 695nm. High absorbance values indicate that the sample possesses significant antioxidant activity. The calibration curve of standard ascorbic acid solutions was used to determine the total antioxidant capacity of the various extracts of *S. taraxacifolia* and the results are expressed as the number

of equivalent of ascorbic acid (mg/g extract). The antioxidant capacity of petroleum ether, ethyl acetate and methanolic extracts are 14.32 ± 2.1, 41.47 ± 4.35 and 19.31 ± 3.2 respectively (Figure 3). The ethyl acetate extract showed the highest total antioxidant capacity when compared to methanolic and petroleum ether extract.

Reducing Power

Ferric reducing antioxidant power (FRAP) assay is based on reducing power mechanism and is an indication of potential antioxidant activity. FRAP assay was originally applied to plasma but is now commonly used in a vast number of matrixes.[19] Reducing activity was determined based on the ability of extracts/reference compounds to reduce a yellow color Fe^{3+}/Ferric cyanide complex to form Fe^{2+} ferrous complex. The amount of Fe^{2+} was monitored by measuring the formation of blue color at 700nm. A higher value of absorbance implies higher concentration of Fe^{+2}-complex and indicate higher reducing power of the extracts/reference compounds. Polyphenolic contents in the extract may function as electron and hydrogen atom donors and therefore should be able to terminate radical chain reaction by converting free radicals and reactive oxygen species to more stable products. The correlation between the polyphenolic constituents and reducing power activity has been reported for several plant extracts.[20] The methanolic extract demonstrated highest reducing power which was even better than the reference rutin in the concentration range of 10-60µg/ml (Figure 4). BHA, a synthetic antioxidant demonstrated significant reducing power far better than the extracts and rutin. The results also suggest that the methanolic extract of *S. taraxacifolia* has a fair ability to donate electrons to reactive free radicals and convert them into stable products.

DPPH Free Radical Scavenging Activity

This colorimetric assay uses the DPPH (2, 2-diphenyl-1-picrylhydrazyl) radical which changes it color from purple to yellow in the presence of antioxidants and is widely used to evaluate the antioxidant potential. DPPH radical scavenging method is based on the principle that a hydrogen donor is an antioxidant. Scavenging of the DPPH radical is also linked to the inhibition of lipid peroxidation. The results of the assay showed that all the extracts of *S. taraxacifolia* possess ability to reduce stable purple colored DPPH radical to yellow colored diphenylpicryl hydrazine suggesting that the extracts are capable of donating hydrogen and acting as antioxidants. The methanolic extract was most potent in scavenging the DPPH radical in comparison to ethyl acetate and petroleum ether extract. The petroleum ether extract showed least ability to scavenge the DPPH radical. However, the radical scavenging ability was significantly lower than that of the synthetic antioxidants like BHA and ascorbic acid. The scavenging ability of the methanolic extract was however comparable to rutin. The potential to scavenge the DPPH radical was measured by determining the EC_{50} value which indicate the concentration required to inhibit 50% of DPPH free radicals. A higher DPPH radical scavenging activity is associated with a lower EC_{50} value. EC_{50} value of the methanolic extract (63.57µg/mL) was much lower than that of ethyl acetate (160.21µg/mL) and petroleum ether extract (343.26µg/mL) of *S. taraxacifolia* (Figure 5). EC_{50} value of methanolic extract was comparable to rutin (45µg/mL), however it was much higher than synthetic antioxidant BHA (10µg/mL) and ascorbic acid (21µg/mL).

ABTS Radical Cation Scavenging Assay

ABTS is a stable radical cation with blue color and characteristic absorption at 734nm. ABTS radical cations are more reactive than DPPH radicals and unlike the reactions with DPPH radical which involve H-atom transfer; the reactions with ABTS radical cation radicals involve electron transfer process.[21] In this method an antioxidant is added to preformed ABTS radical cation and after a fixed time period the remaining ABTS is quantified spectrophotometrically. In ABTS radical cation scavenging assay, the activity of the tested sample extracts was expressed as Trolox equivalent antioxidant capacity (TEAC) defined as micromolar Trolox solution having an antioxidant capacity equivalent to 1g extract. Trolox (6-hydroxy-2,5,7,8-tetramethylchroman-2-carboxylic acid) a water soluble analog of vitamin E is used as standard to represent the antioxidant strength of sample. The extracts exhibited good ABTS radical scavenging ability as all of them were capable of decolorizing the ABTS radical color. The ethyl acetate extract demonstrated highest Trolox equivalent activity of 12645.89 whereas the petroleum ether extract exhibited the least with TEAC of 3976.42 (Figure 6).

