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Antibacterial properties of binary boron-hydroxycarboxylic acid materials

LABORATORY OF INORGANIC CHEMISTRY AND ADVANCED MATERIALS

ARISTOTLE UNIVERSITY OF THESSALONIKI

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Abstract: The synthesis and study of the antibacterial properties of binary boron–hydroxycarboxylic acid materials were carried out in our Laboratory, as boron compounds attract significant research interest due to their biological role. For the synthesis of these materials, citric acid, glycolic acid, 2-hydroxyisobutyric acid, and 2-ethyl-2-hydroxybutyric acid were selected as ligands. The activity of the materials was tested against selected bacterial strains, *Xanthomonas campestris* and *Staphylococcus aureus*. The aim was to discover new materials with antibacterial properties that are also environmentally friendly, in order to control devastating plant diseases such as "Black Rot," which affect not only agricultural crops but also public health.

• Introduction

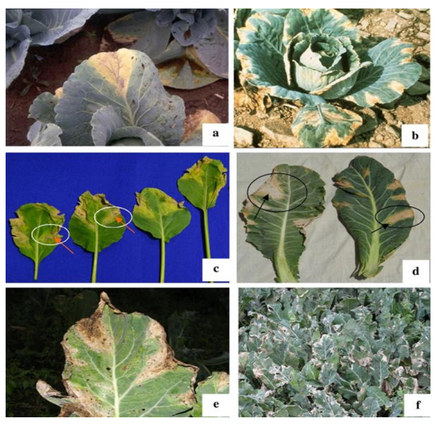


Fig. 1: Symptoms of Black rot[2]

Driven by the urgent need to discover novel antiseptic materials that are also environmentally friendly and safe for agricultural use, researchers are turning their attention to the study of innovative chemical systems composed of hybrid inorganic and organic compounds, the biological activity of which could potentially replace existing antibiotics.[1] Black rot (**Fig. 1**) is a devastating plant disease caused by the bacterium *Xanthomonas campestris*, which affects plants of the Brassica family, leading to significant losses in both yield and crop quality. In this context, binary boron compounds with various hydroxycarboxylic acids (**Fig. 2**) represent a promising approach, as boron is considered an essential micronutrient for plants and has also been extensively studied for its beneficial effects on human and animal biological functions.[3] Cultures of *X. campestris* and *S. aureus* were developed, and antibacterial susceptibility tests were conducted to determine the Minimum Inhibitory Concentration (MIC) of the tested compounds that produces a detectable Zone of Inhibition (ZOI) in bacterial cultures

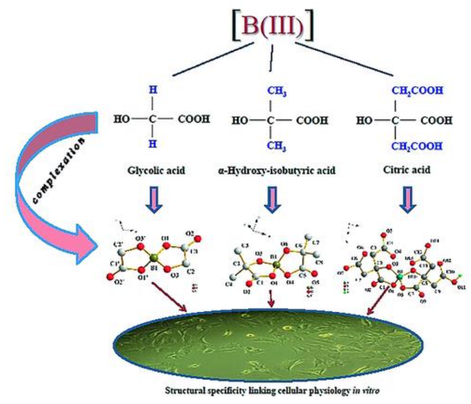
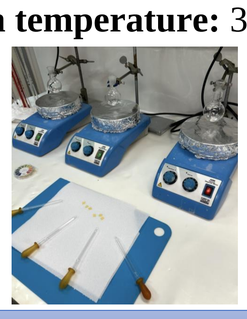


Fig. 2: Binary Boron-Hydroxycarboxylic materials[4]

Materials and methods

Materials: H_3BO_3, citric acid, glycolic acid, 2-hydroxyisobutyric acid, 2-ethyl-2-hydroxybutyric acid, LB Agar, LB Broth.
Sterilization technique: 121 ^oC, 30 min.
Incubation temperature: 30 ^oC for *X. Campestris* and 37 ^oC for *S. Aureus.*

