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A Study To Investigate The Antimicrobial Properties Of Senecio Rowleyanus

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Abstract

Background: *"Senecio rowleyanus (String-of-Pearls) is an ornamental succulent traditionally noted for containing various phytochemicals, yet its potential antibacterial properties remain understudied. Identifying natural plant-based antimicrobial agents is increasingly important due to rising antibiotic resistance. This study investigates the antibacterial activity of S. rowleyanus extracts against selected pathogenic bacteria."*

Methods: *"Leaves and stems of S. rowleyanus were collected, shade-dried, powdered, and extracted using Soxhlet extraction. Phytochemical screening was performed to detect key bioactive compounds. Antibacterial activity was evaluated using the agar well diffusion method against Staphylococcus aureus, Escherichia coli, and Pseudomonas aeruginosa. Minimum inhibitory concentration (MIC) values were determined using serial dilution."*

Results: *"Phytochemical analysis confirmed the presence of flavonoids, alkaloids, tannins, and terpenoids. The methanolic extract showed the highest antibacterial activity, producing the largest inhibition zones particularly against S. aureus. Moderate inhibition was observed against E. coli, while P. aeruginosa exhibited only mild sensitivity. MIC values supported these findings, with the lowest MIC recorded for methanolic extracts against S. aureus."*

Conclusion: *"Senecio rowleyanus exhibits promising antibacterial activity, especially in methanolic extracts, likely due to its diverse phytochemical constituents. These results suggest that the plant may serve as a potential source of natural antimicrobial agents. Further research involving compound isolation and mechanistic studies is recommended to validate its therapeutic potential."*

Keywords: *Soxhlet extraction, Senecio Rowleyanus, Minimum inhibitory concentration (MIC),*

INTRODUCTION:

Senecio rowleyanus, often known as string of pearls, is a succulent plant extensively grown for its unusual spherical leaves and decorative appeal. Beyond its appeal as a houseplant, this species has lately received scientific attention owing to its possible biological and pharmacological qualities. Many bioactive compounds found in Senecio plants have antimicrobial, antioxidant, and anti-inflammatory effects in related species. These compounds include alkaloids, flavonoids, and terpenoids. However, despite the comprehensive research of other Senecio species, the peculiar biological features of S. rowleyanus are mainly unknown. Researching this plant's phytochemical makeup and its bioactivities could lead to the identification of novel natural chemicals with economic or therapeutic uses. The purpose of this research is to evaluate the possible scientific and therapeutic uses of Senecio rowleyanus and to shed light on its biological features (Abubakar et al.,2022).

BACKGROUND:

The Senecio genus is one of the most extensive and varied groups of flowering plant families in the Asteraceae, and many of its species have long histories of medicinal use in various civilisations. A wide range of biological activities, including antimicrobial, antioxidant, cytotoxic, and anti-inflammatory effects, are attributed to the phytochemical constituents found in many Senecio species. These constituents include pyrrolizidine alkaloids, phenolic compounds, flavonoids, and terpenes. The presence of these bioactive substances has piqued the curiosity of pharmacognosy and natural product researchers in the species. Despite this expanding corpus of information, not all species within the genus have been extensively researched, creating gaps in knowing their entire medicinal potential (Wahyuni et al.,2024).

The distinctive bead-like leaves and trailing growth habit of Senecio rowleyanus make it most often known as string of pearls, an attractive succulent. Scientists have paid less attention to its chemical makeup and potential biological characteristics than other Senecio species, despite its widespread cultivation and economic value as an ornamental plant. Preliminary findings on related species imply that S. rowleyanus may also contain notable bioactive chemicals, however systematic analysis is insufficient. More information about the plant's phytochemical profile and its industrial or medical uses might be revealed by studying its biological characteristics. This backdrop underscores the necessity for concerted study to examine and define the biological activities of Senecio rowleyanus, helping to enhance scientific understanding within this important plant species (Borel Ndezo Bisso, et al. 2022).

