8th International Solvothermal and Hydrothermal Association Conference
ISHA 2023
Valladolid, Spain
September 10th–13th, 2023

Supercritical water valorization of chitin in a continuous reaction system

Casas González, A.[1,2], Rodríguez Rojo, S.[1,2], Alonso, E.[1,2]

[1]BioEcoUVa, Research Institute on Bioeconomy, PressTech Group, University of Valladolid, Pº Prado de la Magdalena S/N, 47011 Valladolid, Spain.
[2]Dpt. of Chemical Engineering and Environmental Technology - University of Valladolid, Pº Prado de la Magdalena S/N, 47011 Valladolid, Spain.
Corresponding author email: ealonso@uva.es

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 has high interest as a biocompatible and biodegradable material, but also as a source of biologically active oligosaccharides and monomers, N-acetylglucosamine (depolymerization) and glucosamine (deacetylation). These monomers constitute nitrogen-containing building blocks and open the way to biorefineries of alternative biomasses, such as sea-wastes, to obtain molecules of interest, such as furan- or amine-based monomers[1]. 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[2].

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 and reaction temperature, using the Overend and Chornet[3] severity factor (SF) (7.9 to 9.0), on the solubilization and depolymerization processes. Commercial chitin was used as raw material and characterized by elemental analysis (EA), FT-IR, Particle Size Distribution (PSD) 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 and XRD for comparison with raw material. The results show that, within the studied conditions, chitin could not be fully depolymerized in SCW, at highest SF tested, the solid fraction was still 40%. Higher SF caused partial solubilization and particle size reduction of the solid fraction, and presumably promoted gasification. The presence of water-soluble by-products in every experiment gave us a hint of side reactions competing with depolymerization. Molecular weight analysis of solid products by intrinsic viscosity is being developed to evaluate the depolymerization tendency as a function of SF.

Keywords: Chitin, SCW hydrolysis, N-acetylglucosamine, glucosamine, ultrafast reactor.

References:

[1] *M. Yavada, et al., Bioresour. Bioprocess, 2019, 6:8.*
[2] *M. Osada, et al., Carbohydr. Polym., 2015, 134, 718-725.*
[3] *R. Overend and E. Chornet, Philos. Trans. R. Soc. A., 1987, 321, 523-536.*

Acknowledgements: This work was supported by Spanish Ministry of Science and Innovation (project PID2020-119481RA-I00), the Regional Government of Castilla y León and FEDER-EU, program CLU-2019-04.