Chitosan-based films with incorporated plant extracts with antioxidative and antimicrobial properties

Folije za živila iz hitozana z dodanimi rastlinskimi ekstrakti z antioksidativnimi in antimikrobnimi lastnostmi

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BIOAPP
Pieces of nature

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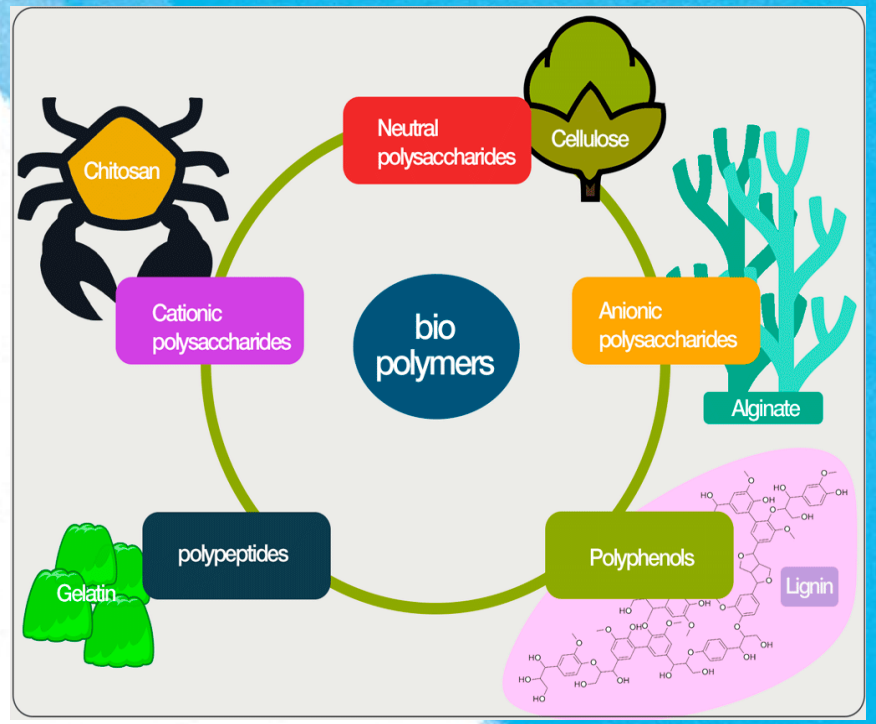
INTRODUCTION

Project consortium



- **Water soluble**
- **Biocompatible**
- **Non-antigenic**
- **Non-toxic**
- **Biofunctional**
- **Antimicrobial**
- **Biodegradable**
- **Edible**

INTRODUCTION

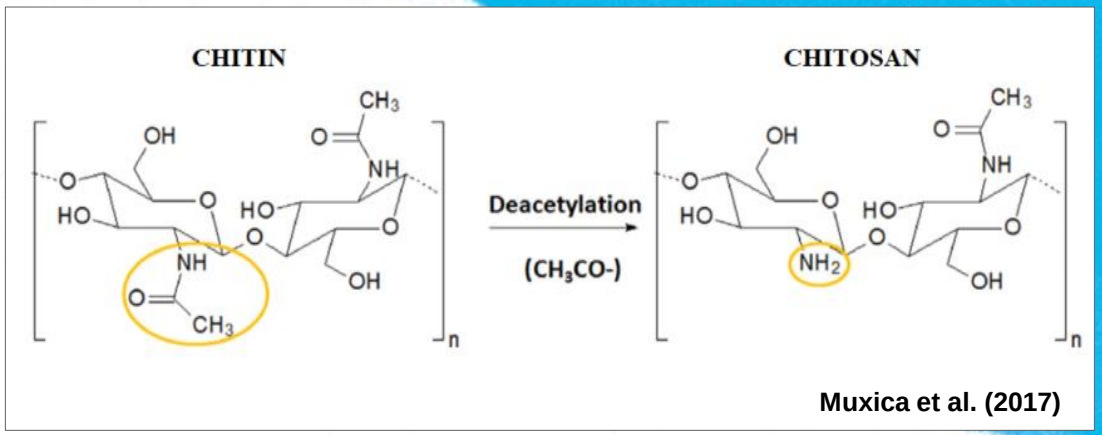
- **Accumulation of synthetic plastics:**
  → serious environmental problem
  → waste mainly from food packaging for single use

- **Trends towards the use of renewable, abundant and low-cost biobased materials to replace the synthetic packaging:**
  → predictions: 20% of the total polymer market by 2020

- **Active food packagings:**
  → incorporation of bioactive components
  → antimicrobial and antioxidant properties
  → extended quality and shelf life of perishable food

- **Chitosan:**
  → derived from naturally renewable chitin
  → non-toxic and biocompatible poylmer

Image: WMW magazine



Muxica et al. (2017)

- **Aim:**
  → preparation and evaluation of chitosan-based films incorporated with different extracts

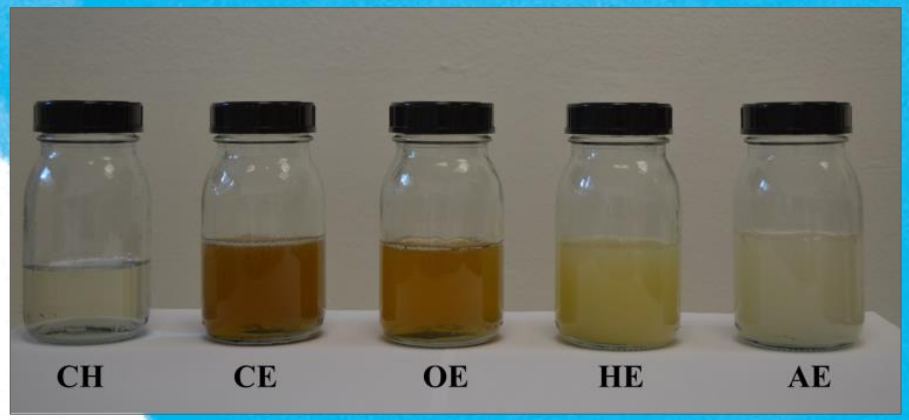
Muxika, A., Etxabide, A., Uranga, J., Guerrero, P., & de la Caba, K. (2017). Chitosan as a bioactive polymer: processing, properties and applications. International journal of biological macromolecules.

