Polypeptides from *Hermetia illucens*: a bio-source for innovative materials in the framework of a circular economy model

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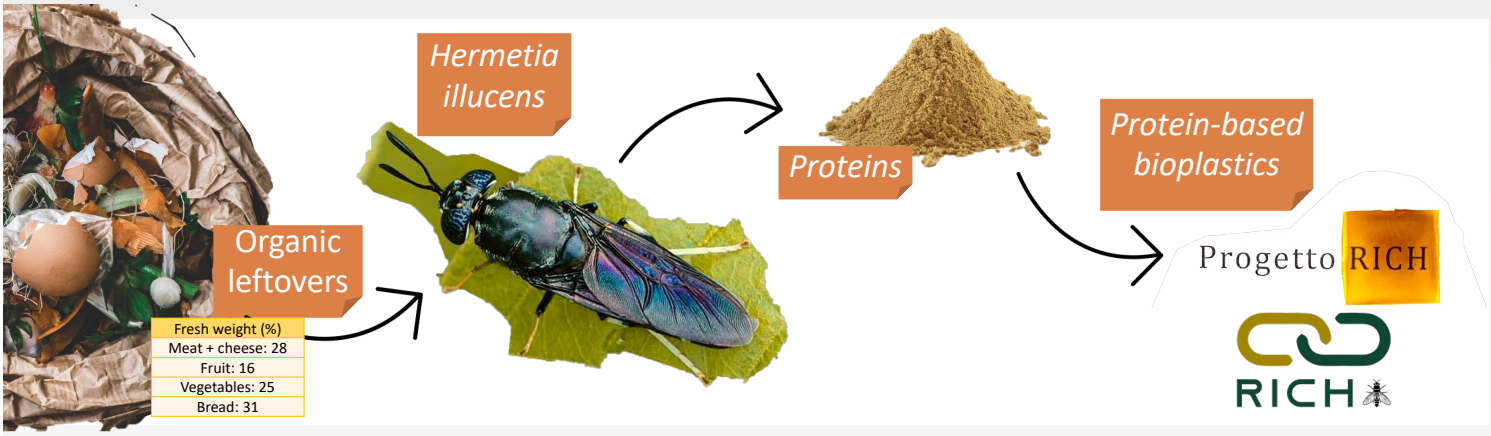


BACKGROUND

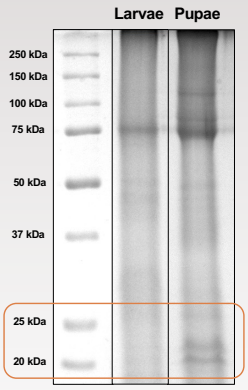
The environmentally sustainable **waste management**, together with waste valorization, is one of the actual challenges pursued by the European Commission[1]. In this scenario, organic waste (OFMSW) valorization is gaining major relevance within **circular economy** models, with **bioconversion** mediated from **insects** being one possible and effective answer to the problem. The **RICH project** investigates the use of the larvae of black soldier fly, ***Hermetia illucens***, to convert low-value organic waste into biomolecules to generate innovative materials. The present study focused on the production and characterization of such materials and their starting extracts

OBJECTIVES

- **Produce bioplastic materials** from polypeptides of the insect *Hermetia illucens* reared on s-OFMSW (surrogate OFMSW), according to state of art procedures[2].
- Gain insights on the involved **macromolecular and supramolecular structures**
- Evaluate the film-forming ability of the **two most fruitful developmental stage** of the insect, namely **Larvae at the 6th** instar and **Pupae** (10% and 16% protein recovery on total weight, respectively).

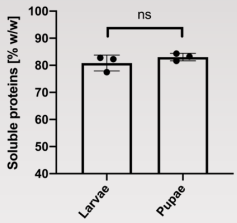
EXTRACTS CHARACTERIZATION

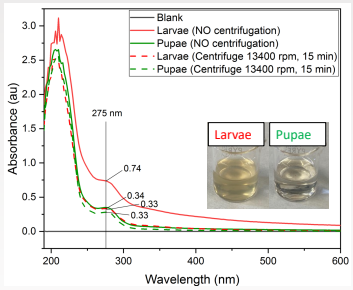
In face of an equal amount of soluble proteins, Larvae extracts are characterized by heavier compounds, which precipitate after centrifugation. SDS-PAGE profiles also highlight the absence of a predominant pool of low MW peptides, unlike Pupae extracts.



SDS-PAGE profiles of solubilized Larvae and Pupae extracts. A presence of a pool of low MW in Pupae extract is visible

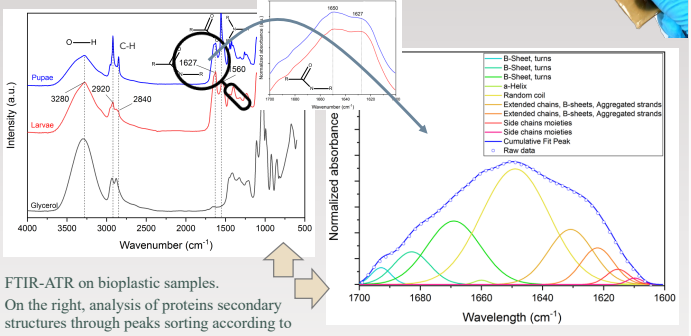
BCA assay reveals an equal amount of proteins in Larvae and Pupae extracts





UV-Visible spectroscopy of Larvae and pupae extracts suspensions in water. Reduction of turbidity in Larvae extract suspension after centrifugation is visible.

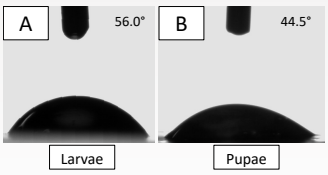
BIOPLASTICS CHARACTERIZATION



FTIR-ATR on bioplastic samples. On the right, analysis of proteins secondary structures through peaks sorting according to Barreto et al.[3]

STRUCTURE	β-sheet, turns	α-helix	Random coil	β-sheet, aggregated	Side chain moieties
[%]	28.98	0.35	46.45	21.59	2.63

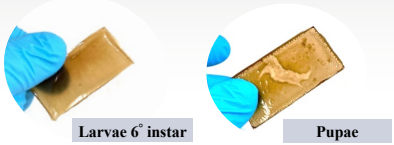
Water contact angle on bioplastic films



Characterization of bioplastics from Larvae and Pupae extracts pointed out a higher extent of H-bonds (3280 cm^{-1}) in films from Larvae, suggesting the presence of a well interconnected supramolecular polypeptide network which also decrease their water uptake. On the other hand, secondary structures are almost the same between the two groups, with a prevalence of random coils for both.

BIOPLASTIC PRODUCTION[2]

PROTEIN DENATURATION pH 10, 80°C (20 min stirring) → **Addition of GLYCEROL** 50% on protein wt. → **SOLVENT CASTING** R.T. 48h



CONCLUSIONS & FUTURE PERSPECTIVES

- The **starting extract is essential** in promoting the formation of a high-quality material. Particularly, extracts from Larvae at the 6th instar led to the best results, giving **robust and elastic films** even after **immersion in water**. **High MWs** and **low steric hindrance** of aminoacids side chains are key factor for the obtainment of a high-quality film.
- Protein-based films from the best extracts display good performances in preliminary tests in view of applications in the **biomedical** and **flexible electronic** fields.

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[3] Barreto, M.S.C., Elzinga, E.J. & Alleoni, L.R.F. The molecular insights into protein adsorption on hematite surface disclosed by in-situ ATR-FTIR/2D-COS study. Sci Rep 10, 13441 (2020)

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