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INNOGRAIN Lab

ENHANCING SUSTAINABLE FOOD STRUCTURES: THE ROLE OF PLANT PROTEINS IN THEIR INTERPLAY WITH STARCH DURING HYDROTHERMAL PROCESSING

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INTRODUCTION

CURRENT FOOD PRODUCTION:

GHG

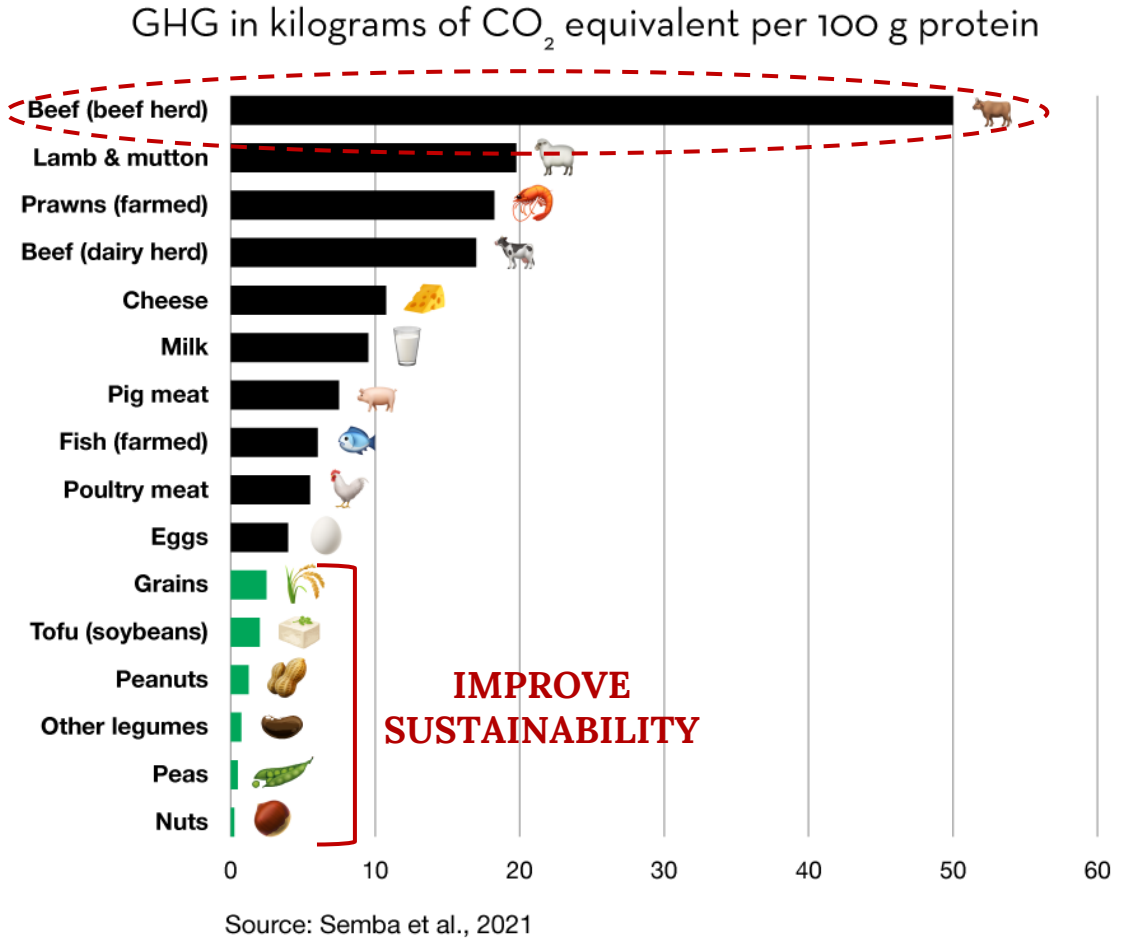
19% - 30%

GLOBAL GHG EMISSIONS

+80% emissions are related to the **production of animal proteins**

A shift in the diet it is necessary

Potential to ↓**75%** the use for agricultural land



Plant proteins, as more sustainable source of protein, can be introduced to the food market to address problems caused by animal protein overconsumption

INTRODUCTION

45–70% OF ENERGY FROM CARBOHYDRATES

CHALLENGE

Understand the functionality of ALTERNATIVE PLANT PROTEINS in the complexity of a starch-based matrix.

Why alternative plant proteins?

- ✓ Less studied.
- ✓ Less likely to cause allergic reactions.
- ✓ Often derived from by-products of other industries.

