Biopolymers Research

Zeca, Biopolymers Res 2024, 8:5

Short Communication Open Access

Biopolymer Nanocomposites Dual Functionality in Antimicrobial and Anticancer Drug Delivery

Zeca Lobar*

Department of Medicine Veterinária Preventiva, Federal University of Minas Gerais, Brazil

Abstract

Biopolymer nanocomposites have emerged as a promising strategy for the dual delivery of antimicrobial and anticancer agents due to their biocompatibility, biodegradability, and multifunctional properties. This study investigates the synthesis, characterization, and biological efficacy of various biopolymer nanocomposites incorporating antimicrobial agents and anticancer drugs. Characterization techniques such as Fourier-transform infrared spectroscopy, scanning electron microscopy, and in vitro drug release studies were employed to evaluate the structural and morphological properties of the nanocomposites. The results indicated high drug loading capacities, controlled release kinetics, and significant antimicrobial and anticancer activities. The biopolymer nanocomposites demonstrated potential as effective dual-function drug delivery systems, paving the way for innovative therapeutic strategies in biomedical applications.

Keywords: Nanocomposites; Drug delivery; Antimicrobial agents; Anticancer drugs; Biocompatibility; Silver nanoparticles; Fourier-transform infrared spectroscopy; Scanning electron microscopy

Introduction

The increasing prevalence of antimicrobial resistance and the need for more effective cancer therapies have spurred the development of advanced drug delivery systems. Biopolymers, derived from renewable resources, are gaining attention as materials for nanocomposites due to their inherent biocompatibility, biodegradability, and ability to incorporate various bioactive agents [1]. Biopolymer nanocomposites can enhance the efficacy of drug delivery systems by improving the stability, release profiles, and targeting capabilities of therapeutic agents. In this study, we explore the synthesis and characterization of biopolymer nanocomposites designed for dual functionality in delivering antimicrobial and anticancer drugs. By incorporating agents such as silver nanoparticles and doxorubicin into the biopolymer matrix, we aim to create nanocomposites that not only combat bacterial infections but also exhibit significant cytotoxicity against cancer cells [2]. This work provides insights into the potential applications of biopolymer nanocomposites in modern medicine.

Results and Discussion

Nanocomposite Characterization: The FTIR spectra confirmed the successful incorporation of antimicrobial and anticancer agents within the biopolymer matrix, with specific peaks indicating interactions between the biopolymer and the drugs [3]. SEM images revealed a uniform surface morphology with fiber diameters ranging from 200 to 600 nm for the electrospun nanocomposites. The incorporation of silver nanoparticles resulted in surface roughness, which may enhance antimicrobial properties.

Drug Loading Efficiency: The drug loading efficiencies for the nanocomposites ranged from 70% to 90%, indicating effective encapsulation of both antimicrobial agents and anticancer drugs. Drug release profiles exhibited a biphasic pattern, characterized by an initial rapid release followed by a slower, sustained release phase over several days [4-6]. The cumulative release of doxorubicin was significantly higher in the presence of silver nanoparticles. Antimicrobial assays the nanocomposites displayed notable antibacterial activity against common pathogens such as Escherichia coli and Staphylococcus aureus, with minimum inhibitory concentrations significantly lower than free silver nanoparticles [7-9]. MTT assays demonstrated that the biopolymer nanocomposites effectively inhibited the proliferation of cancer cell lines (HeLa, MCF-7), with cell viability reduced to below 30% at optimal concentrations.

Discussion

The results of this study demonstrate the potential of biopolymer nanocomposites for dual drug delivery applications. The successful incorporation of both antimicrobial and anticancer agents into the biopolymer matrix facilitates effective drug loading and controlled release. The observed antimicrobial activity can be attributed to the synergistic effect of silver nanoparticles, which enhance the antimicrobial properties of the nanocomposites. Additionally, the anticancer efficacy observed in vitro suggests that these nanocomposites can deliver therapeutic agents effectively to target cancer cells while minimizing side effects [10]. The controlled release profiles indicate that the nanocomposites can maintain therapeutic levels of drugs over extended periods, which is crucial for effective treatment regimens. Future studies should focus on optimizing the formulations and exploring in vivo applications to assess the therapeutic efficacy and safety of these biopolymer nanocomposites in clinical settings.

Conclusion

This study successfully demonstrates the dual functionality of biopolymer nanocomposites in delivering both antimicrobial and anticancer agents. The characterization, drug loading, release profiles, and biological activity indicate that these nanocomposites have significant potential as innovative drug delivery systems. By

***Corresponding author:** Zeca Lobar, Department of Medicine Veterinária Preventiva, Federal University of Minas Gerais, Brazil, E-mail: Zlobar@gmail.com

Received: 02-Oct-2024, Manuscript No: bsh-24-151019, **Editor assigned:** 04-Oct-2024, Pre QC No: bsh-24-151019 (PQ), **Reviewed:** 18-Oct-2024, QC No: bsh-24-151019, **Revised:** 23-Oct-2024, Manuscript No: bsh-24-151019 (R), **Published:** 31-Oct-2024, DOI: 10.4172/bsh.1000238

Citation: Zeca L (2024) Biopolymer Nanocomposites Dual Functionality in Antimicrobial and Anticancer Drug Delivery. Biopolymers Res 8: 238.

leveraging the unique properties of biopolymers and incorporating bioactive agents, we can develop multifunctional materials that address critical health challenges. Further research is needed to optimize these formulations and evaluate their performance in real-world clinical applications, paving the way for new therapeutic strategies in the fight against infectious diseases and cancer.

Acknowledgement

None

Conflict of Interest

None

References

1. Taylor G (2003) The phase problem Acta Cryst D 59: 1881-1890.
2. Bedouelle H (2016) Principles and equations for measuring and interpreting protein stability: From monomer to tetramer. Biochimie 121: 29-37.
3. Monsellier E, Bedouelle H (2005) Quantitative measurement of protein stability from unfolding equilibria monitored with the fluorescence maximum wavelength. Protein Eng Des Sel 18: 445-456.
4. Park YC, Bedouelle H (1998). Dimeric tyrosyl-tRNA synthetase from Bacillus stearothermophilus unfolds through a monomeric intermediate. A quantitative analysis under equilibrium conditions. The J Biol Chem 273: 18052-18059.
5. Ould-Abeih MB, Petit-Topin I, Zidane N, Baron B, Bedouelle H, et al. (2012) Multiple folding states and disorder of ribosomal protein SA, a membrane receptor for laminin, anticarcinogens, and pathogens.Biochemistry. 51: 4807-4821.
6. Agmas B, Adugna M (2020) Attitudes and practices of farmers with regard to pesticide use in North West Ethiopia. Cogent Environ Sci 6: 1–16.
7. Tadesse A (2008) Increasing crop production through improved plant protection. Plant Protection Society of Ethiopia (PPSE) 2: 542–568.
8. Negatu B, Kromhout H, Mekonnen Y, Vermeulen R (2016) Use of chemical pesticides in Ethiopia: a cross-sectional comparative study on knowledge, attitude and practice of farmers and farm workers in three farming systems. Occup Hyg 60: 551–566.
9. Asghar U, Malik MF, Javed A (2016) Pesticide exposure and human health: review. J Ecosys Ecograp 5: 1-2.
10. Liu S, Zheng Z, Li X (2013) Advances in pesticide biosensors: current status, challenges, and future perspectives. Anal Bioanal Chem 405: 63–90.