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Innovative Approaches to Developing Practical Skills in Students in Chemical Disciplines

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Abstract. The aim of the study is to introduce modern innovative approaches into the process of studying synthetic, biological, and biotechnological drugs within chemical disciplines. Innovative approaches to learning comprise new methods, technologies, and forms of classroom organization that make the educational process interactive, flexible, and practice-oriented, replacing traditional passive lectures with active student participation. Modern innovative approaches include the **Flipped Classroom** (where classes focus solely on solving practical problems), **Project-Based Learning** (where assessment is based on creating a real project), **Gamification** (utilizing points, ratings, quests, and interactive platforms), **Blended Learning** (combining traditional classroom sessions with online tools), and **Microlearning** (presenting material in short, concentrated blocks, such as 3–5 minute videos). Technological innovations utilizing artificial intelligence (AI) to create personalized educational trajectories for each student, alongside virtual and augmented reality (VR/AR) for simulating complex or dangerous processes, are highly relevant. Furthermore, computer programs allow researchers not only to model molecular structures using bioisosteric replacement, scaffold combinations, and other operations, but also to predict the physicochemical and biological properties of molecules, enabling *in silico* work with chemical objects (for example, SwissTargetPrediction, ProTox, and others). However, the development of practical laboratory skills using modern high-tech instrumental methods of chromatography and spectroscopy remains paramount. Hands-on laboratory practice utilizing an expanded range of modern high-tech equipment will allow students to master and improve their skills when working with biologically active substances of various origins. Particular attention should be paid to tasks related to specific methods for analyzing substances of biological or biotechnological origin that are actively used in manufacturing medicines. All operational procedures involving biologically active medicinal substances are performed using validated, standardized pharmacopoeial methods. When working with such substances, continuous improvement of techniques, as well as the implementation of new methods and their combinations in analysis, remains highly relevant.

Keywords: practical skills, drugs of synthetic, biological/biotechnological origin, standardization, validation, *in silico*.

INTRODUCTION

Innovative approaches to developing practical skills in chemistry students remain highly important, as they form the foundation for building the competencies of future specialists. These approaches make the educational process interactive, flexible, and practice-oriented. They include the “flipped classroom” model, project-based learning, gamification (utilizing points, ratings, or interactive platforms), blended learning (combining traditional classroom sessions with online tools), and microlearning. Technological innovations—such as utilizing artificial intelligence (AI) to create personalized educational trajectories for each student, and virtual or augmented reality (VR/AR) to simulate complex or dangerous processes—are particularly relevant today. Nevertheless, developing laboratory skills using modern, high-tech instrumental methods remains paramount. Hands-on laboratory practice allows students to effectively master and refine their technical proficiency. Particular attention should be paid to tasks involving specific analytical methods for substances of biological or biotechnological origin, which are widely used in medicine man-

ufacturing. All operational procedures with these biologically active medicinal substances must be performed using validated, standardized pharmacopoeial methods.

LITERATURE REVIEW

Modern approaches emphasize the importance of fostering cooperation between educational institutions and employers to build practical competence. This alignment is reflected in the dual education model and the competency-based approach, both of which combine theoretical training in institutions with hands-on workplace experience. This innovative approach effectively facilitates the acquisition of professional skills and specific competencies necessary for students to succeed in the labor market (Redko et al., 2024; Bratianu et al., 2020; Zhuravlova et al., 2022; Njeri et al., 2023; Alabdulatif et al., 2023; Hassan et al., 2025; Liu et al., 2023; Naseri Jahfari et al., 2022).

This direction holds great promise for educational transformation and the advancement of practical competence. Numerous studies confirm the vital importance of internships in training modern medical and pharmaceutical specialists. Attention is focused on the paradigm shift in contemporary education, particularly regarding practical competence. Another critical area of current research involves investigating the impact of digital and mobile technologies on optimizing the learning process and enhancing students' technical skills. Consequently, it is essential to analyze the specific features of modern higher education transformation within a global context (Pereira et al., 2020; Pokharel et al., 2024; Tastanbekova et al., 2021; Tsekhmister et al., 2016; Pramanik et al., 2020; Sarikhani et al., 2025; Gulati et al., 2025; Sun et al., 2024).

