不同深共熔溶劑應用於甲殼類幾丁質之室溫萃取、結構穩定及轉化成碳材料

吳宜樺(5140)

2025/11/05

大綱

摘要

甲殼類廢棄物中富含具生物可降解性與高附加價值的幾丁質，其高純度回收對於環境永續與資源再利用具有重要意義。傳統酸鹼處理雖能有效分離蛋白質與碳酸鈣，然而操作條件嚴苛且產生大量副產物，限制其綠色應用發展。本研究目的以深共熔溶劑(deep eutectic solvents, DES)為環保介質，探討不同組成、酸鹼性及溫度條件對幾丁質萃取效率與結構穩定性的影響。結果顯示，TEBAC/乳酸(LA)系統於低溫 30 ℃即可達高純度(98.42%)與高產率(92.16%)，並維持較高分子量(3573.85 kDa)，顯示其具備低能耗與保持聚合物結構完整的特性。另一方面，GA-Cys 型 DES 藉由氫鍵與硫醇官能團形成穩定溶劑網絡，能選擇性去除蛋白與無機鹽，提升幾丁質結晶性(74.9%)與熱穩定性，分子量達 3.75×10^5 Da，顯示其優異的結構維護能力。此外，酸性 DES (ChCl/TsOH)於 70～110 ℃範圍內可實現同步脫鈣與脫蛋白，而在高溫條件下(≥130 ℃)則可誘導碳化，展現由幾丁質向碳材料可控轉化的潛力。深共熔溶劑能以溫和條件高效萃取幾丁質，兼具高純度、低能耗與結構穩定性。除能取代傳統酸鹼法外，亦可實現幾丁質向高值化碳材料與生物基材料的綠色轉化，展現永續應用潛力。

Application of different deep eutectic solvents in low-temperature extraction, structural stabilization, and green conversion of crustacean chitin

I-HUA, WU (5140)

2025/11/05

Outline

1. Introduction
2. Chitin was extracted with a deep eutectic solvent at room temperature.
3. Mechanism of avoiding molecular weight degradation in chitin preparation using deep eutectic solvents
4. Transformation of chitin and carbon materials using deep eutectic solvents
5. Conclusion

Abstract

Crustacean waste is rich in biodegradable and high-value chitin, and its high-purity recovery is crucial for environmental sustainability and resource reuse. While traditional acid-base treatments can effectively separate proteins and calcium carbonate, the harsh operating conditions and the production of numerous byproducts limit their potential for green applications. This study investigated the effects of different compositions, acidity, alkalinity, and temperature on the extraction efficiency and structural stability of chitin using deep eutectic solvents (DES) as environmentally friendly media. Results showed that the TEBAC/lactic acid (LA) system achieved high purity (98.42%) and yield (92.16%) at a low temperature of 30°C, while maintaining a relatively high molecular weight (3573.85 kDa), demonstrating its low energy consumption and ability to maintain polymer structural integrity. GA-Cys-based DES, by forming a stable solvent network through hydrogen bonding with thiol functional groups, can selectively remove proteins and inorganic salts, improving chitin crystallinity (74.9%) and thermal stability. Its molecular weight reaches 3.75×10^5 Da, demonstrating its excellent structural preservation capabilities. Furthermore, acidic DES (ChCl/TsOH) can simultaneously decalcify and deproteinize chitin within the temperature range of 70–110°C, while inducing carbonization at elevated temperatures (≥130°C), demonstrating the potential for controllable conversion of chitin into carbon materials. Deep eutectic solvents enable efficient extraction of chitin under mild conditions, combining high purity, low energy consumption, and structural stability. In addition to replacing traditional acid-base methods, they can also enable the green conversion of chitin into high-value carbon materials and bio-based materials, demonstrating potential for sustainable applications.

參考文獻

Feng, M., Yan, J., He, B., Chen, X., & Sun, J. (2021). Controllable conversion of shrimp shells into chitin or derived carbon material using acidic deep eutectic solvent. *International Journal of Biological Macromolecules*, *193*, 347-357.

Ma, J., Chu, D., Rakhimovna, V. N., Wang, P., Zhu, S., Xie, H., Liu, O., Yin, H. (2025). Efficient and green extraction of chitin from mantis shrimp shell using deep eutectic solvents at room temperature. *Bioresource Technology*, 132888.

Wang, Y., Yang, Y., Wang, R., Zhu, Y., Yang, P., Lin, Z., Wang, Z., Cong, W. (2022). Effectively inhibiting the degradation of chitin during extraction from crustacean waste via a novel deep eutectic solvent aqueous solution. *Process Biochemistry*, *121*, 142-151.