SUNFLOWER PROTEIN

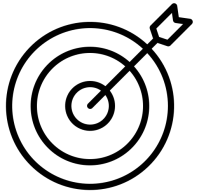
Oilseed
Protein obtained from oil industry

LUPIN PROTEIN

Pulse
High protein
High fiber

Complex reassociations between proteins and starch upon heat processing

→ **CREATING UNIQUE STRUCTURES**



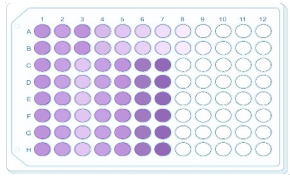
OBJECTIVE

UNDERSTAND THE INTERACTION BETWEEN POTATO AND WHEAT STARCH WITH SUNFLOWER AND LUPIN PROTEIN DURING FOOD PROCESSING

MATERIALS & METHODS

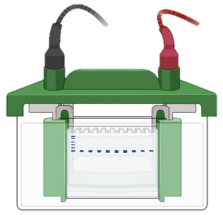
PROTEINS

SUNFLOWER (SPC) LUPIN (LPC)

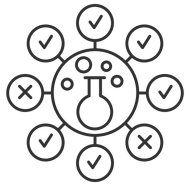


SOLUBILITY

SEM



SDS-PAGE



COMPOSITIONAL

DSC

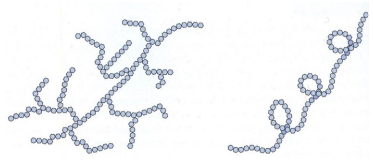
ADDITION +10% & +25%

STARCHES

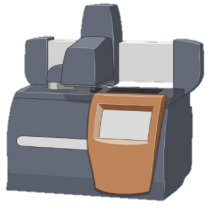
POTATO (PS)

WHEAT (WS)

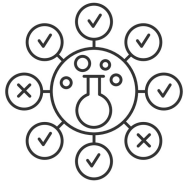
SEM



Mw/ Xam – AM & AP %



DSC



COMPOSITIONAL

20 % SOLIDS

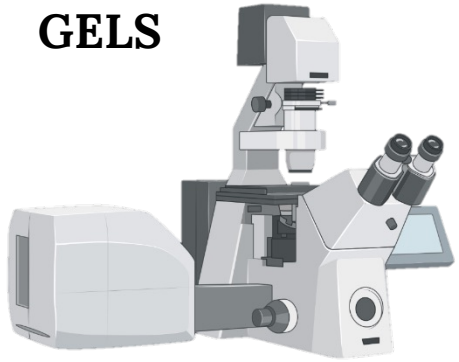
HYDROTHERMAL PROCESSING: Rapid Visco Analyzer

In situ cooking + rheological indicator

High moisture
High T°
Low Shear

TEXTURE ANALYSIS

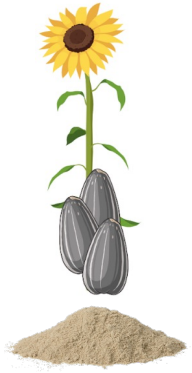
GELS



CONFOCAL SCANNING LASER MICROSCOPY

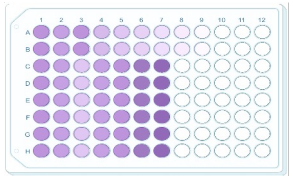
RESULTS: CHARACTERIZATION

PROTEINS



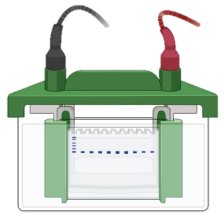
SUNFLOWER (SPC)

LUPIN (LPC)

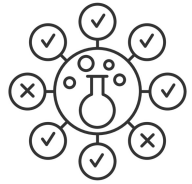


SOLUBILITY

SEM



SDS-PAGE



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DSC

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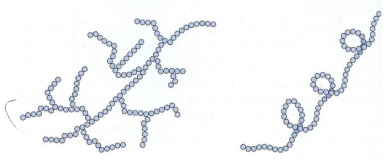
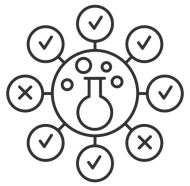