Globally, the development of practical competence—achieved by integrating theoretical institutional training with hands-on skill acquisition—is becoming increasingly critical. Digitalization has significantly influenced educational reform, and addressing practical competencies helps solve key academic and scientific challenges. A well-known issue within higher education is the misalignment between specialist training and current labor market demands. University graduates frequently lack not only professional work experience but also specific practical skills. Consequently, it is essential to further develop innovative approaches to organizing the educational process (Daina et al., 2019; Nizhenkovska et al., 2025; Welchinska et al., 2026).

While completing their final qualification theses, future pharmacists and biotechnologists at the O.O. Bogomolets National Medical University acquire vital practical skills in the product quality control laboratory. To conduct pharmaceutical analysis effectively, students must possess hands-on proficiency with modern analytical equipment, such as chromatographs and spectrometers. Analysis is performed across several key areas: identifying active pharmaceutical ingredients (APIs) and excipients, determining substance purity, and quantifying the content of specific components within drug substances (Welchinska et al., 2024; Welchinska & Vilchynska, 2016; Welchinska et al., 2025).

Validated, standardized pharmacopoeial methods are routinely utilized during experimental work. However, contemporary scientific advancements allow for the introduction of more sensitive analytical techniques into the quality control of medicinal substances.

For instance, rather than relying solely on conventional pharmacopoeial liquid chromatography (LC), recent studies have successfully employed high-performance liquid chromatography (HPLC) and combined hyphenated techniques (Welchinska & Nizhenkovska, 2025; Dynnyk & Welchynska, 2025; Welchinska & Malyuta, 2025; Kharlampovich & Welchinska, 2025).

Furthermore, in alignment with the principles of “green chemistry,” modifying certain analytical procedures is highly advisable, as these adaptations significantly reduce aggressive chemical impacts on the environment.

OBJECTIVES

To analyze the pathways and opportunities for higher education students to acquire practical proficiency in performing analytical procedures during the quality control of medicinal substances of synthetic, biological, and biotechnological origin.

To interpret the obtained data and draw conclusions regarding the feasibility of implementing innovative techniques and modifying existing methods to enhance the identification efficiency of pharmaceutical analysis.

METHODOLOGY

As a highly efficient form of liquid chromatography, High-Performance Liquid Chromatography (HPLC) offers significant advantages, including superior separation resolution, shorter analysis times, and higher throughput compared to conventional low-pressure liquid chromatography methods.

According to the State Pharmacopoeia of Ukraine (SPU), limited adjustments to specific HPLC parameters are permissible to achieve system suitability criteria (e.g., resolution factor $R_s \geq 1.5$ –5.0 and symmetry

factor ≤ 1.25 –2.0) without fundamentally altering the validated method. However, modifications affecting selectivity or sensitivity, such as altering the detector wavelength, are strictly prohibited, as detailed in SPU Sections 2.2.29 “Liquid Chromatography” and 2.2.46 “Chromatographic System Suitability”.

Crucially, if minor parameter adjustments permitted under Section 2.2.46 satisfy these system suitability requirements, additional validation studies are not required. Valid system suitability results confirm that the chromatographic system is fully capable of ensuring adequate separation, specificity, sensitivity, and reproducibility for robust quantification.

RESULTS AND DISCUSSION

During the comparative pharmaceutical analysis of the purity of cytokine-like peptides using two batches of the Alloferon substance, students acquired an extensive range of practical skills in operating HPLC systems. Although Alloferon is not listed in the State Pharmacopoeia of Ukraine (SPU) or the European Pharmacopoeia (Ph. Eur.), a monograph for its pharmaceutical analysis is available in the other Pharmacopoeias. While the standard identification of related impurities in the Alloferon substance is typically performed using conventional LC (Section 2.2.29), we implemented a highly selective HPLC method to analyze Alloferon substances from various manufacturers.

