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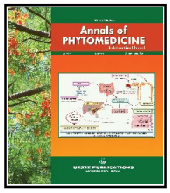

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Comparative antioxidant and antibacterial properties of different plant parts of a medicinally important tree, *Simarouba glauca* DC.

M.B. Manoj and M.H. Niranjan◆

Department of studies in Biotechnology, Davangere University, Shivagangotri, Davangere-577007, Karnataka, India

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Abstract

Different parts of *Simarouba glauca* DC, an important ethnomedicinal tree, were collected from the Kanchikeri forest, Harappanahallitaluk, Vijayanagara district, Karnataka, India and subjected to investigation for its phytochemical constituents, antioxidant and antibacterial properties. The extract's preliminary phytochemical screening results revealed that phenols were detected irrespective of the plant part studies, while glycosides and anthraquinones were absent in all the extracts evaluated. Besides, total phenolic, antioxidant activity and reducing power assay offered a concentration-oriented increase in the activity, with maximum activity noted in methanol extract of leaflet with rachis. The antibacterial studies indicated that all the solvent extracts offered inhibition against selected test pathogens. The methanol extract of leaflet with rachis offered maximum inhibition against the test pathogens with an MIC of 0.625 mg/ ml for *Staphylococcus aureus*, *Escherichia coli* and *Bacillus subtils,* whereas 1.25 mg/ ml for *Pseudomonas aeruginosa*, followed by chloroform extract. Overall, the study results justify the utilization of *Simarouba glauca* as a potential candidate for future drug discovery in the enhancement of bioactive metabolites of interest while *simultaneously conserving* the ethnomedicinally important tree.

1. Introduction

India is a well-diversified nation and a medicinal plants treasure house and is also rich with a variety of economically important plants. Hence, our ancestors used plants as the most important source for curing many diseases from prehistoric periods. Of the world's population, 80% use traditional medicine, which has compounds of medicinal importance (Alves and Rosa, 2005). Natural products possess various functions and are found to be useful for many biological applications (Heinrich *et al*., 2006; Chettri *et al*., 2008). There is a pressing need to uncover innovative chemicals active against highly resistant diseases, and it has been believed that herbal treatments offer the benefit of mixing their medicinal ingredients with numerous additional compounds that seem to be inert (Jaylakshmi *et al*., 2015; Al Habsi *et al*., 2018). Furthermore, in underdeveloped nations, synthetic medications are extremely costly and frequently contaminated (Jamshidi-Kia *et al*., 2018). Screening for the antimicrobial potential of compounds of both biotic and abiotic types is of enormous significance in recent years, as infections have grown to a large amount and resistance of pathogens against current antibiotics has turned out to be an ever-increasing treatment challenge (Ekor, 2014; Uddin *et al*., 2021).

Plants are natural sources that contain structurally distinct compounds that researchers are examining to identify potential bioactive properties that will lead to innovative medication development. Throughout the last several decades, phytochemistry studies have become one of the very important scientific fields for identifying and developing novel phytoconstituents of biological importance that are of importance *via* creative approaches in order to serve humanity (Uddin *et al*., 2021). Plants' therapeutic properties stem from the existence of secondary metabolites, some of which are beneficial bioactive substances capable of combating a variety of maladies and diseases (Eshbakova *et al*., 2022). The chemical constituents found in plants are called phytochemicals and possess medicinal values in treating/curing many diseases. As the physiological effects of these compounds are fixed and definite, they are more advantageous (Khameneh *et al*., 2021). Recently, it has been determined that the bacteria possess genetic features that allow them to enter the environment, persist in a niche, gather food sources, and evade clearance by host immunological and non-immune defensive mechanisms (Diard and Hardt, 2017; Worly, 2023). Although, most bacteria cause disease by directly damaging tissues, others produce toxins that are subsequently transported into the bloodstream to induce systemic pathogenesis. Not all bacteria produce disease; nevertheless, some inevitably cause disease once infected (Helmy *et al*., 2023).

