

A circular economy approach to leather by products valorization towards a zero-waste process

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Introduction


- The tanning industry has a significant waste production and is a major contributor to environmental pollution;
- The adoption of circular economy principles will help repurposing by-products with a focus on reutilizing leather remnants^{1,2};
- With this approach, the objective is to minimize environmental damage and effectively manage waste;
- This will contribute to sustainability with a reduction of overall waste and will align with UN sustainability goal 12 (Ensure sustainable consumption and production patterns) through the re-use of byproducts.

Objectives

- Exploration of different enzymes and conditions to enhance leather industry hydrolysis process to achieve a more sustainable and circular approach;
- Creation of versatile functional coatings within the leather industry;
- Utilization of commercial enzyme (Protabate P) and alternative enzymes (Bromelain and Alcalase) to validate its use;
- Valorization of protein-rich leather by-products.

Methods

Leather scraps



Enzymes:

Protabate P

Bromelain

Alcalase

Conditions:

Enzyme percentage: 10%

Temperature: 37 °C

pH: 8 (Protabate P)

7 (Bromelain)

Hydrolysis time: 24 hours

Enzyme percentage: 10%

Temperature: 60° C

pH: 8

Hydrolysis time: 24 hours

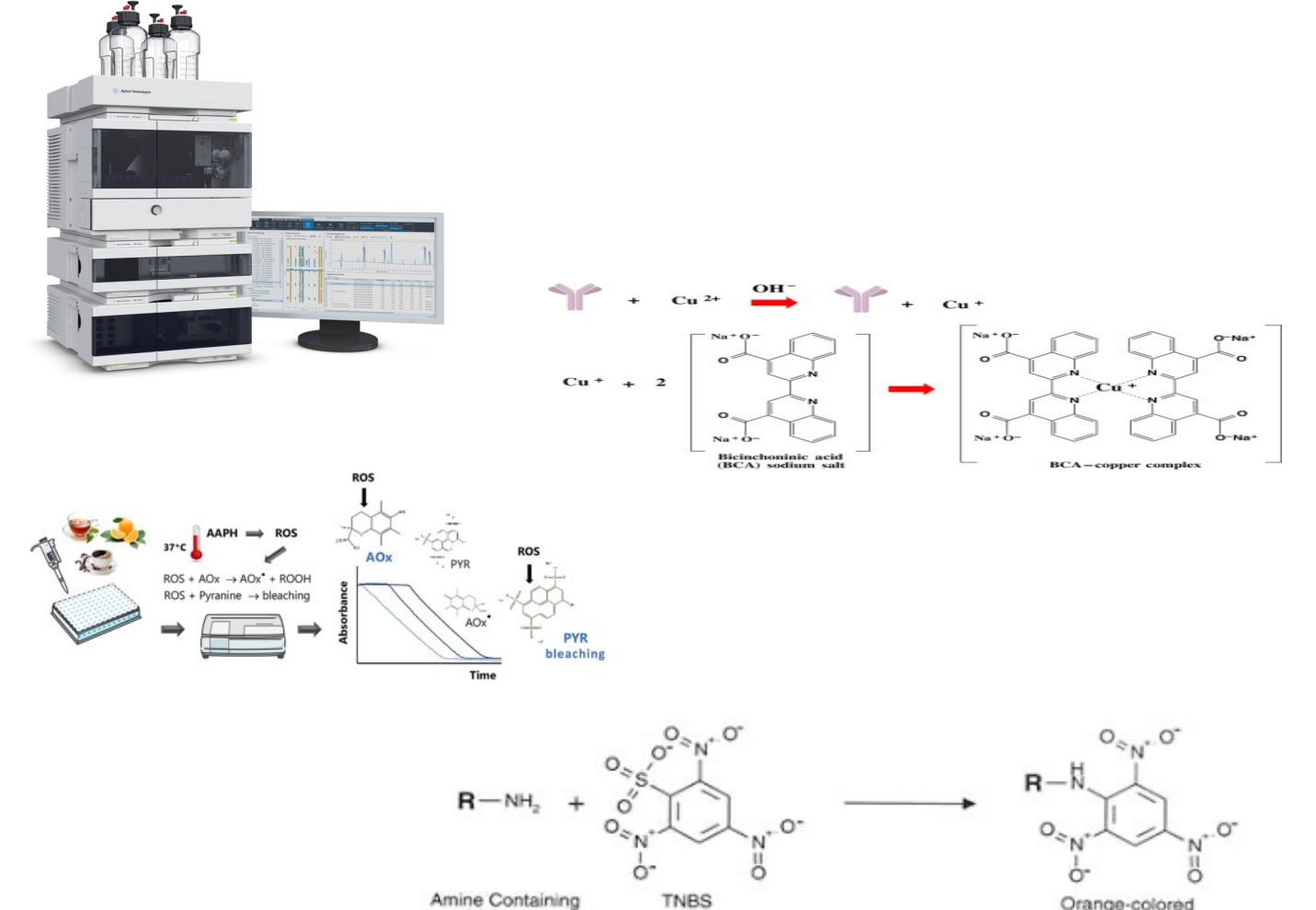
Methodologies:

