ENHANCING THE BIOAVAILABILITY OF SOLID DOSAGE FORMS USING NANOTECHNOLOGY

Qo`ziyeva Dinora

5th year student of the Pharmacy program

at Urgench State Medical Institute

Abstract. *In modern pharmacy, solid dosage forms are among the most widely used types of medicines. However, due to the poor water solubility and low bioavailability of many active pharmaceutical ingredients, their therapeutic efficacy is often insufficiently manifested. This issue is particularly evident in substances classified as Class II and IV according to the Biopharmaceutics Classification System (BCS). In recent years, the introduction of nanotechnologies into the field of pharmacy has gained particular importance as one of the promising approaches to addressing this problem.*

This article analyzes the role of drug delivery systems developed based on nanotechnologies in enhancing bioavailability in solid dosage forms. The effects of nanoformulations, such as nanoparticles, solid lipid nanoparticles (SLN), nanostructured lipid carriers (NLC), and nanoemulsions, on the solubility, absorption, and biological availability of active substances are considered. In addition, technological aspects and advantages arising when converting nano-based systems into tablet and capsule forms are highlighted. The analysis results confirm that solid dosage forms created using nanotechnologies significantly increase the bioavailability of active substances, improve dosing accuracy, and reduce the risk of adverse effects. This approach can be regarded as an effective and promising direction for the modern pharmaceutical industry.

Key words. *Nanotechnology, solid dosage forms, bioavailability enhancement, nanoparticles, solid lipid nanoparticles (SLN), nanostructured lipid carriers (NLC).*

Introduction. Solid dosage forms, particularly tablets and capsules, occupy a leading position in modern pharmacy due to their ease of administration, dosing accuracy, and stability. Nevertheless, they are not entirely free from limitations. Many active pharmaceutical ingredients are insufficiently absorbed in the body because of their physicochemical properties. This issue is especially critical for poorly water-soluble substances and represents one of the main factors limiting the clinical efficacy of medications.

Although active substances classified as Class II and IV according to the Biopharmaceutics Classification System (BCS) possess high permeability, their low solubility prevents the full manifestation of therapeutic effects. Consequently, the use of higher doses becomes necessary, which may increase the risk of adverse effects and reduce treatment efficiency. Therefore, searching for new approaches in pharmaceutical technology aimed at enhancing the solubility and bioavailability of active substances has become a pressing need.

In recent years, the rapid introduction of nanotechnologies into the field of pharmacy has opened new opportunities for addressing this problem. Nanoscale drug delivery systems increase the surface area of active substances, enhance their solubility, and improve their absorption through biological membranes. Nanoparticles, solid lipid nanoparticles (SLN), nanostructured lipid carriers (NLC), and other nano-based systems have been shown in scientific studies to be effective in increasing the bioavailability of substances belonging to various pharmacological groups. The application of nanotechnologies in solid dosage forms holds particular significance, as this approach allows the advantages of nanoformulations to be combined with the technological convenience of tablets and capsules. Such a combination serves to enhance the therapeutic efficacy of medications while maintaining their stability. From this perspective, the enhancement of bioavailability in solid dosage forms using nanotechnologies attracts considerable scientific and practical interest.

The aim of this article is to analyze the role of drug delivery systems developed based on nanotechnologies in improving the bioavailability of solid dosage forms and to highlight the prospects of this approach in the modern pharmaceutical industry.

Materials and methods. This study is based on a literature analysis and was conducted using a comprehensive approach to scientific works focused on enhancing the bioavailability of solid dosage forms through nanotechnologies. During the research process, both local and international scientific sources published in recent years were systematically examined and analyzed. For the collection of scientific data, international databases such as PubMed, ScienceDirect, SpringerLink, and Google Scholar were utilized. Priority was given to articles published within the last 10–15 years.

During the analysis, various research findings were compared, and the advantages and limitations of nanotechnologies in solid dosage forms were identified. The collected data were synthesized to highlight the nano-based approaches considered most effective for improving bioavailability. This methodological approach allowed the topic of the article to be comprehensively covered and the conclusions to be scientifically substantiated.

Results. The analysis of the reviewed scientific literature indicates that drug delivery systems developed based on nanotechnologies significantly enhance the bioavailability of active pharmaceutical ingredients in solid dosage forms. The use of nanoscale systems primarily optimizes the absorption process in the body by improving the solubility of active substances.