Many drugs that have been discovered for various diseases are currently of plant origin, but there is still a lot of room for bio-prospecting novel plant-derived drugs for a variety of other diseases and ailments in pharmaceutical, agricultural, and food industries, cosmetics, natural products, including others that rely on plants for raw materials. In order to preserve traditional knowledge and its usage for discovering active chemical structures for medicine, it is vital to have joint efforts between contemporary and older information about plants (Najmi *et al*., 2022). Antimicrobial activity checks whether the plant has the property to resist the attack of pathogens or whether it will be used to manufacture drugs against microbial

Corresponding author: Dr. M.H. Niranjan
Associate Professor, Department of studies in Biotechnology, Davangere University, Shivagangotri, Davangere-577007, Karnataka, India
E-mail: niranmhniran@gmail.com
Tel.: +91-9449131751

diseases. *Simarouba* species have numerous bioactive chemical constituents, including glaucarubin and simaroubidin that have many pharmacological properties (Manasi and Gaikwad, 2011; Kumar *et al*., 2014). The species, *S. glauca* is a pharmacologically significant plant used to treat malaria, stomach ache, fever and intestinal diseases, analgesia, and antimicrobials (Kumar *et al*., 2014; Hemanth Kumar *et al*., 2020). As a result of its extensive ethnopharmacological features, the current work sought to investigate the phytochemicals associated with *S. glauca* and assess their potential reducing power, antioxidant and antibacterial potential.

2. Materials and Methods

2.1 Collection of plant material and extract preparation

Different parts of *Simarouba glauca* DC. (HDUD 306), an important ethnomedicinal tree, were collected from the Kanchikeri forest, Harappanahallitaluk, Vijayanagara district, Karnataka, India. All the collected plant materials were washed primarily (tap water) to remove any dust particle and blot-dried followed by shade drying. The dried plant materials were fine powdered (using a hand mill) and utilized for further usage. Using a Soxhlet apparatus, 50 g of dried from each of the selected plant materials (Leaflet with rachis, Bark and Seed) were extracted using 500 ml of organic solvents sequentially (petroleum ether, chloroform, methanol and water). Following extraction, the corresponding extracts were evaporated using a rotary evaporator and kept for later research in airtight jars at 4°C (Mahendra *et al*., 2020).

2.2 Analysis for phytochemicals

The extracts underwent qualitative phytochemical screening to identify several classes of active phytochemicals, using the methodology established by Harborne (1973) and Trease and Evans (1987).

2.3 Evaluation for total phenolics

The technique of Singleton *et al*. (1999) was used to evaluate total phenolics in the various solvent extracts of the chosen plant parts. About 20 µl of the extract (0.25 to 2 mg/ml) was combined with 750 µl of sodium carbonate (20%) solution along with 0.25 ml of Folin-Ciocalteu (FC) reagent and mixed gently. After standing in the light for 3 min, the reaction mixture was incubated in the dark for 2 h and absorbance was measured at 765 nm in the presence of the FC reagent. A calibration curve was developed by determining the absorbance of recognized quantities of gallic acid to quantify total phenolics in plant extract.

2.4 Radical scavenging activity

The 2,2- diphenyl-1-picrylhydrazyl (DPPH) technique was used to assess the free radical scavenging capacity of the various solvent extracts of the chosen plant parts (Sultanova *et al*., 2001). About 1 mg of each of the plant extract was dissolved in one milliliter of the corresponding solvent to create the stock solution (1 mg/ml). About 2.85 ml of DPPH (0.3 M) in methanol and 0.15 ml of plant extract were included in the reaction mixture. The concentration of DPPH was maintained while preparing test samples at various concentrations (0.25 to 2 mg/ml) and incubated for 30 min at 37 °C under dark followed by measuring the absorbance at 517 nm. Ascorbic acid was employed as a positive control.

2.5 Reducing power assay

With a few minor modifications, the reduction power assessment of various solvent extracts of the chosen plant parts was performed in accordance with Nagulendran *et al*. (2007). The following ingredients were combined: 0.75 ml of phosphate buffer (0.2 M; pH 6.6), 0.75 ml of potassium ferricyanide (1%) and 0.75 ml each of the plant extract (0.25 to 2 mg/ml). The reaction mixture was incubated at 50ºC for 20 min and 0.75 ml of 10% trichloroacetic acid was added, mixed thoroughly and subjected to centrifugation for 10 min at 3000 rpm. Lastly, 1.5 ml of the distilled water, 0.5 ml of 0.1% $FeCl_3$, and 1.5 ml of the supernatant solution were combined and absorbance was read at 700 nm. Butylated hydroxytoluene (BHT) served as the standard, while phosphate buffer served as a blank.

