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Anti-microbial properties of plant leaves and roots

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ABSTRACT

It has long been known that plants are a rich source of bioactive substances with substantial medicinal potential. Since plant leaves and roots are known to contain a variety of secondary metabolites, including alkaloids, flavonoids, tannins, and phenolic chemicals, the current study focuses on assessing their antibacterial qualities. A variety of pathogenic microorganisms, including both Gram-positive and Gram-negative bacteria as well as fungal strains, were tested against extracts derived from particular plant species. Antimicrobial activity was evaluated using conventional microbiological procedures, such as the agar well diffusion method.

The findings showed that, depending on the kind of plant part, solvent employed, and microbial strain tested, both leaf and root extracts have significant inhibitory effects on microbial development. Although root extracts also shown strong antibacterial potential, leaf extracts frequently demonstrated stronger activity because of a higher concentration of phytochemicals. These results emphasize the value of medicinal herbs as all-natural substitutes for synthetic antibiotics, particularly in view of the rise in antimicrobial resistance.

KEYWORDS

Pathogenic microorganisms; phytochemicals; alkaloids; flavonoids; tannins; phenolic compounds; antimicrobial activity; medicinal plants; leaf and root extracts;; Drug resistance, antifungal activity, natural antibiotics, and plant-based medicines

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1. Introduction

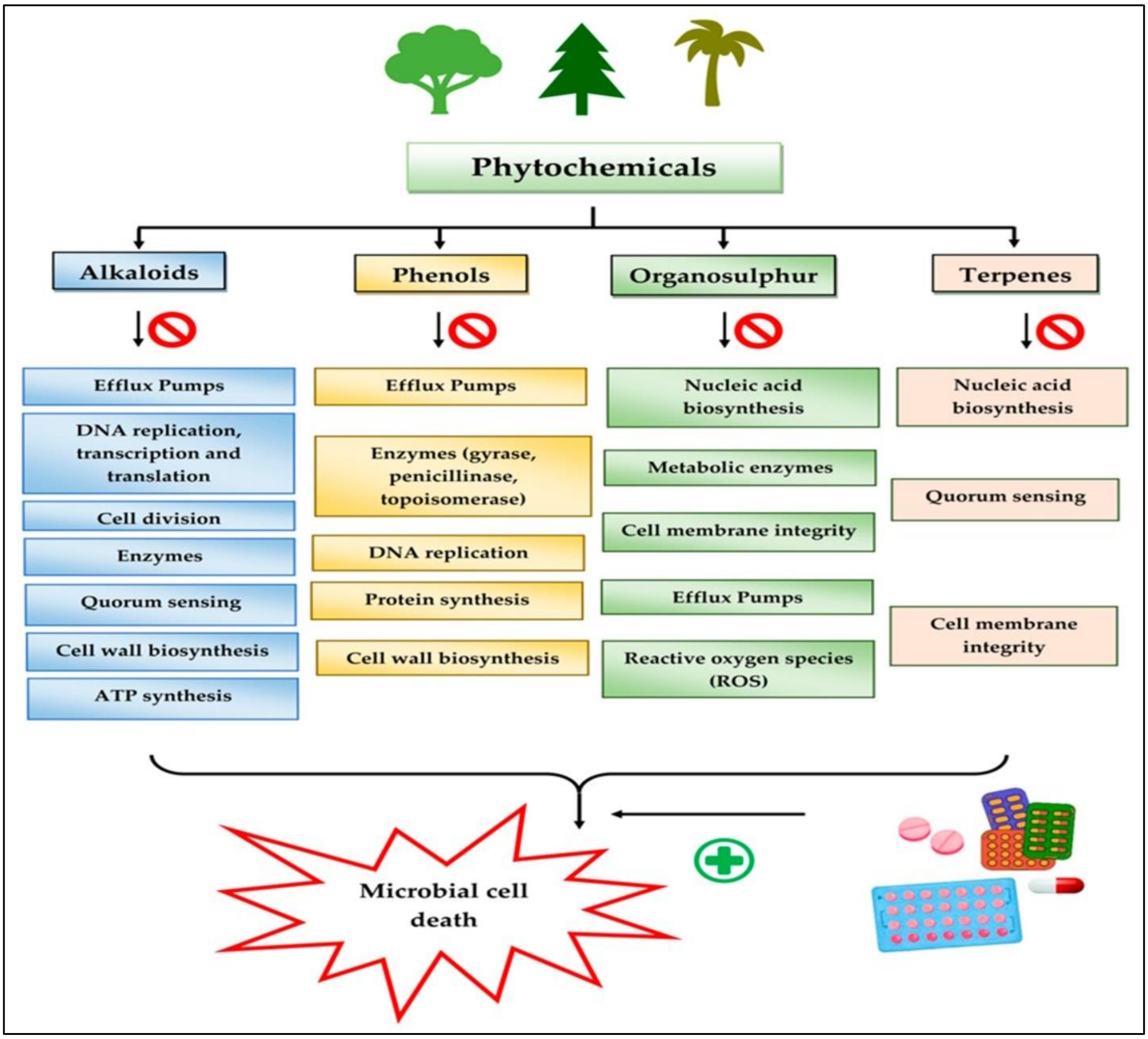
Traditional medical systems including Ayurveda, Unani medicine, and Traditional Chinese medicine have utilized medicinal herbs for ages. To cure illnesses and infections, these systems mostly rely on formulations made from plants. The worrisome growth in antimicrobial resistance (AMR), which poses a threat to global public health, has sparked a renewed interest in plant-based antimicrobials in recent decades (WHO, 2023).

