

**Review article****Impacts of some plant extracts and how effectively they work against*****Pseudomonas aeruginosa*: Review article****Assala Arkan Jawad<sup>1</sup>, Ghinwa S. Majid<sup>1</sup>, Zina F H Al-Obaidi<sup>2</sup>**<sup>1</sup>Department of Biology, College of Science, Al-Nahrain University, Jadiriya, Baghdad, Iraq.<sup>2</sup>Department of Medical and Molecular Biotechnology, College of Biotechnology, Al-Nahrain University, Baghdad, Iraq.**Corresponding author:****Dr. Assala Arkan Jawad**

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E-mails: [assala.a.jawad@nahrainuniv.edu.iq](mailto:assala.a.jawad@nahrainuniv.edu.iq)**DOI:** <https://doi.org/10.71428/BJBMB.2026.0108>**Abstract**

One way that pathogens develop resistance to pharmaceuticals is by forming biofilms, which are 3-D communities of bacteria. As a result, there is considerable interest in identifying new antibiofilm agents from nature that can be used to treat these infections. This review looked at a very common antibiotic-resistant bacterium (*Pseudomonas aeruginosa*) that is a major contributor to human disease because it produces large amounts of biofilm and is a huge contributor to antibiotic resistance in humans. *Pseudomonas aeruginosa* produces many virulence factors and has many virulence-associated genes that make it very troublesome for health care providers because the morbidity and mortality associated with *Pseudomonas aeruginosa* infections are exceedingly high. Treatments focusing on the inhibition of virulence factors are generally more effective than antibiotics at reducing *Pseudomonas aeruginosa* virulence. The primary goal of this review was to evaluate how ginger, coriander leaf, Gardenia, algae, Terminalia bellerica, and eucalyptus extracts affect quorum-sensing (QS)-associated virulence factors and biofilm formation in clinical isolates of antibiotic-resistant *Pseudomonas aeruginosa*. Results indicated that the extracts significantly decreased the protease activity, pyocyanin production, and concentration of exotoxin A produced by the isolates. All clinical isolates exhibited substantially reduced swarming and swimming motility and produced far less biofilm.

**Keywords:** Methanol extract, *Pseudomonas aeruginosa*, Biofilm.**Introduction**

The emergence of drug-resistant strains of many bacteria has been attributed primarily to antibiotics; these synthetic and semi-synthetic antimicrobials have numerous adverse effects. Therefore, most attention has been focused on several plant-derived therapeutic and antibacterial substances in an attempt to solve this problem (1). Methanol extracts of several plants have been found to be an effective

means of resolving this condition (2). Worldwide, multidrug-resistant *P. aeruginosa* has become a more serious clinical concern in recent years. It is now one of the primary reasons for hospital outbreaks.  $\beta$ -lactams are used as the initial treatment. However, it has become resistant to render these drugs ineffective (3). *P. aeruginosa* is gram-negative. It exhibits intrinsic antibiotic resistance, which is related to its limited cell permeability, the

presence of numerous efflux pumps and antibacterial-modifying enzymes, and its capacity to form biofilms (4). *P. aeruginosa* is a well-established biofilm producer under all conditions (5). Chronic infections caused by *P. aeruginosa* biofilms are extremely difficult to treat. Biofilm stability in *P. aeruginosa* requires Fap, the main functional amyloid that forms biofilms (6).

#### Treatment with *Coriandrum sativum* L extract

Coriander (*Coriandrum sativum* L.) is one of the popular essential oil-producing plants from the Apiaceae/Umbelliferae family. The seeds are commonly used to flavor food items, as well as in traditional medicine (7). The essential oil contains  $\alpha$ -pinene,  $\gamma$ -terpinene, camphor, geranial acetate, geraniol, borneol, citronellol,  $\beta$ -caryophyllene, and caryophyllene oxide (8). The cold alcoholic extract of coriander has demonstrated antibacterial activity against *P. aeruginosa*, showing inhibition zones of up to 20 mm (9). Linalool, which comprises over 70% of the essential oil of the coriander fruit, is the major active compound present within this essential oil (10). An example of the effect of linalool on bacterial cells is its ability to alter their normal morphology; when tested against *P. aeruginosa*, linalool has been shown to cause a reduction in the membrane potential (11).