2.6 Antibacterial activity

The different solvent extracts of the leaflet with rachis, bark and seed were evaluated for their antibacterial potential against Gram-positive (*Staphylococcus aureus* MTCC 7443 and *Bacillus subtilis* MTCC 121) and Gram-negative bacterial pathogens (*Escherichia coli* MTCC 7410 and *Pseudomonas aeruginosa* MTCC 1688)], following the method of Mahendra *et al*. (2016). In brief, about 20 ml of nutrient agar (NA) media was poured into each of the Petri plates, allowed to solidify under aseptic conditions and inoculated with 50 µl each of bacterial suspension (1.5 x 10^8 cfu/ ml; 0.5 McFarland standards). A cork borer was used to create a 6 mm diameter well and 50 µl of each plant extract (2 mg) was loaded and subjected to incubation for 24 h at 37ºC. Streptomycin and respective solvents served as positive and negative control, respectively. The inhibition zone around the wells was measured after incubation to note the plant extracts' antibacterial efficacy. Besides, minimum inhibitory concentration (MIC) of the selected plant extracts were also performed by broth micro-dilution technique according to Mahendra *et al*. (2020) by keeping 100 mg/ ml of each of the plant solvent extracts as stock solution (10 to 0.019 mg/ ml).

2.7 Statistical analysis

All the experiments were performed in triplicates. The data was analyzed using Arcsine Transformation and Analysis of Variance (ANOVA) in SPSS Inc. 16.0.

3. Results

3.1 Phytochemical analysis

All the solvent extracts of the *S. glauca* plant materials (leaflet with rachis, bark and seed) were assessed for the presence of different phytochemicals (secondary metabolites). The results indicated that methanol extract showed the occurrence of maximum secondary metabolites irrespective of the plant part used, followed by chloroform leaf extract with rachis. It was observed that except for the anthraquinones, glycosides and proteins, all other phytoconstituents were present in the methanol extract of leaf with rachis, while in chloroform extract apart from the phytoconstituents as mentioned above, saponins and tannins were also not detected (Table 1**)**. In addition, alkaloids and phenols were detected in all the solvent extracts irrespective of the plant part studied, while glycosides and anthraquinones were absent.

Table 1: Phytochemical analysis of different plant parts of *S. glauca*

Phytochemical	Leaflet with rachis					Bark					Seed				
	PE	CF	EA	ME	DW	PE	CF	EA	ME	DW	PE	CF	EA	ME	DW
Alkaloids	++	++	++	++	++	++	++	++	++	++	++	++	++	++	++
Amino acids	--	--	--	++	--	--	--	--	++	--	--	–	–	++	–
Anthraquinones	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Carbohydrates	++	++	++	++	–	–	–	–	++	–	–	–	–	++	++
Fixed oils and fats	++	++	++	++	–	++	++	++	++	–	++	++	++	++	++
Flavonoids	++	++	++	++	–	++	++	–	++	–	++	++	–	++	–
Glycosides	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Phenolics	++	++	++	++	++	++	++	++	++	++	++	++	++	++	++
Proteins	–	–	–	–	–	–	–	–	–	–	++	++	++	++	–
Saponins	–	–	++	++	–	–	–	–	++	–	–	–	–	++	–
Sterols	–	++	–	++	–	–	++	–	++	–	–	–	–	–	–
Tannins	–	–	–	++	–	–	–	–	++	–	–	–	–	++	–
Terpenoids	++	++	–	++	–	++	++	–	++	–	–	–	–	–	–

Note: ++ve indicates the presence of phytochemicals and – –ve indicates the absence of phytochemicals. PE: Petroleum ether; CF: Chloroform; EA: Ethyl acetate; ME: Methanol and DW: Distilled water.

3.2 Total phenolic content

From total phenolic studies, it was observed that all the plant parts of *S. glauca* selected during the study had potential phenolic content and the results are expressed as gallic acid equivalent (GAE) in units of µg per 100 µg of extracts. The results indicated that the crude extracts of the different plant parts possessed total phenolic content within the range of 7.09 to 51.58 µg of GAE per 100 µg of plant extracts. The study's findings demonstrated that, in comparison to the other three solvent extracts, the methanol extracts had a greater phenolic content with a maximum of 51.58 µg of GAE obtained in the plant part leaflet with rachis which was followed by 42.63 µg of GAE and 32.83 µg of GAE in methanol extract of bark and seed of the plant. Besides, a minimum of 7.09 µg of GAE was observed in the distilled water extract bark sample (Figure 1).

