Ultrasound-assisted aqueous extraction (UAE) of proteins from shrimp production waste

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Abstract

Shrimp is, by far, the most consumed crustacean world wide with a global production of 9.4 million tonnes in 2022, with a share of 63% of aquaculture production [1]. During the production and processing, shells and other parts are generated as waste that account for aproximately 50% of the shrimp. The shells are interesting sources of chitin and chitosan, through a process mainly based in the use of inorganic solvents, harmful to the environment due to the use of high concentration and volume, and generating lots of wastewater [2]. Moreover, this process hampers the use of other fractions present in shrimp shell such as proteins, due to degradation by the alkaline inorganic solvent used [3]. Therefore, alternative cleaner processes are needed to develop sustainable crustacean biorefineries for global valorization of shrimp. In a previous group's work, microwave technology has being applied for the extraction of proteins using only water in the range of 175-225 °C, demonstrating its potential as deproteinization solvent [4]. Ultrasonication is a technology that has been used as a pretreatment on chitin extraction from shrimp shells by other processes such as subcritical water hydrolysis [3] and fermentation [5]. However, up to our knowledge, there is not any study in the literature based in the ultrasound-assisted extraction (UAE) of proteins from shrimp shells as a whole fractionation step. For this purpose, the aim of this work is to study the effect of operational variables on the UAE of proteins from shrimp waste using only water as solvent. Temperature (0-65 ºC), Solvent/Feed ratio (10-60 mL/g), amplitude (60-100%), time (5-30 min) and cycle (0.6-1) has been selected for screening tests. A Box-Behnken approach will be performed to maximize protein extraction yield and minimize co-extraction. Proteins will be quantified by the bicinchoninic acid assay (BCA) and free amino acids by the ninhydrin method [4]. Co-extraction will be determined gravimetrically. *Litopenaeus vannamei*'s waste will be used as raw material. The suspension is sonicated by means of the UP400S Ultrasonic Processor (400 W, 24 kHz; Hielscher, Germany), equipped with a 22 mm titanium probe, with a maximum amplitude of oscillation of 100 µm, in a 200 mL jacketed vessel for temperature regulation. Temperature in the extraction vessel was monitored by a thermocouple. Energy consumption is continuosly measured.

References

[1] https://www.fao.org/in-action/globefish/news-events/trade-and-market-news/q1-2023-jan-mar/en/ Accessed 17/02/2024
[2] A.M. Sixto-Berrocal, M. Vázquez-Aldana, S.P. Miranda-Castro, M.A. Martínez-Trujillo, M.R. Cruz-Díaz, Chitin/chitosan extraction from shrimp shell waste by a completely biotechnological process, Int J Biol Macromol 230 (2023) 123204.
[3] M. Matouri, Z. Liu, M.D.A. Saldaña, Production of chitosan from shrimp shell using ultrasound followed by subcritical water hydrolysis, Food Chem 441 (2024) 138248.
[4] M.M. de-Souza-Ribeiro, H. Loya-Pérez, G.E. Alonso-Sánchez, S. Rodríguez-Rojo, Microwave extraction of proteins from Litopenaeus vannamei molt shell using only water as a solvent, in: 14th International Chemical and Biological Engineering Conference, Bragança, Portugal, 2023.
[5] Q. Zhang, L. Duan, Y. Li, Positive effects and mechanism of ultrasound on chitin preparation from shrimp shells by co-fermentation, Ultrason Sonochem 88 (2022) 106066.

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