Numerous bioactive secondary metabolites, including tannins, terpenoids, alkaloids, flavonoids, and phenolic chemicals, are produced by plants. These substances have a protective function against environmental stress and microbiological assault. Such compounds have high antibacterial qualities against bacteria, fungus, and even viruses, according to research in phytochemistry and microbiology (Cowan, 1999; Silva et al., 2020).

The antibacterial activity of various plant sections varies. Higher amounts of bioactive chemicals are produced since leaves are frequently the main location of photosynthesis and metabolite production.

Conversely, protective compounds and vital nutrients that shield plants from soil-borne diseases are stored in the roots. Because leaf extracts include more phenolics and flavonoids than root extracts, studies have demonstrated that leaf extracts often exhibit better antibacterial properties (Doughari, 2012).

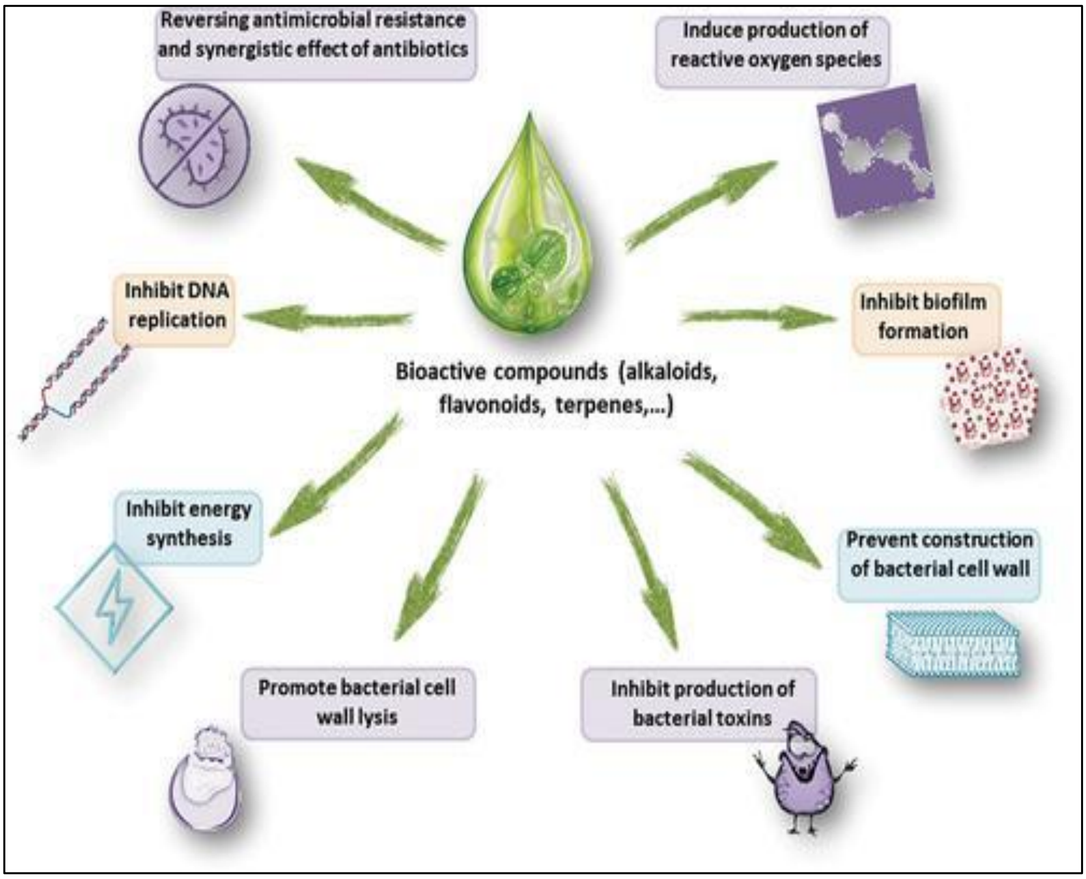
However, strong substances including glycosides and alkaloids that show notable inhibitory actions against harmful microbes are also present in root extracts (Parekh &Chanda, 2007).



Mechanism of Antimicrobial Action

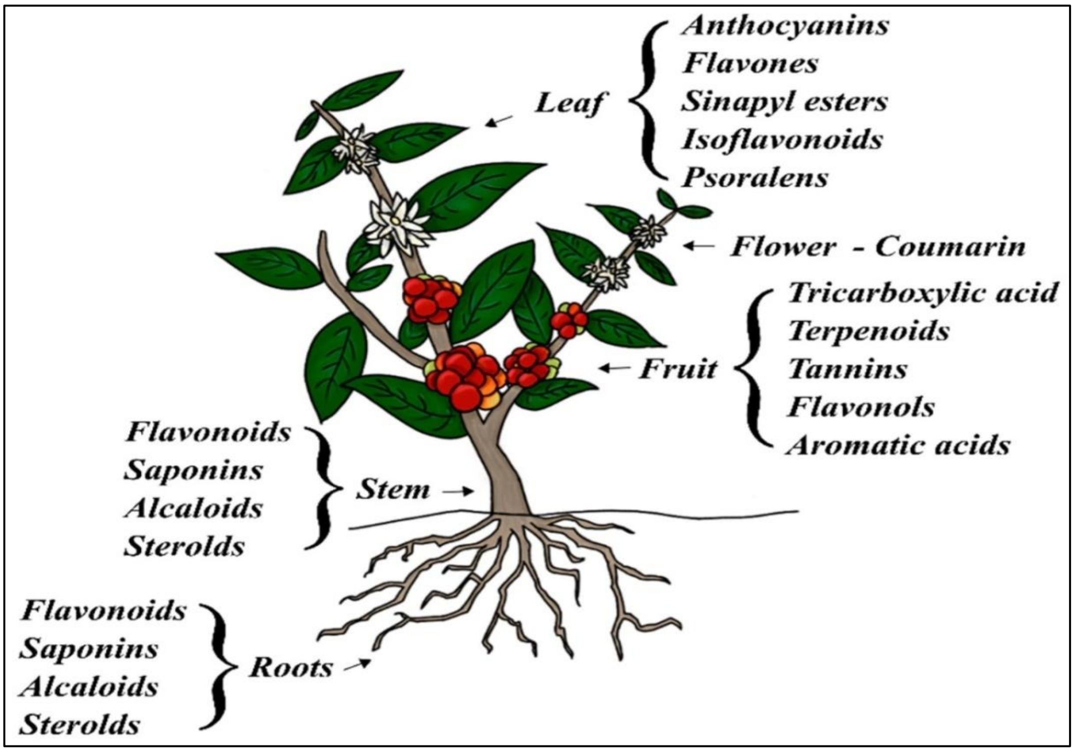
Antimicrobial substances generated from plants work in a number of ways:

- Microbial cell membrane disruption
- suppression of the production of proteins
- interference with the replication of nucleic acids
- Inactivation of enzymes
- Because of these mechanisms, plant extracts are effective against a variety of pathogens, including strains of Escherichia coli and Staphylococcus aureus that are resistant to antibiotics (Burt, 2004).



Sources of Antimicrobial Compounds in Plants

Antimicrobial chemicals are stored in plant tissues like leaves and roots. While roots gather and store protective molecules that guard against soil pathogens, leaves create substances through photosynthesis and metabolic processes. Different plant sections have different levels of antibacterial activity due to structural and functional diversity (Doughari, 2012).



Methodology

1. **Plant Material Selection and Collection**

- Based on their ethnobotanical significance, healthy plant species were chosen.
- Roots and leaves were gathered from locations free of pollution.
- To get rid of dust and impurities, samples were cleaned with distilled water.
- For seven to ten days, plant materials were shade-dried at ambient temperature (25 to 30°C).

2. Plant Extract Preparation

- A mechanical grinder was used to grind dried plant parts into a fine powder.
- Solvent extraction was performed on 20–50 g of powdered material using either distilled water, ethanol, or methanol.
- Methods of extraction employed.
- Maceration (soaking for 24 to 72 hours)
- Continuous hot extraction, or Soxhlet extraction.
- Whatman filter paper was used to filter the extracts.
- A rotary evaporator was used to concentrate the filtrates, which were then kept at 4°C.

3. Microbial Culture Preparation

- Among the test microorganisms were:
- Gram-positive Staphylococcus aureus
- Gram-negative Escherichia coli
- Aspergillusniger, a type of fungus

For bacteria and fungi, cultures were kept on nutritional agar and potato dextrose agar, respectively. McFarland standards were used to standardize microbial suspensions.

4. Agar Well Diffusion Method Antimicrobial Assay

- Microbial cultures were produced and added to sterile agar plates.
- A sterile cork borer was used to create wells with a diameter of 6–8 mm.
- 50–100 µL of plant extracts were added to each well.
- Plates underwent incubation:
- For bacteria, 24 hours at 37°C; for fungus, 48–72 hours at 28°C
- Antimicrobial activity was assessed by measuring zones of inhibition (mm).

5. Gathering and Analyzing Data

- The inhibitory zones' diameter was measured in millimeters.
- To guarantee accuracy, experiments were conducted in triplicate.
- Standard deviation and mean data were computed.
- Bar graphs and tables were used to display

6. Screening for phytochemicals

To find the main phytochemicals, qualitative testing were conducted:

- Alkaloids (test by Mayer)
- Flavonoids (test of Shinoda)
- Tannins (test for ferric chloride)
- Saponins (test of foam)

7. Statistical Analysis

- Data were analyzed using mean ± standard deviation.
- ANOVA (Analysis of Variance) was used to compare results.
- Significance level was set at $p < 0.05$.