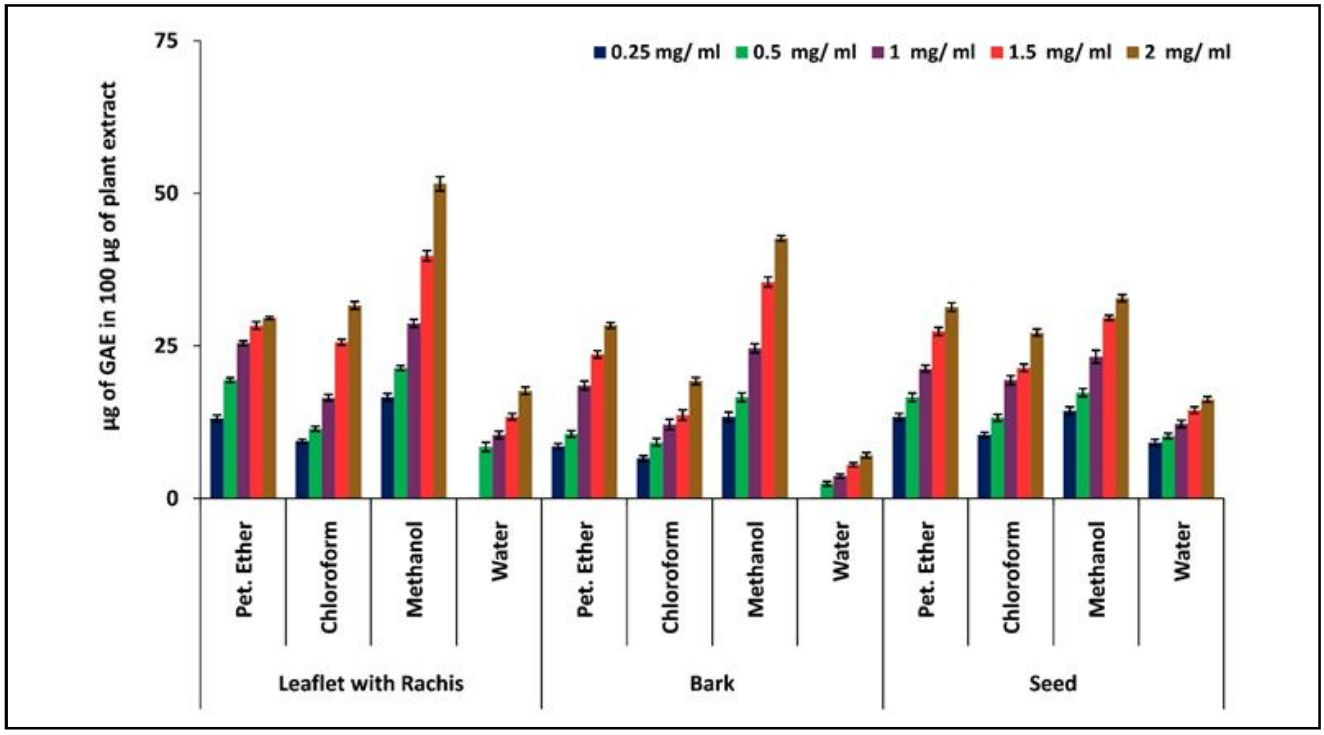

Figure 1: Total phenolics of different plant parts of *S. glauca*.

3.3 Radical scavenging activity (RSA)

The antioxidant potentiality of all the solvent extracts of different samples, as determined by their ability to scavenge free radicals evaluated through DPPH method, is displayed in Figure **2**. The study's findings showed that RSA of the evaluated plant extracts was dosage-dependent, wherein an increased concentration of the plant extract increased RSA. It was also observed that the methanol extract of different plant parts, *viz*., leaflet with rachis (88.72%), bark (77.42%) and seeds (78.60%) of *S. glauca* offered better RSA in comparision to other plant extracts. The IC_{50} of each of the methanolic extracts of the leaflet with rachis was found to be 0.49 mg/ml. Apart from the above, the leaflet with rachis extract showed higher RSA activity irrespective of the solvent used for extraction when compared to bark and seed extracts. Likewise, 75% of inhibition was noted in ascorbic acid at 50 µg/ ml.