#### Treatment with ginger extract

Researchers tested whether the herb ginger can prevent *P. aeruginosa* PA14 from forming biofilms, since ginger has been used as a traditional medicine for thousands of years for the treatment of infections, and researchers believe it has anti-biofilm properties. The azocasein assay indicated that the addition of ginger honey to the medium reduced the extracellular protease activity of *P. aeruginosa* strains by a significant amount. Zingerone (a metabolite found in ginger) was also shown to reduce *P. aeruginosa*'s pyocyanin production by inhibiting both the las and rhl sectors, as well as significantly reducing *P. aeruginosa*'s swimming/swarming motility. Various

concentrations of ginger ethanolic extract have been tested to see how well they work at inhibiting the production of pyocyanin pigments or biofilms from *P. aeruginosa*. Kim's study in 2013 showed that the ginger ethanol extract had anti-biofilm properties at a concentration of 5% but did not have any measurable effect at 1% or 3% (12).

#### Treatment with *Gardenia thailandica* methanol extract

Zinc oxide nanoparticles were biogenically synthesized using *Gardenia thailandica* methanol extract, whose minimum inhibitory concentration values against *P. aeruginosa* revealed a range of 2 to 64  $\mu\text{g/mL}$ , which significantly decreased the membrane's integrity and increased both inner and outer membrane permeability (13). After interacting with the surface and/or core of the bacteria, the zinc oxide nanoparticles can exhibit a number of bactericidal activities. These substances tend to be very harmful for microorganisms; however, they do not affect human cells (14,15)

#### Treatment with algal extracts

The green algae *U. lactuca* provide cyclohexane and ethyl acetate, while the extract of cyclohexane (CH) appears to inhibit the growth of microcolonies and therefore decrease the number of adherent cells. In contrast, it has been suggested that ethyl acetate (EA) extract could influence both biofilm matrix production and destruction (16).

#### Treatment with *Terminalia bellerica*

*T. bellerica* belongs to the family Combretaceae. found in China, India, and other tropical and subtropical Asian countries. Non-toxic polar antibacterial chemicals with strong thermal stability were found in the aqueous and methanol extracts of the dried pericarp of *T. bellerica* fruits, which indicated their effectiveness against *P. aeruginosa* (17). *T. bellerica* methanolic fruit extract significantly inhibited  $\alpha$ -amylase (IC<sub>50</sub> value 45.20 g/mL) and  $\alpha$ -glucosidase (IC<sub>50</sub> value 175.35 g/mL) (18).

### Treatment with Eucalyptus

Eucalyptus has been used as a medicinal plant for centuries because of its antiviral, antibacterial, anti-inflammatory, antifungal, and antioxidant properties (19). A substantial ( $p < 0.05$ ) decrease in swarming motility was noted, and the highest and most obvious inhibition of pyocyanin production occurred at 1/2 MIC., EPS, and biofilm inhibition (20). Demonstrated at 5–10  $\mu\text{g}/\text{disc}$ , Eucalyptus Camaldulensis essential oils have antibacterial efficacy against tested *P. aeruginosa*, *P. fluorescens*, and *P. putida*, whose biofilm development was suppressed. Additionally, the essential oils like citronellal (30.67%) and citronellol (19.14%) from *E. citriodora* damaged the cell membrane, which allowed components like DNA and RNA to leak out. Essential oils (EO) effectively inhibited biofilm formation when anti-quorum-sensing activity was investigated (21).

### Potential Adverse Effects

The safety of a plant product is not necessarily ensured by being classified as "natural." It should be noted that adverse impacts are still possible, but they are often mild and only affect a tiny percentage of individuals. According to recent studies, a number of plants that were thought to be harmless for many generations are now associated with toxicity and health problems. Therefore, to achieve the best outcomes in herbal medicines, it is essential to completely understand the biological characteristics and chemical makeup of medicinal plants to achieve optimal results in herbal therapies.

### Conclusion

The results of this study demonstrate that extracts of ginger, coriander (*Coriandrum Sativum* L.), Gardenia Thailandica Methanol, algae, Terminalia Bellerica and eucalyptus have an effect against *Pseudomonas Aeruginosa* and are thus recommended as a viable alternative to antibiotics for treating *Pseudomonas Aeruginosa* infections.