PREPARATION OF CHITOSAN-BASED FILMS

chitosan in aqueous solution of lactic acid
+
glycerol (plasticizer)
+
extracts

Homogenization

Vacuum-filtration



Casting

Drying

FILMS PRELIMINARY CHARACTERIZATION

- Critical property for the film application UV light blockage and consumer acceptance
- Evaluated throughout transmittance of the samples in UV and visible spectrum (λ = 250 – 800 nm)

- UV spectrum:

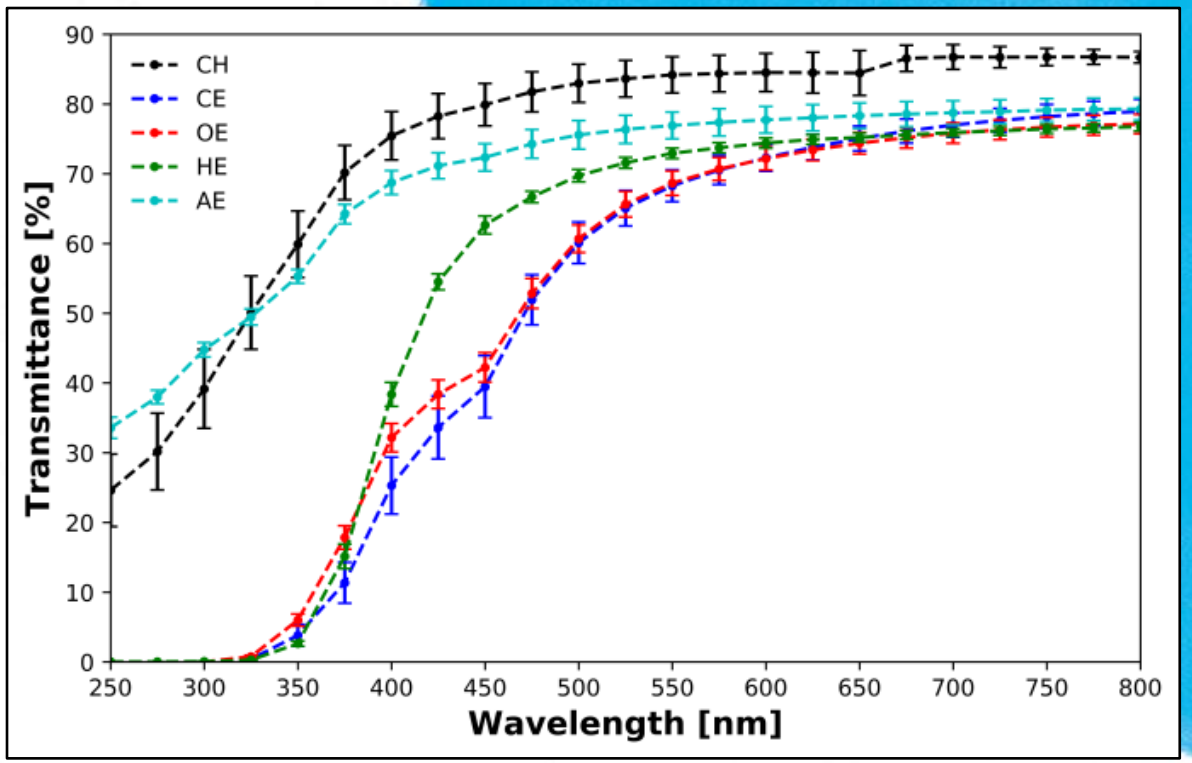
  CH and AE → up to 65%

  CE, OE and HE → up to 20%

- Visible spectrum:

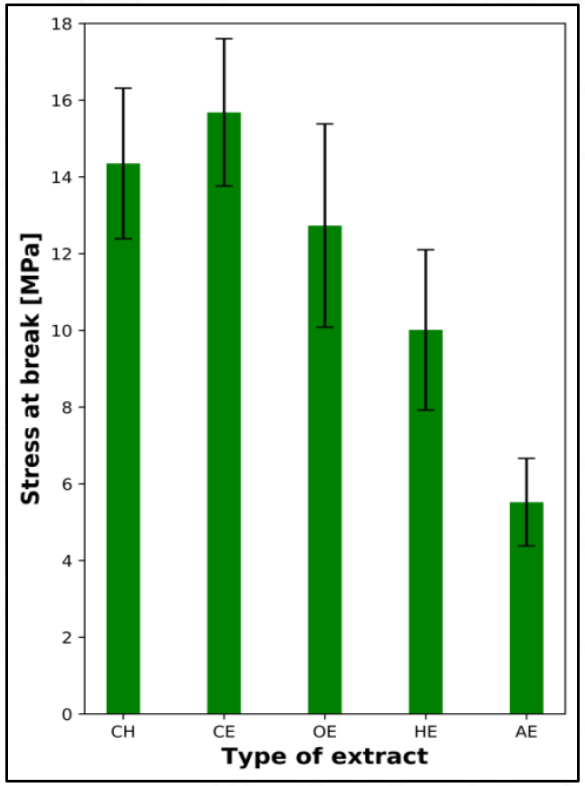
  CH → up to 85%

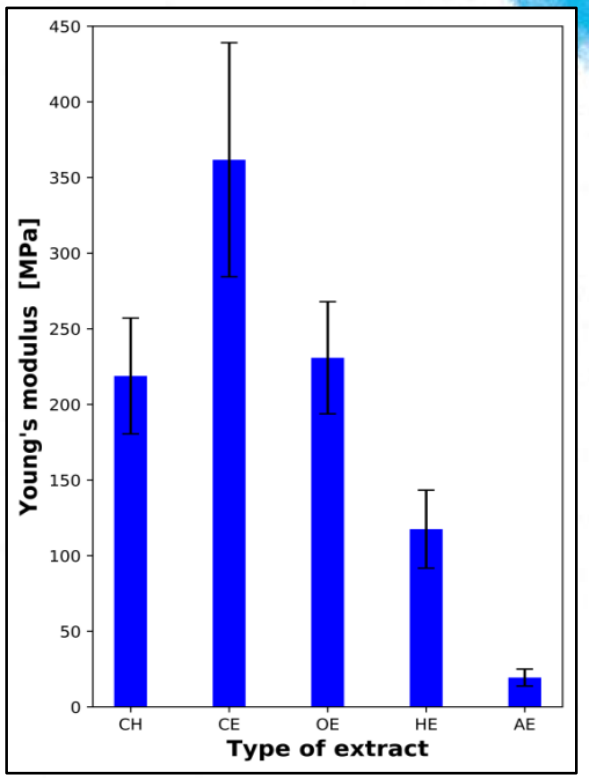
  CE, OE, HE and AE → ~70%

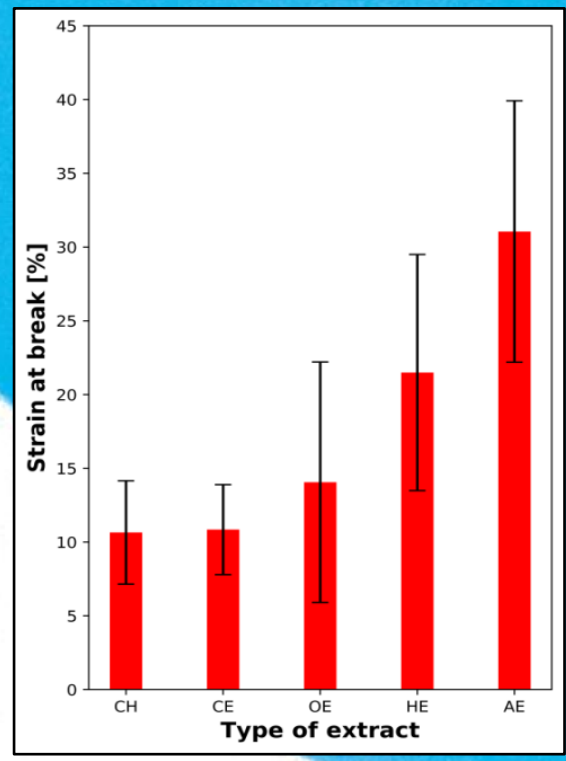


FILMS PRELIMINARY CHARACTERIZATION

- **Ideal films → adequate mechanical properties → depend on polymer amount, presence of exogenous components, and preparation technique**