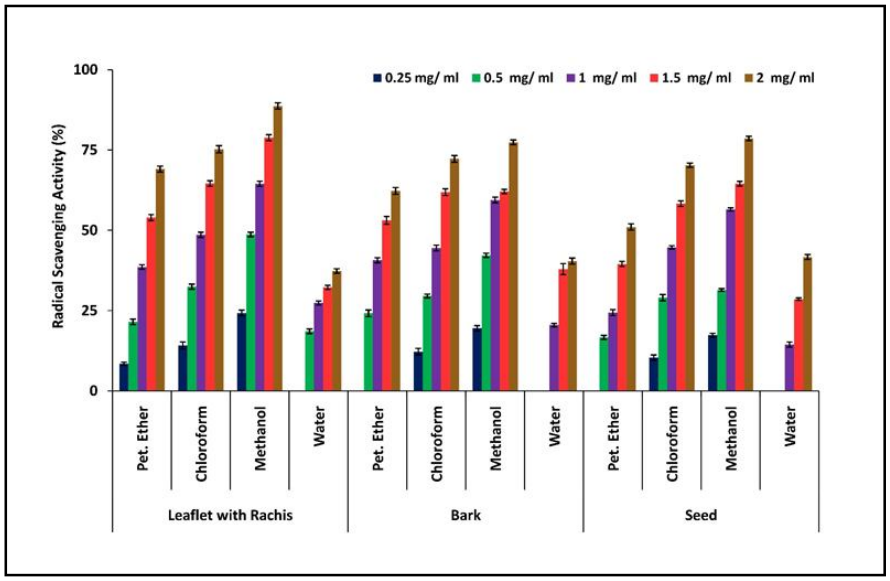

Figure 2: Radical scavenging activity of different plant parts of *S. glauca*.

3.4 Reducing power assay

Reducing power characteristic is linked to the existence of reductones, which function as antioxidants by dissolving the chain of free radicals by donating one atom of hydrogen. A compound's reducing power can be used as a gauge for possible antioxidant activity. The findings showed that when the plant extracts concentration increased from 0.25 mg/ml to 2 mg/ ml, the capacity to reduce power increased irrespective of the type of plant part used. With an absorbance of 3.17 at 2.5 mg/ ml, leaf with rachis methanol extract of *S. glauca* possessed the highest reducing power, followed by chloroform extract of the same plant material compared to other solvent extracts (Figure 3). Similarly, the least reducing power capacity was observed in the water extract of bark (0.33 at 2 mg/ ml), while the standard (BHT) used in the study showed an absorbance of 1.84 to 3.58 from 0.25 mg/ ml to 2 mg/ ml, respectively.

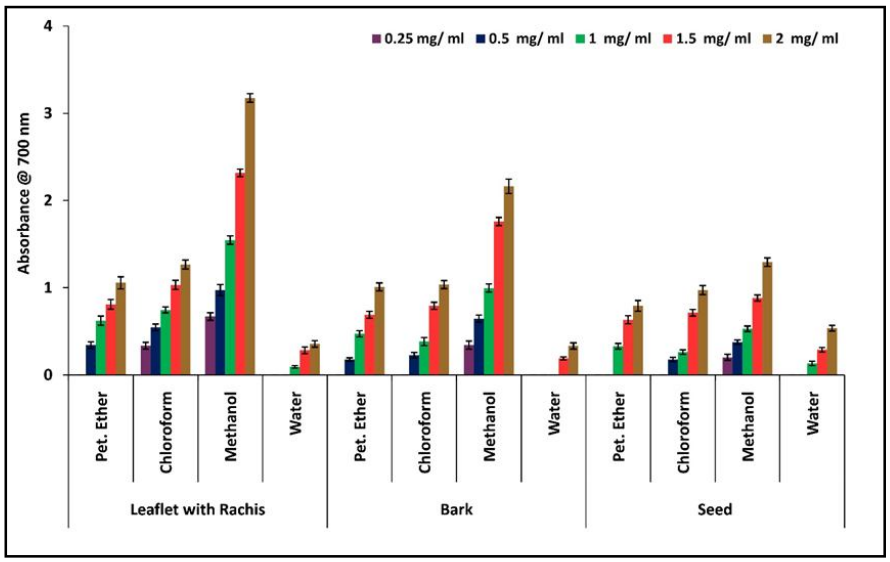

Figure 3: Reducing power properties of different plant parts of *S. glauca*.

3.5 Antibacterial activity

The antibacterial efficacy of all the solvent extracts of different plant parts of *S. glauca* were evaluated by well-diffusion assay and the results are tabulated in Table 2. The results showed that all the solvent extracts (petroleum ether, ethyl acetate and methanol) offered inhibition against selected test pathogens. As noted in the previous experiments, methanol extract of leaflet with rachis offered maximum inhibition against the test pathogens with 20.46 mm (*S. aureus*), 18.36 mm (*E. coli*), 13.20 mm (*B. subtilis*) and 8.40 mm (*P. aeruginosa*), followed by chloroform extract (Figure 4). The streptomycin positive control exhibited a maximum of 27.53 mm, 28.23 mm, 28.3 mm and 29.43 mm of inhibition zone against *S. aureus*, *B. subtilis*, *E. coli* and *P. aeruginosa*, respectively. Similarly, the methanolic leaflet with rachis extract offered the least MIC, which was found to be 0.625 mg/ ml for *S. aureus, E. coli* and *B. subtils* while the MIC of 1.25 mg/ ml was noted for *P. aeruginosa* with the ethyl extract of leaflet with rachis among all the extracts evaluated. Besides, an MIC of 0.019 mg/ ml was observed for all the evaluated test bacteria when subjected to streptomycin treatment.