Ferrous ion Chelation

Elemental species such as ferrous iron (Fe^{2+}) can facilitate the production of reactive oxygen species (ROS) within animal and human systems and accordingly the ability of substances to chelate iron can be a measure of its antioxidant capability. Chelation of transition metal prevent them to act as catalysts for the Fenton type reaction and catalysis of hydroperoxide, and is one of the important mechanisms of antioxidant activity.[22] Therefore, the extracts of *S. taraxacifolia* were also evaluated for iron (II) chelating ability. Chelating agents reduce the redox potential and thus stabilize the oxidized form of the metal ions and may serve as secondary antioxidants. EDTA was used as a positive control in this assay. The ethyl acetate and methanolic extract of *S. taraxacifolia* exhibited ability to chelate ferrous ion. The chelating ability of the methanolic extract (51.65%) was higher than ethyl acetate extract (43.67%) at the concentration of 100µg/mL (Figure 8). The chelating ability of the methanolic extract was comparable to the rutin, however it was significantly low when compared to standard EDTA. It has also been reported that phenolic compounds with a properly oriented functional groups can chelate with metal ions and therefore, the phenolic

compounds in the methanolic extract with properly oriented functional groups may be held responsible for higher chelating activity.

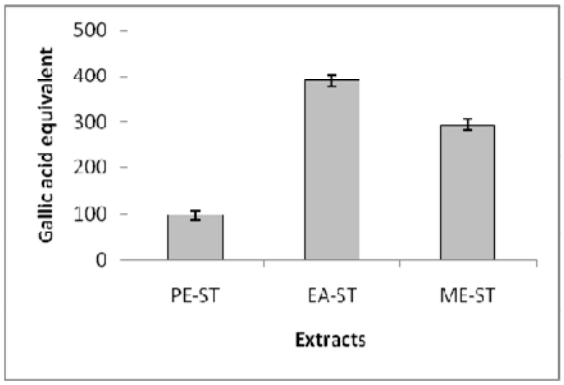
Antimicrobial Activity

The antibacterial assays were performed by the agar-well diffusion and minimum zone of inhibition (mm) were determined. The results of antibacterial study revealed that the extracts possesses moderate to low antibacterial activity (Table 1).

The susceptibility of the bacteria to the extracts varied according to the microorganism and the polarity of the extract.

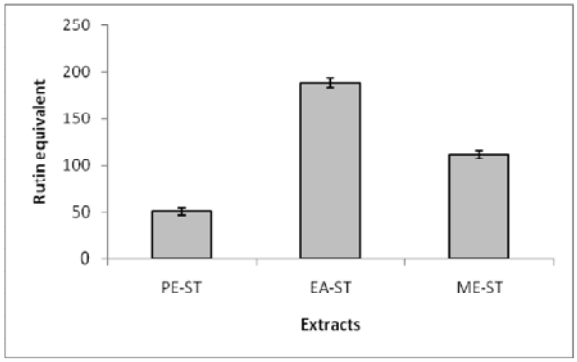
The methanolic extract exhibited the most potent antibacterial activity when compared to the ethyl acetate and petroleum ether extract.

The zone of inhibition was highest in *Staphylococcus aureus* (17.67±1.73mm) and least in *Escherichia coli* (9.67±1.52mm) for methanolic extract of *S. taraxacifolia.* The ethyl acetate extract showed varied zone of inhibition from 9.33±1.15mm to 14.33±1.52mm against all the tested bacteria. The antibacterial activity was however significantly less when compared with the positive control Ofloxacin. The terpenes and phenolic content such as flavonoids and tannins possess antibacterial activity.[23] The antimicrobial activity of flavonoids is due to their ability to complex with extracellular and soluble protein and to complex with bacterial cell wall while that of tannins may be related to their ability to inactivate microbial adhesions, enzymes and cell envelop proteins. The antibacterial activity of the methanolic extract may be due to the presence of flavonoids. The extracts also exhibited better inhibitory activity against Gram-positive bacterium in comparison to Gram-negative bacterium.[24,25] The permeability of the cell wall of the Gram-negative bacterium is generally poor than Gram-positive ones because of the presence of the high level of phospholipids in the cell wall compared with Gram-positive bacteria and this may be the probable reason for difference in spectrum of activity of the extracts.



