Shrimp molt protein extraction by subcritical water conditions in continuous ultrafast reactors.

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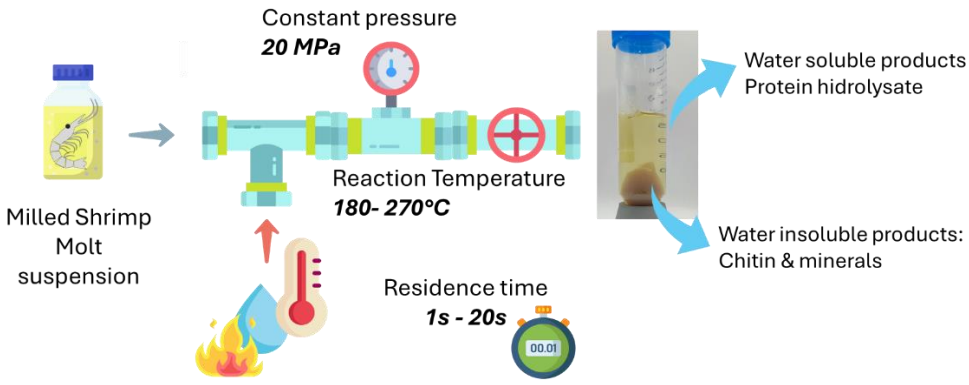
GRAPHICAL ABSTRACT



ABSTRACT

Shrimp aquaculture is a growing economic sector; it accounts for the 63% of global shrimp production [1] and indoor farming is gaining importance, mainly in USA and Europe, to produce high quality and sustainable seafood [2]. During shrimp production, molt residue is generated as shrimp replace their old shell with a new one. For a sustainable development of shrimp farming, particularly of inner one, the global valorization is of primary importance. Similar to exoskeleton of adults' shrimp, molts are mainly composed of chitin (20-30%), minerals (30-50%, mainly $CaCO_3$), proteins (15-30%), and minor components carotenoids like astaxanthin [3], in variable percentage depending on the species and level of maturity. Although, shrimp residue is conventionally used to produce chitin and chitosan, the process uses intensively inorganic solvents, generates high volume of wastewater and emission of carbon dioxide [3], and hinders the valorization of other fractions present in shrimp shell.

In this context, the use of subcritical water as a clean, efficient, and selective process for protein hydrolysates for feed and functional foods production has been studied in literature [4]. Protein from shrimp shell can be recovered as hydrolysate using subcritical water at high yield, 96%, at 260 ºC for 5 minutes [5]. Due to high temperature processing, it is necessary to minimize the formation of degradation products from protein [4], as well as, from chitin. According to literature, chitin degradation starts in same range of temperature and time [6]. Some years ago, our group developed ultrafast sudden expansion micro-reactors (UF-SEMR) for biomass continuous processing with residence time in the range of seconds providing fractionation of lignocellulose biomass [7]. In this technology, biomass stream is heated to the operating temperature by direct mixing with a hot pressurized water stream reaching the desired temperature just before entering the reactor. Instantaneous cooling is achieved through sudden

decompression. Thus, residence time is precisely controlled avoiding side reactions during long heating and cooling periods.

In this work, UF-SEMR are used under subcritical conditions for the selective recovery of the protein fraction from shrimp molts preserving the original chitin structure in the solid residue for further valorization. Various reactor volumes are employed to control residence time within the range of 1–20 s for temperatures from 180 to 270ºC, while pressure was kept constant at 20MPa. A 75% protein from the molt shell, quantified by the bicinchoninic acid assay (BCA), was extracted in only 19.3s at 208ºC with minimal degradation (no free aminoacids were detected by HPLC analysis). Additionally, molecular weight of protein hydrolysate will be also correlated with operating conditions. Further, chitin content, its molecular weight and acetylation degree (DA) will be evaluated in the solid product to assess its integrity.

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