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Commentary

Eco-biomaterials: Sustainable drug delivery platforms from natural polymers and waste derivatives

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A B S T R A C T

The growing demand for sustainable and eco-friendly drug delivery systems has resulted in considerable interest in eco-biomaterials developed from natural polymers and waste-derived products. This allows their use and potential in controlled and targeted drug delivery applications, in summary, will probably have considerable afford-able advantage as these natural resources are numerous/and also unique with regards of biocompatibility, biodegradability, and expense. The environmental advantages of choosing waste-derived eco-biomaterials, are further, demonstrated by taking a circular economy in utilizing waste/derivation process to produce eco-biomaterials/biomedicine then optimizing patient care, keep sustainability. Overall, this article's discussion around eco-biomaterials is to demonstrate their potential impact in being sustainable alternatives of conventional human-made chemicals/synthetic carriers in traditional pharmaceutical technologies and improving patient care.

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The drug delivery area has recently entered an era of sustainability and consideration for the environment [1]. Traditional synthetic materials produced predominantly from non-renewable resources and frequently associated with environmental toxicity, are increasingly transitioning to eco-biomaterials. Eco-biomaterials are derived from natural polymers and waste by-products, and they are paramount to develop sustainable drug delivery methods in accordance with green chemistry principles and the framework of circular economy [2]. Natural polymer world, including chitosan, alginate, cellulose, starch, and gelatin, have gained substantial attention, chitosan, alginate, cellulose, starch, and gelatin because of their biocompatibility, biodegradability, and non-toxic properties [3-5]. Furthermore, these materials are commonly found in nature, and can be easily obtained from renewable resources such as crustacean shells, seaweed, plants, and animal tissues. Thus, reliantly design kinds of versatile drug delivery systems hydrogels, nanoparticles, films, and microspheres that will release therapeutic agents in a controlled manner [6, 7]. In addition, the chemical composition of the natural polymer materials is rich in functional groups that can be chemically modified. This provides the opportunity to control drug release kinetics and also discuss ranging interactions with biological tissues [8]. Using waste-derived biomaterials into drug delivery systems facilitates waste valorization and reduces the need for virgin raw materials. The use of eco-biomaterials in drug delivery has added benefits that go beyond sustainability. Their biodegradability leads to reduced long-term loading in the body and environment, therefore, reducing the possibility of chronic toxicity [9]. Natural polymers often exhibit bioactivity features, such as antimicrobial action or wound healing, which can be beneficial in the combined therapies from their bioactivity [10, 11]. Natural polymers are processed under mild conditions, which will assist with protecting the stability and activity of sensitive drugs, enabling beat dealing with proteins, peptides and nucleic acids [12]. However, natural polymers will still have quality and performance variations from sources and extraction and development processes, and so there needs to be continued development of advanced characterization and scalable production technology which protects reproducibility and conforms to regulations [13, 14]. On top of these areas, we need to conduct interdisciplinary research fields by collaborating with materials science, pharmacology, and environmental science, to manipulate the platform for human clinical use [15].

Fundamentally, eco-biomaterials which are natural polymers and waste residues provide opportunities for sustainable and innovative developments within drug delivery technology. By linking renewable resources and applying circular economy principles, these platforms are not only environmentally responsible but they also improve therapeutic opportunities as well as patient safety. Additional exploration and development in this field has potential for producing sustainable, safer, and effective drug delivery systems for the future.

Author Contributions

Bahram Rezazadeh Moghaddam: Conceptualization, Writing – original draft, Writing – review & editing; **Mahsa Hojjati:** Writing – original draft, Writing – review & editing. All authors read and approved the final version of manuscript.

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data Availability

No data is available.

Ethical issues

The authors confirm full adherence to all ethical guidelines, including the prevention of plagiarism, data fabrication, and double publication.

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