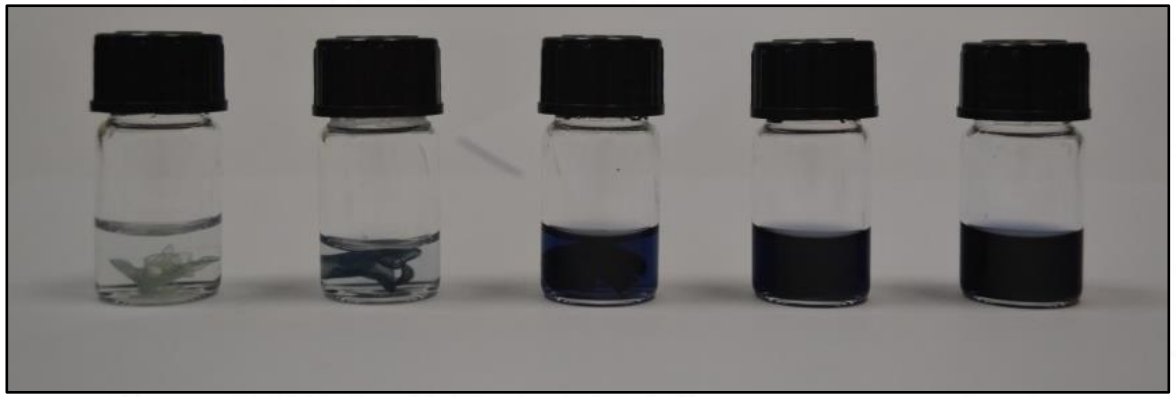




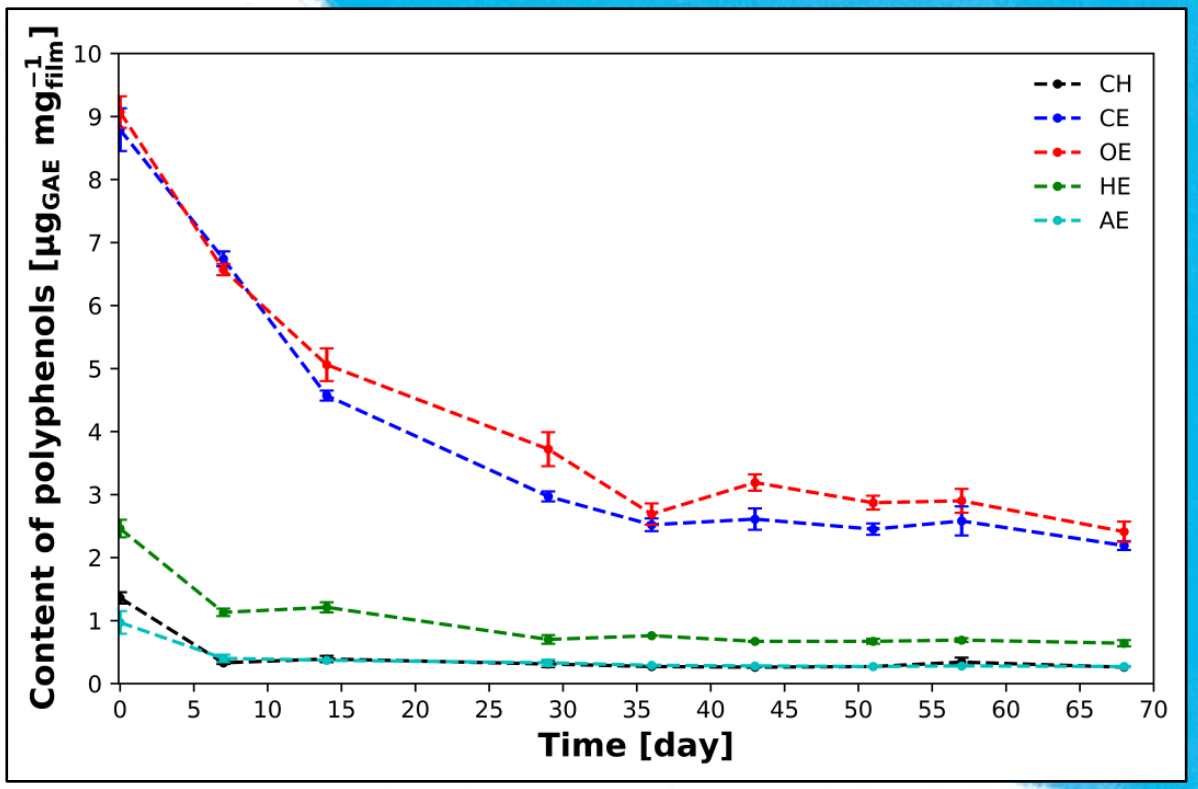
- **stress at break (cca. 16 MPa) and Young‘s modulus (cca. 360 MPa)**
- **strain at break → up to 32%**

FILMS PRELIMINARY CHARACTERIZATION

- Crude estimation of the total phenolic content in the chitosan-based films
- After the color development, the absorbance of the solution was measured at λ = 765 nm

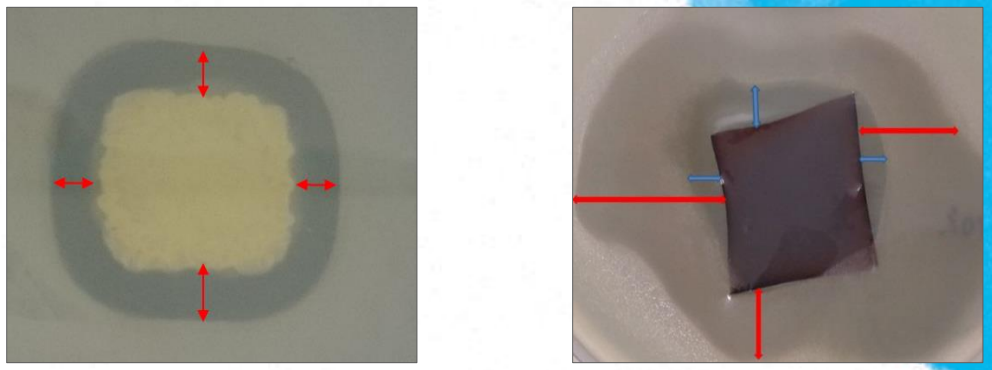


- From 1 to 9 $\mu g_{GAE}\ mg_{film}^{-1}$



FILMS PRELIMINARY CHARACTERIZATION

- *Escherichia coli* (Gram-negative) and *Bacillus subtilis* (Gram-positive)



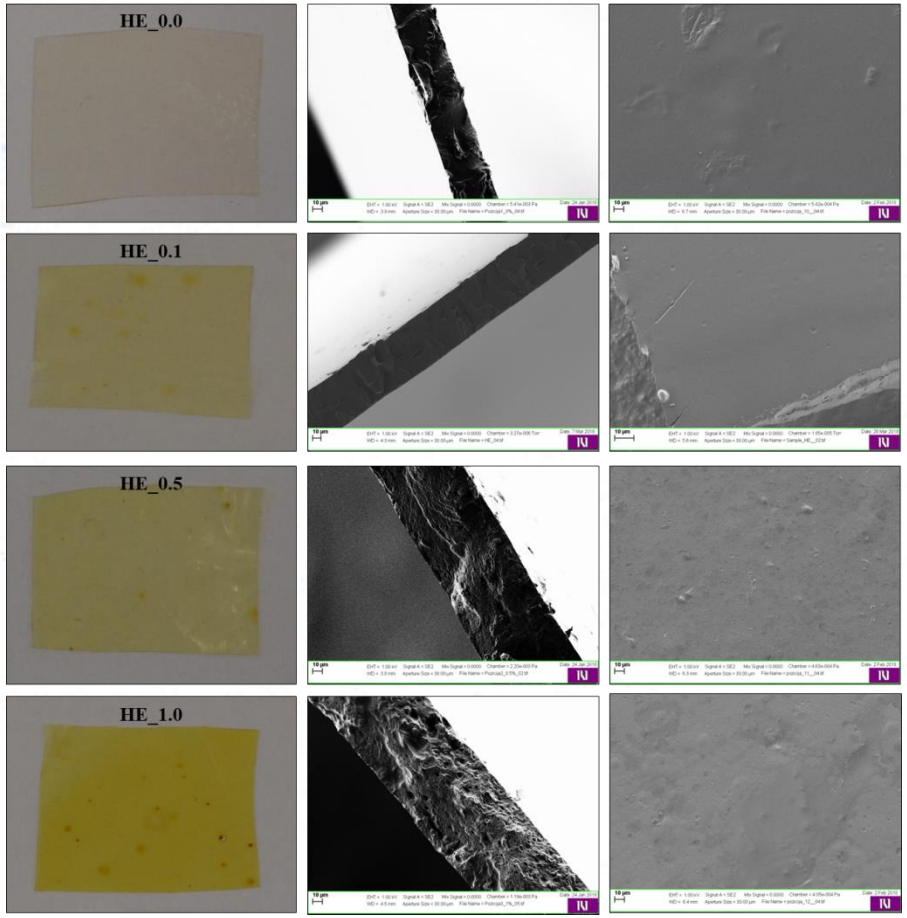
Visual presentation of clear and partially clear zones around the film