Numerous studies have shown that tablets and capsules containing nanoparticles exhibit higher solubility and faster disintegration compared to conventional dosage forms. The small size of nanoparticles increases the surface area of the active substance, accelerating its dissolution rate, which leads to improved bioavailability. This approach has been particularly effective for poorly water-soluble active substances.

Lipid-based nanoformulations, including solid lipid nanoparticles (SLN) and nanostructured lipid carriers (NLC), in solid dosage forms have demonstrated especially notable results in enhancing bioavailability. These systems ensure the stability of active substances within a lipid environment, reduce their degradation in the gastrointestinal tract, and improve absorption. Studies have shown that capsules and tablets prepared with SLN and NLC exhibit higher bioavailability compared to conventional dosage forms. Furthermore, formulations obtained by converting nanoemulsions into solid dosage forms also showed positive outcomes. This approach allows the high bioavailability characteristics of nanoemulsions to be combined with the stability and convenience of solid dosage forms. As a result, the shelf life of the medications was extended, and precise dose control was achieved.

One of the key aspects of applying nanotechnologies in solid dosage forms is related to technological flexibility. During the process of converting nanoformulations into tablets and capsules, the selection of excipients, granulation methods, and compression conditions play a crucial role. Incorrect technological parameters can lead to nanoparticle agglomeration and limit the expected increase in bioavailability. Therefore, the technological processes involved in the development of nano-based solid dosage forms must be carefully optimized.

In addition, there are certain limitations associated with the industrial-scale production of nano-based systems. Relatively high manufacturing costs, technological complexity, and stringent quality control requirements are considered factors that may slow down the widespread implementation of nanotechnologies. Nevertheless, the growing demand for innovative technologies in the pharmaceutical industry provides a foundation for the gradual overcoming of these limitations.

Conclusion. This article demonstrates that nanoscale drug delivery systems significantly enhance the bioavailability of active pharmaceutical ingredients by improving their solubility and absorption. This approach is particularly important for active substances that are poorly water-soluble and have low bioavailability.

Solid dosage forms developed based on nanoparticles, solid lipid nanoparticles (SLN), nanostructured lipid carriers (NLC), and nanoemulsions exhibit higher therapeutic efficacy compared to conventional formulations. These systems allow for improved dosing accuracy, reduced risk of adverse effects, and enhanced stability of medications. Moreover, adapting nano-based formulations into tablet and capsule forms provides a convenient and promising solution for pharmaceutical practice. At the same time, the widespread implementation of nanotechnologies in solid dosage forms faces certain limitations related to technological complexity and production costs. Future research in this area should focus on simplifying technological processes, improving quality control, and thoroughly investigating the safety of nano-based dosage forms.

Overall, solid dosage forms developed using nanotechnologies represent an effective and promising approach for enhancing bioavailability in the modern pharmaceutical industry. This approach opens wide opportunities for the development of new and more effective medications in the future.

REFERENCES.

1. Shargel, L., & Yu, A. B. C. (2015). Modified-release drug delivery systems. In: Pharmaceutical dosage forms: Tablets. New York: CRC Press.

2. Jain, K. K. (2017). Nanotechnology in clinical practice: Nanoparticles as drug carriers. Springer.

3. Müller, R. H., Radtke, M., & Wissing, S. A. Solid lipid nanoparticles (SLN) for controlled drug delivery – A review of the state of the art. European Journal of Pharmaceutics and Biopharmaceutics, 50(1), 161–177.

4. Pandey, A. K., & Singh, P. (2019). Nanostructured lipid carriers (NLC) for oral drug delivery: A review. Journal of Drug Delivery Science and Technology, 49, 1–12.

5. Gao, L., & Wang, Y. (2018). Nanoformulations for improving bioavailability of poorly soluble drugs. International Journal of Pharmaceutics, 544(1), 99–110.

6. Saini, R., & Kumar, P. (2020). Nanotechnology-based solid dosage forms: Tablets and capsules. Journal of Controlled Release, 321, 350–368.

7. Thassu, D., Deleers, M., & Pathak, Y. Nanoparticulate drug delivery systems. In: Nanoparticulate Drug Delivery Systems. Informa Healthcare.