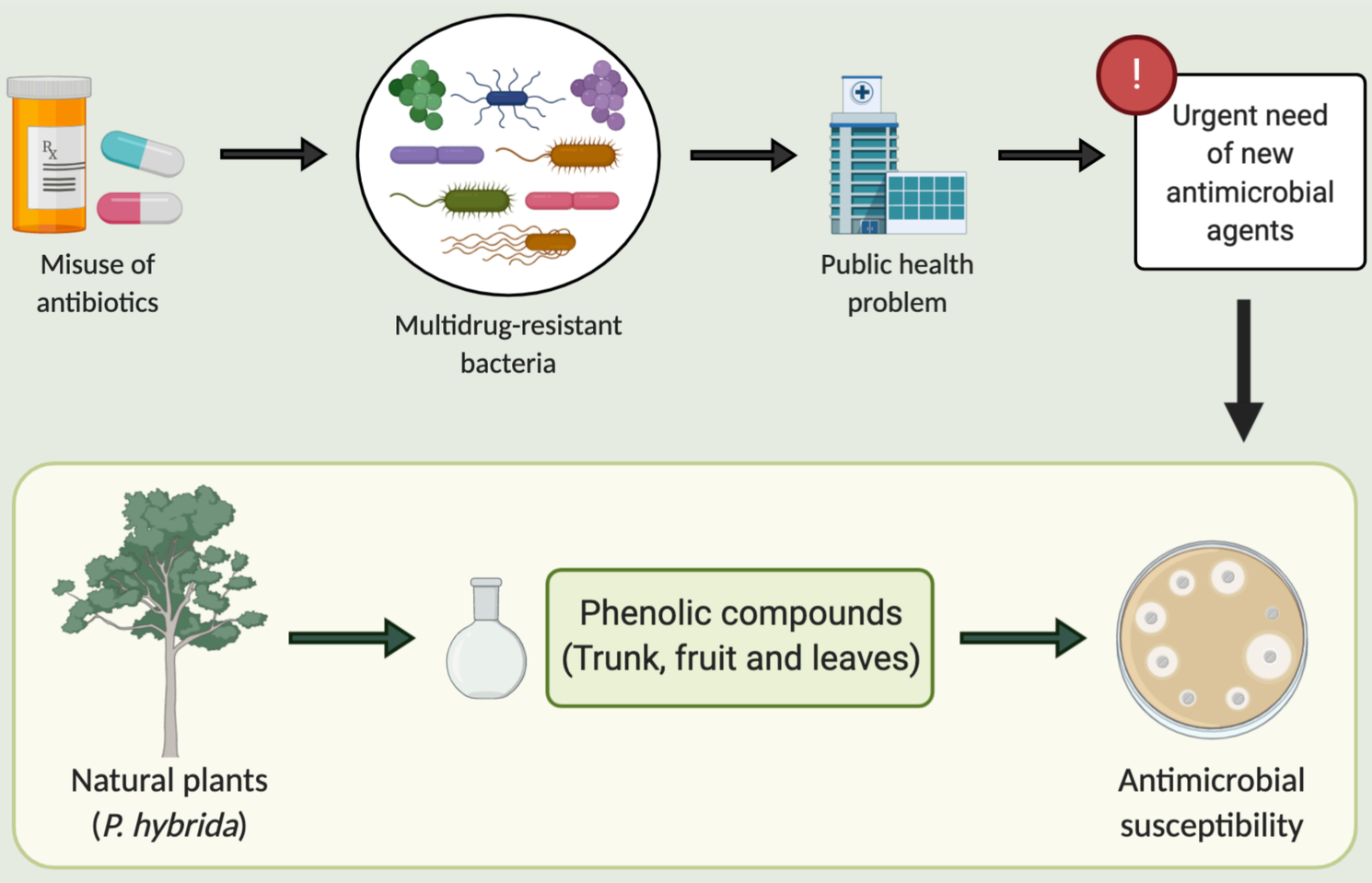
# Antimicrobial Activity of Phenolic Compounds Extracted from *Platanus hybrida*: Exploring Alternative Therapies for a Post-Antibiotic Era

**Jessica Ribeiro [1], Vanessa Silva [1,2,3,4], Alfredo Aires [5], Rosa Carvalho [6], Gilberto Igrejas [2,3,4] and Patrícia Poeta [1,4*]**

[1] Microbiology and Antibiotic Resistance Team (MicroART), Department of Veterinary Sciences, University of Trás-os-Montes and Alto Douro (UTAD), Vila Real, Portugal;
[2] Department of Genetics and Biotechnology, University of Trás-os-Montes and Alto Douro, Vila Real, Portugal;
[3] Functional Genomics and Proteomics Unit, University of Trás-os-Montes and Alto Douro (UTAD), Vila Real, Portugal;
[4] Associated Laboratory for Green Chemistry (LAQV-REQUIMTE), University NOVA of Lisbon, Caparica, Portugal;
[5] Centre for the Research and Technology of Agro-Environmental and Biological Sciences (CITAB), University of Trás-os-Montes and Alto Douro (UTAD), Vila Real, Portugal;
[6] Department of Agronomy, School of Agrarian and Veterinary Sciences, University of Trás-os-Montes e Alto Douro (UTAD), Vila Real, Portugal.