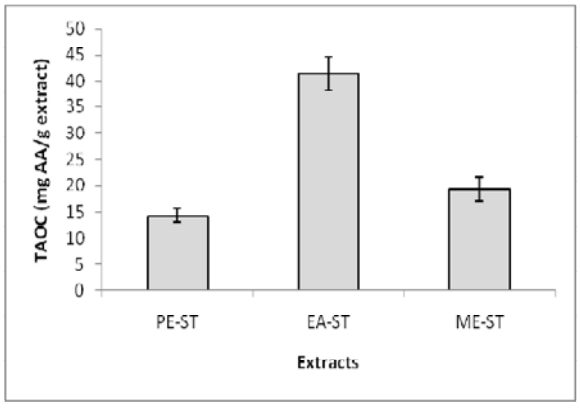
Note: PE-ST, EA-ST and ME-ST are petroleum ether, ethyl acetate and methanolic extracts of *S. taraxacifolia* respectively.

Figure 1: Total phenolic contents (mean of three determinations ± SEM) in extracts of *S. taraxacifolia* (GAE/g extract).



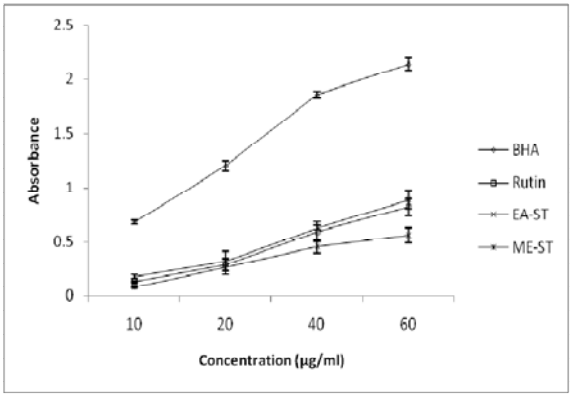
PE-ST, EA-ST and ME-ST are petroleum ether, ethyl acetate and methanolic extracts of *S. taraxacifolia* respectively.

Figure 2: Total flavonoid contents (mean of three determinations ± SEM) in extracts of S. *taraxacifolia* (Rutin equivalent/g extract)



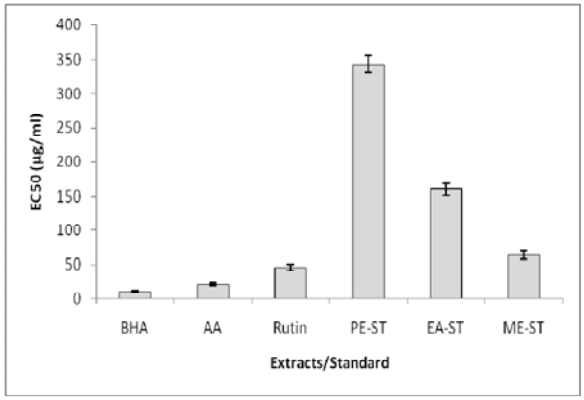
PE-ST, EA-ST and ME-ST are petroleum ether, ethyl acetate and methanolic extracts of *S. taraxacifolia* respectively.

Figure 3: Antioxidant capacity of extracts of *S. taraxacifolia* expressed as ascorbic acid equivalent (mean of three determinations ± SEM).



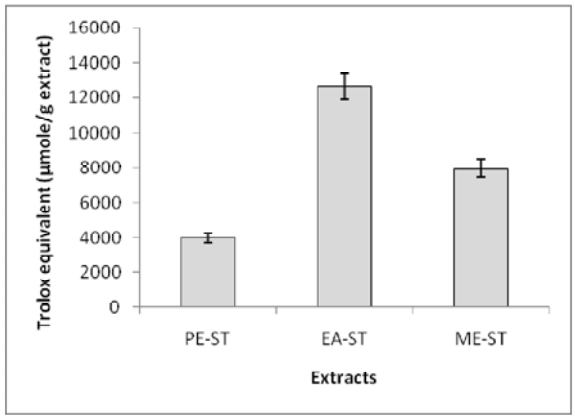
EA-ST and ME-ST are ethyl acetate and methanolic extracts of *S. taraxacifolia* respectively.

