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# Advanced Manufacturing Processes and 3D Printing Approaches for Enhancing Solubility and Bioavailability of Poorly Water-Soluble Drugs

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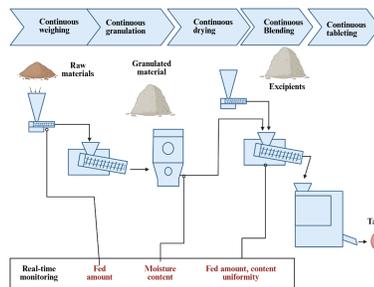
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## Abstract

Poor aqueous solubility is a critical challenge in drug development, often leading to low oral bioavailability and limited therapeutic efficacy. To address this issue, advanced manufacturing processes and 3D printing technologies have emerged as powerful strategies for improving drug solubility and dissolution behavior. Advanced techniques such as hot-melt extrusion, spray drying, nanocrystal technology, co-crystallization, lipid-based systems, and amorphous solid dispersions enable stable formulations with enhanced solubility and scalable production. In parallel, 3D printing offers unique advantages in fabricating personalized, complex, and controlled-release dosage forms, making it an attractive approach for precision medicine. This review highlights the principles, advantages, and applications of these technologies in enhancing the solubility and bioavailability of poorly water-soluble drugs. Comparative insights into their effectiveness, case studies of successful formulations, and emerging trends are discussed. While challenges remain in terms of stability, regulatory acceptance, and large-scale translation, the integration of advanced manufacturing with 3D printing and computational tools holds immense potential to revolutionize future pharmaceutical development and patient-centered therapies.

## Graphical Abstract



## Keywords

3D Printing | bioavailability | water-soluble drugs | aqueous solubility | permeability

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## Conflicts of Interest

The authors declare no conflicts of interest.

## Ethical Approval and Consent to Participate

Not applicable.

## References

[1] Alqahtani, M. S., Kazi, M., Alsenaidy, M. A., & Ahmad, M. Z. (2021). Advances in oral drug delivery. *Frontiers in pharmacology*, 12, 618411. [CrossRef] [Google Scholar]