CATÓLICA PORTO

BIOTECNOLOGIA

Physical properties and stability in food systems – the relationship with molecular mobility

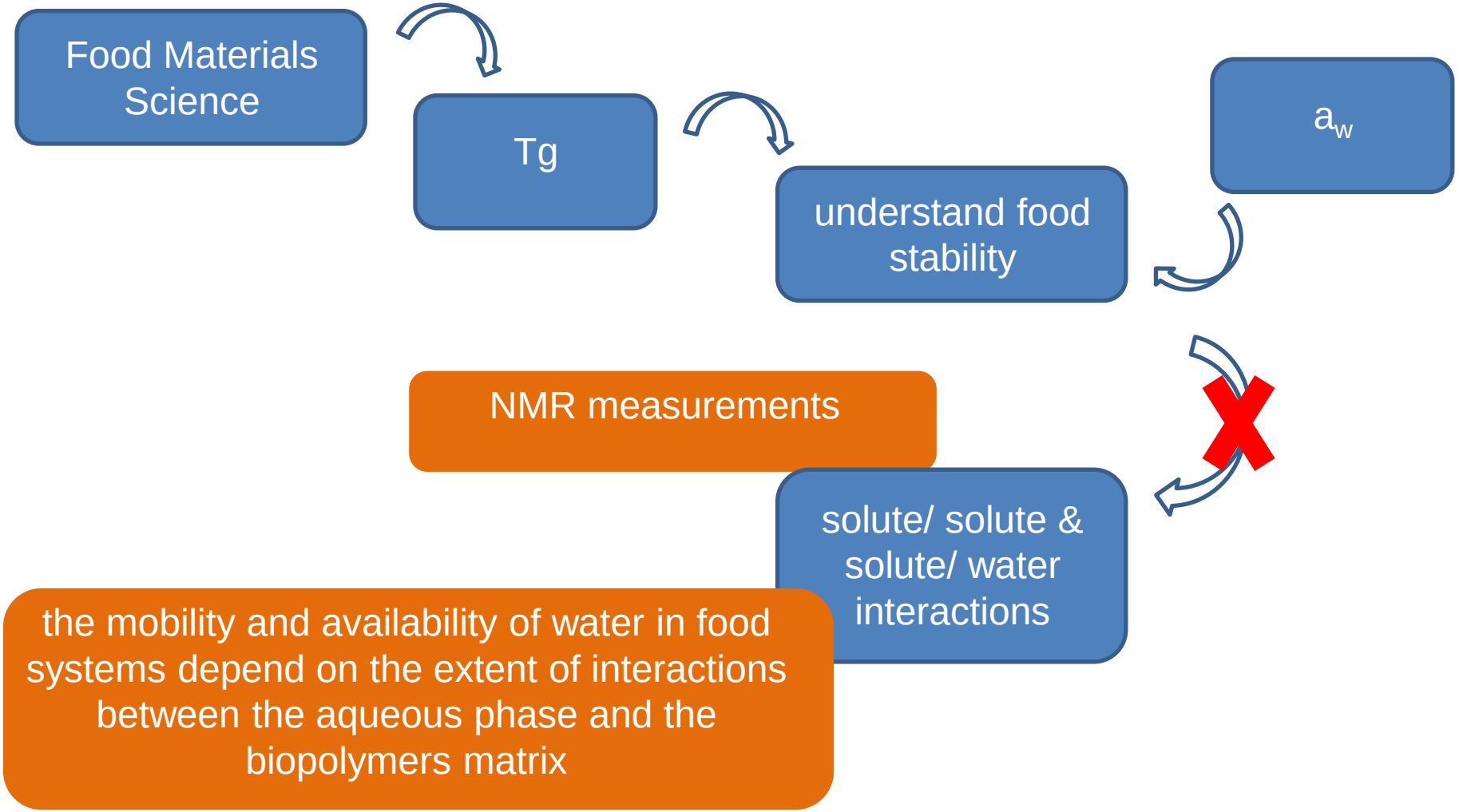
Joana F. Fundo; Mafalda A.C. Quintas, Cristina L.M. Silva

OBJECTIVE

Evaluate how molecular mobility affects macroscopic properties and stability in food systems

- **Model food systems - sucrose solutions**
  - chitosan edible films
- **Real food systems - fruits and vegetables**

Framework


Food Materials Science
Tg
understand food stability
a_w
NMR measurements
solute/ solute & solute/ water interactions
the mobility and availability of water in food systems depend on the extent of interactions between the aqueous phase and the biopolymers matrix