### Recommendations

Most antibiotics cannot pass through the exopolysaccharide structure that bacteria form when they develop biofilms. We therefore need substances that can damage the bacterial system in a variety of ways. Microbial infections have traditionally been treated with plant extracts or components.

Future research should investigate these extracts and their individual components to develop additional potential anti-virulence agents to modulate antibiotic-resistant infections. Lastly, additional studies into the effect of several other plant extracts (e.g., clove, turmeric, and black pepper) on quorum sensing at the cellular and molecular levels must also be completed.

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### References

- 1- Al-Mashhadani, T. A., Kadhum, F. M., Jawad, A. A., Ajeel, K. K., & Mohsen, A. H. (2025). Investigating the antibacterial activity of Zinc Oxide Nanoparticles against staphylococcus aureus isolates. *Journal of Bioscience and Applied Research/Journal of Bioscience and Applied Research*, 11(1), 270–280. <https://doi.org/10.21608/jbaar.2025.419993>
- 2- Al-Mijalli, S. H., Hachlafı, N. E., Khalil, Z., Laaboudi, W., Abdallah, E. M., Alshabirmi, F. M., Mohamed, N. H., Al-Farga, A., & Mrabti, H. N. (2025). Unlocking the Antibacterial Potential of Eucalyptus citriodora Hook: Essential Oil on Some Bacterial Pathogens with a Focus on Antiadhesive, Antibiofilm, and Mechanisms of Action Against Pseudomonas aeruginosa. *Foodborne Pathogens and Disease*. <https://doi.org/10.1177/15353141251405079>
- 3- Alotaibi, B., Negm, W. A., Elekhawy, E., El-Masry, T. A., Elharty, M. E., Saleh, A., Abdelkader, D. H., & Mokhtar, F. A. (2022). Antibacterial activity of nano zinc oxide green-synthesised from Gardenia thailandica triveng.

- Leaves against *Pseudomonas aeruginosa* clinical isolates: in vitro and in vivo study. *Artificial Cells Nanomedicine and Biotechnology*, 50(1), 96–106. <https://doi.org/10.1080/21691401.2022.2056191>
- 4- Bektaş, S., Özdal, M., & Gürkök, S. (2023). Antibiofilm activities and in vitro susceptibility testing of eucalyptus (*Eucalyptus camaldulensis*) essential oil (EO) against fish pathogen *Pseudomonas* species. *The Trout Journal of Atatürk University*, 1(1), 8-14.
  - 5- El-Sapagh, S., El-Shenody, R., Pereira, L., & Elshobary, M. (2023). Unveiling the Potential of Algal Extracts as Promising Antibacterial and Antibiofilm Agents against Multidrug-Resistant *Pseudomonas aeruginosa*: In Vitro and In Silico Studies including Molecular Docking. *Plants*, 12(18), 3324. <https://doi.org/10.3390/plants12183324>
  - 6- ErsiN, E., & Şenkal, B. C. (2023). Impacts of essential oil and extracts obtained from coriander cultivars (*Coriandrum sativum* L.) on some important pathogenic bacteria. *Current Perspectives on Medicinal and Aromatic Plants (CUPMAP)*. <https://doi.org/10.38093/cupmap.1281520>
  - 7- Fraenkel, C., Starlander, G., Tano, E., Sütterlin, S., & Melhus, Å. (2023). The First Swedish Outbreak with VIM-2-Producing *Pseudomonas aeruginosa*, Occurring between 2006 and 2007, Was Probably Due to Contaminated Hospital Sinks. *Microorganisms*, 11(4), 974. <https://doi.org/10.3390/microorganisms11040974>
  - 8- González-Burgos, E., Liaudanskas, M., Viškelis, J., Žvikas, V., Janulis, V., & Gómez-Serranillos, M. P. (2018). Antioxidant activity, neuroprotective properties, and bioactive constituents analysis of varying polarity extracts from *Eucalyptus globulus* leaves. *Journal of Food and Drug Analysis*, 26(4), 1293–1302. <https://doi.org/10.1016/j.jfda.2018.05.010>
  - 9- Habh, A. M., Twaij, B. M., & Al-Oqaili, R. M. S. EFFECT OF COLD AND HOT ALCOHOLIC EXTRACT OF CORIANDRUM SATIVUM L SEEDS AGAINST PSEUDOMONAS AERUGINOSA AND STAPHYLOCOCCUS AUREUS.
  - 10- Hansen, K. H., Golcuk, M., Byeon, C. H., Tunc, A., Plechinger, E. B., Dueholm, M. K. D., Conway, J. F., Andreasen, M., Gur, M., & Akbey, Ü. (2025). Structural basis of *Pseudomonas* biofilm-forming functional amyloid FapC formation. *Science Advances*, 11(39), eadx7829. <https://doi.org/10.1126/sciadv.adx7829>
  - 11- Hemida, K. A., Khalid, S., Abdelatif, A. M., & Reyad, A. M. (2024). A study of phytochemical screening and antibacterial effect of some methanolic plant extracts on *Pseudomonas aeruginosa*. *Fayoum Journal of Agricultural Research and Development /Fayoum Journal of Agricultural Research and Development*, 38(1), 1–14. <https://doi.org/10.21608/fjard.2024.342076>
  - 12- Kim, H., & Park, H. (2013). Ginger Extract Inhibits Biofilm Formation by *Pseudomonas aeruginosa* PA14. *PLoS ONE*, 8(9), e76106. <https://doi.org/10.1371/journal.pone.0076106>
  - 13- Jawad, A. A., & Utba, N. M. (2023). ANTISEPTICS RESISTANCE GENES (QACA/B, SMR) DETECTION AND EXPRESSION IN STAPHYLOCOCCUS AUREUS. *IRAQI JOURNAL OF AGRICULTURAL SCIENCES*, 54(4), 1147–1154. <https://doi.org/10.36103/ijas.v54i4.1808>
  - 14- Krell, T., & Matilla, M. A. (2024). *Pseudomonas aeruginosa*. *Trends in microbiology*, 32(2), 216–218.
  - 15- Yameny, A. A Comprehensive Review on Nanoparticles: Definition, Preparation, Characterization, Types, and Medical Applications. *Journal of Medical and Life*

