



Evaluation of antimicrobial activity of Pine natural extracts against Agri- and Food-related pathogenic bacteria

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INTRODUCTION

The continuous use of synthetic antimicrobials has led to the emergence of resistant pathogenic microorganisms. Natural extracts represent a highly promising alternative in the agri-food sector aiming to replace synthetic antimicrobial agents. The bioactive components contained in plant extracts have the capacity to inhibit the growth of pathogenic microorganisms, effectively contributing to the management of microbial infection (1). The use of ideal alternative solvents, along with suitable techniques and procedures at the processing stages associated with green extraction, ensures low toxicity and minimal environmental footprint, without causing any harmful impact on the environment (2, 3, 4).

MATERIAL AND METHODS

An investigation was conducted to evaluate the antimicrobial potential of extracts, derived from needles, male cones, and male cones containing pollen of Pine (*Pinus halepensis*), collected from the Attica region in Greece, against seventeen pathogenic bacteria. The green solvents that used were isopropanol and water, in a 90:10 % (v/v) ratio.



Needles



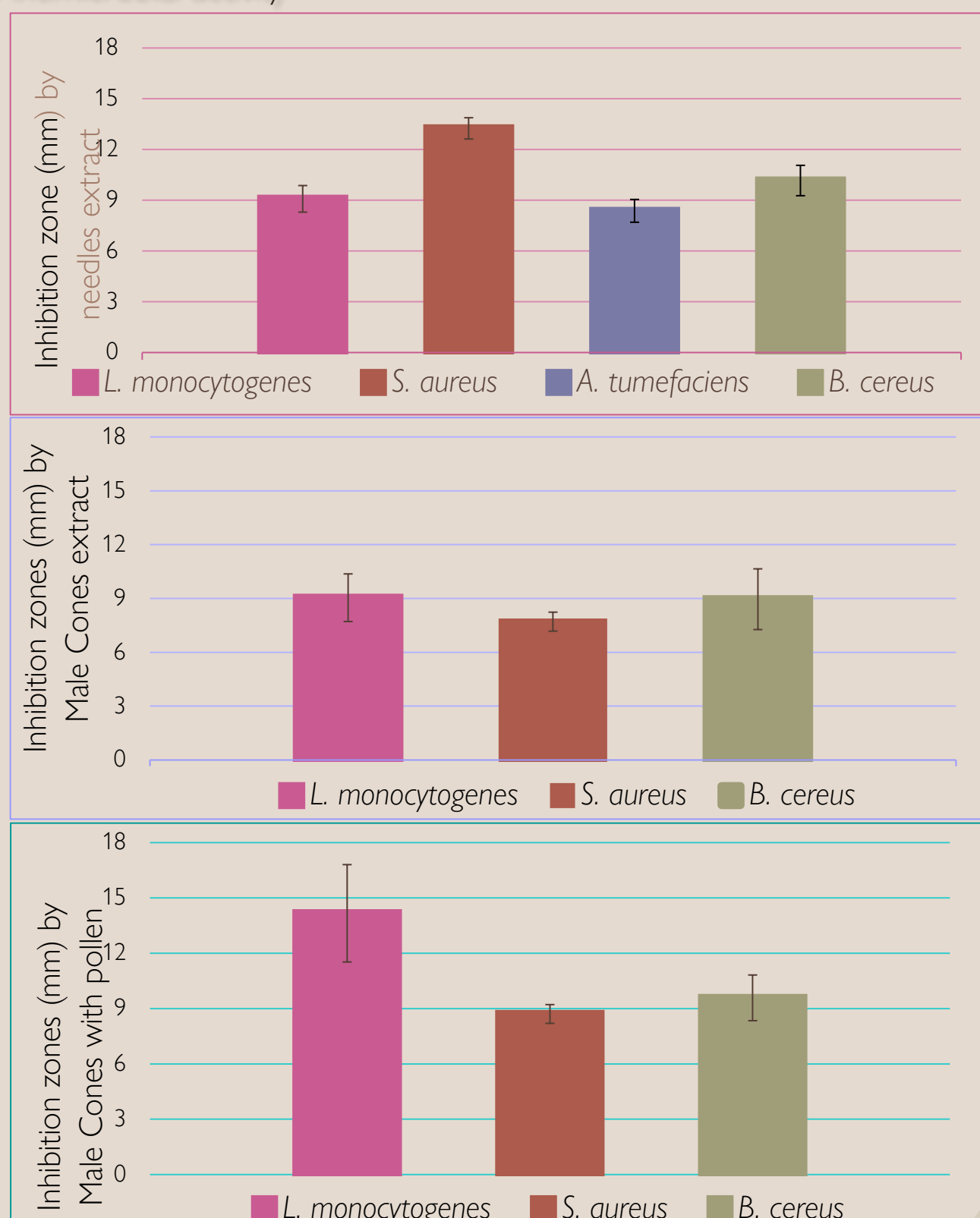
Male cones



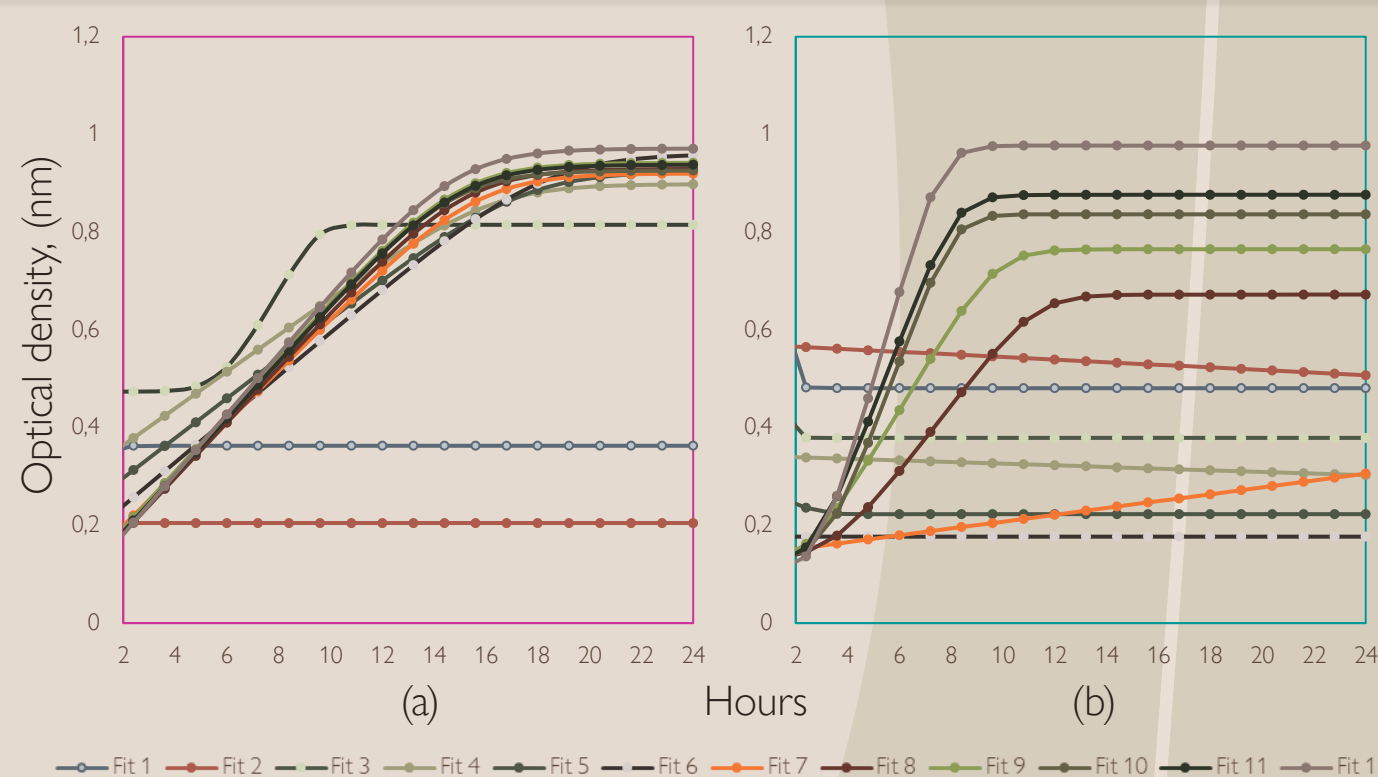
Male cones with pollen

RESULTS

Antimicrobial activity



Graph 1. The antimicrobial efficacy of extract obtained from Pine's vegetative and reproductive organs, tested against pathogenic bacteria. The results represented inhibition zones (mm), with error bars indicating standard deviation from six replicate tests.