Chitosan Films vs Fresh-cut Pear & Melon

Chitosan Films

- Good models for food systems - semicrystalline matrices
- Interesting physical properties
- Straightforward matrices/ Easily reproducible
- Molecular mechanisms poorly understood

Fresh-cut Fruit

- Real food system/ More complex system
- Water can be present in both intra and extra cellular spaces - influences the behaviour of water mobility

Methodology – Samples Preparation

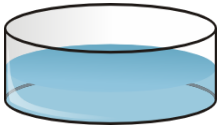
Chitosan Films

Chitosan
(1, 2 and 3% w/v)

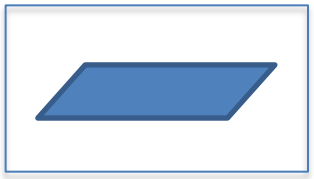
Glycerol
(10, 50 and 90% w/w)

1% lactic acid solution

Solvent Casting



40º C until equilibrium



RH = 53% and T= 22ºC

Fresh-cut Fruit

Stored at refrigerate temperature -10 days

Methodology - Characterisation

Chitosan Films

- Water Content
- Water Activity
- Chitosan and Glycerol
- Thickness
- Moisture Content
- Films Solubility
- Barrier Properties (Water vapour and Oxygen permeability)
- Thermal Analysis
  - Glass transition temperature (Tg)
  - Crystallinity (melting Δh)
- Mechanical Properties
  - Elongation at break (EB)
  - Tensile strength (TS)

Fresh-cut Fruit

- Water Content
- Water Activity
- Total Colour Difference (TCD)
- Electrolyte Leakage
- Scanning Electron Microscope (SEM)
- Optical Microscope (MO)
- ^{o}Brix
- pH

Methodology - Characterisation

NMR Measurements

Free Induction Decay and Spin Spin Relaxation

sample relaxation time was determined (**T2**) :

Bruker AVANCE III
300 MHz

Chitosan Films

$$Y = A_1 \exp^{(-X/T2gly)} + A_2 \exp^{(-X/T2water)}$$

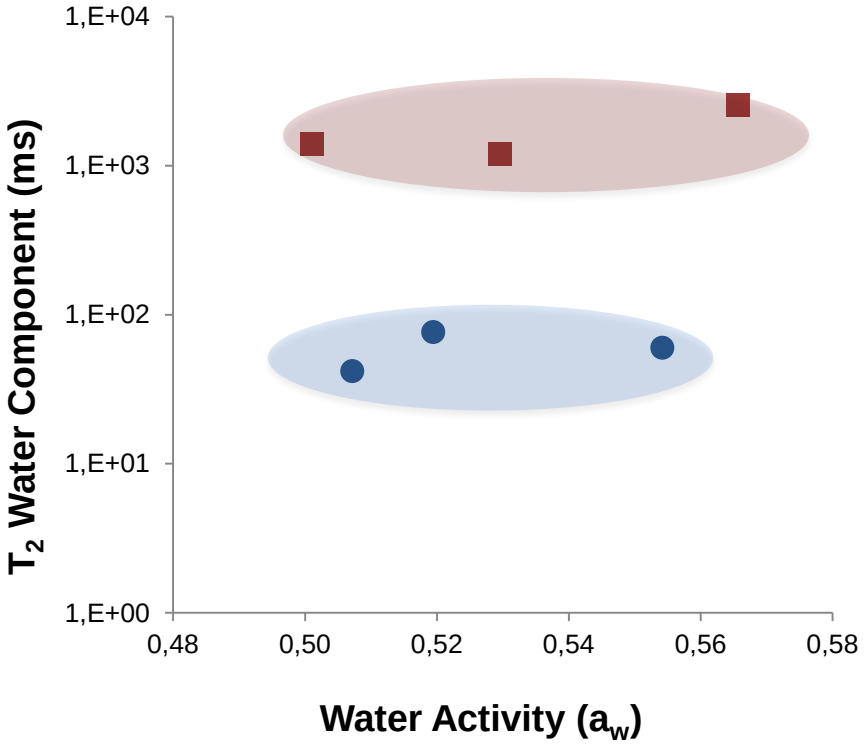
Fresh-cut Fruit

$$Y = A_1 \exp^{(-X/T2vacuole)} + A_2 \exp^{(-X/T2cytoplasm)} + A_3 \exp^{(-X/T2cell\ wall)}$$

