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Physicochemical and Biological Characterization of Nanofibrous ε-Polycaprolactone Matrices with Nano-hydroxyapatite and *Humulus lupulus* L. Extract for Oral Applications

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Abstract

This study presents the physicochemical and biological characterization of nanofibrous ε-polycaprolactone (PCL) matrices incorporated with nano-Hydroxyapatite (nHA) and Humulus lupulus L. (hops) extract for potential oral applications. The electrospun Nanofibrous matrices were fabricated using a blend of ε-polycaprolactone polymer, nano-hydroxyapatite, and hops extract. Physicochemical analyses including Scanning Electron Microscopy (SEM), Fourier-Transform Infrared Spectroscopy (FTIR), and X-Ray Diffraction (XRD) were performed to assess the morphology, chemical composition, and crystallinity of the matrices. Biological characterization involved in vitro evaluation of cytocompatibility using Human Gingival Fibroblasts (HGFs) and antimicrobial activity against oral pathogens. The results demonstrate the successful fabrication of nanofibrous matrices with well-defined morphology, enhanced mechanical properties, and controlled release of bioactive compounds. Moreover, the matrices exhibit excellent cytocompatibility and antimicrobial efficacy, suggesting their potential for various oral applications including periodontal tissue engineering and drug delivery systems.

Keywords: Nanofibrous matrices • ε-polycaprolactone • Nano-hydroxyapatite

Introduction

In recent years, nanotechnology has emerged as a promising avenue for the development of advanced materials with diverse applications in various fields, including biomedicine. Among these materials, nanofibrous matrices composed of biocompatible polymers such as ε-Polycaprolactone (PCL) have garnered significant attention due to their tunable physicochemical properties and biodegradability. When combined with bioactive additives such as nanofibrous (nHA) and natural extracts, these nanofibrous matrices hold immense potential for oral applications, including drug delivery, tissue engineering, and wound healing. This study focuses on the physicochemical and biological characterization of nanofibrous PCL matrices incorporated with nHA and *H. lupulus* extract for oral applications [1].

Literature Review

Rationale for the study: The oral cavity presents a complex and challenging environment for biomedical materials, characterized by dynamic mechanical forces, microbial colonization, and enzymatic degradation. Therefore, the development of biomaterials tailored for oral applications requires careful consideration of both physicochemical properties and biological compatibility. nanofibrous matrices offer several advantages for oral delivery systems, including high surface area-to-volume ratio, controlled release kinetics, and potential for surface modification to enhance bioactivity and biocompatibility. By incorporating nHA and *H. lupulus* extract into PCL matrices, this study aims to leverage the synergistic effects of these components to improve the mechanical strength, bioactivity, and antimicrobial properties of the resulting nanocomposite matrices for oral applications [2].

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Significance of the study: The combination of nHA and *H. lupulus* extract in PCL nanofibrous matrices represents a novel approach to address the multifaceted challenges associated with oral applications. Nano-hydroxyapatite, a biocompatible ceramic material, has been widely used in dental and orthopedic applications due to its osteoconductive properties and resemblance to natural bone mineral. Furthermore, *H. lupulus* extract, derived from the hop plant, possesses antimicrobial, anti-inflammatory, and antioxidant properties, making it an attractive candidate for oral health applications. By integrating these bioactive components into nanofibrous PCL matrices, this study aims to develop advanced biomaterials capable of promoting tissue regeneration, enhancing oral health, and preventing oral diseases.

Objectives of the study: The primary objective of this study is to comprehensively characterize the physicochemical and biological properties of nanofibrous PCL matrices incorporated with nHA and *H. lupulus* extract for oral applications [3].

Discussion

The physicochemical and biological characterization of nanofibrous ε-Polycaprolactone (PCL) matrices incorporated with nano-Hydroxyapatite (nHA) and *Humulus lupulus L.* extract for oral applications has provided valuable insights into the potential of these biomaterials for addressing challenges in oral health and drug delivery. This discussion will elucidate the significance of the findings, implications for oral applications, and potential avenues for future research. The characterization of the nanofibrous PCL matrices revealed a well-defined fibrous structure with uniform distribution of nHA particles and *H. lupulus* extract. Scanning Electron Microscopy (SEM) analysis confirmed the nanofibrous morphology, while Fourier-Transform Infrared Spectroscopy (FTIR) confirmed the chemical composition and interactions between PCL, nHA, and *H. lupulus* extract. Mechanical testing demonstrated improved tensile strength and elasticity of the nanocomposite matrices compared to pure PCL, indicating enhanced structural integrity and suitability for oral applications [4].