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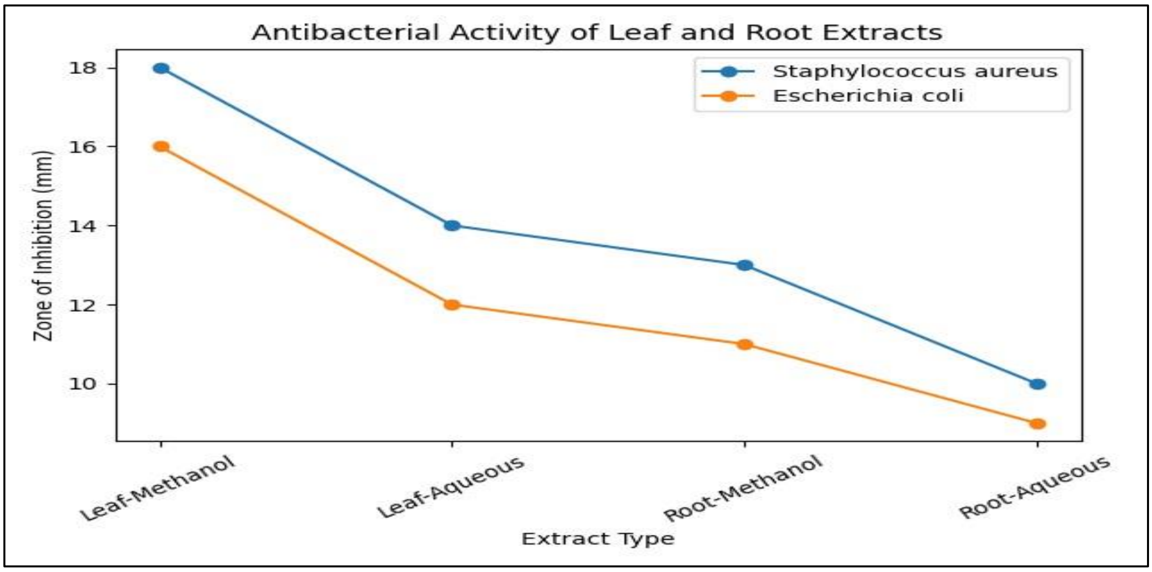
1. Result Tables

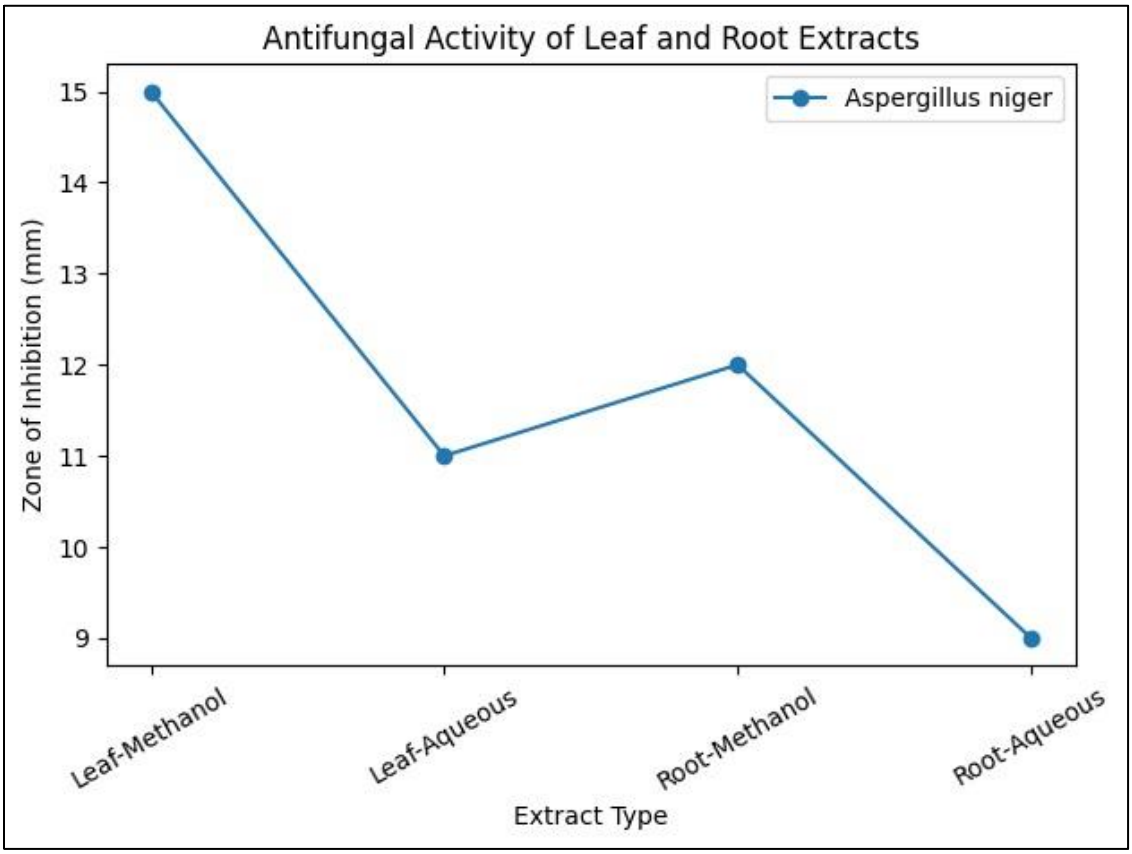
Table 1: Antibacterial Activity (Zone of Inhibition in mm)