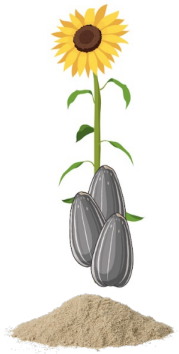
Mw – AM & AP %

DSC



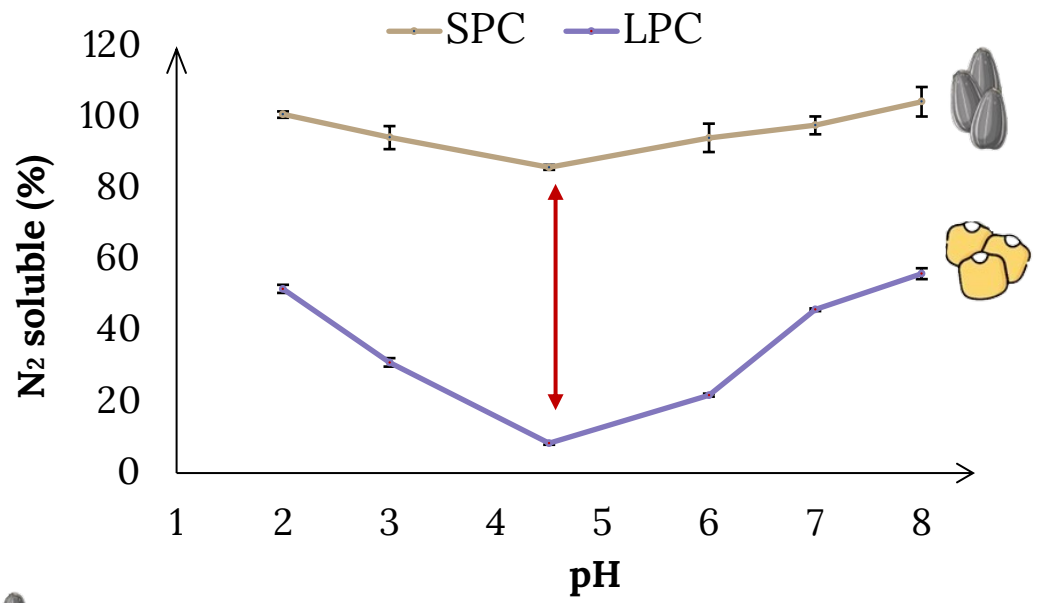
COMPOSITIONAL

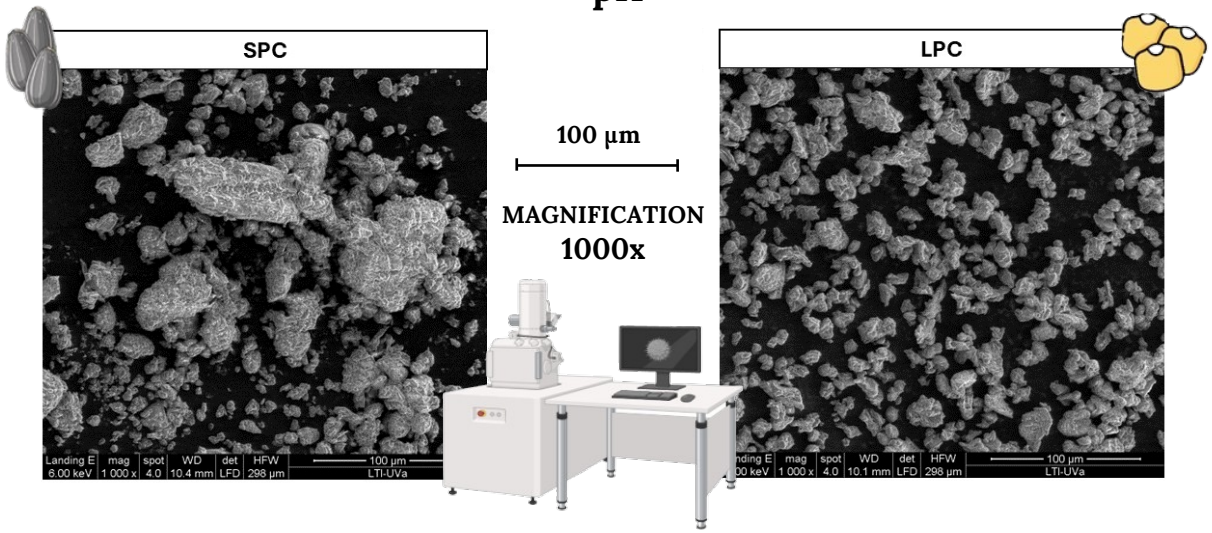
PROTEINS CHARACTERIZATION

PROTEIN 53,1±0,0% 	**PROTEIN 49,8±0,0%** 
Lipids: 6,9±0,3% **Ash: 6,9±0,1%** **Carbohydrates*: 33,0±0,4%**	**Lipids: 8,2±0,6%** **Ash: 3,9±0,0%** **Carbohydrates*: 38,1±0,6%**
Zpot: -20,6±0,8mV	**Zpot: -16,37±0,2 mV**
LGC: 14% **WBC: 1,67±0,07 g/g**	**LGC: 18%** **WBC: 1,20±0,11 g/g**