SOME KEY RESULTS

Chitosan Films

Mobility vs Water Activity

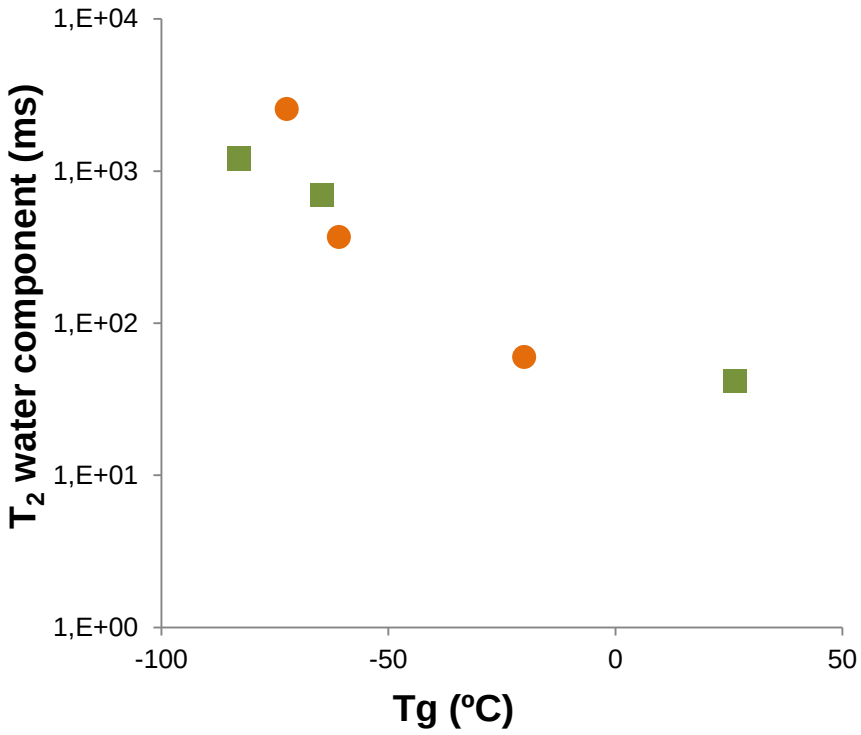


Films with the same composition – same total water content

The increase on water activity does not reflect on water mobility

Contribute to understanding differences in the stability of foods with same water activity

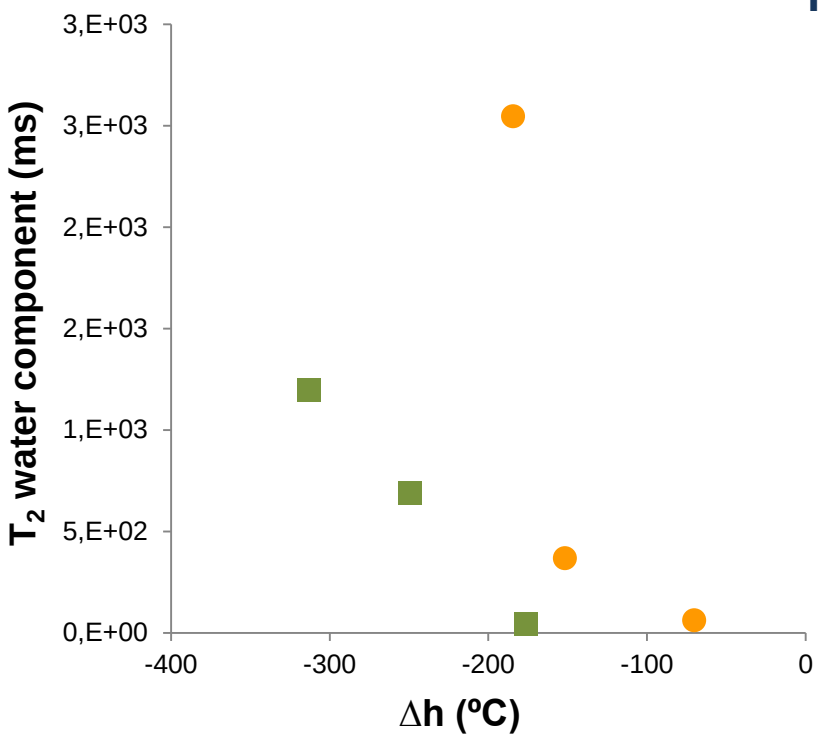
Mobility VS Glass Transition



Molecular mobility at room temperature decreases with increasing glass transition temperature