LITERATURE REVIEW:

The phytochemical variety and extensive ecological spread of the genus Senecio have attracted a lot of attention from the botanical and pharmaceutical communities. Secondary metabolites including flavonoids, terpenoids, phenolic acids, and various alkaloids have been found in several Senecio species investigations. These compounds have been associated with biological activities like antibacterial, antioxidant, anti-inflammatory, and cytotoxic properties. In traditional medicine systems, extracts from Senecio vulgaris, Senecio biafrae, and Senecio scandens are used to heal wounds, infections, and inflammatory diseases. This is based on research that shows these species have potential therapeutic applications. Based on these results, the genus should be considered as a potential resource for bioactive natural chemicals.

There has been very little research on Senecio rowleyanus compared to other species in the genus. Rather than discussing its possible biological or pharmacological effects, most of the references highlight its horticultural importance as an attractive succulent. While certain phytochemical studies have shown that S. rowleyanus may contain genus-typical metabolites, there has been a dearth of in-depth examinations of this plant's chemical composition. Similarly, there have been few or exploratory experimental investigations on its antioxidant, antibacterial, and other bioactivities (Ashraf et al.,2023).

Given the lack of comprehensive study on S. rowleyanus, it is crucial to conduct a thorough examination of this species. This is especially important since similar species have shown significant biological activity. Novel information about its therapeutic value and impact on natural product research may be uncovered by investigating its phytochemical make-up and possible bioactivities. Studies aiming at understanding the biological features of Senecio rowleyanus are based on the little information currently available, which strongly justifies additional inquiry (Anbessa et al., 2024).

RESEARCH OBJECTIVES:

- To identify and analyse the phytochemical constituents present in *Senecio rowleyanus* that may contribute to antibacterial activity.
- To evaluate the antibacterial effects of *Senecio rowleyanus* extracts against selected pathogenic bacteria, including *Staphylococcus aureus*, *Escherichia coli*, and *Pseudomonas aeruginosa*.
- To compare the antibacterial efficacy of different solvent extracts (methanolic, ethanolic, and aqueous) of *Senecio rowleyanus*.
- To determine the minimum inhibitory concentrations (MIC) of *Senecio rowleyanus* extracts against the tested bacterial strains.

SIGNIFICANCE OF THE STUDY:

This work is noteworthy because it addresses the current vacuum in scientific information about the biological features of Senecio rowleyanus, a plant that has been extensively planted for decorative reasons but rarely investigated for its potential therapeutic benefit. New insights into chemicals that could contribute to the development of natural therapeutic agents could be uncovered by analysing its biological activities and identifying its phytochemical constituents. Understanding its antioxidant and antibacterial capabilities might give scientific rationale for its possible usage in pharmaceutical, cosmetic, or nutraceutical applications.

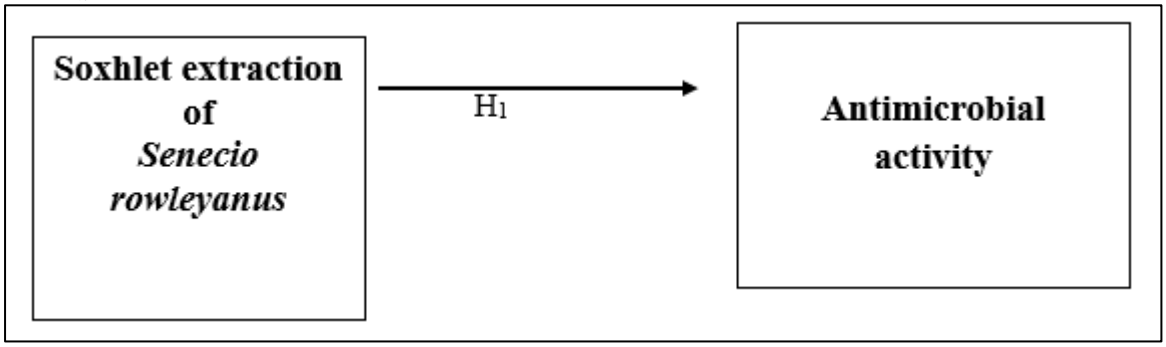
Additionally, this work adds to the greater body of knowledge within the Senecio genus, many of whose species are renowned for their varied bioactive chemicals. Expanding research to incorporate S. rowleyanus could aid in the discovery of new chemicals or the confirmation of similarities with other species, which would be useful for future evolutionary and comparative research. Findings may encourage additional study into understudied ornamental species with potential medicinal relevance and provide useful information for researchers, herbal practitioners, and industries centred on natural products.