*By difference

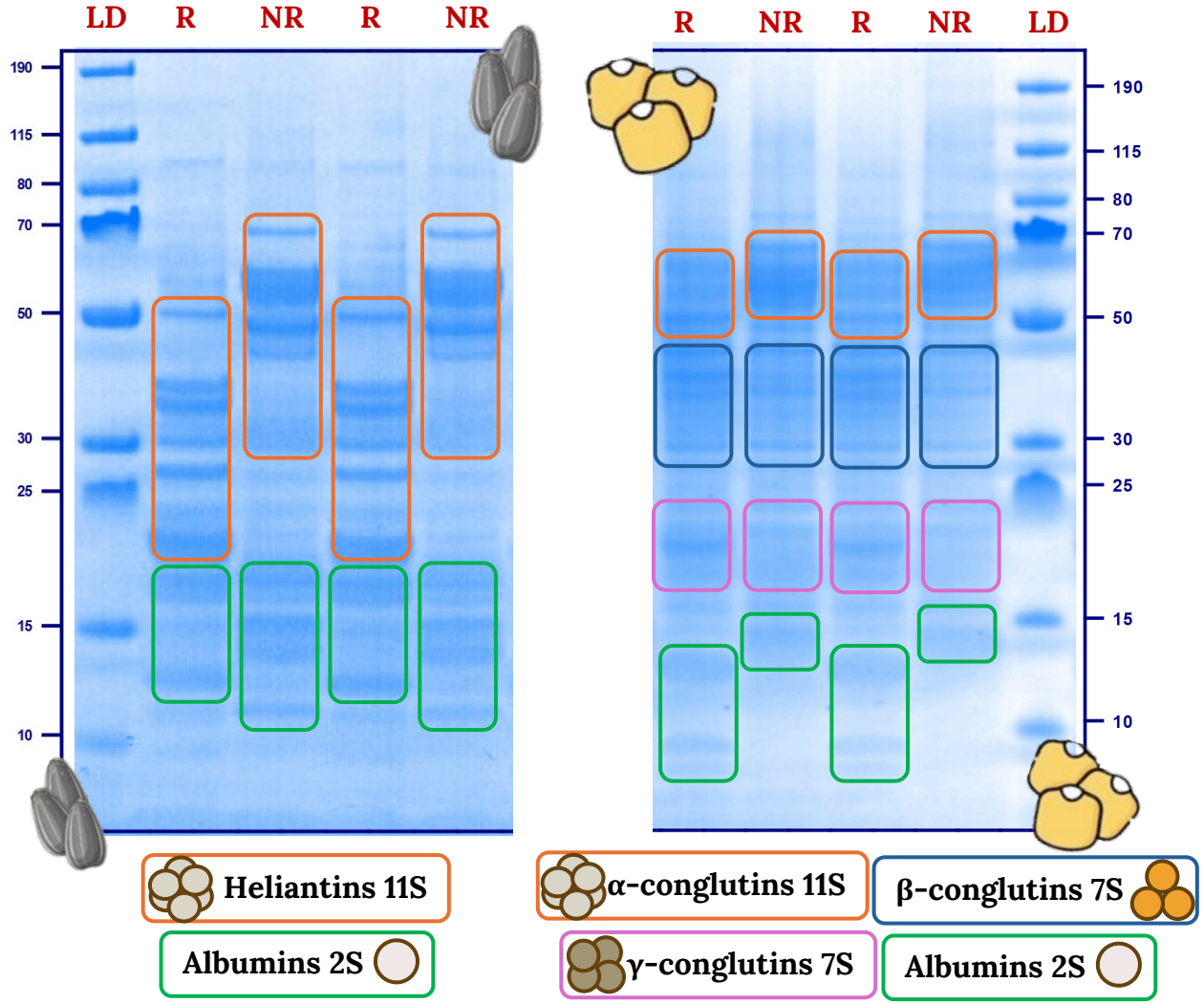
PROTEIN SOLUBILITY





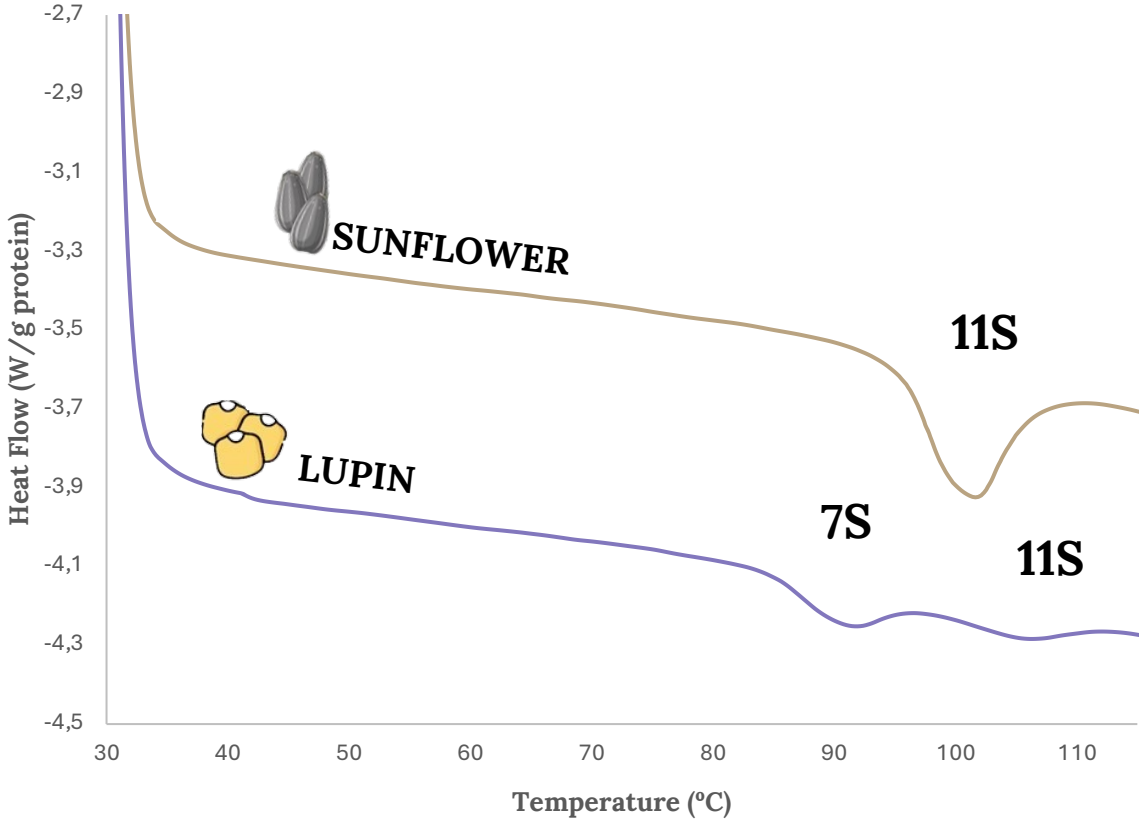
PROTEINS CHARACTERIZATION

SDS-PAGE Electrophoresis



LD: LADER – R: REDUCING CONDITION – NR: NON-REDUCING CONDITION

DSC: Differential Scanning Calorimetry



SUNFLOWER

11S

$T_0 = 91ºC$

$\boldsymbol{T_p = 101ºC}$

$T_c = 109ºC$

$\boldsymbol{\Delta H = 6,39\ J/g_{protein}}$

LUPIN

7S

$T_0 = 82ºC$

$\boldsymbol{T_{p1} = 91ºC}$

$T_c = 97ºC$

