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REINFORCING EFFECT OF DIALDEHYDE NANOFIBRILLATED CELLULOSE ON MULTIFUNCTIONAL GELATIN PLASTICS PRODUCED BY CONTINUOUS SOLUTION CASTING

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INTRODUCTION

Multifunctional packaging based on renewable polymers has emerged as an eco-friendly alternative to conventional plastics by combining biodegradability with antioxidant and antimicrobial functions [1,2].

Gelatin is a promising matrix due to its excellent film-forming ability and renewable nature [3].

Gelatin films' **hydrophilicity** limits their performance, requiring reinforcement strategies.

MAJOR ISSUE

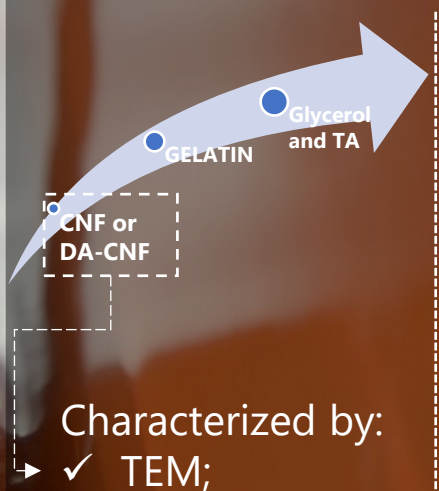
TECHNOLOGICAL OVERCOMING

Use of surface-modified **cellulose nanofibrils (CNF)** as reinforcing agents.

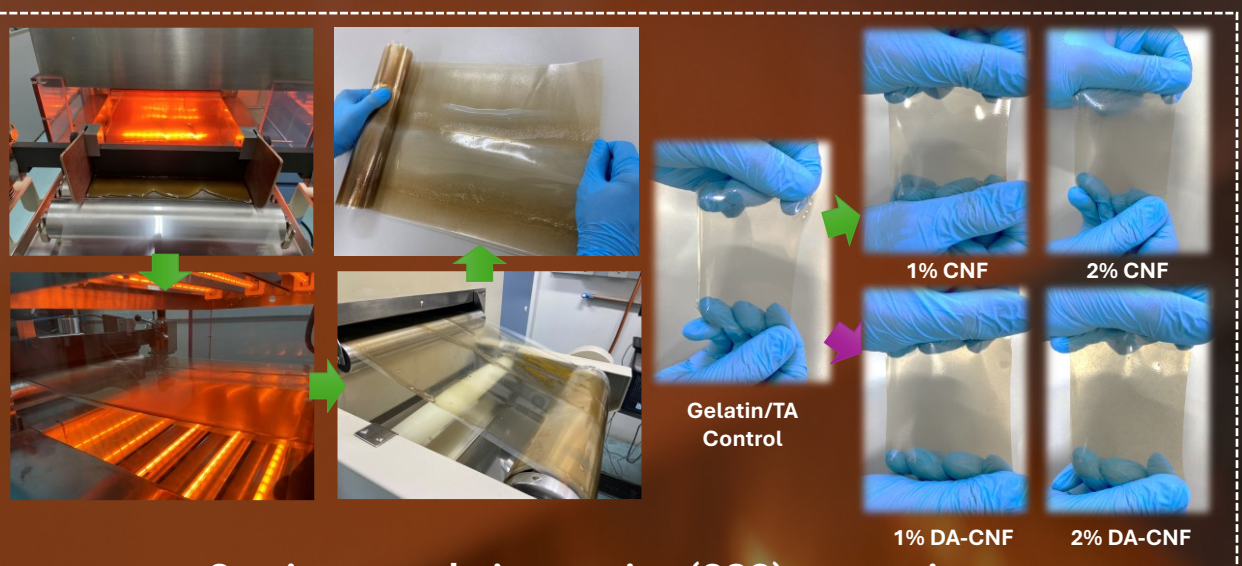
OBJECTIVE

CNF was chemically oxidized using $NaIO_4$ to produce dialdehyde nanofibrillated cellulose (DA-CNF) to improve compatibility with gelatin and tannic acid (TA) -based films.