Plant Part	**Extract Type**	***Staphylococcus aureus***	***Escherichia coli***
Leaf	Methanol	18 ± 0.5	16 ± 0.6
Leaf	Aqueous	14 ± 0.4	12 ± 0.5
Root	Methanol	13 ± 0.6	11 ± 0.4
Root	Aqueous	10 ± 0.5	9 ± 0.3



Antifungal Activity (Zone of Inhibition in mm)

Plant Part	**Extract Type**	***Aspergillusniger***
Leaf	Methanol	15 ± 0.4
Leaf	Aqueous	11 ± 0.3
Root	Methanol	12 ± 0.5
Root	Aqueous	9 ± 0.4



The strongest antibacterial activity was demonstrated by methanolic leaf extracts. Compared to root extracts, leaf extracts were more successful.
Compared to Gram-negative bacteria (E. coli), Gram-positive bacteria (S. aureus) were more vulnerable. The antifungal activity was noteworthy yet mild.

Discussion

The current study supports previous findings in plant-based drug discovery research by confirming that plant leaves and roots have important antibacterial qualities. Because leaves include larger concentrations of phytochemicals such flavonoids, tannins, and phenolic compounds, leaf extracts showed greater antibacterial efficacy than root extracts among the examined samples (Cowan, 1999).

Compared to aqueous extracts, methanolic extracts showed stronger inhibitory effects, suggesting that organic solvents are more effective at removing bioactive substances. Parekh and Chanda (2007) showed increased antibacterial activity in solvent-based extracts, which is consistent with this observation.
Differences in cell wall structure explain why Gram-positive bacteria (Staphylococcus aureus) are more susceptible than Gram-negative bacteria (Escherichia coli). The outer barrier of gram-negative bacteria prevents antibiotic substances from penetrating them (Burt, 2004).
Plant extracts may also be useful in managing fungal infections, according to the antifungal activity against Aspergillusniger. Fungal growth suppression and membrane rupture may be facilitated by the presence of alkaloids and saponins (Silva et al., 2020).
The study's overall findings emphasize the use of medicinal herbs as a natural source of antibacterial medicines. These results bolster the growing need to create plant-based substitutes for synthetic antibiotics because of the rise in antimicrobial resistance.

Conclusion

Plant leaf extracts, especially methanolic extracts, have potent antibacterial activity against bacterial and fungal diseases, as the experimental results unequivocally show. Though not as much, roots also play a major role. These results highlight the potential of plants in contemporary pharmaceutical applications and validate historic medicinal uses.