Peptide size evaluation
Size exclusion (SE-HPLC)³

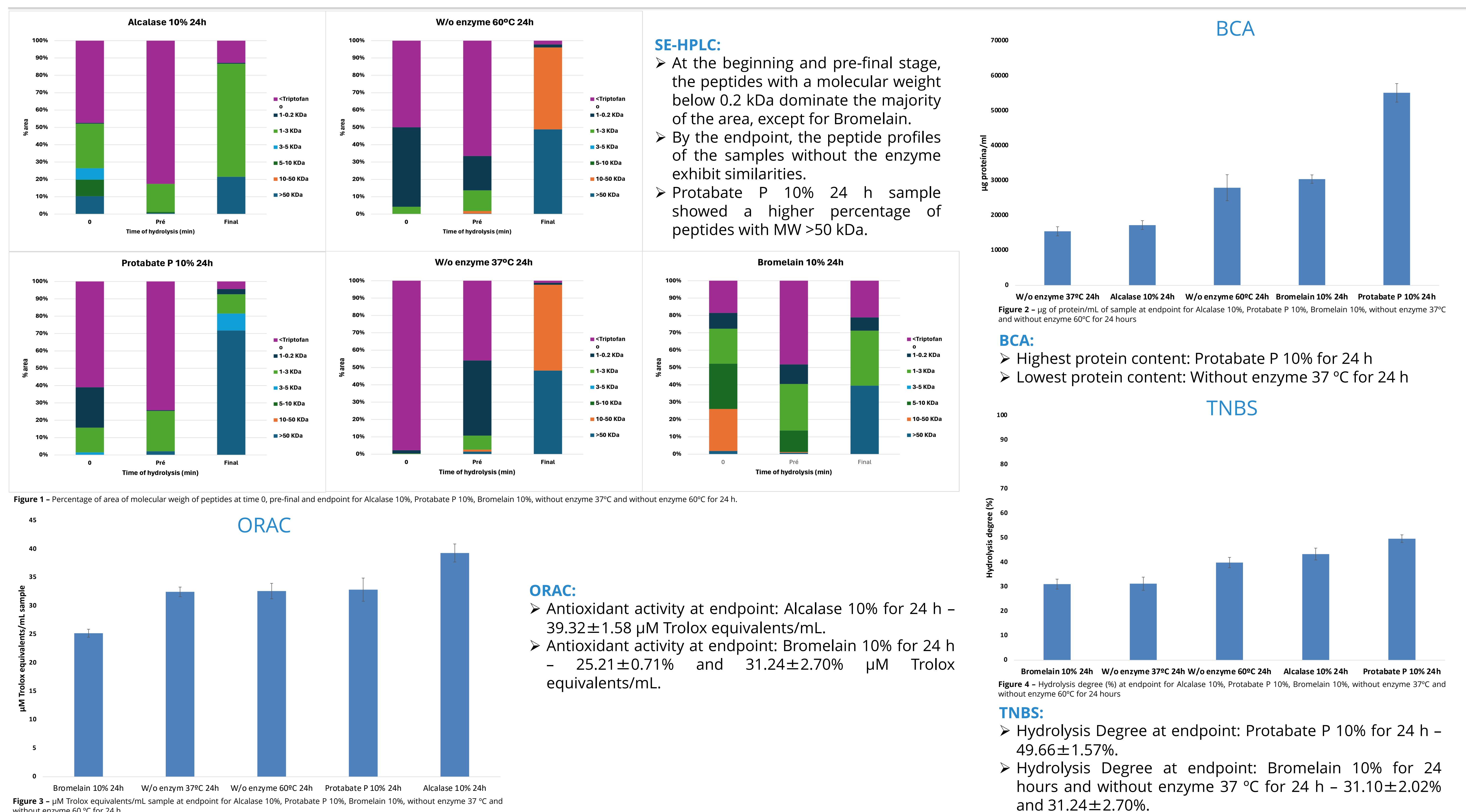
Total protein
BCA method⁴

Antioxidant activity
ORAC method⁴

Hydrolysis Degree
TNBS methodology⁴

Results



Conclusions

- Protabate P 10% 24 h had higher hydrolysis degree (49.66%) and higher total protein (55103.43 µg protein/mL) than all the other enzymes.
- Regarding antioxidant activity, Alcalase 10% 24 h showed higher values (39.32 µM Trolox equivalents/mL).
- Apart from total protein, Bromelain 10% 24 h showed the lowest values for hydrolysis degree and antioxidant activity.
- Between time 0 and pre-final, molecules with MW <0.2 kDa consistently have a higher area.
- Conducting an enzyme inactivation (2 h/90 °C) might result in molecule aggregation, leading to an increase in molecules with MW exceeding 50 kDa.
- Re-using leather byproducts can help the tanning industry to reduce the waste and achieve the UN sustainability goal nr 12.
- This study outlines the potential of re-using leather by-products to create versatile functional coatings through a circular and more sustainable process.

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