Enzymatic Synthesis of Tannin-Chitosan-Based Biopolymer Films for Innovative and Sustainable Active Food Packaging

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INTRODUCTION

Bio-based polymers offer a promising and sustainable alternative to synthetic polymers

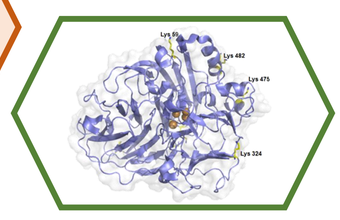
Tannins are polyphenols with the potential to replace fossil-based materials

Enzymatic polymerization with oxidative enzymes, such as laccases, stands out as a "green" strategy for obtaining polymers

Tannin extraction treatments influence enzymatic polymerization efficiency

Copolymerization of tannins with chitosan allows modification of the polymer mechanical properties

The objective of this work was to synthesize chitosan-tannin biofilms with potential applications in food packaging



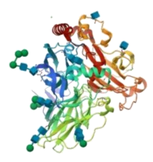
METHODOLOGY

Characterization of tannins

- Proximate and ultimate analysis
- Elemental analysis
- Thermogravimetric analysis (TGA)
- Infrared analysis (FT-IR)
- Micropyrolysis coupled to gas chromatography with mass spectrometry (PY-GC/MS)

Purification and characterization of the enzyme

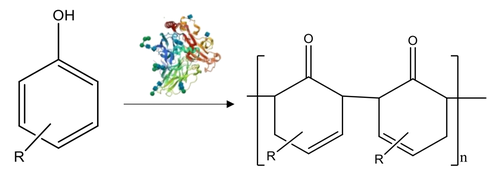
- Activity at different pH and temperature
- Protein concentration
- Electrophoresis
- Purification



Enzymatic polymerization

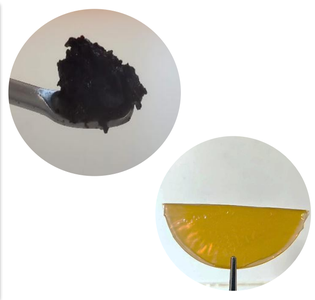
- Viscosity
- Phenol content
- Chitosan

1 h a 40 °C



Polymer Characterization

- Thermogravimetric analysis (TGA)
- Mid-infrared analysis (FT-IR)
- Micropyrolysis coupled to gas chromatography with mass spectrometry (PY-GC/MS)
- Antioxidant properties
- Photoprotective capacity
- Water solubility test
- Scanning Electron Microscope (SEM)



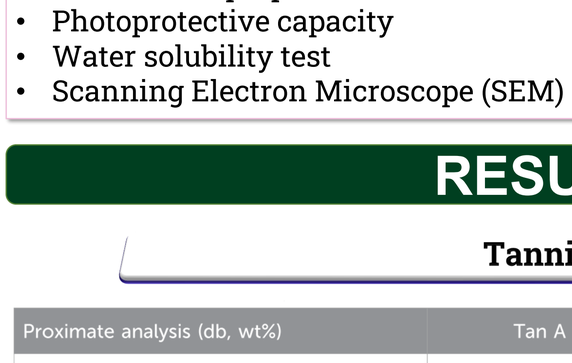
RESULTS

Tannins

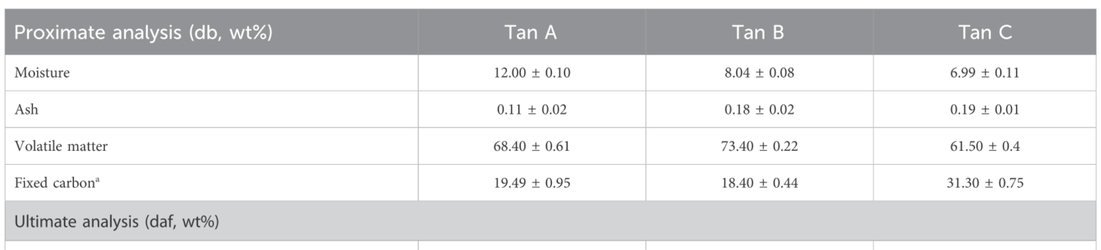
Proximate analysis (db, wt%)	Tan A	Tan B	Tan C
Moisture	12.00 ± 0.10	8.04 ± 0.08	6.99 ± 0.11
Ash	0.11 ± 0.02	0.18 ± 0.02	0.19 ± 0.01
Volatile matter	68.40 ± 0.61	73.40 ± 0.22	61.50 ± 0.4
Fixed carbon[a]	19.49 ± 0.95	18.40 ± 0.44	31.30 ± 0.75
Ultimate analysis (daf, wt%)			
C	46.3 ± 0.1	44.9 ± 0.1	52.8 ± 0.3
H	4.64 ± 0.06	4.27 ± 0.19	5.41 ± 0.01
N	0.408 ± 0.019	0.326 ± 0.004	0.190 ± 0.033
O[a]	48.7 ± 0.2	50.5 ± 0.6	41.6 ± 0.8

[a]By difference; db, dry basis; daf, dry and ash-free.