$\boldsymbol{\Delta H = 2,84\ J/g_{protein}}$

11S

$T_0 = 99ºC$

$\boldsymbol{T_{p2} = 106ºC}$

$T_c = 114ºC$

$\boldsymbol{\Delta H = 1,40\ J/g_{protein}}$

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STARCHES CHARACTERIZATION

AM: 21,9%
AP: 78,1%

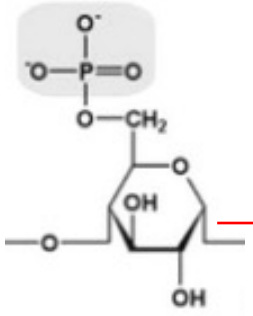
AM: 27,1%
AP: 72,9%

AM Xam: 2169 GU
AP Mw: 10399 kDa

AM Xam: 1666 GU
AP Mw: 8455 kDa

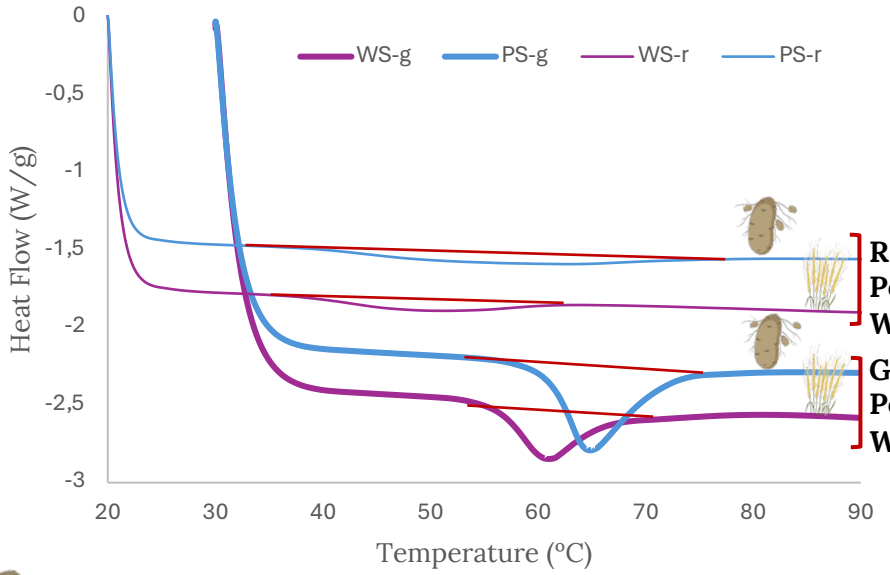
Ash: 0,178±0,003%

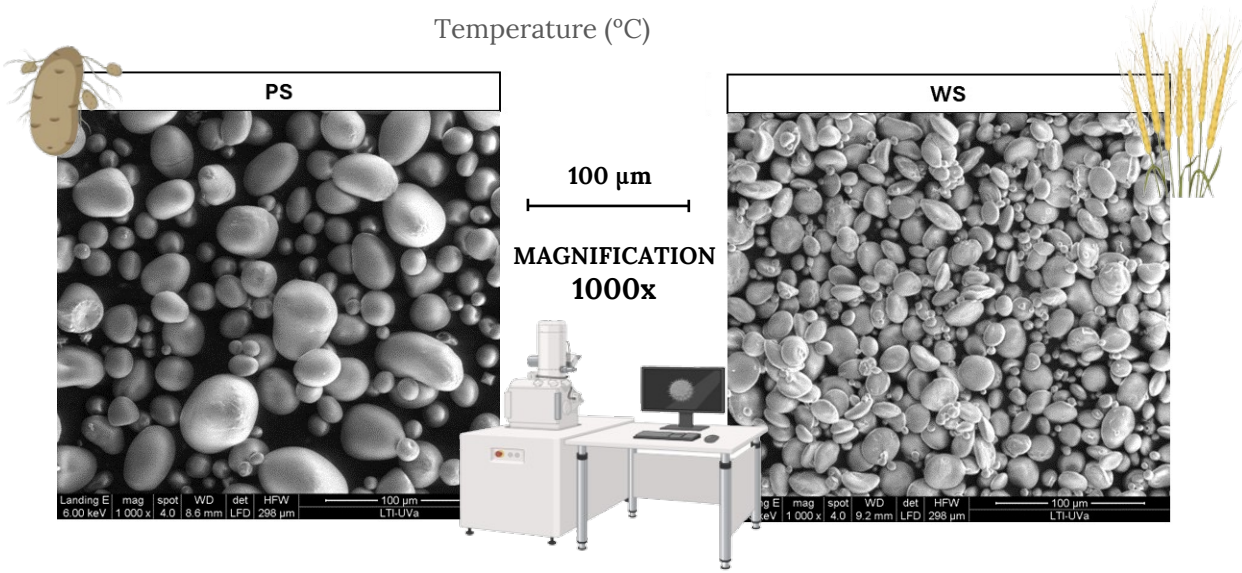