References

1. Ahmad, I. (2001). Antimicrobial properties. https://link.springer.com
2. Ali, H. (2014). Medicinal plant research. https://www.sciencedirect.com
3. Bhuyan, D. (2021). Plant-based antimicrobials. https://www.mdpi.com
4. Burt, S. (2004). Essential oils antibacterial activity. https://doi.org/10.1016/j.ijfoodmicro.2004.03.022
5. Chanda, S. (2014). Medicinal plant uses. https://www.sciencedirect.com
6. Cowan, M. (1999). Review antimicrobial plants.
7. Cowan, M. M. (1999). Plant products as antimicrobial agents. *Clinical Microbiology Reviews*. https://doi.org/10.1128/CMR.12.4.564
8. Das, K. (2010). Antimicrobial activity plants. https://www.ncbi.nlm.nih.gov
9. Doughari, J. H. (2012). Phytochemicals extraction. https://www.intechopen.com
10. Dubey, N. (2012). Natural products antimicrobial. https://link.springer.com
11. Eloff, J. N. (1998). Antibacterial activity screening. https://www.ncbi.nlm.nih.gov
12. Evans, W. C. (2009). Pharmacognosy book. https://www.elsevier.com
13. Fabricant, D. S. (2001). Medicinal plants importance. https://pubmed.ncbi.nlm.nih.gov
14. Ghosh, A. (2008). Plant antimicrobial compounds. https://www.sciencedirect.com
15. Gupta, P. D. (2015). Herbal medicines. https://www.ncbi.nlm.nih.gov
16. Harborne, J. B. (1998). Phytochemical methods. https://www.springer.com
17. Jain, A. (2016). Phytochemical studies. https://www.springer.com
18. Joshi, B. (2009). Antimicrobial plant extracts. https://www.ncbi.nlm.nih.gov
19. Kaur, G. (2015). Plant bioactive compounds. https://www.springer.com
20. Khan, R. (2015). Antimicrobial resistance plants. https://www.ncbi.nlm.nih.gov
21. Kuete, V. (2010). Medicinal plant antimicrobial. https://www.sciencedirect.com
22. Kumar, S. (2013). Medicinal plants review. https://www.sciencedirect.com
23. Mishra, A. (2012). Herbal drug research. https://www.springer.com
24. Ncube, B. (2008). Plant extracts antimicrobial. https://www.sciencedirect.com
25. Pandey, A. (2017). Herbal drug research. https://www.researchgate.net
26. Parekh, J., &Chanda, S. (2007). Antibacterial activity. https://www.sciencedirect.com
27. Patel, J. (2016). Antimicrobial activity plants. https://www.ncbi.nlm.nih.gov
28. Prakash, P. (2013). Medicinal plants antibacterial. https://www.ncbi.nlm.nih.gov
29. Rai, M. (2017). Plant antimicrobial compounds. https://link.springer.com
30. Rios, J. L. (2005). Medicinal plant antimicrobial. https://doi.org/10.1016
31. Savoia, D. (2012). Plant-derived antimicrobial. https://doi.org
32. pSaxena, M. (2013). Phytochemical screening. https://www.researchgate.net
33. Saxena, S. (2014). Herbal medicine research. https://www.researchgate.net
34. Sharma, A. (2018). Phytochemical analysis. https://www.researchgate.net
35. Silva, N. C. C. (2020). Natural antimicrobials. https://www.mdpi.com
36. Singh, H. (2018). Antimicrobial plant extracts. https://www.ncbi.nlm.nih.gov
37. Singh, R. (2016). Antibacterial plant extracts. https://www.ncbi.nlm.nih.gov
38. Sofowora, A. (1993). Medicinal plants traditional medicine. https://www.springer.com
39. Tiwari, P. (2011). Phytochemical screening methods. https://www.ncbi.nlm.nih.gov
40. Trease, G. E. (2002). Pharmacognosy. https://www.elsevier.com
41. Verma, S. (2019). Ethnobotany study. https://www.scopus.com
42. WHO (2023). Antimicrobial resistance. https://www.who.int