The analysis was performed on an Agilent 1260 Infinity II chromatograph equipped with a UV detector (set at 220 nm). Separation was achieved using an ODS Hypersil column 250 mm x 4.6 x 3 μ m, maintained at a column temperature of 35°C.

The following chromatographic conditions were established: a flow rate of 1.5 mL/min, an injection volume of 20 μ L, an ambient sample temperature, and a run time of 12 min. The mobile phase consisted of a mixture of acetonitrile R, trifluoroacetic acid R, 2M ammonium sulfate solution R, and water R at a ratio of 5:0.1:10:84.9 (v/v/v/v).

To achieve optimal peak separation and symmetry, a systematic screening of various chromatographic columns was conducted. The experiment evaluated C18, C8, and CN columns with lengths of 150 and 250 mm.

Based on the experimental results, the best chromatographic performance was achieved using an ODS Hypersil (C18) column 250 mm x 4.6 mm. Furthermore, the ratio of the mobile phase components was precisely modified to maximize separation efficiency.

Chromatograms of the Alloferon substance batches were recorded, and the obtained results are presented in Figures 1–3.

Figure 1 illustrates the chromatogram of the Alloferon reference standard ($R_t = 4.192$ min), which exhibits identified impurities 1, 2, 3, 6, and 7, as well as an unidentified impurity ($R_t = 9.166$ min).

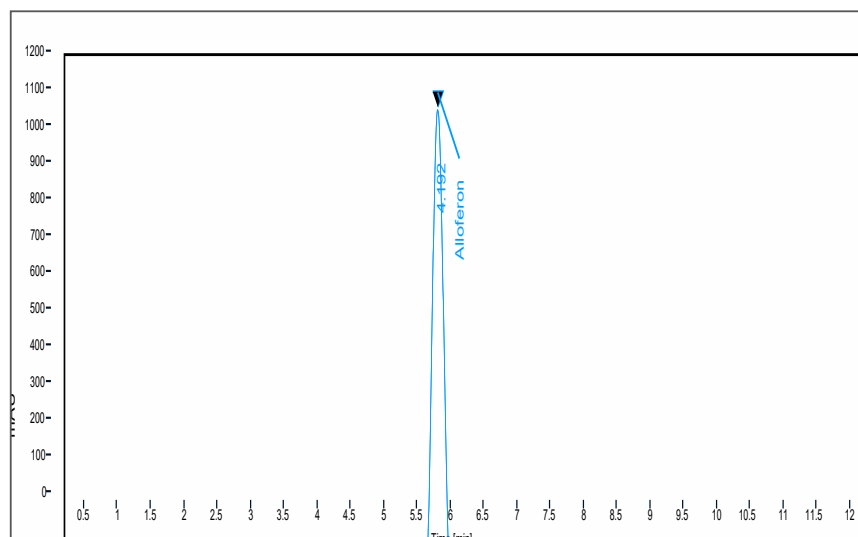


Figure 1. Chromatogram of the standard sample: Alloferon ($R_t = 4.192$ min), identified impurity: Impurity 1 ($R_t = 1.676$ min), Impurity 2 ($R_t = 1.807$ min), Impurity 3 ($R_t = 2.366$ min), Impurity 6 ($R_t = 4.716$ min), Impurity 7 ($R_t = 5.273$ min), unidentified impurity ($R_t = 9.166$ min)

Figure 2 illustrates the chromatogram of sample (1) Alloferon which contain identified impurity: Impurity 1, Impurity 2, Impurity 3, Impurity 4, Impurity 5, Impurity 6, Impurity 7, Impurity 8 and unidentified impurity ($R_t = 5.403$ min).