Ash: 0,158±0,003%



One out of 200-300 glucose units of **amylopectin is phosphorylated**

DSC





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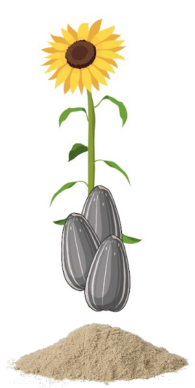

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LUPIN (LPC)

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GELS

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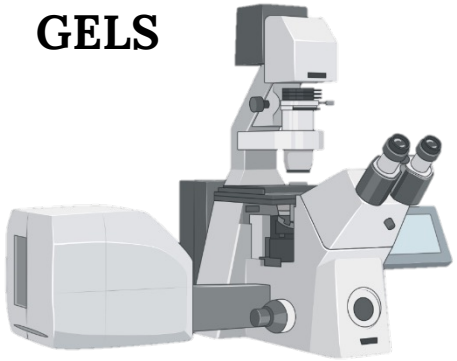
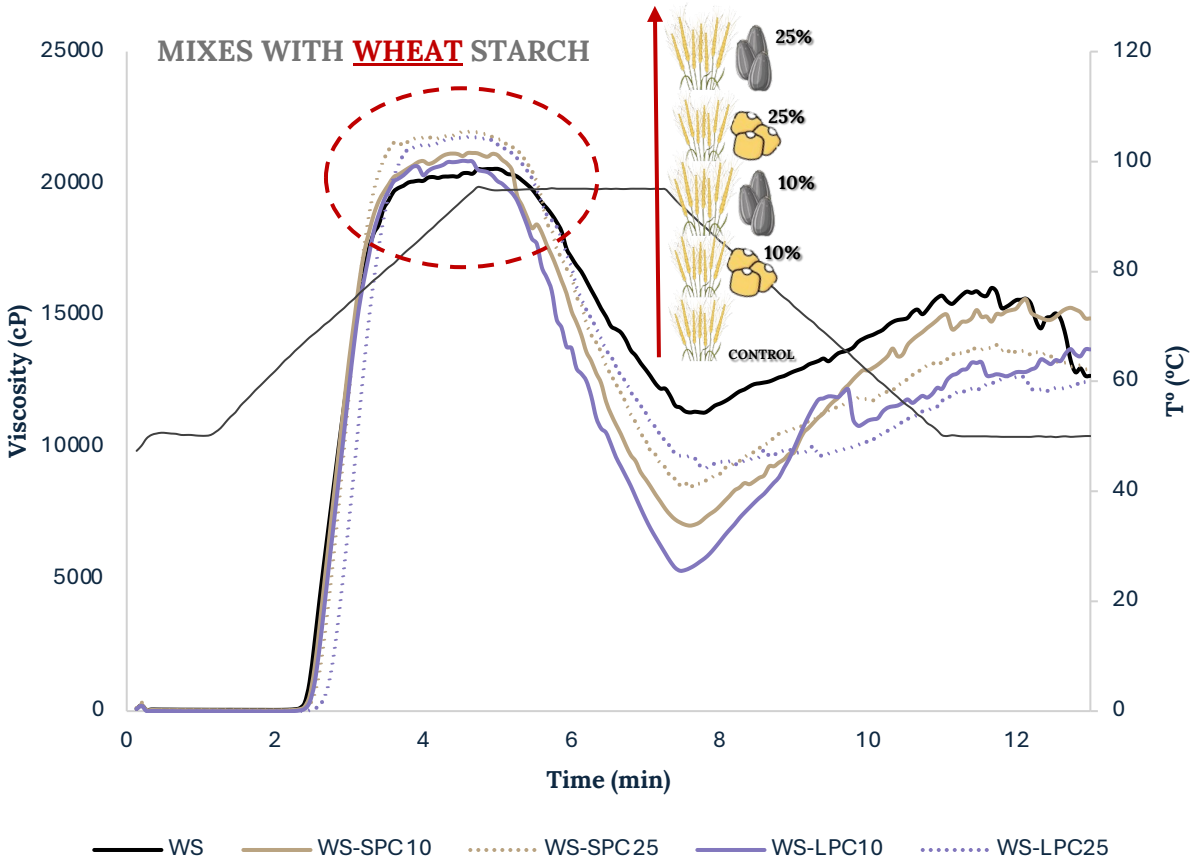


