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Process development for plant-based high-value pharmaceuticals under a green sustainable framework.

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ABSTRACT

Parthenolide, a sesquiterpene lactone from feverfew (Tanacetum parthenium), and its derivatives have shown promising anticancer properties. However, the commercial production of parthenolide is limited due to high processing costs, low natural abundance, and small-scale demand.

This study focuses on the development and optimization of parthenolide extraction within a green, sustainable framework. The production workflow was designed to meet the logistical and economic constraints of a pilot-scale facility, prioritizing eco-friendly methods. Ethanol was chosen as the primary extraction solvent due to its sustainability, even though it is more expensive than conventional solvents like acetonitrile. The study evaluated extraction parameters such as temperature, solvent-to-biomass ratio, extraction duration, and agitation time. Results showed that extraction efficiency peaked at short durations, and temperature had minimal impact on the kinetics. Rapid biomass removal post-extraction was crucial for maximizing yield and minimizing product loss.

The effect of biomass composition on extraction efficiency was also explored, comparing fresh and dried biomass. Dried biomass resulted in higher parthenolide concentrations. The impact of multiple extraction cycles was analyzed, revealing diminishing returns with each cycle. Agitation during extraction was optimized to enhance mass transfer.

Filtration processes were refined using a sequential approach, starting with dead-end

filtration for coarse solids removal, followed by tangential flow filtration (TFF) with 0.1 µm, 50 kDa, and 5 kDa membranes. This method reduced contamination while preserving the product and its integrity. This improved downstream chromatographic performance.

This research provides a comprehensive, scalable process for parthenolide production, emphasizing sustainability. The study is funded by the Defence Innovation Partnership's (DIP) Collaborative Research Fund and the South Australian immunoGENomics Cancer Institute (SAiGENCI).

KEY WORDS

Cancer, Scalability, Optimisation, Drug, Bioprocessing

BIOGRAPHY

Dr. Luis Toronjo-Urquiza is a Lecturer in Biopharmaceutical Engineering at the University of Adelaide, where he also serves as Discipline Lead in Bioprocess Engineering and Program Director of the Master in Biopharmaceutical Engineering. His research focuses on sustainable biopharmaceutical production, process development, and integrating natural compounds into healthcare solutions. He specializes in optimizing upstream and downstream processes for recombinant proteins and plant-based pharmaceuticals. As a board member of the Bioprocessing Network Organization, he promotes innovation and knowledge exchange. Dr. Toronjo-Urquiza is committed to advancing greener, more accessible pharmaceutical production methods globally.

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