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

de-Souza-Ribeiro, Mauricio M.[1,2], *Casas González, Andrea*[1,2], *Alonso, Esther*[1,2], *Rodríguez-Rojo, Soraya* [1,2]

BioEcoUVa, Research Institute on Bioeconomy, PressTech Group, University of Valladolid, Spain

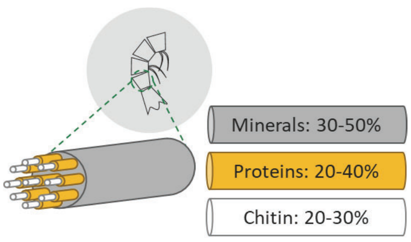
Dpt. Chemical Engineering and Environmental Technology, School of Industrial Engineering, UVa, Spain.

*corresponding author: soraya.rodriguez@uva.es

EIFS 2024 – 3er Encuentro Ibérico de Fluidos Supercríticos

UVa

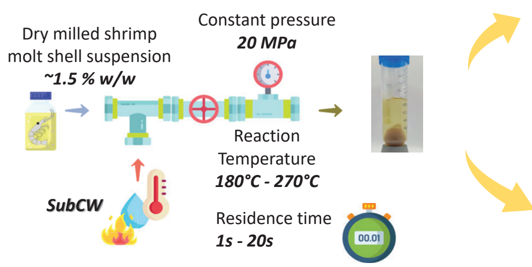
Introduction



Aproximate composition of shrimp molt and shell[2]

- Aquaculture is an important sector in shrimp market: 63% of global production with indoor farming growing [1]
- Molt residue is generated with similar composition to adult shrimp Shell
- Generally valorized for chitin production by intense use of acid and alkali solutions that hampers the use of other valuable components, namely, proteins, but also minerals
- Subcritical water is a clean and selective media for protein hydrolysates production: 96% yield at 260°C for 5 min[3]
- To reduce degration of proteins in the extract and chitin in the solid, low residence time is required [4,5]: ultrafast sudden expansion micro-reactors (UF-SEMR) for biomass continuous processing developed in our group[6] allow to reduce residence time below 60s

Experimental set-up: UF-SEMR



Analytical methods

Water soluble products: Protein hydrolysate

- Protein content (BCA method, AA profile by HPLC)
- Total Organic Carbon (TOC), Inorganic Carbon (IC) & Total Nitrogen (TN)
- pH, $CaCO_3$ content
- HPLC profile for degradation products
- MALDI-ToF

Water insoluble products: Chitin and minerals

- Elemental Analysis (C,H, N)
- Ash content (TGA)
- FTIR & X-Ray diffraction
- Particle size distribution (laser diffraction)

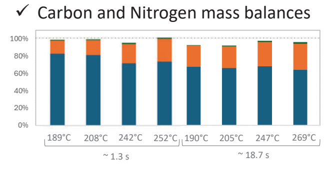
Results

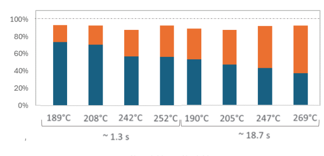
✓ Raw material composition & Elemental Analysis

Component	% Dry basis
Fatty acids	0.7125 ± 0.003
Protein	11.7 ± 0.5
Chitin	15.1 ± 0.6
Ash	54.82 ± 0.09

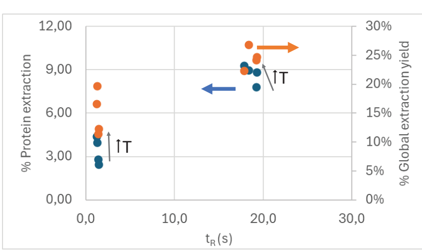
Element	% Dry basis
C	23.26 ± 0.08
H	2.855 ± 0.007
N	3.92 ± 0.03

✓ Carbon and Nitrogen mass balances

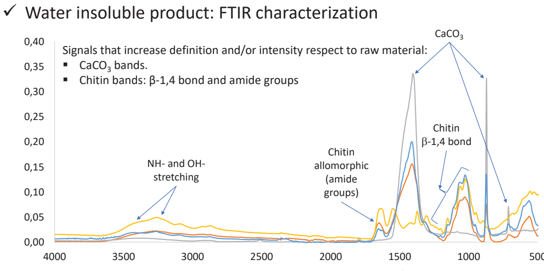




✓ Water soluble product: Protein extraction and global extraction yield



✓ Water insoluble product: FTIR characterization



Preliminary conclusions & On track

- ***Water soluble product :*** Maximum **protein extraction** of 9.3% at 269°C and 17.8s. Similar yield found for microwave processing (own results) at 206°C for 5.6 min.
- **Residence time** has a greater effect on **protein extraction** than reaction temperature: **On-going** experiments at longer residence time in the low temperature range
- Higher **purity of extract** at longer **residence time**: protein extraction increase by 2- 3 fold and global extraction yield by 1.3 – 2 fold:
  On going characterization: co-extraction and degradation compounds, and molecular weight of peptides (protein hydrolysate)
- ***Water Insoluble product:*** composite of $CaCO_3$ and chitin. **On-going** structural characterization to verify no degradation of chitin (α allomorph and acetylation degree)
- **Particle size reduction** by mechanical effect, no effect of residence time nor temperature, in tested range: 75% reduction as D (3,4) from 72 μm to 19 μm (average values)

References

[1] https://www.fao.org/in-action/globefish/news-events/trade-and-market-news/q1-2023-jan-mar/en/ Accessed 30/05/2024. [2] Maschmeyer, T. et al., Chem. Soc. Rev., 49,(2020) 4527–4563. [3] Espíndola-Cortés, A. et al. Carbohydr. Polym., 172, (2017) 332–341. [4] Rogalinski, T., et al. J. Supercrit. Fluids 36, 49–58 (2005). [5] Yang, W., et al. (2018). J. Supercrit. Fluids 135, 254–262. [6] Cantero, D.A. et al.,BioresourceTech. 135 (2013) 697–703

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. M.M. de Souza Ribeiro thanks Junta de Castilla y León for his doctoral grant. Noray Sea Food company is acknowledged for providing molt shells.*