# The potential of agrofood byproducts to develop sustainable bioplastic packaging materials by blown extrusion

Paulo Brites[1], Amparo López-Rubio[2], Idalina Gonçalves[1], J. M. Oliveira[3]

[1]*CICECO – Aveiro Institute of Materials, Department of Materials and Ceramic Engineering, University of Aveiro, 3810-193, Aveiro, Portugal*
[2]*IATA-CSIC – Institute of Agrochemistry and Food Technology, 46980 Paterna, Valencia, Spain*
[3]*ESAN – Escola Superior Aveiro Norte, University of Aveiro, 3830-193, Aveiro, Portugal*

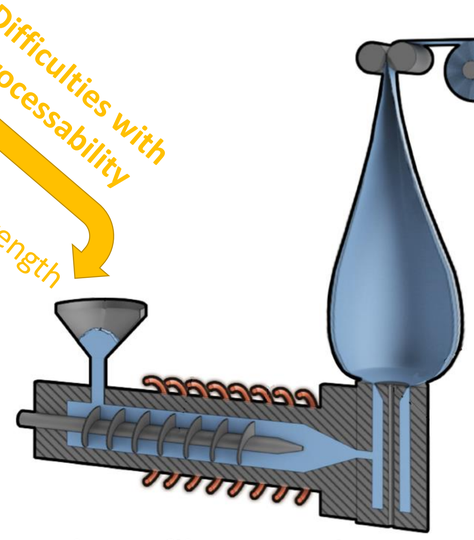
E-mail: paulodavid@ua.pt

## Framework

**Commercially available starch**

- Renewable
- 100% Biodegradable
- Film-forming ability (enabled by plasticizers addition)
- Competition with food industry

Difficulties with processability
- Low MFI
- Low melt strength
- Low thermal stability



**Blown film extrusion**
- Widely used for plastic packaging production

**Brittle** and **water sensitive** materials

## Objective

➢ Development of **sustainable** and **biodegradable starch-based formulations** compatible with **blown film extrusion** for **bioplastic packaging production**

## Hypothesis

Potato and rice industry byproducts

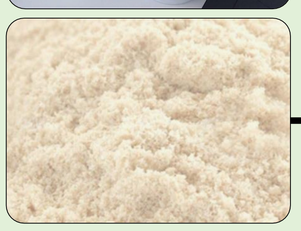



- To enhance the thermoplastic starch (TPS) processability
- To enhance the TPS-based films performance

**Competitive TPS packaging produced through blown extrusion**

## Research methods and techniques

**1. Fractionation and characterization of potato/rice byproducts**


Wet sieving, Spray-drying

**Starch**
- GC-FID;GC-MS
- GPC
- DSC
- XRD
- SEM

Wet sieving, Spray-drying

**2. Chemical modification of polyssacharides**


Hydrothermal extraction


**Fillers**

Silica
FTIR; XRD; TG-DTA; SEM

Cellulose
XRD; FTIR; TGA; TEM

Acid hydrolysis ($H_2SO_4$)

**Cellulose nanocrystals**

**Plasticizers**

Arabinoxylans
GC-FID; GC-MS

Oil
GC-FID

Reactive extrusion/mechanochemistry

**Starch esterification and transesterification**

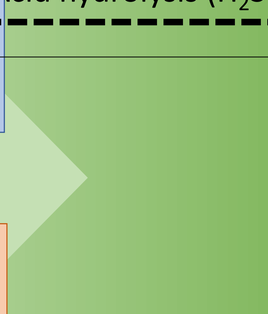
**Starch-esters**




Melt-mixing

**TPS esters-based materials**

**3. Development of TPS esters-based films**



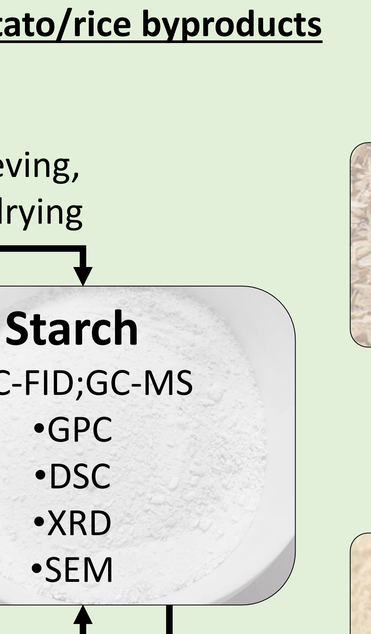
Tape extrusion

- MFI (Fluidity)
- DSC (Thermal properties)
- TG/DTA (Thermal properties)

**Selection of most promising materials**

✓High MFI
✓High melt strength
✓High thermal stability
✓High flexibility
✓Low water sensitivity

Scale up



**4. Blown extrusion of TPS esters-based films**

- WCA (wettability)
- Mechanical properties
- WVTR, OTR (Barrier properties)
- CIELab (Optical properties)

## Future prespectives

- Creation of **scientific knowledge** to implement completely **biodegradable starch-based materials** in a **massively** used **industrial processing technique** for plastic **packaging production**, blown film extrusion
- Implementation of a **circular economy** in the **agrofood** and **plastic industry**

## Acknowledgments

Thanks are due to the University of Aveiro and FCT/MCTES for the financial support of CICECO-Aveiro Institute of Materials (FCT Ref. UIDB/50011/2020 & UIDP/50011/2020) through national founds and, where applicable, co-financed by the FEDER, within the PT2020 Partnership Agreement, and to the Portuguese NMR Network. The authors acknowledge to FCT for the financing of the PhD research grant(UI/BD/151143/2021). Thanks are also due to "A Saloinha, Lda" for providing potato byproducts, "Qualiriso, Lda" and "Valente Marques, S.A" for providing rice byproducts. FCT is also thanked by the Scientific Employment Stimulus program (IG, CEECIND/00430/2017).