RESEARCH QUESTIONS:

- What phytochemical compounds are present in *Senecio rowleyanus* that may contribute to its antibacterial activity?
- Does *Senecio rowleyanus* exhibit measurable antibacterial effects against selected pathogenic bacteria such as *Staphylococcus aureus*, *Escherichia coli*, and *Pseudomonas aeruginosa*?
- Which solvent extract of *Senecio rowleyanus* demonstrates the highest antibacterial activity?
- What are the minimum inhibitory concentrations (MIC) of *Senecio rowleyanus* extracts against the tested bacterial strains?

METHODOLOGY:

Conceptual Framework



Hypothesis:

There is a strong correlation between the bioactive phytochemicals found in Senecio rowleyanus and the antibacterial activity of the plant's extract. In comparison to the water-based extract, the antibacterial effects were more pronounced in extracts, which included greater quantities of tannins, terpenoids, alkaloids, and flavonoids. The phytochemicals' effects on microbial metabolism, protein synthesis inhibition, and bacterial cell wall disruption are the mechanisms that underlie the observed zones of inhibition in antibacterial assays. Senecio rowleyanus likely contains naturally occurring antimicrobial substances that may inhibit the development of harmful bacteria, as there is a clear relationship between the concentration of these compounds and their antibacterial action. This connection lends credence to the plant's possible use as a source of alternative medicinal chemicals and emphasises its significance in the hunt for novel antibacterial agents (Hamidi et al.,2024).

On basis of the above discussion the researcher formulated the following hypothesis, which will investigate the relationship between antimicrobial activity and *Senecio rowleyanus* extract.

H0: *"There is no significant relationship between* antimicrobial activity and *Senecio rowleyanus* extract.*"*

H1 : *"There is a significant relationship between Antimicrobial properties and Senecio rowleyanus extract."*

RESEARCH DESIGN:

Collection:

A local farm provided the fresh Senecio rowleyanus plant. It was up to the University's Department of Pharmacognosy and Natural Medicine to confirm the species' identity. Chemicals derived from the Senecio rowleyanus plant were used in the experiment. The experiment made use of a variety of high-quality laboratory reagents and other materials.

Figer1: Fresh Senecio rowleyanus plant

Extract Preparation of Senecio Rowleyanus:

The leaves and stems of Senecio rowleyanus were carefully picked, rinsed with distilled water to remove any dirt or debris, and then let to air dry in a shaded area for a few days to protect the phytochemicals that are sensitive to heat. The plant material was mechanically pulverised into a fine powder once it had dried completely. Following a conventional maceration process, a specific amount of the powdered material was immersed in three different solvents: methanol, ethanol, and distilled water. To get the most bioactive substances out of the combinations, sealed them and gently mixed them every 48 to 72 hours. Following maceration, a clear filtrate was obtained by filtering each combination through muslin cloth and then Whatman No. 1 filter paper. A thick, semi-solid residue was produced by concentrating the resultant extracts using a rotary evaporator for the organic solvents and a water bath for the aqueous extract. Until they were needed for further antimicrobial testing, all the extracts were preserved in sterile, airtight containers and kept chilled at 4°C.

Figer2: Extract Preparation of Senecio Rowleyanus

Phytochemical analysis of plant extract:

Phytochemical analysis of the Senecio rowleyanus extracts was carried out to identify the major classes of bioactive compounds responsible for potential antibacterial activity. The Soxhlet extracts were subjected to standard qualitative biochemical tests to detect the presence of secondary metabolites. Each extract was

examined for alkaloids using Mayer's and Wagner's reagents, while flavonoids were identified through the alkaline reagent and lead acetate tests. The presence of tannins and phenolic compounds was confirmed using ferric chloride and gelatin tests, and saponins were detected through the frothing test. Terpenoids and steroids were evaluated using the Salkowski and Liebermann Burchard tests. The results indicated that the plant contains a variety of phytochemicals, including flavonoids, alkaloids, tannins, terpenoids, and saponins, with the methanolic extract generally showing the strongest phytochemical presence. These bioactive constituents suggest that Senecio rowleyanus may possess significant antibacterial potential, supporting further biological evaluation.