Escherichia coli → highly resistant

Bacillus subtilis → sensitive to HE, CE, and OE

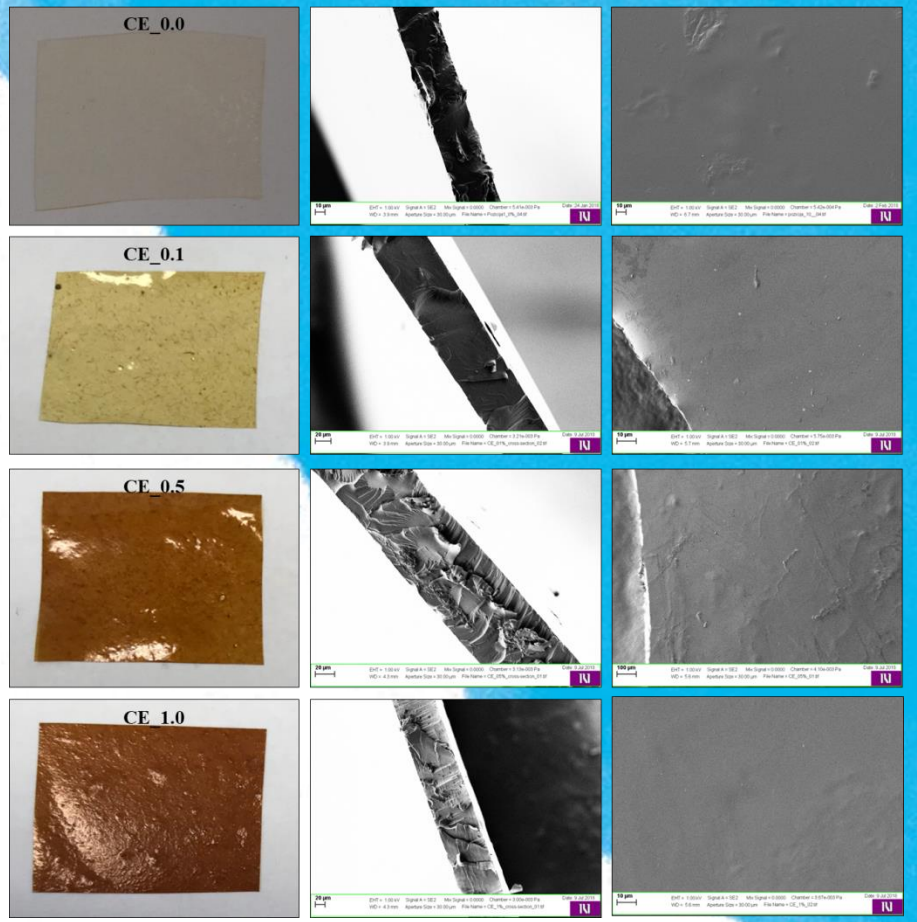
FILMS WITH EXTRACT

HE



- Thickness: 48 – 95 µm
- Density: 1.3 – 2.6 g cm^{-3}

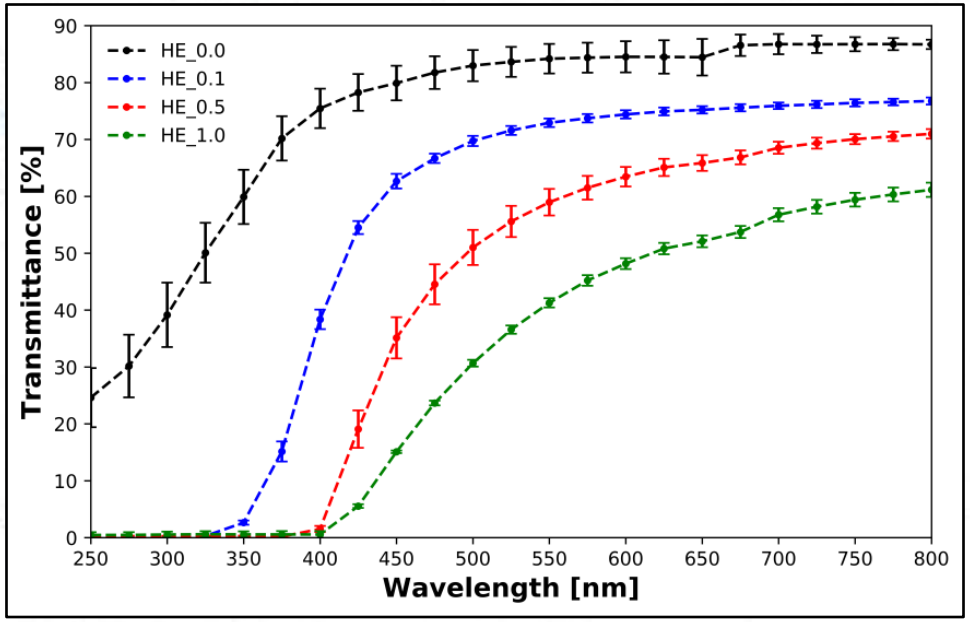
CE

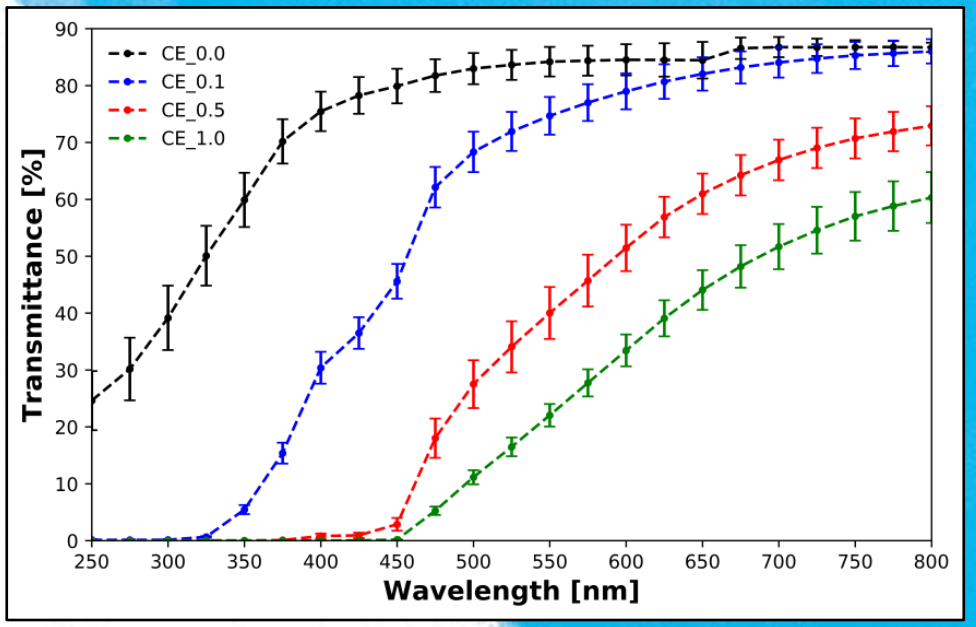


- Thickness: 67 – 86 µm
- Density: 1.5 – 1.8 g cm^{-3}

FILMS WITH EXTRACTS

HE ⟷ CE



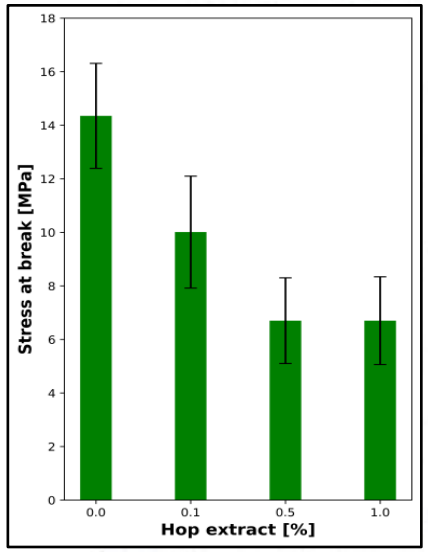


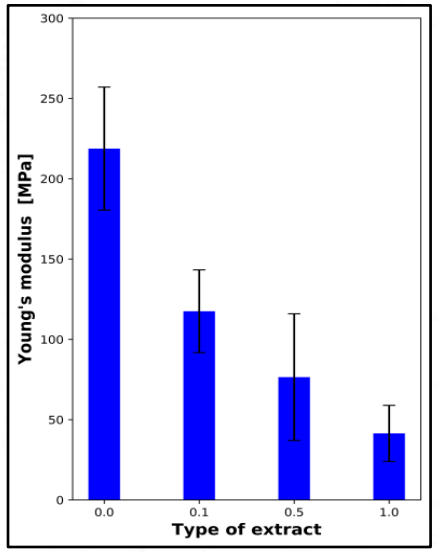