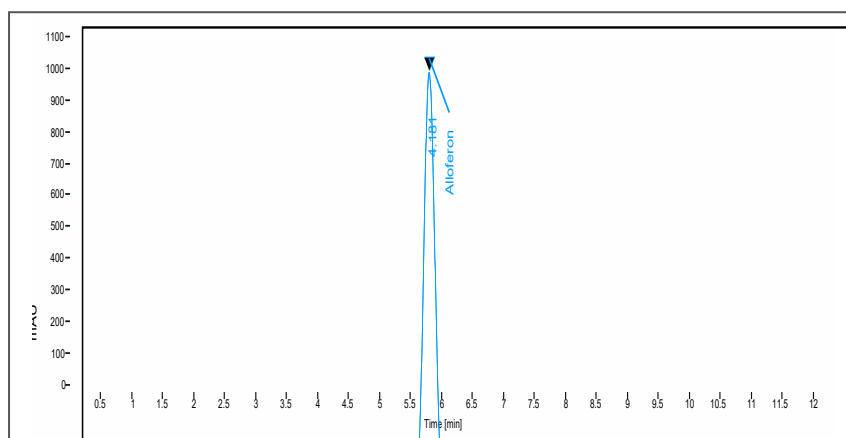


Figure 2. The chromatogram of sample (1): Alloferon ($R_t=4.181$ min), identified impurity: Impurity 1 ($R_t = 1.674$ min), Impurity 2 ($R_t = 1.769$ min), Impurity 3 ($R_t = 2.281$ min), Impurity 4 ($R_t = 3.598$ min), Impurity 5 ($R_t = 3.802$ min), Impurity 6 ($R_t = 4.632$ min), Impurity 7 ($R_t = 5.065$ min), Impurity 8 ($R_t = 7.396$ min), unidentified impurity ($R_t = 5.403$ min).

The chromatogram of sample (2) of Alloferon illustrates the clear analytical signals of identified impurities 1, 2, 3, 4, 5, 6, 7 and 8. No unidentified impurities are observed (Fig. 3).

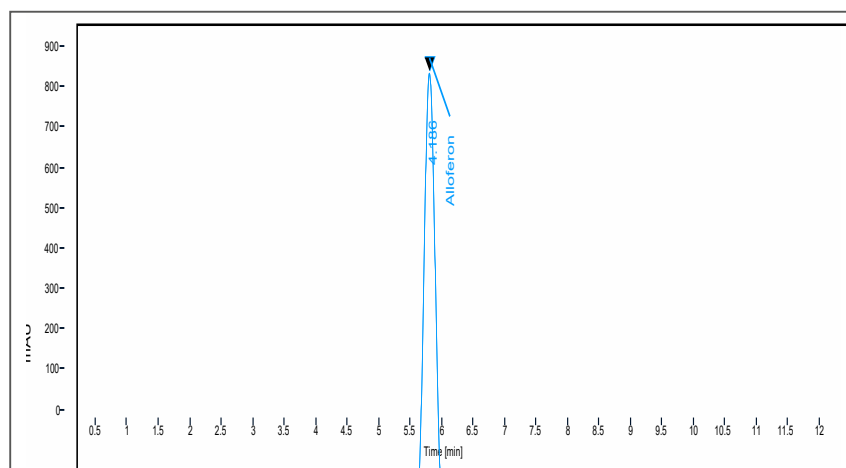


Figure 3. The chromatogram of sample (2): Alloferon ($R_t = 4.186$ min); identified impurities: Impurity 1 ($R_t = 1.697$ min), Impurity 2 ($R_t = 1.809$ min), Impurity 3 ($R_t = 2.286$ min), Impurity 4 ($R_t = 3.602$ min), Impurity 5 ($R_t = 3.805$ min), Impurity 6 ($R_t = 4.634$ min), Impurity 7 ($R_t = 5.069$ min), Impurity 8 ($R_t = 7.402$ min)

After conducting the research, the results obtained were calculated.

