SUSTAINABLE DEVELOPMENT OF MICROFLUIDIC PLATFORMS FOR MANUFACTURING OF DRUG DELIVERY SYSTEMS

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ABSTRACT

Therapeutics have significantly evolved over the years, from small molecules to biopharmaceuticals (e.g., proteins, peptides, and nucleic acids) and, most recently, to live-cell therapies [1]. In the pharmaceutical industry, significant progress has been made in the development of novel drug delivery strategies aimed at optimizing therapeutic impact and minimizing side effects. Microscale technologies, in particular, have advanced considerably in this regard.

Particles in the micrometer size range (1-1000μm) possess the potential to serve as versatile carriers for multiple drugs, offering notable benefits such as improved biocompatibility, target specificity, uniform encapsulation, and controlled, sustained drug release. [2]. However, the commercialization of micro-drug delivery systems encounters significant challenges. Their production heavily depends on traditional small-scale batch methods, which suffer from inadequate mixing, lack of quality control, low reproducibility, difficulties in scaling up, and inability to decouple manufacturing stages in real time.

Microfluidic devices have shown immense potential in overcoming challenges associated with conventional formulation methods. Effective delivery vehicles require tailored and controllable properties. Microfluidic systems are characterised by their controllability, flexibility, and portability, simultaneously reducing manufacturing time, minimizing uncertainties, and enhancing overall efficiency.

In this research, PLGA (Poly(lactic-co-glycolic-acid)) microparticles are synthesized using droplet-based microfluidics to characterize and correlate microparticle nucleation and growth to droplet formation. Two different flow-focusing microreactors are investigated to identify operating conditions that optimize particles' size, uniformity, and throughput. A 2D CFD (Computational Fluid Dynamics) model is also developed to reveal complex flow pattern characteristics (i.e. internal circulations in droplets). The results explain the mechanisms involved during droplet formation in the microreactors that affect microparticles' size and distribution for the development of well-designed micro-drug delivery systems.

KEYWORDS: Microfluidics, Drug delivery, Microparticles, Synthesis

REFERENCES

[1] Vargason AM, Anselmo AC, Mitragotri S. (2021). Nat Biomed Eng 5, 951–967

[2] Lengyel M., Kalllai-Szabo N, Antal V, Laki AJ, Antal I. (2019). Sci Pharm 87(3), 20