- **UV spectrum:**
  - → **HE_0.0 → up to 70%**
  - → **HE_0.1 → up to 40%**
  - → **HE_0.5 and HE_1.0 → no transmittance**
- **Visible spectrum:**
  - → **increasing HE → transmittance decreasing**

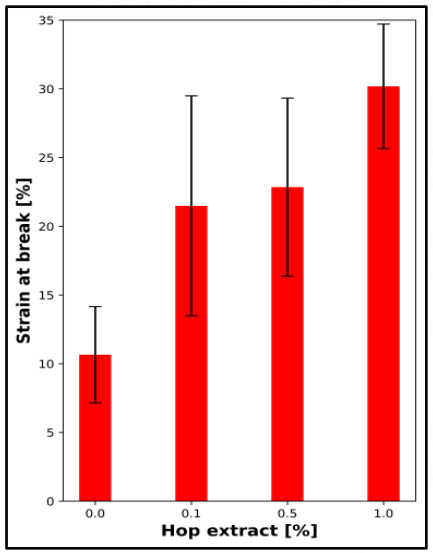
- **UV spectrum:**
  - → **CE_0.0 → up to 70%**
  - → **CE_0.1 → up to 25%**
  - → **CE_0.5 and CE_1.0 → no transmittance**
- **Visible spectrum:**
  - → **increasing CE → transmittance decreasing**

