Conclusions. The study demonstrated the ability of phosphate-solubilizing *Penicillium* strains to produce hydroxamate-type siderophores and revealed significant correlations between siderophore production and phosphate-solubilizing activity. A pronounced strain-specific pattern of siderophore production was also observed. The experimental strains were indicated as promising for further studies related to phosphate solubilization and siderophore production and for potential application in agriculture.

References:

1. Ahash, S., Manikandan, K., Sivasankari Devi, T., Elamathi, S., Maragatham, S., & Subrahmaniyan, K. (2025). Phosphate-solubilizing microorganisms for sustainable phosphorus management in rice. Rhizosphere, 34, 101096. https://doi.org/10.1016/j.rhisph.2025.101096
2. Gu, S., Wei, Z., Shao, Z., Friman, V. P., Cao, K., Yang, T., Kramer, J., Wang, X., Li, M., Mei, X., Xu, Y., Shen, Q., Kümmerli, R., & Jousset, A. (2020). Competition for iron drives phytopathogen control by natural rhizosphere microbiomes. Nature microbiology, 5(8), 1002–1010. https://doi.org/10.1038/s41564-020-0719-8
3. Schwyn, B., & Neilands, J. B. (1987). Universal chemical assay for the detection and determination of siderophores. Analytical biochemistry, 160(1), 47–56. https://doi.org/ 10.1016/0003-2697(87)90612-9
4. Swayambhu, G., Bruno, M., Gulick, A. M., & Pfeifer, B. A. (2021). Siderophore natural products as pharmaceutical agents. Current opinion in biotechnology, 69, 242–251. https://doi.org/10.1016/j.copbio.2021.01.021

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PRODUCTION OF AUXIN-LIKE COMPOUNDS AND SIDEROPHORES BY *OCHROBACTRUM RHIZOSPHAERAE* IMV B-7956 UNDER T THE INFLUENCE OF NaCl

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Abstract. The ability of *Ochrobactrum rhizosphaerae* IMV B-7956 bacteria to produce auxin-like compounds and siderophores at various NaCl concentrations was investigated. The bacteria, isolated from filtrates of the Lviv municipal solid waste landfill, were cultured in LB liquid medium containing NaCl concentrations of 0.5, 2.5, 4.5, and 6.5 % for 5 days. On days 3, 4, and 5 biomass accumulation and the content of auxin-like compounds and siderophores in the culture medium were determined. Auxin-like compounds and siderophores were determined using a spectrophotometric method, while biomass was determined by weighing. It was found that the NaCl concentration affected both bacterial growth and the production of the studied metabolites; the highest biomass accumulation was observed at 4.5 % NaCl, whereas the addition of 6.5 % NaCl significantly inhibited culture growth. The highest production of siderophores was recorded at 4.5 % NaCl on days 4 and 5 of cultivation, whereas the highest levels of auxin-like compounds were predominantly observed at lower NaCl concentrations. The results obtained confirm the promise of further study of the biotechnological potential of *O. rhizosphaerae* IMV B-7956 bacteria.
Keywords: plant growth-promoting bacteria, phytohormones, siderophores, halotolerance.

Introduction. Auxins, particularly indole-3-acetic acid (IAA), play a key role in plant growth and development by the regulation of cell division, elongation, and root system

formation. Auxins are synthesized not only by plants but also by bacteria and are used in interactions with the plant or in the regulation of their own physiological processes (Etesami, 2024; Duca et al., 2020). The bacterial production of auxin-like compounds promotes plant growth, in particular by modifying the architecture of the root system and increasing nutrient absorption (Etesami, 2024; Poria et al., 2022). Siderophores are low-molecular-weight compounds with a high affinity for Fe^{3+}, synthesized primarily under conditions of available iron deficiency (Kramer, 2020). They facilitate the mobilization and absorption of iron by bacteria and may also enhance its availability to plants and inhibit the growth of phytopathogens (Cai et al., 2026). The synthesis of auxins and siderophores is an important component of bacteria's ability to stimulate plant growth. Bacteria of the genus *Ochrobactrum* are capable of synthesizing IAA and siderophores and stimulating plant growth (Yu et al., 2017). Study of the production of these metabolites by strains isolated from extreme environments contributes to the study of their adaptation mechanisms and the search for microorganisms with promising biotechnological properties.

The aim of this study was to evaluate the ability of *O. rhizosphaerae* IMV B-7956 bacteria, isolated from the leachate of the Lviv municipal solid waste landfill, to synthesize auxin-like compounds and siderophores under the influence of different concentrations of NaCl.

Methods. In this study *O. rhizosphaerae* IMV B-7956 bacteria were used. Bacteria were isolated at the Department of Microbiology of Ivan Franko National University of Lviv. The bacteria were cultured in Luria-Bertani (LB) liquid medium with a baseline concentration of NaCl 0.5 %, which was used as a control. The ability of bacteria to synthesize auxin-like compounds and siderophores was studied under the influence of concentrations of 2.5 %, 4.5 %, and 6.5 % NaCl. Bacteria were cultivated for 5 days under constant aeration. On days 3, 4 and 5 of growth culture liquid was collected and centrifuged (5,000 rpm for 10 min). The supernatant was used to determine auxin-like compounds and siderophores, and the bacterial cell pellet was used to determine biomass by the weight method. The content of auxin-like compounds was determined spectrophotometrically after mixing the supernatant with Salkowski's reagent in a 1:1 ratio and measuring the optical density at wavelength 536 nm. Siderophore production was determined spectrophotometrically after mixing the supernatant with Chrome Azurol S (CAS) reagent in a 1:1 ratio and measuring the optical density at 630 nm. The obtained values were used to calculate the concentrations of the studied metabolites and biomass. The results were processed and calculated using Microsoft Excel.

