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# TRANSFORMING FOOD PROCESSING BYPRODUCTS INTO SUSTAINABLE BIOPLASTICS AND THEIR PROPERTIES

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## INTRODUCTION

**Our planet is seriously polluted with plastics**. 7 billion of the 9.2 billion tons of plastic produced from 1950-2017 ended up in landfills or dumped. We need new **biodegradable and bio-based alternatives.**

**Plant biomass** is the most abundant organic resource on Earth, and the industrial sector that produces materials depends mainly on it to move to a **circular economy**.

**Vegetable residues** are a significant part of plant biomass that does **not compete with food** or forage crops in terms of production land and resources.

In particular, those that are **inedible** by-products of the industrial processing of plant biomass, are **easily recoverable and potentially reusable.**

## OBJECTIVES

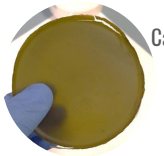
- ✓ Study the effect of the **alkaline medium** to deconstruct vegetable waste biomass for the production of regenerated-biomass **bioplastic composites**.
- ✓ **Assessment of the benefits obtained** when **compared** to the already published hydrolysis in **acid media.**

## METHODOLOGY

**Spinach stems (SS)**
✓ 35% cellulose
✓ 16% hemicellulose, and
✓ 35% pectin
**Dried and grinded to powder**

Hydrolyzed in:
✓ 1 M **acetic acid**, or
✓ 1 M **ammonium hydroxide**
at 30 °C for 24 h.

Casting

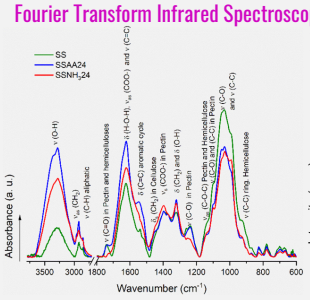


Alkali-hydrolyzed SS

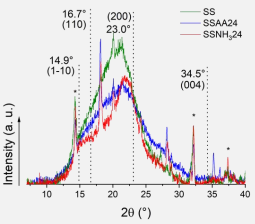
Acid-hydrolyzed SS

## RESULTS & DISCUSSION

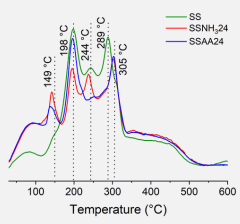
### Fourier Transform Infrared Spectroscopy



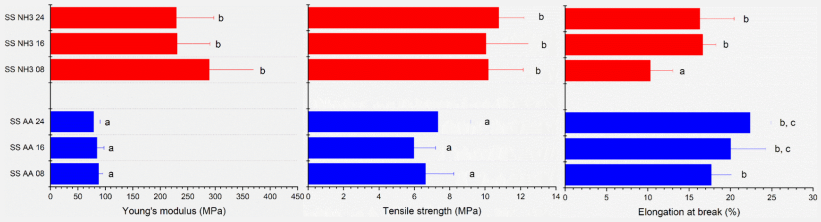

### X-Ray Diffraction



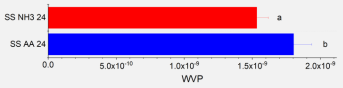

### Thermogravimetric analysis



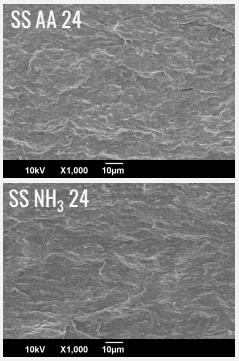

### Mechanical properties



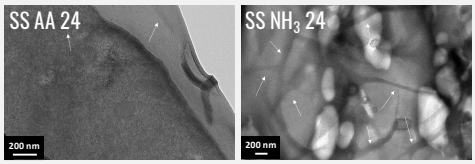

### Water vapor permeability



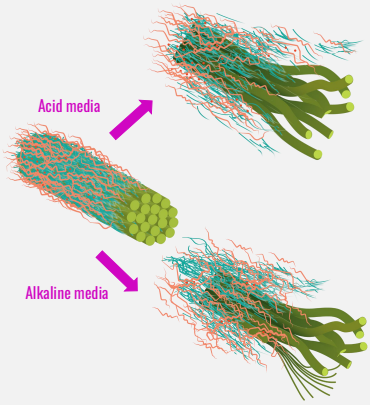

### SEM




### TEM




### In summary...




✓Preferential hydrolysis of hemicellulose rather than pectin followed by sugars degradation/oxidation.
✓Partial de-esterification of methoxyl and acetyl groups.
✓More susceptible to oxidative reactions (films with darker color)
✓Partial cellulose microfibrillation.
✓Polymorph I not affected.

✓Superior hydrolysis of pectin and hemicellulose followed by sugars degradation/oxidation.
✓Saponification of methoxyl groups of pectin and O-acetyl groups of hemicellulose.
✓Cellulose micro/nanofibrillation.
✓Polymorph I not affected.

## CONCLUSIONS

Alkaline hydrolysis carried out in aqueous ammonia led to cellulose nanofibrillation as a consequence of a more efficient hydrolysis of other cellular components such as pectin and hemicellulose. Cellulose microfibers were released after hydrolysis in acetic acid and aqueous ammonia, but alkali media also produced the nanofibrillation of cellulose, which positively affected the mechanical and barrier properties of SS bioplastics.

## ACKNOWLEDGEMENTS

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