FILMS WITH EXTRACTS

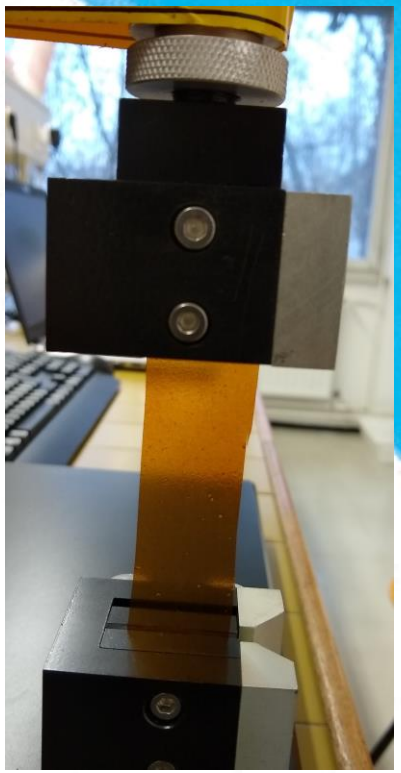
HE ⟷ CE







- **Stress at break → HE_0.0**
- **Young‘s mod. → HE_0.0**
- **Strain at break → HE_1.0**



Process of the film testing

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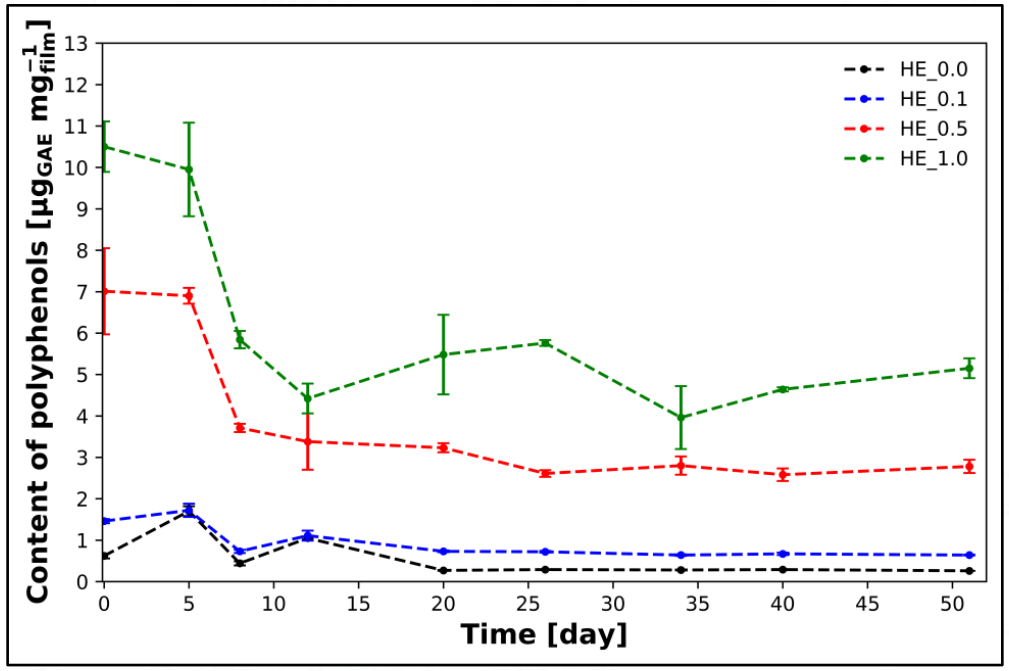
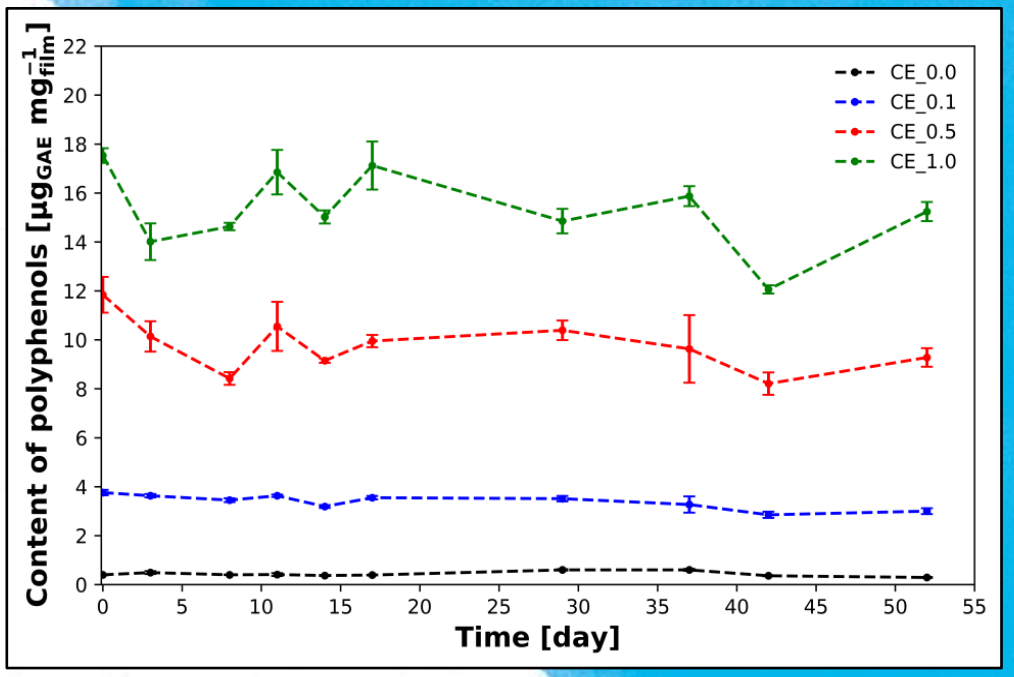
FILMS WITH EXTRACTS

