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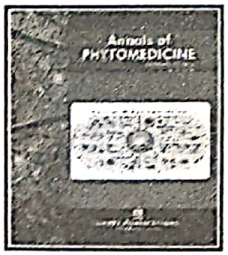
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Engineering technologies for curcumin recovery from *Curcuma longa* L.: Advances, process optimization, and phytomedicinal applications

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Abstract

The main bioactive substance derived from *Curcuma longa* L. rhizomes, curcumin, has garnered a lot of interest because of its many pharmacological characteristics and industrial uses. With an emphasis on curcumin's antioxidant, anti-inflammatory, antibacterial, anticancer, neuroprotective, and cardioprotective properties; this article offers a thorough summary of the phytomedicinal relevance of curcumin. Both traditional extraction methods, such as solvent and Soxhlet extraction, and cutting-edge engineering technologies, such as ultrasound-assisted extraction, microwave-assisted extraction, supercritical fluid extraction, enzyme-assisted extraction, and pressurised liquid extraction, are critically examined in this article. In order to increase extraction efficiency and environmental sustainability, recent developments in green extraction techniques specifically, the use of deep eutectic solvents and sustainable solvent systems are also covered. Important process optimisation techniques are also highlighted in the paper, such as the use of statistical tools like artificial neural networks and response surface approach to identify the best extraction parameters. A summary of curcumin's industrial uses in the food, cosmetic, pharmaceutical, and nutraceutical industries is also provided. The article concludes by outlining future research directions like hybrid extraction technologies, nanoencapsulation systems, green solvents, and artificial intelligence-based process optimisation. It also discusses the main obstacles to curcumin utilisation, such as low bioavailability, stability concerns, and challenges in large-scale implementation. All things considered, the review offers insightful information on the creation of effective and sustainable methods for curcumin extraction and use in a range of industrial applications.

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