Figure 4: Reducing power (mean of three determinations ± SD) of the extracts of *S. taraxacifolia.*



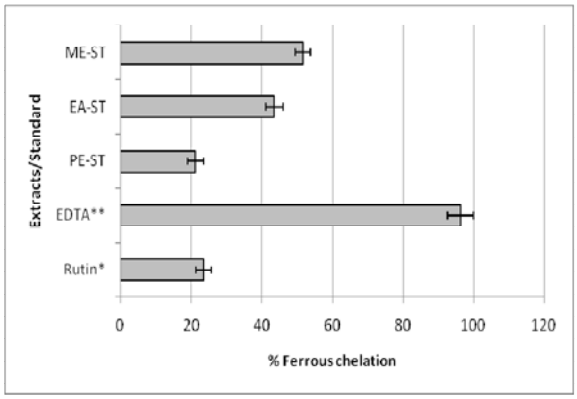
PE-ST, EA-ST and ME-ST are petroleum ether, ethyl acetate and methanolic extracts of *S. taraxacifolia* respectively.

Figure 5: DPPH radical scavenging ability (EC_{50} µg/mL ± SD) of extracts of *S. taraxacifolia.*



PE-ST, EA-ST and ME-ST are petroleum ether, ethyl acetate and methanolic extracts of *S. taraxacifolia* respectively.

Figure 6: ABTS radical cation scavenging ability (Trolox equivalent µmole/g ± SD) of the extracts of *S.taraxacifolia.*



PE-ST, EA-ST and ME-ST are petroleum ether, ethyl acetate and methanolic extracts of *S. taraxacifolia* respectively.

Figure 7: Ferrous ion chelating activity (% ferrous chelation ± SD) of extracts of *S. taraxacifolia.* *Rutin 50µg/mL, **EDTA 10µg/mL.

Table 1: Inhibition zone (mm diameter ± SD) observed in agar-well diffusion assay for extracts of *Sassurea taraxacifolia.*

Microorganism	Diameter of zone of Inhibition (mm)			
	PE-ST	EA-ST	ME-ST	Ofloxacin
E. coli	7.33 ± 1.15	9.33 ± 1.15	9.67 ± 1.52	26.33 ± 1.73
S. aureus	8.33 ± 1.15	14.33 ± 1.15	17.67 ± 1.73	14.67 ± 1.15
B. subtilis	8.67 ± 1.15	13.67 ± 1.52	15.33 ± 1.15	15.33 ± 1.52
S. typhi	7.33 ± 1.15	10.67 ± 1.52	11.33 ± 1.15	25.67 ± 1.52

CONCLUSION

In conclusion, the present study revealed antioxidant and antibacterial potential of the extracts of *Sassurea taraxacifolia.*

The antioxidant activity is exhibited by extracts by several mechanisms that include mechanisms like donation of hydrogen to scavenge DPPH radical or transfer of electrons to scavenge ABTS radical cations and ability to chelate metal ions like ferrous.

The presence of high phenolic compounds was held accountable for antioxidant activity in most of the assays.

The methanolic extract of *S. taraxacifolia* also exhibited moderate antibacterial activity.

Therefore, it can be concluded that ethyl acetate extract of *S. taraxacifolia* can be used as a source of natural antioxidants and suggests the need for further research to isolate, identify and characterize its phytoconstituents.