Table 2: Antibacterial properties of solvent extracts of different plant parts of *S. glauca*

Plant part	Solvent	Zone of inhibition (in mm)				MIC (mg/ ml)			
		S. aureus	*E. coli*	*B. subtilis*	*P. aeruginosa*	*S. aureus*	*E. coli*	*B. subtilis*	*P. aeruginosa*
Leaflet with	Petroleum ether	13.40 ± 0.36^{f}	13.90 ± 0.11^{e}	10.53 ± 0.17^{f}	7.86 ± 0.36^{c}	1.25	1.25	1.25	1.25
Rachis	Chloroform	16.20 ± 0.23^{d}	16.13 ± 0.14^{c}	11.46 ± 0.08^{e}	0.00 ± 0.00^{c}	1.25	1.25	1.25	-
	Methanol	20.46 ± 0.17^{b}	18.36 ± 0.14^{b}	13.20 ± 0.23^{d}	0.00 ± 0.00^{c}	0.625	0.625	1.25	-
Bark	Petroleum ether	13.86 ± 0.17^{f}	11.90 ± 0.17^{g}	12.20 ± 0.23^{e}	0.00 ± 0.00^{c}	1.25	1.25	1.25	-
	Chloroform	15.83 ± 0.20^{d}	13.96 ± 0.12^{e}	14.16 ± 0.20^{c}	0.00 ± 0.00^{C}	1.25	1.25	1.25	-
	Methanol	17.90 ± 0.17^{c}	15.20 ± 0.23^{d}	16.03 ± 0.14^{b}	7.10 ± 0.14^{b}	1.25	0.625	0.625	1.25
Seed	Pet. Ether	11.86 ± 0.17^{g}	0.00 ± 0.00^{h}	12.30 ± 0.26^{e}	0.00 ± 0.00^{c}	1.25	-	1.25	-
	Chloroform	13.20 ± 0.23^{f}	12.56 ± 0.20^{f}	14.50 ± 0.20^{c}	8.40 ± 0.17^{b}	1.25	1.25	1.25	1.25
	Methanol	14.86 ± 0.17^{e}	14.10 ± 0.11^{e}	16.16 ± 0.23^{b}	0.00 ± 0.00^{c}	1.25	1.25	1.25	-
	Streptomycin	27.53 ± 0.17^{a}	28.23 ± 0.20^{a}	28.30 ± 0.32^{a}	29.43 ± 0.20^{a}	0.019	0.019	0.019	0.019

Values are means of three independent replicates (n = 3) and ± indicates standard error.

