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ANTIMICROBIAL ACTION AND PHYTOCHEMICAL PROFILES OF SELECTED PLANT EXTRACTS AGAINST *BACILLUS SUBTILIS*

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Abstract. This study evaluates the phytochemical profiles and antimicrobial efficacy of seven plant species (*Vaccinium corymbosum*, *Ampelopsis brevipedunculata*, *Hemerocallis fulva*, *H. citrina*, *Glechoma hederacea*, *Galinsoga parviflora*, and *Solidago canadensis*) against *Bacillus subtilis*. Antibacterial activity strongly depended on solvent choice, organ specificity, phenological phase, and extraction method. Hydroethanolic extracts of *S. canadensis* and *H. fulva* flowers produced inhibition zones (up to 20 mm), while reflux extraction optimized *A. brevipedunculata* flavonoid yield to 28.76 mg/g.
Keywords: *Bacillus subtilis*, plant extracts, flavonoids, antimicrobial activity, biotechnological potential.

Widespread antibiotic use in medicine and agriculture has accelerated antimicrobial resistance, driving the search for novel, eco-friendly plant-derived bioactive compounds. The Gram-positive, spore-forming bacterium *Bacillus subtilis* serves as a classic model for evaluating plant metabolites due to its labile cell membranes during the vegetative phase and spore-forming capability under stress (Su et al., 2020). Although natural antibacterial targets remain insufficiently explored, plant flavonoids act via mechanisms distinct from conventional antibiotics, offering potential to bypass resistance (Pandey & Kumar, 2013). Disruption of cell membrane integrity directly triggers metabolic dysfunction and cell death (Hartmann et al., 2010), though flavonoid–membrane lipophilic interactions remain a subject of debate (Sanver et al., 2016). Key flavonoid antibacterial mechanisms include enzyme

inhibition (Havsteen, 2002) and DNA gyrase blockade–either through direct DNA binding or ATP-binding site inhibition (Plaper et al., 2003). Quercetin specifically alters membrane permeability, causes physical envelope damage, suppresses protein and nucleic acid synthesis, reduces virulence factor expression, disrupts mitochondrial function, and blocks biofilm formation (Nguyen & Bhattacharya, 2022). Quercetin-loaded nanoparticles induce cell wall destruction in resistant *Escherichia coli* and *B. subtilis* (Yang et al., 2017). Furthermore, quercetin complexes with Mn^{2+}, Hg^{2+}, Co^{2+}, and Cd^{2+} exert bactericidal activity against *Staphylococcus aureus*, *Bacillus cereus*, *Pseudomonas aeruginosa*, *E. coli*, and *Klebsiella pneumoniae*, whereas free quercetin at identical concentrations remains inactive (Bravo & Anacona, 2001). Beyond susceptibility, *B. subtilis* can metabolically transform toxic phenols; for instance, *B. subtilis* ATCC 23857 biotransforms quercetin into apigenin-7-O-pentoside and 9 other derivatives with enhanced antitumor activity (El Gendy et al., 2025), underscoring the broader biotechnological potential of this bacterium (van Dijl & Hecker, 2013).

Aim of the study: to analyse and systematise research findings on the effects of aqueous and aqueous-ethanolic extracts of plants from the Lviv region on *Bacillus subtilis*.

Materials and methods. Research objects: *B. subtilis* (VKM B408) and plant raw materials, including *V. corymbosum*, *A. brevipedunculata*, *H. fulva*, *H. citrina*, *G. hederacea*, *G. parviflora*, and *S. canadensis*. Maceration and reflux methods were used to obtain aqueous and aqueous-ethanol extracts. Distilled water and aqueous ethanol solutions of various concentrations (20 %, 60 %, 70 %, and 96 %) were employed as extractants. The total content of polyphenols and flavonoids was determined spectrophotometrically (Yavorska et al., 2023). Antimicrobial activity was determined by the agar diffusion method (using 6 mm diameter wells) on tryptic soy agar. Inoculum standardization was adjusted to 0.5 on the McFarland scale. Ciprofloxacin (0.3 %) and pure extractants served as controls. Statistical analysis was carried out using the Jamovi 2.3 software and MS Excel.

Results. Aqueous and hydroethanolic extracts of seven plant species revealed pronounced selective sensitivity in *Bacillus subtilis*, governed by extractant polarity, extraction method, and raw material phytochemical profile. High-concentration hydroethanolic solvents (60–80 %) maximized polyphenol and flavonoid yields, directly enhancing antibacterial efficacy. In particular, *H. fulva* flower extracts and *S. canadensis* extracts formed growth inhibition zones of up to 20 mm, which directly correlated with high levels of flavonoids (254.30 ± 0.93 μg/g) and total phenols (8.55–9.92 mg/g). A clear organ specificity of biologically active substance accumulation (the activity of *H. fulva* flowers versus that of *H. citrina* leaves) and a dependence on the phenophase (peak activity of *V. corymbosum* in the post-fruit ripening phase) were revealed. In addition, the use of reflux extraction increased the yield of *A. brevipedunculata* flavonoids to 28.76 mg/g (compared to 22.33 mg/g in the case of maceration), resulting in the inhibition of *B. subtilis* up to 16 mm. At the same time, aqueous extracts of *G. hederacea* and *A. brevipedunculata* also inhibited *B. subtilis* (SIR: up to 20 mm and 16 mm, respectively).

Conclusions and future directions. The plant extracts studied exhibit a pronounced selective antimicrobial effect against *B. subtilis*, which directly correlates with the polyphenol and flavonoid content, and depends upon extractant polarity, organ specificity, phenophase and extraction method. Further work will involve investigating the effect of sub-inhibitory concentrations of these extracts on sporulation and biofilm formation.

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EFFECTIVENESS OF *LACTOBACILLI* AND CERIUM DIOXIDE NANOPARTICLES IN THE TREATMENT OF INFECTED WOUNDS

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Abstract. The dynamics of reparative processes in wound tissue and the microbial status of the wounds were evaluated. Structural changes in the skin at different stages of healing were examined using histological methods. The antibacterial activity of CeO_2 nanoparticles, *L. plantarum* IMV B-8195, and the biocomposite against *S. aureus* was determined. The potential of these agents as promising components for the prevention and treatment of infectious skin lesions was investiga.
Keywords: cerium dioxide (CeO_2), *Lactobacillus*, wound, skin, *Staphylococcus aureus*.