According to the results of the research, it was found that the sample of substance (1): contains 97.7 % Alloferon compared to the standard sample, and substance (2): 97.4 % Alloferon compared to the standard sample.

It was also found that in the substance (1) submitted for research, unidentified accompanying impurities were found, the total content of which is 2.3 % (with an allowable norm of 4 %) and does not contain a single impurity, the amount of which exceeded 2 %.

In the substance (2) submitted for research, unidentified accompanying impurities were found, the total content of which is 2.6 % (with an allowable norm of 4 %) and does not contain a single impurity, the amount of which exceeded 2 %.

Regarding the purity of Alloferon substances from various manufacturers, global pharmaceutical practice requires an assay content ranging from 98.5 % to 101.0 % on a dried basis. Laboratory-scale peptide samples must maintain a purity of at least 95.0 %. Purity and the profiles of related compounds are routinely verified using HPLC, mass spectrometry (MS), and ^1H NMR spectroscopy. Pharmaceutical standards strictly limit the levels of peptide-related impurities, thereby ensuring the absence of general toxicity, as well as mutagenic, allergenic, or carcinogenic effects.

Lyophilization of the raw material is conducted using an acetic acid solution, as the peptide is highly susceptible to biodegradation and requires stabilization.

The presence of unidentified impurities in the reference standard and Alloferon indicates molecular biodegradation, yet total impurity levels remain within established limits.

This experiment enabled the mastery of HPLC techniques, including condition optimization, column selection, and the minimization of hazardous solvents for assessing substance purity.

CONCLUSIONS

This study demonstrates that implementing modern innovative educational approaches, particularly integrating hands-on laboratory practice with state-of-the-art analytical equipment, effectively bridges the gap between theoretical knowledge and professional competencies in higher pharmacy and biotechnology education.

By optimizing the High-Performance Liquid Chromatography (HPLC) parameters for the purity and impurity profiling of the cytokine-like peptide Alloferon, a robust and highly selective analytical method was successfully established in accordance with the regulatory frameworks of the Pharmacopoeias.

The experimental framework not only confirmed that the total impurity levels in the analyzed Alloferon batches remain within acceptable pharmacopoeial limits despite minor environmental biodegradation, but also served as an invaluable educational tool.

Through this practice-oriented approach, students achieved comprehensive technical proficiency in chromatographic system suitability assessment, method optimization, green chemistry principles via the minimization of hazardous solvents, and advanced data interpretation, thereby ensuring their readiness for the modern pharmaceutical labor market.

DECLARATION

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Data Availability Statement. The data that support the findings of this study are available from the corresponding author upon reasonable request.

Ethics Approval and Informed Consent. Not applicable.

Conflict of Interest. The authors declare no conflict of interest.

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REFERENCES

- Alabdulatif, A., Thilakarathne, N., Lawal, Z., Fahim, K. E., & Zakari, R. (2023). Internet of Nano-Things (IoNT): A Comprehensive Review from Architecture to Security and Privacy Challenges, *Sensors*, 23(5), 2807. <https://doi.org/10.3390/s23052807>
- Bratianu, C., Hadad, S., & Bejinaru, R. (2020). Paradigm shift in business education: A competence-based approach. *Sustainability*, 12(4), 1348. <http://dx.doi.org/10.3390/su12041348>