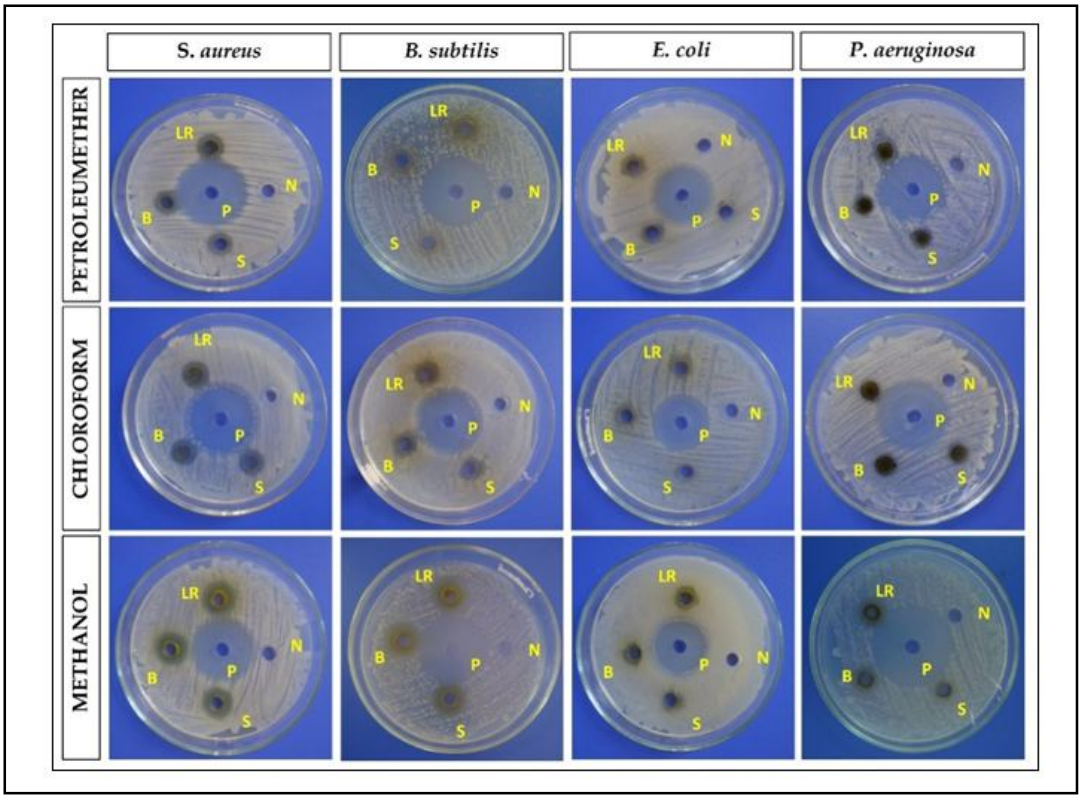

Figure 4: Antibacterial properties of different plant parts of *S. glauca* observed by well-diffusion assay. LR- Leaflet with rachis; B- Bark; S- Seed; N- Respective solvent; P- Streptomycin.

4. Discussion

Since thousands of years, nature has provided medicinal substances, and a startling number of contemporary medications have been derived from natural resources (Helmy *et al*., 2023) and according to Jaylakshmi *et al*. (2015) and Al Habsi *et al*. (2018), these phytochemical elements also have a variety of medicinal and preventive benefits. As evidenced by the old Indian medical system, plants offer positive medicinal benefits, and interest in traditional natural goods has grown significantly. Phytochemical components are essential to plants since they both show physiological action and add to their therapeutic value (Shariff, 2001). According to Mahendra *et al*. (2019), plants synthesize or metabolize phytochemical elements such as alkaloids, tannins, flavonoids, saponins, sterols, and triterpenes for defense purposes, which may be poisonous or beneficial to humans. Studies have found that phytochemicals which are produced naturally within the plant including alkaloids, flavonoids and steroids are mostly responsible in plant development and defense against various harmful microorganisms (Sriram, 2023). Despite advances in the advance of synthetic drugs, plant-based drugs have played a central part in developing powerful lead molecules. Among the FDA-approved anti-infectious and anticancer drugs, the natural origin of drugs has a share of 60 to 75% of natural compounds or their derivatives.

Sequential extraction using varying solvents-from low polar to high polar-was carried out in the current investigation and it was observed that in comparison to non-polar solvents, polar solvents had a higher yield, thereby depicting the presence of more polar chemicals than non-polar ones in the test plant materials (Singh *et al*., 2002). It was noted that extracting the physiologically active components from plants by successive extraction using solvents with different polarity is a promising method for future research on plant extracts (Mahendra *et al*., 2020). The phytochemical screening studies of *S. glauca* leaflet with rachis, bark and seed extracts revealed that alkaloids and phenols were noticed in all the solvent extracts irrespective of the plant part studied, while glycosides and anthraquinones were not present in all the different solvent extracts of *S. glauca* irrespective of the part used. Likewise, Jayalakshmi *et al*. (2015) noted the occurrence of various phytochemicals, including alkaloids, in diverse solvent extracts of *Curcuma amada* and *Zingiber officinale*, respectively. Alkaloids and tannins are recognized for their diverse pharmacological properties, such as their ability to induce spasmolysis in smooth muscle cells, among other secondary metabolites that have been identified (Cragg and Newman, 2005). Flavonoids have remarkable abilities in scavenging free radicals, preventing illness, and having therapeutic effects, according to Annegowda *et al*. (2010). Besides, research has also depicted that flavonoids and phenols have the ability to act on microorganisms that cause illness (Ruiz-Teran *et al*., 2008).

Plant phenolic compounds possess antiviral, anti-inflammatory, antitumor, and antibacterial properties in addition to their primary role in antioxidant activity (Yang *et al*., 2013). The current studies showed that *S. glauca* extracts encompassed a higher phenolic content of 51.58 µg of GAE per 100 ìg of plant extracts, as noted in the methanolic leaf extract with rachis. Similar findings were reported by Manasa *et al*. (2019) and Puneetha *et al*. (2013), who found that the plant extracts of *Lepianthes umbellata* and the mistletoe *Dendrophthoe trigona* possessed higher total phenolic content.