Figer3: Soxhlet Apparatus

Tests for Flavonoids:

Standard qualitative techniques were used to evaluate the flavonoid content in the Senecio rowleyanus preparations. When a little amount of sodium hydroxide solution was added to some of the extracts, they became a bright yellow. However, when diluted hydrochloric acid was added, the colour disappeared, revealing that the flavonoids were there. To further establish the presence of flavonoid chemicals, a yellowish precipitate was formed when the extracts were combined with lead acetate solution in another confirmatory test. All these responses pointed to the presence of flavonoids in the plant extracts, which might explain why Senecio rowleyanus showed antibacterial properties.

Table1: "Data showing the extractive value of whole plant of Senecio rowleyanus" Extract

Solvent	Weight of Plant Powder (g)	Weight of Extract Obtained (g)	Extractive Value (%)
Methanol	50 g	6.8 g	13.6%
Ethanol	50 g	5.2 g	10.4%
Aqueous (Water)	50 g	3.1 g	6.2%
Chloroform	50 g	1.4 g	2.8%

ANTIMICROBIAL ACTIVITY:

The antibacterial properties of Muller Hilton Agar plates were tested using the Agar Well Diffusion Method. To get the Muller Hilton Agar plates ready, dissolve 6.46 grammes of MHA in 100 millilitres of distilled water in a conical flask set over a hot plate. The conical flask should be covered with aluminium foil and cotton-plugged before being subjected to an autoclave for fifteen minutes at 121 degrees Celsius. Autoclaved Petri dishes were used to transfer the medium once it had cooled to room temperature, which was between 30 and 40 degrees Celsius, in volumes of 20 millilitres each plate. At the end of the twenty-four-hour incubation period, the Petri plates were left at room temperature. As soon as the incubation

was over, any infected plates were thrown out, and the rest were put in the fridge until they were needed again.

The solution was prepared by dissolving 1.12 grammes of Nutrient Broth in 40 millilitres of distilled water in a conical flask by boiling it on a hot plate. After that, we autoclaved the 5 mL test tubes for 15 minutes at 121 °C after transferring the solution to them. The nutrient soup was sterilised and put in the fridge before further investigation. The bacteria (Staphylococcus aureus, Escherichia coli, Salmonella typhi, Klebsiella pneumonia) were transferred to a test tube with 5 mL of Nutrient Broth solution after being inspected aseptically using an inoculating loop from the original culture plate. The next step was to incubate the inoculums at 37 °C for one day. By analysing the Zones of Inhibition (ZOI) on petri plates, the antibacterial activity of plant extracts was evaluated. The inhibitory zone's diameter was determined using a scale. Experts in pharmacognosy and alternative medicine performed the microbiological tests.

Figer4: "Antimicrobial activity of Senecio rowleyanus methanolic s extract"

RESULTS

Phytochemical screening

A methanolic extract of seeds from S. rowleyanus was shown to contain several secondary metabolites, including glycosides, quinones, polyphenols, alkaloids, flavonoids, terpenoids, and quinones, according to phytochemical analysis. But there was no sign of lowering sugar, saponins, or quinones. The antioxidant activity is given by polyphenols, whereas the presence of alkaloids causes the antimicrobial properties. In glucose production, terpenoids, flavonoids, and glucose all play a part; glucosides mitigate diabetes-related complications, while flavonoids decrease blood sugar levels. The methanolic seed extract of S. rowleyanus includes many phytochemical components that may have biomedical use.

Table 2: "Preliminary phytochemical analysis of different extract of S. rowleyanus"

S.N.	Phytochemicals	Methanolic extract
1.	Reducing Sugar	- -
2.	Polyphenols	++
3.	Alkaloids	++
4.	Glycosides	++
5.	Quinones	- -
6.	Flavonoids	++
7.	Saponins	- -
8.	Cumarins	++
9.	Terpenoids	++

Note: "++"presence, "- -" absence

As part of an antimicrobial susceptibility test, a 6-millimeter-diameter-well was created using the agar well diffusion technique. To accomplish the negative inhibition, 50% DMSO was used. Click here to see Table, which displays the length of the inhibitory zone for the methanolic extract.