MATERIALS AND METHODS



Characterized by:
- ✓ TEM;
- ✓ FTIR;



Continuous solution casting (CSC) processing

Samples:

Control – Gelatin/TA/glycerol film.

Gelatin/TA/glycerol films containing 1 and 2% CNF.

Gelatin/TA/glycerol films containing 1 and 2% DA-CNF.

Properties assessed:
- ✓ Tensile properties;
- ✓ Water uptake;
- ✓ WVP.

RESULTS AND DISCUSSION

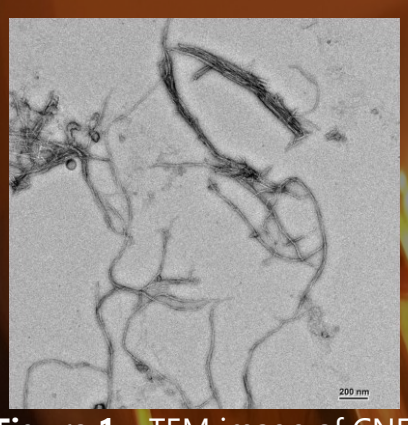


Figure 1 – TEM image of CNF.

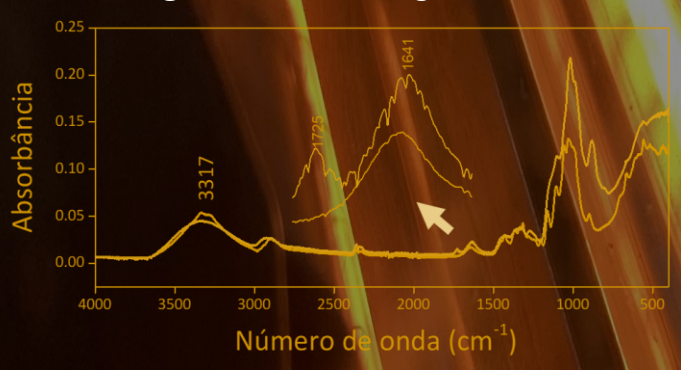


Figure 2 – FTIR spectra of CNF and DA-CNF.

Table 1 – Mechanical properties - tensile strength (σ_T), elongation at break (ε_b) and elastic modulus (E), water absorption (W_{uptake}) and water vapor permeability (WVP) of gelatin/TA/CNF and gelatin/TA/DA-CNF bionanocomposites.

Film	σ_T (MPa)	ε_b (%)	E (MPa)	W_{uptake} (%)	WVP (g H_2O $Pa^{-1}s^{-1}$ m^{-1})
Gelatin/TA (control)	0.9 ± 0.5	31 ± 15	74 ± 16	n.d.*	$8.4 \pm 0.8 \times 10^{-6}$
Gelatin/TA/CNF1%	1.7 ± 0.2	82 ± 12	39 ± 10	383 ± 55	$3.6 \pm 0.1 \times 10^{-6}$
Gelatin/TA/CNF2%	3.1 ± 0.3	39 ± 7	76 ± 29	399 ± 05	$2.6 \pm 0.7 \times 10^{-6}$
Gelatin/TA/DA-NFC1%	2.3 ± 0.2	71 ± 11	80 ± 18	326 ± 48	$5.0 \pm 0.3 \times 10^{-6}$
Gelatin/TA/DA-CNF2%	3.5 ± 0.3	64 ± 27	86 ± 5	357 ± 44	$1.6 \pm 0.2 \times 10^{-6}$

- ➢ Both CNF and DA-CNF promoted improvements in the physical performance of the gelatin/TA films.
- ➢ DA-CNF showed slightly better compatibility with the gelatin matrix and reduced water uptake compared to unmodified CNF.

CONCLUSIONS

The incorporation of CNF and especially DA-CNF proved effective for improving the performance of multifunctional gelatin films. These results demonstrate the strong potential of DA-CNF-reinforced gelatin bioplastics for sustainable food packaging applications with antioxidant functionality and improved barrier properties. Future studies will further explore the antimicrobial activity associated with aldehyde-functionalized nanocellulose and its synergistic effects with tannic acid.

REFERENCES

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