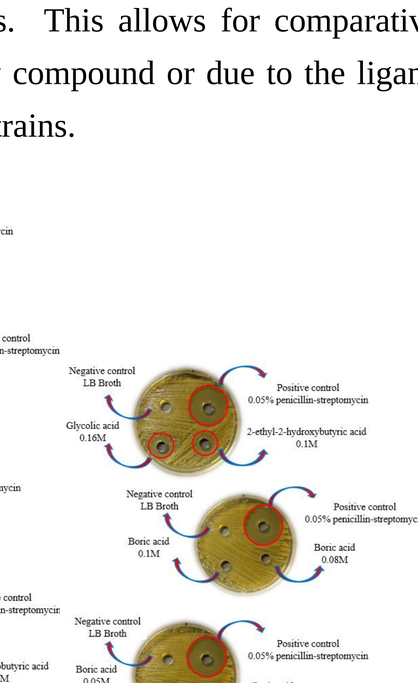


Material synthesis

Preparation of LB Broth and LB Agar

Sterilization

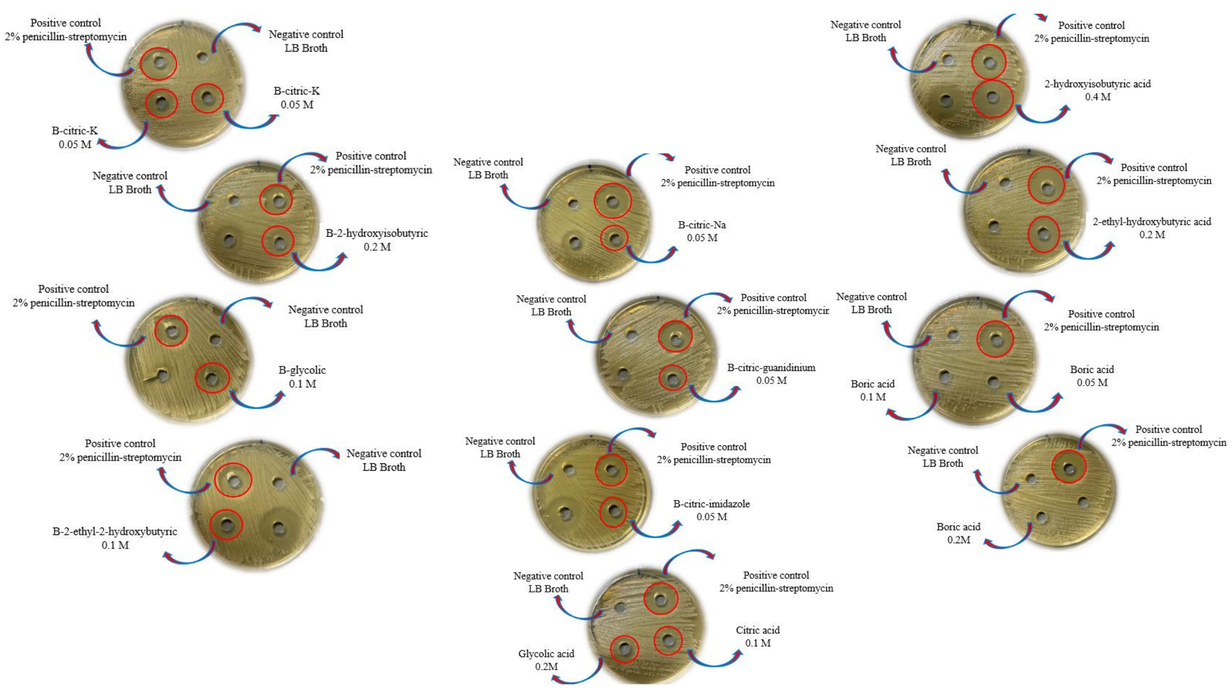
Incubation



UV-spectrophotometer

Results and discussion

The antibacterial activity of binary boron-hydroxycarboxylic acid materials was studied using solid cultures of the pathogens *Xanthomonas campestris* and *Staphylococcus Aureus*, employing the zone of inhibition (ZOI) method. The aim is to determine the minimum concentration of each material, at which visible bacterial growth is inhibited. Both the binary boron–hydroxycarboxylic acid materials and the corresponding free ligands were tested at equivalent concentration ratios. This allows for comparative evaluation of their antibacterial activity, in order to assess whether the observed inhibition is attributed solely to the formation of the binary compound or due to the ligand itself. Through this comparative approach, the study aims to clarify the role of boron in the bioactivity of the compounds against the bacterial strains.



ZOI against *X. campestris*

ZOI against *S. aureus*

Conclusions

- Binary boron-hydroxycarboxylic acid materials indeed possess antibacterial properties against both *X. Campestris* and *S. Aureus* bacterial strains with a notably enhanced effect observed against Gram-positive bacteria (*S. aureus*).
- The presence of boron enhances the antibacterial activity of the ligands in most of the materials, which have been synthesized.
- Binary boron-hydroxycarboxylic acid materials merit further consideration as potential future antibacterial agents in biological applications.

Literature

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[2]. Z. Liu, H. Wang, J. Wang, J. Lv, B. Xie, S. Luo, S. Wang, B. Zhang, Z. Li, Z. Yue, J. Yu, Frontiers in Microbiology, 13 (2022) 1023826.
[3]. A. Lopalco, A.A. Lopedota, V. Laquintana, N. Denora, V.J. Stella, Journal of Pharmaceutical Sciences 109 (2020) 2375-2386.
[4]. S. Matsia, O. Tsave, A. Hatzidimitriou, C. Gabriel, M. Bertmer, A. Salifoglou, European Journal of Inorganic Chemistry, (2018) 1284-1301.