HE ⟷ CE



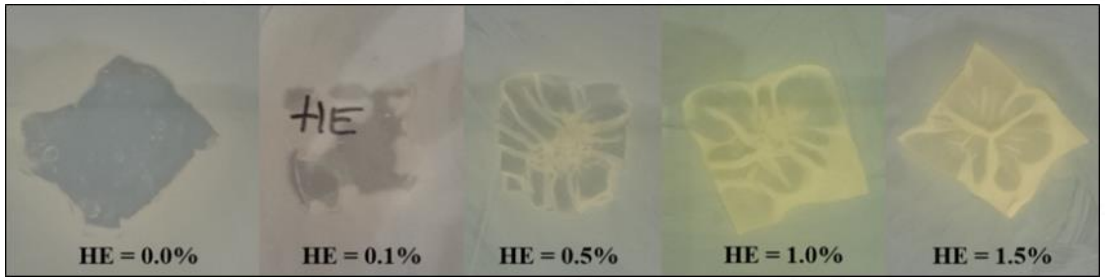


- **Up to 11 μg_{GAE} mg_{film}^{-1}**
- **Increase of total polyphenols with increasing HE**
- **Decrease of polyphenols after 8 days of storage**

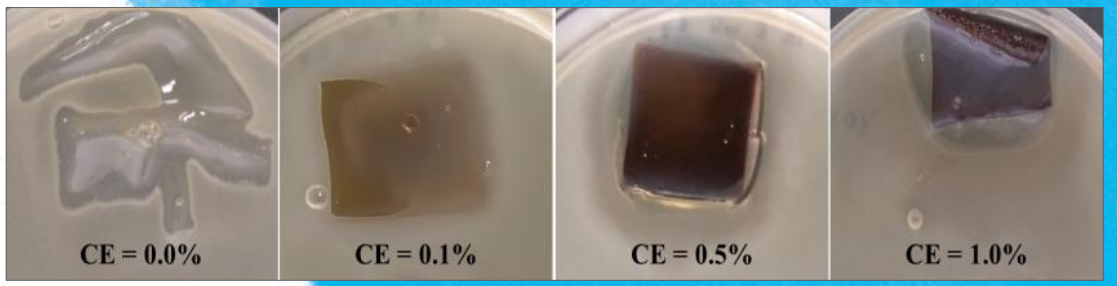
- **Up to 18 μg_{GAE} mg_{film}^{-1}**
- **Increase of total polyphenols with increasing CE**
- **No decrease of polyphenols during the storage**

FILMS WITH EXTRACTS

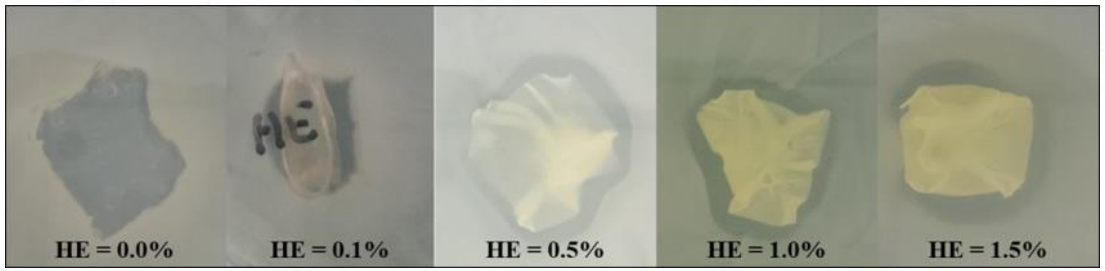
HE ⟵ ⟶ CE



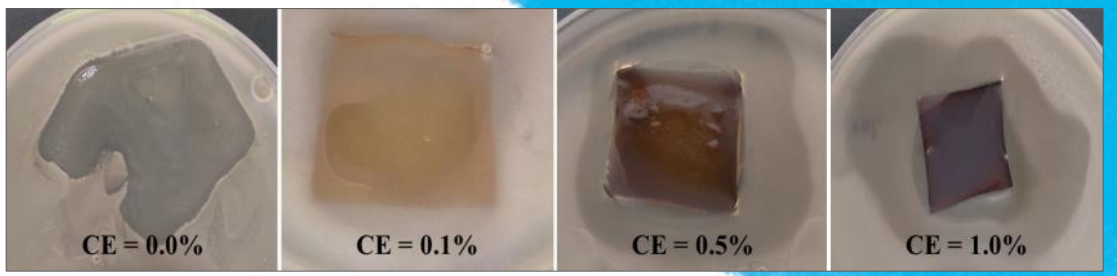
E. coli → **resistant to HE**



E. coli → **sensitive to CE → up to 18 mm inhibition zone**



B. subtilis → **sensitive to HE → up to 2.9 mm inhibition zone**



B. subtilis → **sensitive to CE → up to 16 mm inhibition zone**

CONCLUSIONS

- **The chitosan-based films with the addition of different extracts were successfully prepared and characterized regarding physical, mechanical, antioxidant and antimicrobial properties**

- **The incorporation of extracts affected:**
  - **→ water-related properties**
  - **→ optical properties**
  - **→ antioxidant capabilities**
  - **→ antimicrobial properties**

Scale-up of films production

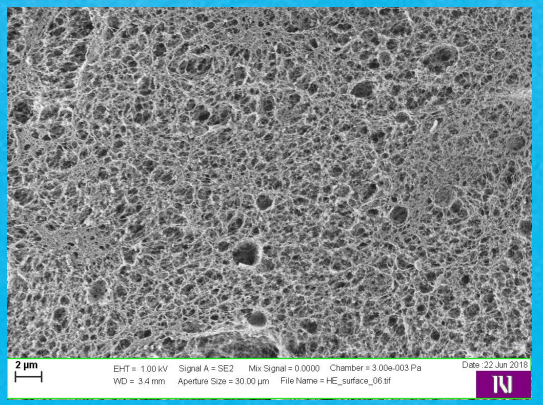
- **Excellent overall potential for food shelf life extension**

- **High potential for further development and scale-up**

OTHER APPLICATIONS

Water-solubile pods

Fluid gels



Aerogels

Product packaging design

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THANK YOU FOR YOUR ATTENTION!

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