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Review

Advances in Natural Product Extraction Techniques, Electrospun Fiber Fabrication, and the Integration of Experimental Design: A Comprehensive Review

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Abstract: The present review explores the growing interest in the techniques employed for extracting natural products. It emphasizes the limitations of conventional extraction methods and introduces superior non-conventional alternatives, particularly ultrasound-assisted extraction. Characterization and quantification of bioactive constituents through chromatography coupled with spectroscopy are recommended, while the importance of method development and validation for biomarker quantification is underscored. At present, electrospun fibers provide a versatile platform for incorporating bioactive extracts and have extensive potential in diverse fields due to their unique structural and functional characteristics. Thus, the review also highlights the fabrication of electrospun fibers containing bioactive extracts. The preparation of biologically active extracts under optimal conditions, including the selection of safe solvents and cost-effective equipment, holds promising potential in the pharmaceutical, food, and cosmetic industries. Integration of experimental design into extraction procedures and formulation development is essential for the efficient production of health products. The review explores potential applications of encapsulating natural product extracts in electrospun fibers, such as wound healing, antibacterial activity, and antioxidant properties, while acknowledging the need for further exploration and optimization in this field. The findings discussed in this review are anticipated to serve as a valuable resource for the processing industry, enabling the utilization of affordable and environmentally friendly, natural, and raw materials.

Keywords: natural product; extraction; hyphenated technique; experimental design; electrospinning

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Citation: Ponphaiboon, J.; Krongrawa, W.; Aung, W.W.; Chinatangkul, N.; Limmatvapirat, S.; Limmatvapirat, C. Advances in Natural Product Extraction Techniques, Electrospun Fiber Fabrication, and the Integration of Experimental Design: A Comprehensive Review. *Molecules* **2023**, *28*, 5163. https://doi.org/10.3390/molecules28135163

Academic Editors: Irinel Adriana Badea, Rodica Olar and Magdalena Mititelu

Received: 31 May 2023
Revised: 20 June 2023
Accepted: 20 June 2023
Published: 2 July 2023

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1. Introduction

Researchers are increasingly interested in the use of plant-derived, bioactive extracts due to the beneficial effects of their phytochemical constituents on human health. Phytochemical constituents, primarily polyphenols, are synthesized as secondary metabolites by plants through diverse metabolic pathways within plant cells [1]. Additionally, the extraction of bioactive compounds from animal tissues, such as beef fat and deer antler, remains popular, necessitating specialized extraction procedures. Extraction is a technique utilized in natural product research to separate bioactive compounds from various natural materials. Both plant and animal tissues are capable of yielding a variety of bioactive extracts, which can be prepared using a vast array of extraction techniques.

Conventional extraction techniques, including Soxhlet extraction, maceration, percolation, and decoction, are known to be time-, solvent-, and energy-intensive [2]. In contrast, various non-conventional techniques for the extraction process, such as supercritical fluid