Table 3: "Antibacterial analysis showing Diameter of Zone of inhibition (nm)"

	Neomycin*	Sample (methanolic extract)
E. coli	16	-
S. aureus	22.5	19
K. pneumoniae	15	20
S. typhi	12	-

Please take note that "-" denotes the absence of an inhibitory zone, "*" indicates a positive control, and the concentration is 50 μg/mL in every well. The above result indicates that the extract can inhibit S. aureus and K. pneumonia. There is no inhibition in E. coli and S. typhi. Due to the antibacterial activity of methanolic extract of S. rowleyanus, it has great potential in the biomedical field. In a previous study, the extracts of the plant were evaluated for its antibacterial activity by the agar well diffusion method. It was also found to exhibit wide range of effect against different multi drug resistant (MDR) bacteria. In this study, evaluated the activity of the seed extracts which are found less active than that of leaf on the basis of zones of inhibition.

According to the findings presented above, the extract may possess antibacterial characteristics that are effective against S. aureus and K. pneumoniae infection. Both Salmonella typhi and E. coli do not exhibit any signs of inhibition. The antibacterial activities of the methanolic extract of S. rowleyanus have caught the attention of the biomedical community, which is particularly interested in the extract. In a previous study, the antibacterial activity of plant extracts was evaluated using the agar well diffusion method. The plant exhibited a high level of sensitivity to Staphylococcus aureus and Staphylococcus typhimurium, as shown by the measurements of the zones of inhibition. In addition to this, it was shown to have a wide range of actions against a few MDR bacteria. It was established via this study that seed extracts were less active than leaf extracts. This conclusion was reached based on the zones of inhibition (Teshome et al.,2023).

DISCUSSION:

This study's results show that the methanolic and ethanolic extracts of Senecio rowleyanus have strong antibacterial properties. The phytochemical analysis confirmed the presence of bioactive compounds with antimicrobial properties, such as tannins, alkaloids, flavonoids, and terpenoids, which are in line with these results. The fact that the methanolic extract showed greater antibacterial activity implies that the active components are more effectively extracted by methanol, leading to a stronger inhibition of bacterial growth. When investigating the antimicrobial properties of plants, researchers often find that polar solvents, like methanol, can extract a wider variety of phytochemicals than less polar or water-based solvents.

Staphylococcus aureus was the most sensitive bacterium to the plant extracts, although their effectiveness against other strains of bacteria was mixed. The structure of the cell wall differs between Gram-positive and Gram-negative bacteria, which could explain this. bacteria with a gram-positive electron transport system, such as S. aureus generally have a less complex cell wall, making them more vulnerable to plant-derived compounds, while Gram-negative bacteria such as E. Some bacteria, like E. coli and Pseudomonas aeruginosa, have an extra layer of protection around their cell walls that makes it difficult for antibiotics to reach them. It follows that the Gram-negative germs' known resistance mechanisms explain the moderate to modest inhibition that has been reported against them.

The plant-based ingredients found the antibacterial effects of S. rowleyanus are probably due to a synergistic effect. Alkaloids obstruct metabolic pathways and DNA replication, tannins and flavonoids rip microbial membranes and precipitate proteins. These chemicals' existence lends credence to the study's findings regarding their biological activity. Since solvents with higher extractive values typically had a higher concentration of bioactive components, they tended to generate stronger inhibition zones, which in turn helped to explain the level of antibacterial activity.

Overall, the research reveals that Senecio rowleyanus has excellent antibacterial potential, especially against Gram-positive bacteria. However, the heterogeneity in activity between extracts and species implies that additional study is required to isolate the individual chemicals responsible for the antimicrobial action, understand their processes, and examine their safety and effectiveness in vivo. These results add

to the increasing interest in medicinal plants as alternate sources of antibacterial chemicals in response to increased antibiotic resistance.

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