- Science*, 2024; 6(4): 663-672. doi: 10.21608/jmals.2024.419629
- 16- Kumar, V., Kumari, P., Arora, V., Dixit, H., Singh, R., & Sharma, N. (2022). Antimicrobial and Antidiabetic activities of different parts of Terminalia bellerica fruits. *Arabian Journal of Medicinal & Aromatic Plants*, 8, 115-130.
- 17- Liu, X., Cai, J., Chen, H., Zhong, Q., Hou, Y., Chen, W., & Chen, W. (2020). Antibacterial activity and mechanism of linalool against *Pseudomonas aeruginosa*. *Microbial Pathogenesis*, 141, 103980. <https://doi.org/10.1016/j.micpath.2020.103980>
- 18- Miari, M., Rasheed, S. S., Ahmad, N. H., Itani, D., Fayad, A. A., & Matar, G. M. (2020). Natural products and polysorbates: Potential Inhibitors of biofilm formation in *Pseudomonas aeruginosa*. *The Journal of Infection in Developing Countries*, 14(06), 580–588. <https://doi.org/10.3855/jidc.11834>
- 19- Ng, W., Hing, C., Loo, C., Hoh, E., Loke, I., & Ee, K. (2023). Ginger-Enriched Honey Attenuates Antibiotic Resistant *Pseudomonas aeruginosa* Quorum Sensing Virulence Factors and Biofilm Formation. *Antibiotics*, 12(7), 1123. <https://doi.org/10.3390/antibiotics12071123>
- 20- Omar, A., Barakat, M., Alzaghari, L. F., Abdulrazzaq, S. B., Hasen, E., Chellappan, D. K., & Al-Najjar, M. A. A. (2024). The effect of Jordanian essential oil from coriander seeds on antioxidant, anti-inflammatory, and immunostimulatory activities using RAW 246.7 murine macrophages. *PLoS ONE*, 19(8), e0297250. <https://doi.org/10.1371/journal.pone.0297250>
- 21- Rima, M., Trognon, J., Latapie, L., Chbani, A., Roques, C., & Garah, F. E. (2022b). Seaweed Extracts: A Promising Source of Antibiofilm Agents with Distinct Mechanisms of Action against *Pseudomonas aeruginosa*. *Marine Drugs*, 20(2), 92. <https://doi.org/10.3390/md20020092>