- Daina, A., Michielin, O., & Zoete, V. (2019). SwissTargetPrediction: updated data and new features for efficient prediction of protein targets of small molecules. *Nucleic Acids Research*, 47(W1), W357–364. <https://doi.org/10.1093/nar/gkz382>
- Dynnyk, A. O. & Welchynska, O. V. (2025). Modern approaches in the analysis of medicinal products of biological/biotechnological origin. *Student scientific bulletin. Agrarian sciences and food*, 2 (19), 78–86. https://www.mnau.edu.ua/files/nauk_rob/studentresearchjournal175.pdf.
- Hassan, Y. M., Wanas, A., Ali, A. A., & El-Sayed, W. M. (2025). Integrating artificial intelligence with nanodiagnosics for early detection and precision management of neurodegenerative diseases. *Journal of Nanobiotechnology*, 23, 668. <https://doi.org/10.1186/s12951-025-03719-x>
- Kharlampovich, S. A., & Welchinska, O. V. (2025). Combination of gas chromatography-mass spectrometry methods for studying the content of pesticides in medicinal plant raw materials. In V. Shpak (Comp.) & S. Tabachnikov (Ed.), *Modern aspects of science and education: Collective monograph* (pp. 406–410). GS Publishing Services..
- Liu, X., Jing, Y., Xu, C., Wang, X., Xie, X., Zhu, Y., Dai, L., Wang, H., & Wangand, S. Yu. (2023). Medical Imaging Technology for Micro/Nanorobots. *Nanomaterials*, 13(21), Article 2872. <https://doi.org/10.3390/nano13212872>
- Naseri Jahfari, A., Tax, D., Reinders, M., & van der Bilt, I. (2022). Machine learning for cardiovascular outcomes from wearable data: Systematic review from a technology readiness level point of view. *JMIR Medical Informatics*, 10(1), e29434. <https://doi.org/10.2196/29434>
- Nizhenkovska, I., Welchinska, O., Gorchakova, N., & Narokha, V. (2025). Modelyuvannya/prohnozuвання fizyko-khimichnykh parametriv, biolohichnoyi aktyvnosti ta farmakokinetyky pokhidnoyi DL-tryptofanu in silico (Modeling/prediction of physico-chemical parameters, biological activity and pharmacokinetics of the derivative of DL-tryptophan in silico). *Phytotherapy. Journal*, (3), 13–21. <https://doi.org/10.32782/2522-9680-2025-3-13>.
- Njeri, S. N., Smith, J. A., & Ayaka, P. G. (2023). Involvement of stakeholders in establishment of infrastructure projects in schools. *European Journal of Development Studies*, 3(5), 1–6. <http://dx.doi.org/10.24018/ejdevelop.2023.3.5.305>
- Pereira, E. T., Vilas-Boas, M., & Rebelo, C. (2020). University curricula and employability: The stakeholders' views for a future agenda. *Ind. High. Educ.*, 34(5), 321–9. <http://dx.doi.org/10.1177/095042220901676>
- Pokharel, S., Pandey, A., & Dahal, S.R. (2024). Globalization, brain drain, and its impact in Nepal. *Futurity Philosophy*, 3(3), 4–21. <https://doi.org/10.57125/FP.2024.09.30.01>
- Pramanik, P., Solanki, A., Debnath, A., Nayyar, A., El-Sappagh, S., & Kwak, K.-S. (2020). Advancing modern healthcare with nanotechnology, nanobiosensors, and internet of nano things: Taxonomies, applications, architecture, and challenges. *IEEE Access*, 8, 65230–65266. <https://doi.org/10.1109/ACCESS.2020.2984269>
- Redko, K., Riznyk, D., Nikolaiev, S., Yatsenko, O., & Shuplat, O. (2024). The role of investment in creating a sustainable financial future: Strategies and tools. *Futurity Economics & Law*, 4(3), 20–33. <https://doi.org/10.57125/FEL.2024.09.25.02>
- Sarikhani, E., Mahato, K., Casanova, A., Rahmani, K., & Wang, J. (2025). Nanosensors for real-time intracellular analytics. *Nature Nanotechnology*, 20, 1374–1387. <https://doi.org/10.1038/s41565-025-02032-w>