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REFERENCES

1. Wen XB, Miao F, Zhou L, Zhang M, He QL, *In vitro* antioxidant activity of *Parnassia wightiana* W. extracts. *Chinese J Nat Med,* 10(3), 2012, 190-195.
2. Ilhami G, Mahfuz E, Hassan YAE, Antioxidant activity of clove oil- A powerful antioxidant source. *Arabian J of Chem,* 5, 2012, 489-99.
3. Chi-Chun W, Hua BL, Ka-Weng C, Feng C, A systematic survey of antioxidant activity of 30 Chinese medicinal plants using the ferric reducing antioxidant power assay, Food Chem, 97, 2006, 705-711.
4. Lijun S, Jianbao Z, Xiaoyun L, Liyu Z, Yali Z, Evaluation of antioxidant activity of total flavonoids extract from persimmon (*Diospyros Kaki* L.) leaves. *Food Chem Toxicol,* 49, 2011, 2689-2696.
5. Feng L, Feifei W, Fang Y, Yong F, Zhihong X, Fangmei Y, *In vitro* antioxidant and anticancer activities of ethanolic extract of selenium-enriched green tea. *Food Chem*, 111, 2008, 165-170.
6. Patel DK, Kumar R, Prasad SK, Hemalatha S, *Pedalium murex* Linn. (Pedaliaceae) fruits: A comparative antioxidant activity of its different fractions. *Asian Pac J Trop Biomed,* 2011, 395-400.
7. Rengasamy R, Raja K, Rajasekaran A, Perumal A, *In vitro* antioxidant activities of ethanol extract from *Enhalus acoroides* (L.F.) Royle. *Asian Pac J Trop Biomed,* 2010, 898-901.
8. Ilhami G, Gungor S, Sukru B, Mahfuz E, Kufrevioglu O I, Comparison of antioxidant activity of clove (*Eugenia caryophylata* Thunb) buds and lavender (*Lavendula stoechas* L.). *Food Chem,* 87, 2004, 393-400.
9. Ozsoy LN, Yilmaz T, Kurt O, Cana A, Yanardag R, *In vitro* antioxidant activity of *Amaranthus lividus*. *Food Chem,* 116, 2009, 867-872.
10. Gaur R D. *Flora of district Garhwal, North West Himalaya*. Transmedia: Srinagar Garhwal; 1999, 102-105.
11. Mbaebie BO, Edeoga HO, Afolayan AJ, Phytochemical analysis and antioxidants activities of aqueous stem bark extract of *Schotia latifolia* Jacq. *Asian Pac J Trop Biomed,* 2012, 118-124.
12. Prieto P, Pineda M, Aguilar M, Spectrophotometric quantification of antioxidant capacity through the formation of phosphomolybdenum complex: specific application to determination of Vitamin E, *Anal Biochem,* 269, 1999, 337-341.
13. Oyaizu M, Studies on product browning reaction prepared from glucose amine. *Japan J Nutri,* 44, 1986, 307-315.
14. Sheng JC, Zhou J, Wang L, Xu J, Hu Q, Antioxidant activity of ethanol and petroleum ether extracts from Brazilian propolis. *Eur Food Res Tech,* 225(2), 2007, 249-253.
15. Roberta R, Nicoletta P, Anna P, Ananth P, Min Y, Catherine R E, Antioxidant activity applying an improved ABTS radical cation decolorization assay, *Free Rad Bio Med,* 26, 1999, 1231-1237.
16. Wang T, Jonsdottir R, Olafsdottir G. Total phenolic compounds, radical scavenging and metal chelation of extracts from Icelandic seaweeds. *Food Chem,* 116, 2009, 240-248.
17. Yuan Z, Wang ZZ, Phenolic composition and antioxidant activities of two Phlomis species: A correlation study. *C R Biologies,* 332, 2009, 816-826.
18. Jingsheng H, Huang B, Xiaoquan B, Jun T, Ling Z, Youwei W, *In vitro* and *in vivo* antioxidant activity of the ethanolic extract from *Meconopsis quintuplinervia*. *J Ethnopharmacol,* 141, 2012, 104-110.
19. Marcio C, Isabel C F R. A review on antioxidants, peroxidants and related controversy: Natural and synthetic compounds, screening and analysis methodologies and future perspectives. Food Chem Toxicol, 51, 2013, 15–25.
20. Amarowicz R, Pegg R B, Raim M, Bral P, Weil J A. Free radical scavenging capacity and antioxidant activity of selected plant species from the Canadian Prairies. *Food Chemistry,* 84, 2004, 551–562.
21. Kaviarasan S, Naik G H, Gangabhagirathi R, Anuradha C V, Priyadarsiniln K I. *In vitro* studies on antiradical and antioxidant activities of fenugreek (*Trigonella foenum graecum*) seeds. *Food Chem,* 103, 2007, 31–37.
22. Dinis TCP, Madeira VMC, Almeida LM, Action of phenolic derivatives (acetoaminophen, salycilate and 5-aminosalycilate) as inhibitors of membrane lipid peroxidation and peroxyl radical scavengers. *Arch Biochem Biophys;* 315, 1994, 161-169.
23. Cowan M M, Plants products as antimicrobial agents. *Clin Microbiol Rev,* 12, 1999, 564-582.
24. Erasto P, Bojase MG, Majindra RRT, Antimicrobial and antioxidant flavonoids from the roots wood of *Bolusanthus spesiosus*. Phytochem, 65, 2004, 875-880.
25. Kiessoun K, Adama H, Jacques FM, Alexis NL, Alain S, Nicolas B, Antimicrobial activity of polyphenol rich fractions from Sida alba L. (Malvaceae) against co-trimoxazole resistant bacteria strains. *Annals of Clin Micro Antimicrobials,* 11, 2012, 1-5.

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