PY-GC/MS



TGA



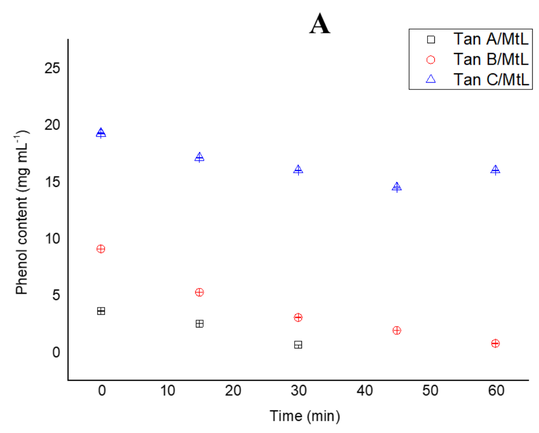
ACKNOWLEDGEMENTS

The authors thank the Project FONDECYT N°11251670

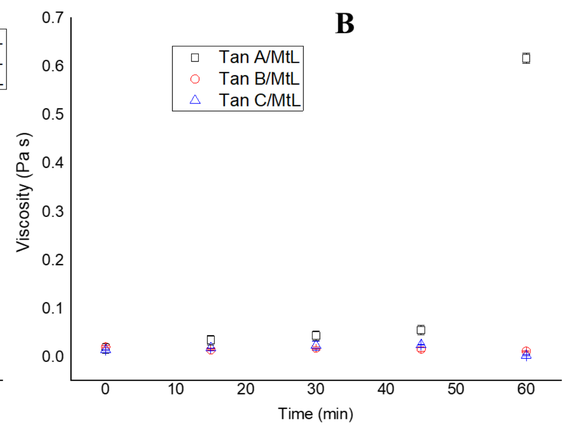
RESULTS

Enzyme Polymerization

Phenol content

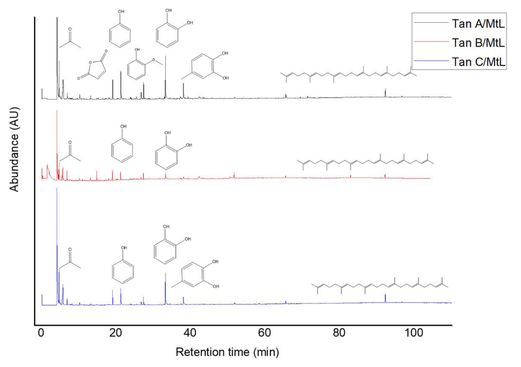


Viscosity

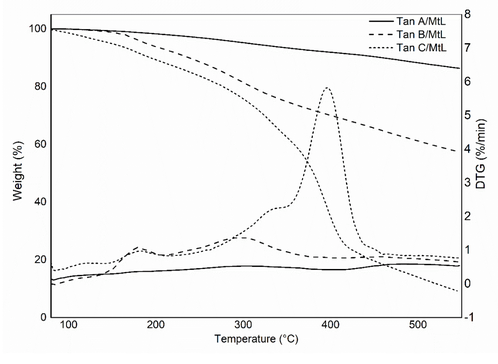


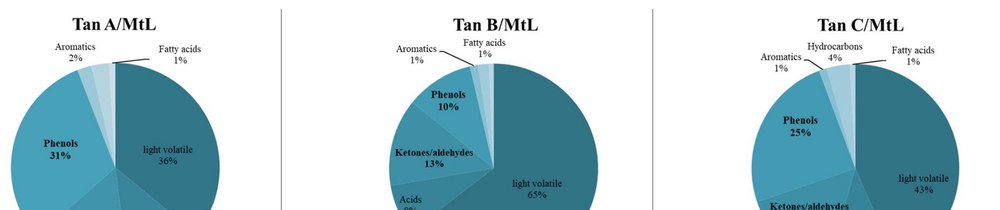
Tannin polymers

PY-GC/MS

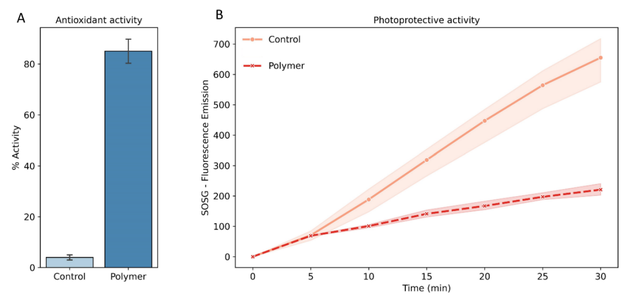


TGA





Antioxidant and photoprotective capacity



Water solubility

Tannin-chitosan films

UV-Protection

SEM

CONCLUSIONS

The enzymatic polymerization of tannins and the properties of the resulting polymers were evaluated, demonstrating improved thermal stability along with antioxidant and photoprotective properties. The tannin with the highest polymerization tendency was copolymerized with chitosan, yielding films with mechanical stability, UV protection, and low water absorption capacity. These materials show potential for application in food packaging.

REFERENCES

M. Vera, et al. Journal of Applied Polymer Science, 141, 22 (2024).
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