Behaviour suggests the increase of mobility with increase of free volume

Mobility vs Crystallization



0,055

0,26

For films with similar thickness, mobility increases with crystallinity

Polymeric chain is organised in the crystalline lattice

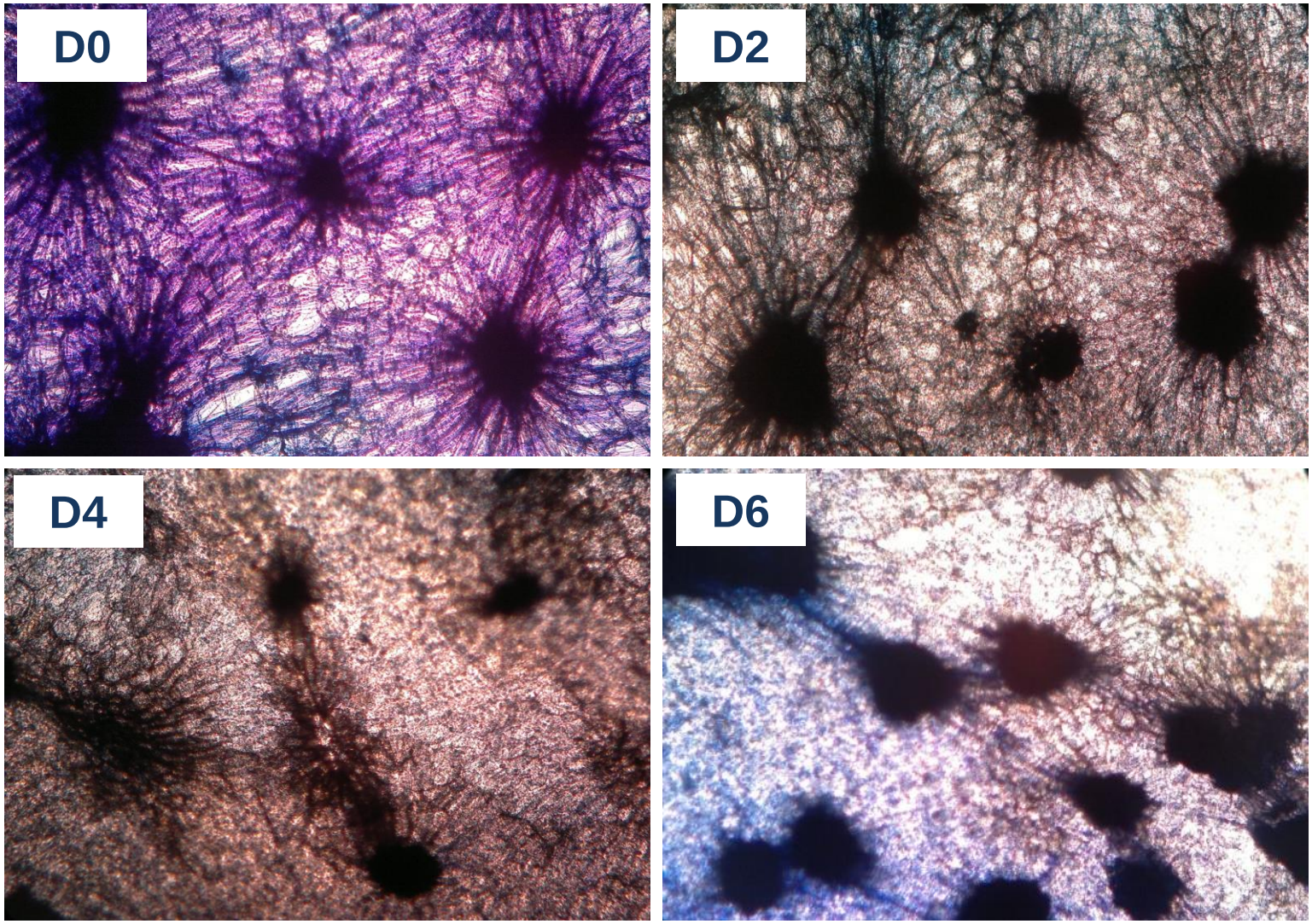
Polymer binding sites are "occupied" with polymer-polymer bonds

- **Free volume of the system increases**
- **Water molecules are free to move in the matrix**

