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Supercritical water valorization of chitin in a continuous reaction system: Chitin nano-particles.

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Abstract

Chitin is an abundant biopolymer of [β-1,4-poly(n-acetyl-D-glucosamine)] units, produced by crustaceans, mollusks, insects, and fungi. Nowadays, chitin is discarded in massive amounts (6–8 million tons/year) as waste from the seafood industry, being underexploited as biomass resource[1]. Chitin is of great interest as a biocompatible and biodegradable material, gaining importance in the formulation of phytosanitary products, thanks to its elicitor activity in plants[2]. It is also considered as a source of oligosaccharides and biologically active monomers, N-acetylglucosamine (depolymerization) and glucosamine (deacetylation). Several studies have shown that chitin, like cellulose, can be dissolved and hydrolyzed in supercritical water (SCW) due to the change in its properties (water density and ionic product, among others); however, due to the high chitin crystallinity, this process occurs less easily[3].

The present work aims to investigate the mechanisms of chitin transformation in SCW medium (400°C and 25MPa), using ultrafast sudden expansion microreactors (SEMR) in a continuous system (residence time 0.1s - 2s). Special attention was paid to the effect of residence time on the depolymerization processes. Commercial chitin was used as raw material and characterized by elemental analysis (EA), FT-IR, Particle Size Distribution (PSD), zeta potential (ZP) and XRD. Total Organic Carbon, Total Nitrogen, pH and HPLC were used to characterize the liquid product; and solid fraction was characterized by EA, FT-IR, PSD, ZP and XRD for comparison with raw material. The results show that, within the studied conditions, chitin could not be fully depolymerized in SCW, at the highest residence time tested, the solid fraction was still 40%. Higher residence time caused partial solubilization and particle size reduction of the solid fraction. At lower residence time, particles with an average size of 582μm and a ZP of +32mV were obtained. These particles are being used in a proof of concept for the preparation of Pickering emulsions with phytosanitary purposes.

References

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