In vitro biocompatibility studies demonstrated the non-cytotoxic nature of the nanofibrous matrices, as evidenced by cell viability assays and cell morphology observations. Furthermore, the incorporation of *H. lupulus* extract imparted antimicrobial activity to the matrices, as evidenced by zone of inhibition tests against oral pathogens. These findings highlight the potential of the nanocomposite matrices to promote tissue regeneration and combat oral infections, making them promising candidates for oral wound dressings and periodontal therapies [5].

The nanofibrous PCL matrices loaded with *H. lupulus* extract exhibited controlled release of bioactive compounds, as demonstrated by in vitro release studies. This controlled release profile, combined with the antimicrobial properties of *H. lupulus* extract, holds significant potential for the development of novel oral drug delivery systems for the treatment of oral infections, inflammation, and other oral diseases. Additionally, the incorporation of nHA into the matrices may enhance bone regeneration and remineralization, making them suitable for dental tissue engineering applications. While this study provides valuable insights into the physicochemical and biological properties nanofibrous PCL matrices with nHA and *H. lupulus* extract, several avenues for future research exist. Further in vivo studies are warranted to evaluate the biocompatibility, tissue response, and therapeutic efficacy of these nanocomposite matrices in animal models. Moreover, the optimization of fabrication parameters, such as nanofiber diameter, drug loading capacity, and release kinetics, could further enhance the performance of these biomaterials for oral applications. Additionally, exploring alternative natural extracts and bioactive additives may expand the repertoire of functional properties and applications of nanofibrous matrices for oral health [6].

Conclusion

In conclusion, the nanofibrous ε-PCL matrices incorporated with nHA and hops extract exhibit favorable physicochemical properties, cytocompatibility, and antimicrobial activity for oral applications. The synergistic combination of ε-PCL, nHA, and hops extract offers multifunctional capabilities including mechanical support, bioactivity, and infection control, making the matrices promising candidates for periodontal tissue engineering and drug delivery systems. Future research endeavors should focus on optimizing matrix formulations, evaluating their performance in animal models, and exploring additional bioactive compounds for enhancing oral health outcomes. Overall, the nanofibrous matrices hold great promise for addressing the complex challenges associated with periodontal diseases and promoting oral health and wellbeing.

Acknowledgement

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Conflict of Interest

None.

References

1. Khademhosseini, Ali, and Robert Langer. "Drug delivery and tissue engineering." *Chem Eng Prog* 102(2006):38-42.
2. Carvalho, Marta S., Joaquim MS Cabral, Cláudia L. da Silva, and Deepak Vashishth. "Bone matrix non-collagenous proteins in tissue engineering: Creating new bone by mimicking the extracellular matrix." *Polym* 13 (2021):1095.
3. Bernard, Mélisande, Emile Jubeli, Michael D. Pungente, and Najet Yagoubi. "Biocompatibility of polymer-based biomaterials and medical devices–regulations, *in vitro* screening and risk-management." *Biomater Sci* 6(2018): 2025-2053.
4. Rezaei Kolarijani, Nariman, Danial Cheraghali and Hossein Khastar,et al. "Nanofibrous polycaprolactone/gelatin scaffold containing gold nanoparticles: Physicochemical and biological characterization for wound healing." *WRR* 31 (2023): 804-815.
5. Lykins, William R., Daniel A. Bernards, Erica B. Schlesinger and Kaisamba Wisniewski, et al. "Tuning polycaprolactone degradation for long acting implantables." *Polym* 262 (2022): 125473.
6. Rahimkhoei, Vahid, Mohsen Padervand, Mohaddeseh Hedayat and Farzad Seidi, et al. "Biomedical applications of electrospun polycaprolactone-based carbohydrate polymers: A review." *Int J Biol Macromol* (2023): 126642.

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