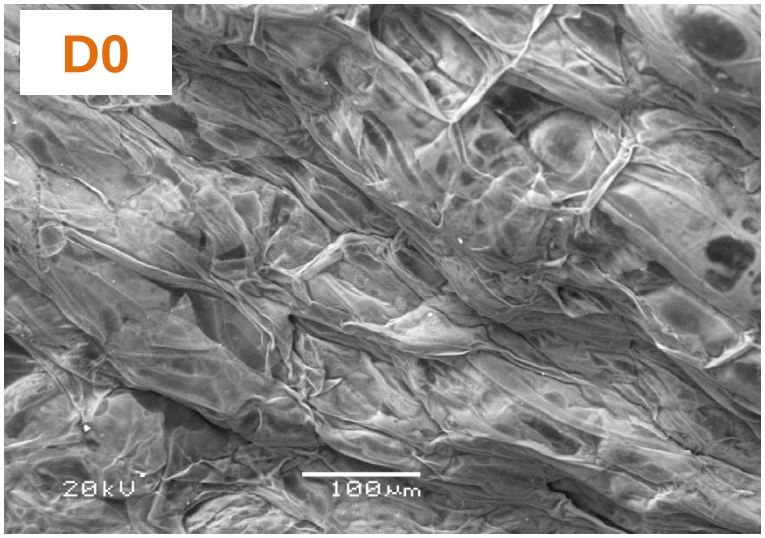
SOME PRELIMINARY RESULTS

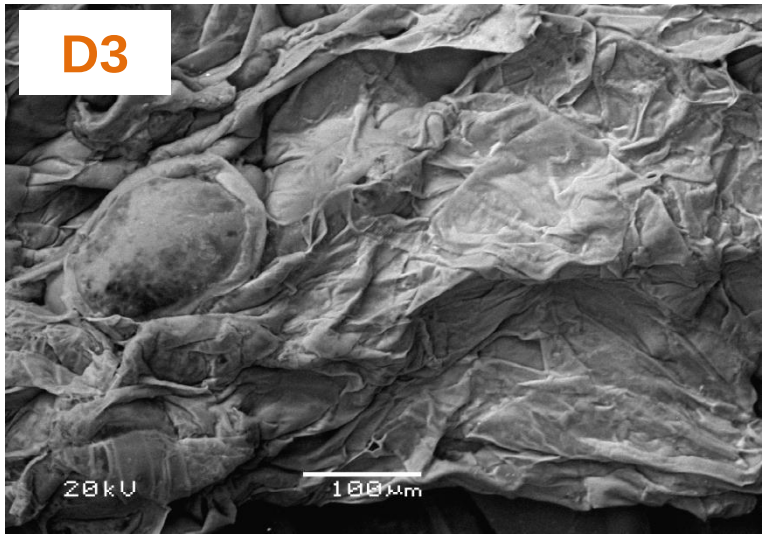
Fresh-cut Pear

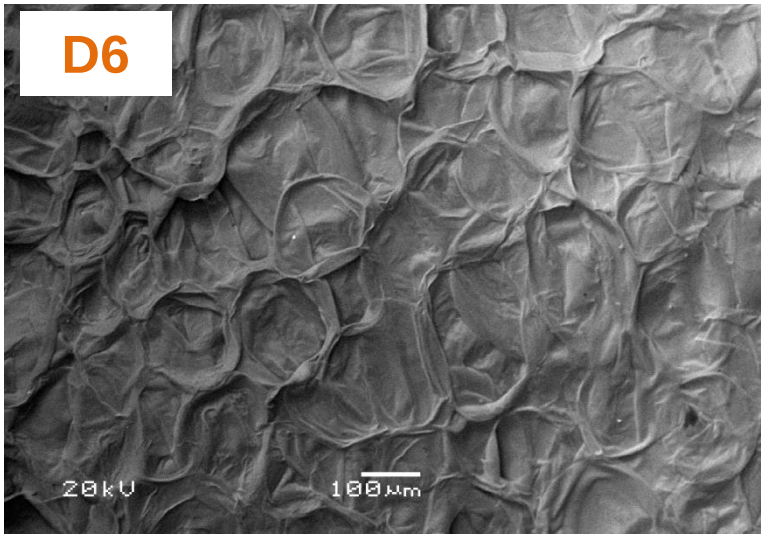
Mobility – Pear Microstructure

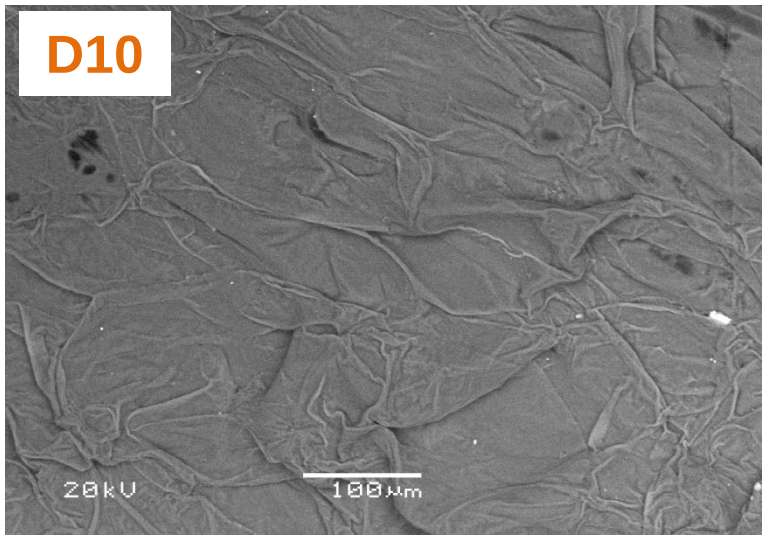


Mobility – Pear Microstructure

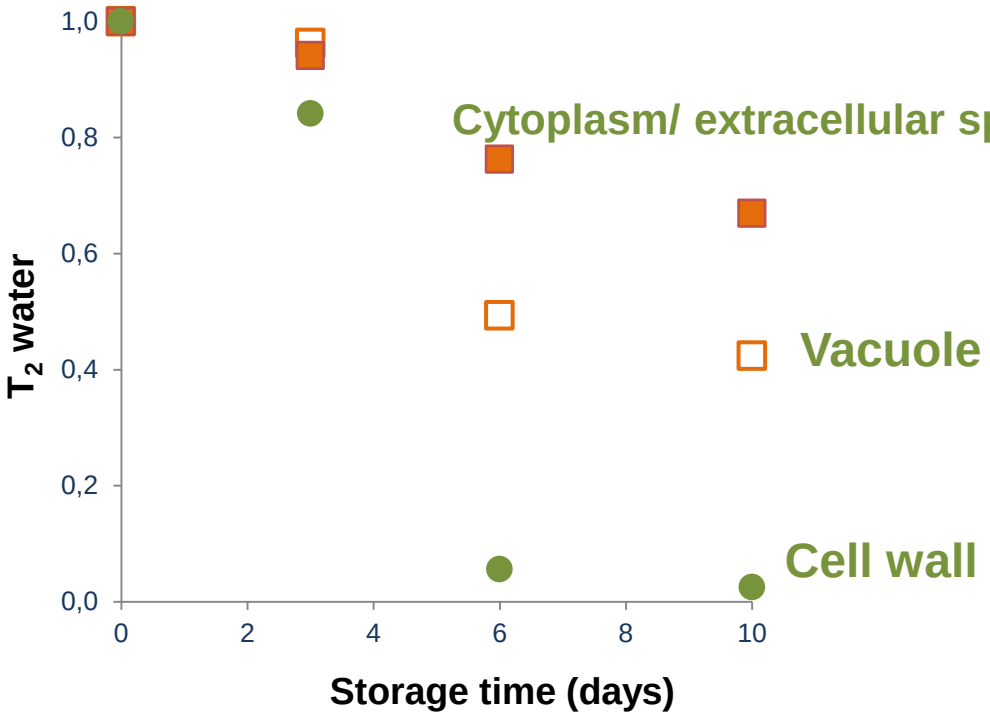








Mobility – Storage Time



Three relaxation times (T2) can be assigned to water located in the vacuolar, cytoplasm and cell wall compartment

(as is described in literature)

These results will also allow to determine the distribution of water between the subcellular spaces

DATA ANALYSIS IN PROGRESS

Conclusions

Chitosan Films

- Water molecular mobility behaviour has no relationship with water activity
- Glass transition increases with decreasing mobility (relates with free volume)
- Water molecular mobility increases with crystallinity of films with the same thickness

Fresh-cut pear

- Water molecular mobility decreases with the storage time
- Microscope images show a structure change that is observed in NMR measurements, with the decrease of T_2

CATÓLICA PORTO

BIOTECNOLOGIA

Thank you for your attention!