Graph 2. Changes on absorption at 600 nm of *Escherichia coli* (a) and *Bacillus cereus* (b) growth under optimal conditions, affected by different concentrations of Pine extracts (needles and male cones with pollen, respectively). Fit 1 to 11, demonstrate the impact of reduced extract concentrations, whereas Fit 12, illustrates the growth of the microbe under positive control conditions.

CONCLUSIONS

- Natural extracts derived from Pine via green extraction methods were proposed as effective antimicrobial agents for application in the agricultural and food sectors. These extracts demonstrated inhibitory activity against pathogenic bacteria including *Escherichia coli*, *Vibrio harveyi*, *Staphylococcus epidermidis*, *Staphylococcus aureus*, *Listeria monocytogenes*, *Bacillus cereus*, and *Agrobacterium tumefaciens*.
- Conversely, minimal inhibition was observed against *Pseudomonas aeruginosa*, *Serratia marcescens*, *Yersinia enterocolitica*, *Klebsiella aerogenes*, *Salmonella enterica*, and *Salmonella typhimurium*. Additionally, *Citrobacter freundii*, *Klebsiella oxytoca*, *Serratia liquefaciens*, and *Cronobacter sakazakii* exhibited resistance to all tested extracts.
- The potential role of these natural extracts in modulating the evolution of antibiotic resistance should be further investigated to predict and mitigate resistance development.

REFERENCES

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