Results. NaCl concentration significantly affected the biomass accumulation of *O. rhizosphaerae* IMV B-7956 and the production of auxin-like compounds and siderophores. The highest biomass values were observed at 4.5 % NaCl (2.514, 2.814, and 2.443 mg/mL on days 3, 4, and 5, respectively), whereas at 6.5 % NaCl, biomass was the lowest – 0.714, 0.743, and 0.857 mg/mL on days 3, 4, and 5, respectively. In the control (0.5 % NaCl) biomass was 2.043 mg/mL on 3 day and decreased slightly to 1.814 mg/mL on days 4 and 5, whereas at 2. 5 % NaCl, a gradual decrease in biomass was observed from 2.514 to 2.086 mg/mL.

Thus, a moderate increase in salinity to 2.5–4.5 % did not inhibit the growth of the strain, and the greatest accumulation of biomass was observed at 4.5 % NaCl, whereas 6.5 % NaCl had a pronounced inhibitory effect.

The production of auxin-like compounds by *O. rhizosphaerae* IMV B-7956 also depended on the duration of cultivation and the NaCl concentration: maximum values on day 3 were observed at 0.5 % NaCl (5.85 μg/mL), whereas at 6.5 % salt their level was minimal (0.04 μg/mL). The highest production of auxin-like compounds was recorded at 0.5 % NaCl: 2.78 μg/mL on day 4 and 3.30 μg/mL on day 5 of growth. The siderophore content showed a different trend: on day 3, the highest value was observed under the influence of 2.5 % NaCl

(13.38 a.u.), on day 4 – at 4.5 % (17.57 a.u.), and on day 5– again at the 4.5 % NaCl (21.16 a.u.). Under the influence of 6.5 % NaCl, siderophore production remained the lowest throughout the entire study period.

Conclusions. The obtained results indicate that the bacterium *O. rhizosphaerae* IMV B-7956 is capable of producing auxin-like compounds and siderophores under the influence of NaCl.

References

1. Cai, J., Fang, Y., Liu, X., Adjei, M. O., & Fan, B. (2026). Revealing Microbial Siderophores: From Genes to Applications. Microorganisms, 14(2), 393. https://doi.org/10.3390/ microorganisms14020393
2. Duca, D. R., & Glick, B. R. (2020). Indole-3-acetic acid biosynthesis and its regulation in plant-associated bacteria. Applied microbiology and biotechnology, 104(20), 8607–8619. https://doi.org/10.1007/s00253-020-10869-5
3. Etesami, H., & Glick, B. R. (2024). Bacterial indole-3-acetic acid: A key regulator for plant growth, plant-microbe interactions, and agricultural adaptive resilience. Microbiological research, 281, 127602. https://doi.org/10.1016/j.micres.2024.127602
4. Kramer, J., Özkaya, Ö., & Kümmerli, R. (2020). Bacterial siderophores in community and host interactions. Nature reviews. Microbiology, 18(3), 152–163. https://doi.org/10.1038/s41579-019-0284-4
5. Poria, V., Dębiec-Andrzejewska, K., Fiodor, A., Lyzohub, M., Ajijah, N., Singh, S., & Pranaw, K. (2022). Plant Growth-Promoting Bacteria (PGPB) integrated phytotechnology: A sustainable approach for remediation of marginal lands. Frontiers in plant science, 13, 999866. https://doi.org/10.3389/fpls.2022.999866
6. Yu, X., Li, Y., Cui, Y., Liu, R., Li, Y., Chen, Q., Gu, Y., Zhao, K., Xiang, Q., Xu, K., & Zhang, X. (2017). An indoleacetic acid-producing Ochrobactrum sp. MGJ11 counteracts cadmium effect on soybean by promoting plant growth. Journal of applied microbiology, 122(4), 987–996. https://doi.org/10.1111/jam.13379

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OPTIMIZATION OF THE ISOLATION METHOD FOR EXOPOLYSACCHARIDES OF PROBIOTIC *BACILLUS VELEZENSIS* STRAINS

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Abstract. This study focused on the implementation and adaptation of new approaches for extracting exopolysaccharides (EPS) from the probiotic bacterial strains *Bacillus velezensis* UCM B-7242 and *B. velezensis* UCM B-7243. The primary objective of this research was to optimize the EPS isolation method by eliminating the conventional alcohol precipitation stage to achieve the highest possible yield and purity of the exopolysaccharides. In the course of the study, five sequential extraction stages were conducted and optimized, resulting in concentrated EPS samples with a significantly reduced content of co-extracted impurities.
Keywords: exopolysaccharides, ethanol-free extraction, probiotic strains, *Bacillus velezensis.*

Introduction. Exopolysaccharides produced by probiotic bacteria possess significant potential for biomedical applications, serving as an effective natural alternative to synthetic