*jessicalribeiro97@gmail.com

## Graphical Abstract




## Introduction

Multidrug-resistant bacteria are a significant threat to public health and new classes of antibiotics and approaches to treatment are needed **[1].** Plants have been used from many centuries for therapeutic purposes and several studies showed that natural plant-derived compounds could be a promising mean to fight microbial resistance but only a few were conducted with antibiotic resistant bacteria **[2,3]**. *Platanus hybrida,* also known as London Plane, is a hybrid between *Platanus occidentalis* (American origin) and *Platanus orientalis* (Oriental origin). It is widely used as an urban tree because it provides a large number of ecosystem services, grows fast, has a good tolerance to urban microclimate conditions and it is quite resistant to soil compaction and air pollution **[4]**. Therefore, the aim of this study was to extract phenolic compounds from the leaves, fruits and tree trunk of *Platanus hybrida* and evaluate their antimicrobial activity against antibiotic resistant bacterial strains.

## Material and Methods

The polyphenolic compounds were extracted using a water/ethanol (20:80) mixture. Two grams of powder of each sample was extracted with 100 mL of solvent by stirring for 2h. The extracts were redissolved in dimethyl sulfoxide (DMSO) to a final concentration of 100 mg/mL. Antimicrobial susceptibility assay was performed using Kirby-Bauer disc diffusion method and was tested against ten different bacteria: *Listeria monocytogenes*, *Bacillus cereus*, *Enterococcus faecium*, *Enterococcus faecalis*, *Staphylococcus aureus*, *Staphylococcus epidermidis*, *Salmonella enteritidis*, *Pseudomonas aeruginosa*, *Klebsiella pneumoniae* and *Escherichia coli*.

## Results

*L. monocytogenes* was the only bacteria that showed susceptibility to all the extracts. None of the phenolic extracts had any effect against *E. faecium, E. faecalis* and *S. enteritidis*. The higher susceptibility zone (19mm), which was caused by the fruit extracts (100mg/mL), was observed against *E. coli*.

In general, fruit extracts had the better antimicrobial efficacy, since they had effect against eight of the ten bacteria tested and showed lower MIC values. Contrarily, the trunk extracts only had effect against *L. monocytogenes* with MIC of 100mg/mL. The leaves extracts showed antimicrobial efficacy against six bacteria.

**Tabel 1.** Minimum inhibitory concentration (MIC, mg/mL) and inhibition zones (mm) of the phenolic extracts from the trunk, fruits and leaves against multidrug-resistant Gram-positive and Gram-negative bacteria.

| Bacterial Strain | | MIC (mg/mL) | | |
|---|---|---|---|---|
| | | Trunk | Fruit | Leaf |
| Gram-positive | *L. monocytogenes* | 100 (10) | 10 (9) | 10 (8) |
| | *B. cereus* | - | 25 (11) | - |
| | *E. faecium* | - | - | - |
| | *E. faecalis* | - | - | - |
| | *S. aureus* | - | 25 (8) | 50 (9) |
| | *S. epidermidis* | - | 25 (10) | 25 (13) |
| Gram-negative | *P. aeruginosa* | - | 25 (12) | 75 (9) |
| | *K. pneumoniae* | - | 10 (12) | 10 (10) |
| | *S. enteritidis* | - | - | - |
| | *E. coli* | - | 10 (9) | 25 (10) |

## Conclusion

The sensitivity of multidrug-resistant bacteria to natural phenolic compounds depends on bacterial species, the polyphenol structure of the phenolics as well as the methods used for the experiments. More studies, including *in vivo* experiments, should be undertaken to better clarify the molecular mechanisms underlying the protection of plane tree extracts against pathogenic bacteria. Nevertheless, the obtained results add evidence that these extracts can be an interesting source of phenolic compounds with antimicrobial activities which may provide assistance to antibiotics.

## References

**[1]** Imane, N.I.; Fouzia, H.; Azzahra, L.F.; Ahmed, E.; Ismail, G.; Idrissa, D.; Mohamed, K.H.; Sirine, F.; L'Houcine, O.; Noureddine, B. Chemical composition, antibacterial and antioxidant activities of some essential oils against multidrug resistant bacteria. *Eur. J. Integr. Med.* **2020**, *35*, 101074, doi:10.1016/j.eujim.2020.101074.

**[2]** Freitas, P.R.; de Araújo, A.C.J.; dos Santos Barbosa, C.R.; Muniz, D.F.; Rocha, J.E.; de Araújo Neto, J.B.; da Silva, M.M.C.; Silva Pereira, R.L.; da Silva, L.E.; do Amaral, W.; et al. Characterization and antibacterial activity of the essential oil obtained from the leaves of Baccharis coridifolia DC against multiresistant strains. *Microb. Pathog.* **2020**, *145*, 104223, doi:10.1016/j.micpath.2020.104223.

**[3]** Edziri, H.; Haddad, O.; Saidana, D.; Chouchen, S.; Skhiri, F.; Mastouri, M.; Flamini, G. Ruscus hypophyllum L. extracts: chemical composition, antioxidant, anticoagulant, and antimicrobial activity against a wide range of sensitive and multi-resistant bacteria. *Environ. Sci. Pollut. Res.* **2020**, *27*, 17063–17071, doi:10.1007/s11356-020-08159-8.

**[4]** Cariñanos, P.; Ruiz-Peñuela, S.; Valle, A.M.; de la Guardia, C.D. Assessing pollination disservices of urban street-trees: The case of London-plane tree (Platanus x hispanica Mill. ex Münchh). *Sci. Total Environ.* **2020**, *737*, 139722, doi:10.1016/j.scitotenv.2020.139722.

**ACKNOWLEDGMENTS:**

This work was also supported by the Associate Laboratory for Green Chemistry-LAQV which is financed by national funds from FCT/MCTES (UID/QUI/50006/2020). Vanessa Silva is grateful to FCT (Fundação para a Ciência e a Tecnologia) for financial support through PhD grant SFRH/BD/137947/2018.