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Formulation strategies in pharmaceutical preparation: From conventional dosage forms to nanocarriers.

Nathan Khaled*

Department of Pharmaceutical Sciences, Dublin School of Science, Ireland

***Correspondence to:** Nathan Khaled, Department of Pharmaceutical Sciences, Dublin School of Science, Ireland. E-mail: n.khaled@pharmchem.dublinsci.ie

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Introduction

Formulation is a cornerstone of pharmaceutical development, transforming active pharmaceutical ingredients (APIs) into effective, safe, and user-friendly drug products. Traditionally, the pharmaceutical industry relied heavily on conventional dosage forms such as tablets, capsules, suspensions, and ointments. While these remain essential, advances in drug delivery science have ushered in a new era of formulation strategies, particularly nanocarrier systems that offer improved bioavailability, targeted delivery, and patient-centric solutions [1].

Conventional dosage forms are still widely used due to their simplicity, stability, and cost-effectiveness. Tablets and capsules dominate the market, offering accurate dosing, ease of administration, and extended shelf life. Liquids, creams, and injectables provide alternatives for specific patient populations. However, these forms often fall short when dealing with poorly soluble drugs, targeted delivery requirements, or controlled-release needs [2].

The effectiveness of a drug depends not only on its pharmacological properties but also on how it is delivered to its site of action. Poor water solubility, degradation in the gastrointestinal tract, and rapid clearance from the body can reduce therapeutic outcomes. These challenges have driven the development of more advanced formulation techniques that improve drug stability, enhance absorption, and extend circulation time [3].

To overcome limitations of immediate-release products, modified-release formulations—such as sustained-release, controlled-release, and delayed-release systems—have been developed. These dosage forms maintain steady drug levels over extended periods, reduce dosing frequency, and improve patient compliance. Technologies like osmotic pumps, polymer-coated pellets, and matrix tablets are commonly used in designing such formulations [4].

Alternative delivery routes, such as transdermal patches and buccal or nasal sprays, provide non-invasive options for systemic drug delivery. These systems bypass the gastrointestinal tract and first-pass metabolism, leading to better bioavailability. The formulation of such products involves the careful selection of permeation enhancers, adhesives, and film-forming agents to ensure effective drug transport through biological barriers [5].

Conclusion

From simple tablets to sophisticated nanocarrier systems, pharmaceutical formulation has undergone a remarkable transformation. Modern formulation strategies not only address long-standing challenges like solubility and bioavailability but also open new avenues for targeted and personalized therapies. As the pharmaceutical industry continues to evolve, a multidisciplinary approach combining chemistry, biology, and material science will be essential for developing the next generation of effective and patient-friendly drug products.

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