Due to their remarkable ability to significantly minimize tissue damage and accelerate the healing process, antioxidants are the agents that are essential for coetaneous tissue repair. Reactive oxygen species or ROS, are often produced by the human body and can be advantageous in tiny quantities. However, large volumes of these ROS are formed when the body experiences elevated oxidative stress due to environmental dangers or impairment in metabolism brought on by various medical disorders, such as medication side effects or inadequate antioxidant intake in the diet (Mahendra *et al*., 2020). As a therapeutic or preventative approach, the exogenous delivery of antioxidants must be used to mitigate this potentially harmful scenario (Tosum *et al*., 2009). The current investigation on different parts of *S. glauca* solvent extracts for antioxidant activity by DPPH method revealed that the RSA increased with the concentration, thereby depicting a dose-dependent activity. Previous studies have noted that plants may provide an alternative supply of antioxidants with strong antioxidative stress activities because manufactured antioxidants have a danger of side effects (Lobo *et al*., 2010). According to Middleton *et al*. (2013), antioxidants can scavenge free radicals implicated in various ailments, including cancer, cardiovascular disease, and neurological diseases. During the study, a maximum of 81% RSA was noticed in the methanolic extract of the leaf with rachis with an IC_{50} value of 0.49 mg/ml and results corroborated to the findings of Bhaigyabati (2011), which revealed that the methanolic extract of *Sargassium muticum* possessed the best antioxidant potential.

The reducing power of phytochemical substances, which transfer electrons and have reductones, in plant extracts is another significant measure of antioxidant activity (Li and Lin, 2010). These chemicals function as primary and secondary antioxidants by removing free radicals, stimulating the immune system, regulating gene expression, and inhibiting antimicrobial activities (Liu, 2004). In the reducing power studies, antioxidants in the sample reduce Fe^{3+} to Fe^{2+} by contributing an electron and creating the same, which can then be measured at 700 nm and higher absorption suggests higher reductive capacity (Olayinka *et al*., 2010).

The quest for novel antimicrobial compounds has become necessary due to the emergence of drug resistance in human infections in opposition to widely used antibiotics; as a result, research on plants as a source of novel biomolecules for controlling plant diseases has increased during the new millennium (Uddin *et al*., 2021; Sriram, 2023; Poyil and Shamna, 2023). Higher plants have yet to be fully investigated for their potential as a source of novel medications, as they produce different secondary metabolites with varying biological activities. The World Health Organisation (WHO) supports, encourages, and makes it easier for herbal medicine to be used effectively in health initiatives in underdeveloped nations. The antibacterial activity test is the initial step toward achieving this objective, and during the study, methanol extract of leaflet with rachis offered considerable antibacterial properties against all the test pathogens compared to others. Besides, the leaflet with rachis methanolic extract offered the least MIC of 0.625 mg/ml for all the test pathogens except for *P. aeruginosa* for which the least MIC of 1.25 mg/ ml was noted with the ethyl extract of the same plant part. Similarly, Chattopadhyay *et al*. (2001) found that *Alstonia macrophylla* crude extracts exhibited flavonoid, triterpene, and steroid presence and strong efficacy against several bacterial pathogens. Besides, Akharaiyi *et al*. (2012) and Jaylakshmi *et al*. (2015) noted

that *Piper betle* and *Spathodea campanulata* crude methanol and chloroform extracts demonstrated the occurrence of many phytochemicals in addition to demonstrating strong antibacterial activity. The study found that *S. glauca* has several secondary metabolites that have antioxidant and antibacterial properties. However, more research involving separating and purifying the active principle(s) is necessary for its better usage as a medicinal agent. In addition, the study also determines the usefulness of plants in Ayurveda, which may be utilized to invent novel medications, including *S. glauca*.

5. Conclusion

Medicinal plants are a valuable source of human health because they include phytochemical elements responsible for various pharmacological actions. Based on the present findings, the current study indicated that the leaflet with rachis of *S. glauca* is higher in phytochemical components than other plant parts (bark and seed). The study also noted that the plant extracts possessed significant total phenolic content apart from exhibiting substantial reducing power, antioxidant and antibacterial properties, with the highest biological activities noted in the methanolic extract of leaflet with rachis. As a result, it has the potential to be exploited to develop stronger natural medications. In conclusion, the plant *S. glauca* in this study has several secondary metabolites that exhibit reducing power, antioxidant and antibacterial properties. However, further research is required to discover the plant's active principle (s) that is of biological importance and to understand the mode of action for its better usage as a medicinal agent.

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Conflict of interest

The authors declare no conflicts of interest relevant to this article.

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