- Gulati, S., Yadav, R., Kumari, V., Nair, S., Gupta, C., & Aishwari, M. (2025). Nanosensors in healthcare: Transforming real-time monitoring and disease management with cutting-edge nanotechnology. *RSC Pharmaceutics*, 2(5), 1003–1018. <https://doi.org/10.1039/d5pm00125k>
- Sun, T., Chen, J., Zhang, J., Zhao, Z., Zhao, Y., Sun, J., & Chang, H. (2024). Application of micro/nanorobot in medicine. *Frontiers in Bioengineering and Biotechnology*, 12, 1347312. <https://doi.org/10.3389/fbioe.2024.1347312>
- Tastanbekova, N., Abenova, B., Yessekeshova, M., Sagalieva, Z., & Abildina, G. (2021). Development of professional skills in the context of higher school dual education. *Int. J. Emerg. Technol. Learn*, 16(10), 179. <http://dx.doi.org/10.3991/ijet.v16i10.19373>
- Tsekhmister, Y., & Welchinska, E. (2016). Carbon (II) monoxide as a subject for poisons studying of study on discipline toxicological chemistry (criminal analysis) at the pharmaceutical department of the National Medical University in Ukraine. *CBU International conference proceedings 2016: Innovations in Science and Education*. 4, 744–749. <https://doi.org/10.12955/cbup.v4.843>
- Zhuravlova, Y., Kichuk, Y., Yakovenko, O., Miziuk, V., Yashchuk, S., & Zhuravska, N. (2022). Innovations in education system: Management, financial regulation and influence on the pedagogical process. *J. Curric. Teach.*, 11(1), 163. <http://dx.doi.org/10.5430/jct.v11n1p163>
- Welchinska, O., & Malyuta, N. (2025). Application of HPLC method with variation of experimental parameters in pharmaceutical analysis of ascorbic acid substance. *Modern medicine, pharmacy and psychological health*, 1 (19), 120–125. <https://doi.org/10.32689/2663-0672-2025-1>.
- Welchinska, O., & Nizhenkovska, I. (2025). Chromatographic studies of drugs substances: a case study in university scientific activities. *University Science*, 1(1), 3–18. <https://doi.org/10.51587/3068-3580/US-2025-05-1-3-18>
- Welchinska O., Nizhenkovska I., Kryvoshey M., & Meleshko R. (2026). Osoblyvosti ta perevahy farmatsevtichnoho analizu substansiyi sorbitolu pryrodnoho, biotekhnologichnoho abo syntetychnoho pokhodzhennya metodom VERKH [Features and advantages of pharmaceutical analysis of sorbitol substance of natural, biotechnological or synthetic origin by HPLC]. *Fitoterapiia. Chasopys – Phytotherapy. Journal*, 2, 201–211. <https://doi.org/10.32782/2522-9680-2026-2-201>
- Welchinska, O., Nizhenkovska, I., & Meleshko, R. (2024). Suchasni pidkhody do farmatsevtichnoho analizu metodom VERKH alkaloyidu paklitakselu (Modern approaches to the pharmaceutical analysis by HPLC of paclitaxel alkaloid). *Fitoterapiia. Chasopys – Phytotherapy. Journal*, 3, 168–174. <https://doi.org/10.32782/2522-9680-2024-3-168>.
- Welchinska, O., Nizhenkovska, I., & Meleshko, R. (2025). Implementatsiya metodu VERKH u farmatsevtichnyy analiz alkaloyidu hrupy izokhinolinu (Implementation of the HPLC method in the pharmaceutical analysis of isoquinoline alkaloid). *Fitoterapiia. Chasopys – Phytotherapy. Journal*, 4, 198–207. <https://doi.org/10.32782/2522-9680-2025-4-198>
- Welchinska, E., & Vilchynska, V. (2016). New compound N1,N1'-(2"-bromo-2"-chloroethenyl)-bis-(5-fluorouracil) as the active antitumor agent for sarcoma 180. *CBU International Conference Proceedings 2016: Innovations in Science and Education*, 4, 740–743. <https://doi.org/10.12955/cbup.v4.842>