than after LPS stimulation ($p = 0.0357$). The significant increase in CD206 MFI, together with the non-significant upward trend in CD80 MFI, suggests that the response to Pyofag may involve a mixed pattern of polarization-associated marker expression rather than a unidirectional M1- or M2-like shift. Given its polyvalent composition, the response to Pyofag should be considered a composite effect of multiple phages.

Conclusions. The pattern of polarized activation of RAW264.7 macrophages following exposure to Pyofag does not conform to the classical M1/M2 dichotomous paradigm. A moderate increase in phagocytic activity and a pronounced upregulation of CD206, indicative of an anti-inflammatory metabolic shift, accompanied by a trend toward increased CD80 expression, suggest a complex and multidirectional modulation of macrophage functional state rather than a unidirectional polarization. These findings support the view that Pyofag may induce a mixed or intermediate macrophage activation phenotype. A more precise characterization of this response will require a broader functional assessment, including cytokine production, reactive oxygen species generation, and arginine metabolism.

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Tymoshok N.[1], Kharchuk M.[1], Bityutskyy V.[2], Tsekhmistrenko S.[2], Spivak M.[1]

SELENIUM NANOPARTICLES SYNTHESIZED USING *LACTOBACILLUS PLANTARUM* IMV B-7679 AND SYNERGISTIC EFFECT OF SELENIUM NANOPARTICLES-ANTIBIOTIC COMBINATIONS

[1]D. K. Zabolotny Institute of Microbiology and Virology of the National Academy of Sciences of Ukraine, 154 Akademika Zabolotnoho St., Kyiv, 03143, Ukraine
[2]Bila Tserkva National Agrarian University, 8/1 Soborna Sq., Bila Tserkva, 09119, Ukraine
e-mail: n_timoshok@ukr.net

Abstract. Selenium nanoparticles (Nano-Se) were obtained by using *Lactobacillus plantarum* IMV B-7679. In vitro studies have shown that Nano-Se possess antimicrobial properties and exhibited significant synergistic effects when Nano-Se were combined with traditional antibiotics. The results of this study confirmed that nanoselen could be a potential carrier system for cefotaxime targeting

Gram-negative and Gram-positive microorganisms. The prepared nanoparticles are considered stable because they are of biogenic origin and show uniformity in size as well as shape.
Keywords: green synthesis, selenium nanoparticles, probiotic strains, *L. plantarum* IMV B-7679, antibiotics, Selenium nanoparticles-antibiotic combinations, antimicrobial activity, Cefotaxime, disk diffusion test.

The synergistic action of antibiotics and biogenic nanoselen is one of the most promising directions in modern nanobiotechnology and pharmacology, aimed at overcoming multidrug resistance of bacteria (Ridha et al., 2024).

The purpose of our work was to obtain Nano-Se produced by *L. plantarum* IMV B-7679, to study their antimicrobial properties and synergistic action with antibiotics *in vitro* to reduce their dose during combined use and increase the sensitivity of bacteria to drugs.

The ability of *L. plantarum* IMV B-7679 to quickly reduce sodium selenite with the formation of Nano-Se has been established (Tymoshok et al., 2023).

Thus, during the cultivation of the culture, after the introduction of sodium selenite at 5 ppm by Se, after 48–72 hours, changes in the color of the suspension of *L. plantarum* IMV B-7679 were noted, and according to the data of transmissible electron microscopy, spherical Nano-Se granules measuring 150–180 nm were noted. Such selenium nanoparticles, exceeding the size of 100 nm, were called lactomicrosel. *L. plantarum* IMV B-7679, rich in bioactive metabolites including those acting as a natural antibiotic, has been proposed as a suitable candidate for the synthesis of biogenic Nano-Se.

It should be noted that Nano-Se play a vital role in overcoming antibiotic resistance (Truong et al., 2021). The antibacterial activity of Nano-Se, which was obtained with the strain IMV B-7679, was confirmed using a disk diffusion test, according to CLSI (2015). The resulting Nano-Se in an amount of 100 mg were suspended in 0.15 M NaCl to obtain a concentration of 100 mg/mL. The resulting solution of Nano-Se suspension was applied with a volume of 100 µL to discs of filter paper (ø 6 mm) and allowed to dry for use in the test. Using disco-diffusion analysis, experimental Nano-Se nanoparticles demonstrated significant antimicrobial activity against *Staphylococcus aureus* and *Eshcherichia coli*, *Pseudomonas aeruginosa*, *Candida albicans*.

Antibacterial activity studies were conducted with both cases only Nano-Se and in Selenium nanoparticles-antibiotic combinations. It was established that *S. aureus* UKM B-918 (ATCC 6538) was sensitive to selenium nanoparticles, so the growth inhibition zone was –16 ± 0.2 mm. However, *S. aureus* UKM B-4001 (ATCC 6538 P) was found to be non-sensitive because the inhibition zone was 8 ± 0.3 mm. According to the work Jahdaly Al et al. (2021) the Inhibition zone <10 mm is considered non-sensitive.

The selenium nanoparticles-antibiotic combinations for activity against *S. aureus* and *E. coli*, *P. aeruginosa*, *C. albicans* were studied. Antibacterial activity of lincomycin, kanamycin, cefotaxime against *S. aureus* strains (MSSA), *C. albicans* increases in the presence of Nano-Se. Antibacterial activity of gentamicin, cefotaxime increases in the presence of Nano-Se against *P. aeruginosa*. While Cefotaxime and Monomycin increase activity in the presence of Nano-Se against *E. coli*. The combination of Nano-Se with generation I aminoglycosides and generation III cephalosporins, a bactericidal effect that is associated with impaired cell wall protein and/or mucopeptide formation, proved promising. The ability of Nano-Se to enhance the antibacterial activity of cefotaxime, an inhibitor of cell wall synthesis, opens up new possibilities for influencing the macromolecular targets of gram-positive and gram-negative pathogens. The synergistic action of antibiotics inhibiting the synthesis of cell wall proteins and/or mucopeptides and biogenic Nano-Se *in vitro* at the nanolevel, as opposed to free antibiotics, may be an improved broad-spectrum strategy to prevent resistance mechanisms in pathogens.

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Yavorska H.[1], Vorobets N.[2]

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

[1]Ivan Franko National University of Lviv, 4 Hrushevsky St., Lviv, 79005, Ukraine
[2]State Non-Profit Enterprise "Danylo Halytsky Lviv National Medical University", 69 Pekarska St., Lviv, 79010, Ukraine
e-mail: halyna.yavorska@lnu.edu.ua

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