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Microbial Chemistry–Based Approaches to Controlled Drug Release Systems

Nadège L. Kouassi*

Department of Pharmaceutical Sciences and Biomaterials, Université Félix Houphouët-Boigny, china,

***Corresponding author:** Nadège L. Kouassi. Department of Pharmaceutical Sciences and Biomaterials, Université Félix Houphouët-Boigny, china,

Email: nadege.kouassi.controlrelease@proton.me

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Abstract

Controlled drug release systems are designed to deliver therapeutic agents at predetermined rates and durations to improve efficacy and reduce side effects. Microbial chemistry contributes significantly to this field through the production of biopolymers, metabolites, and nanostructures capable of regulating drug release profiles. Microbial-derived materials offer biocompatibility, biodegradability, and chemical tunability, making them suitable for advanced drug delivery applications. This article examines the role of microbial chemistry in controlled drug release, focusing on material properties, chemical mechanisms, and pharmaceutical relevance.

***Keywords:** Microbial chemistry, controlled drug release, biopolymers, drug delivery systems, pharmaceutical technology*

Introduction

Controlled drug release represents a critical advancement in pharmaceutical technology, aiming to maintain therapeutic drug concentrations while minimizing dosing frequency and adverse effects. Microbial chemistry provides chemically diverse and biologically compatible materials that enable precise control over drug release behavior. Microorganisms synthesize polymers such as polysaccharides and polyesters that can be chemically modified to regulate degradation rates and drug diffusion. From a chemical perspective, these microbial polymers possess functional groups that interact with drug molecules, influencing encapsulation efficiency and release kinetics. Microbial metabolites and biosurfactants further enhance controlled release systems by stabilizing drug carriers and modulating interactions with biological environments. Advances in microbial fermentation and material processing have enabled consistent production of these materials with defined chemical properties. Controlled release formulations benefit from the mild processing conditions associated with microbial materials, preserving drug stability and activity. As pharmaceutical research increasingly focuses on targeted and long-acting

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therapies, microbial chemistry offers versatile solutions for designing controlled drug delivery systems that balance chemical functionality with biological compatibility.

Conclusion

Microbial chemistry plays a vital role in controlled drug release by providing functional materials capable of precise and sustained therapeutic delivery. Continued research into microbial-derived systems will advance the development of innovative drug delivery technologies.

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