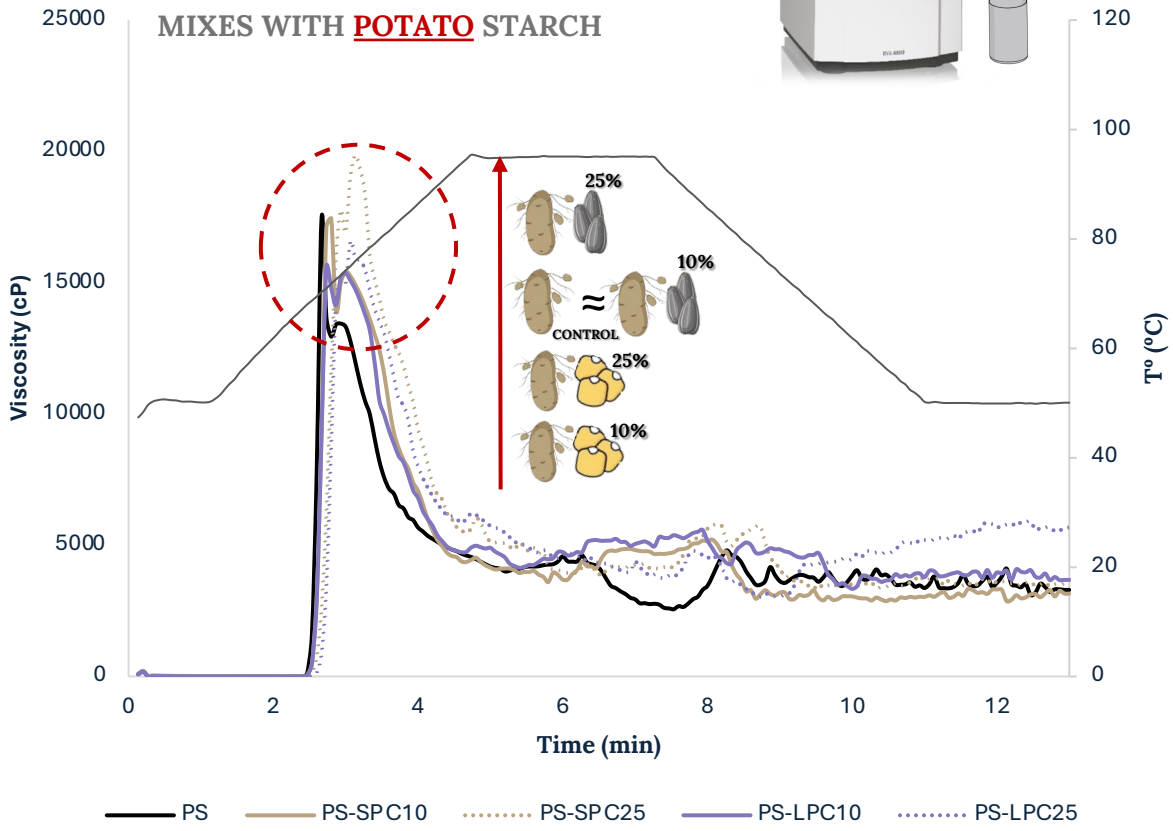
CONFOCAL SCANNING LASER MICROSCOPY

HYDROTHERMAL PROCESSING OF MIXES

RVA - Rapid Visco Analyzer



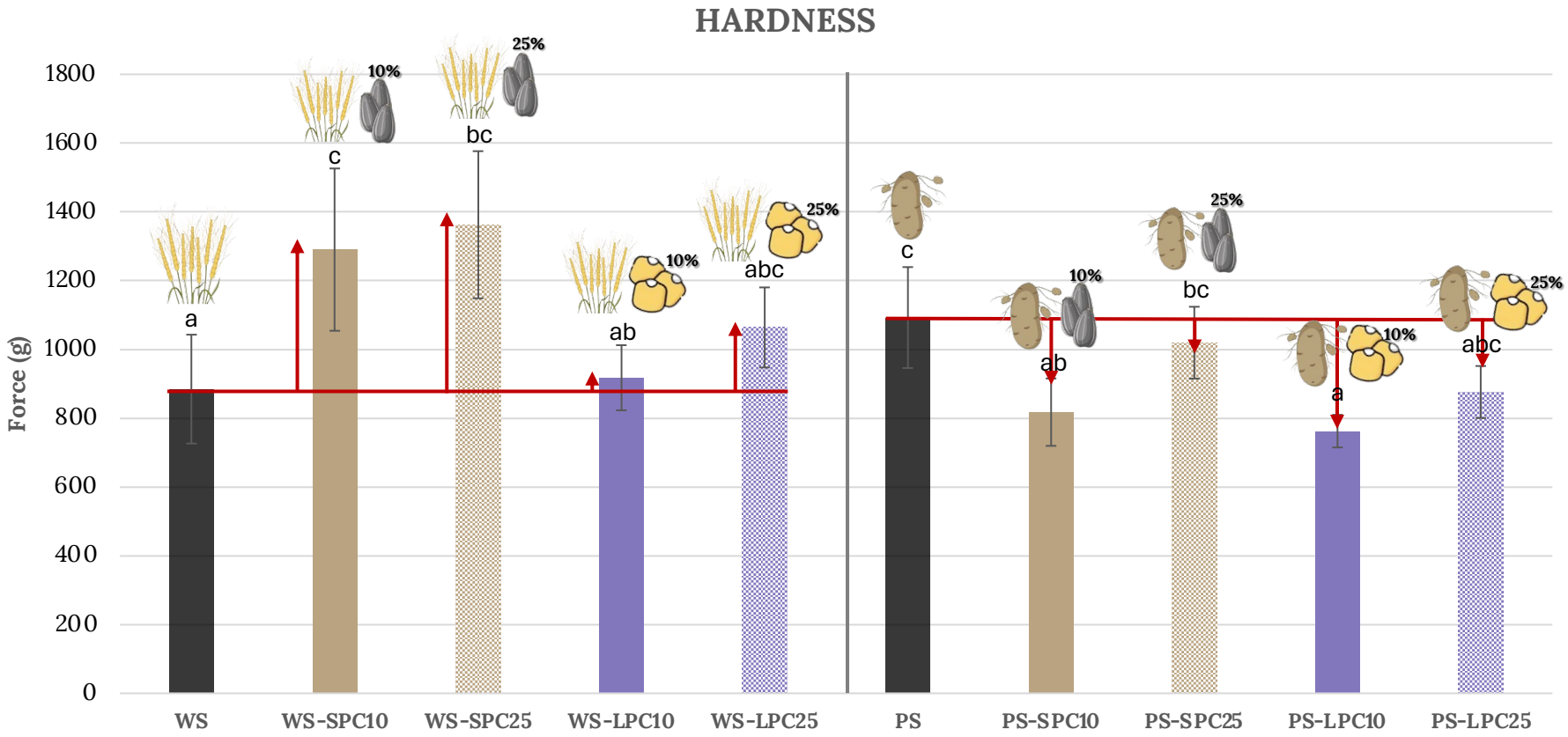
- ✓ All mixes **>** peak viscosity than control.
- ✓ Higher addition of solids <u>results</u> in higher peak viscosity.



- ✓ Peak viscosity: Sunflower **>** Control **>** Lupin.
- ✓ Higher addition of solids <u>does not result</u> in higher peak viscosity.

GEL TEXTURE

TEXTUROMETER



- ✓ All mixed wheat systems are harder than control, especially sunflower.
- ✓ All mixed potato systems are weaker than control, especially lupin.
- ✓ Sunflower showed more firmness than lupin.

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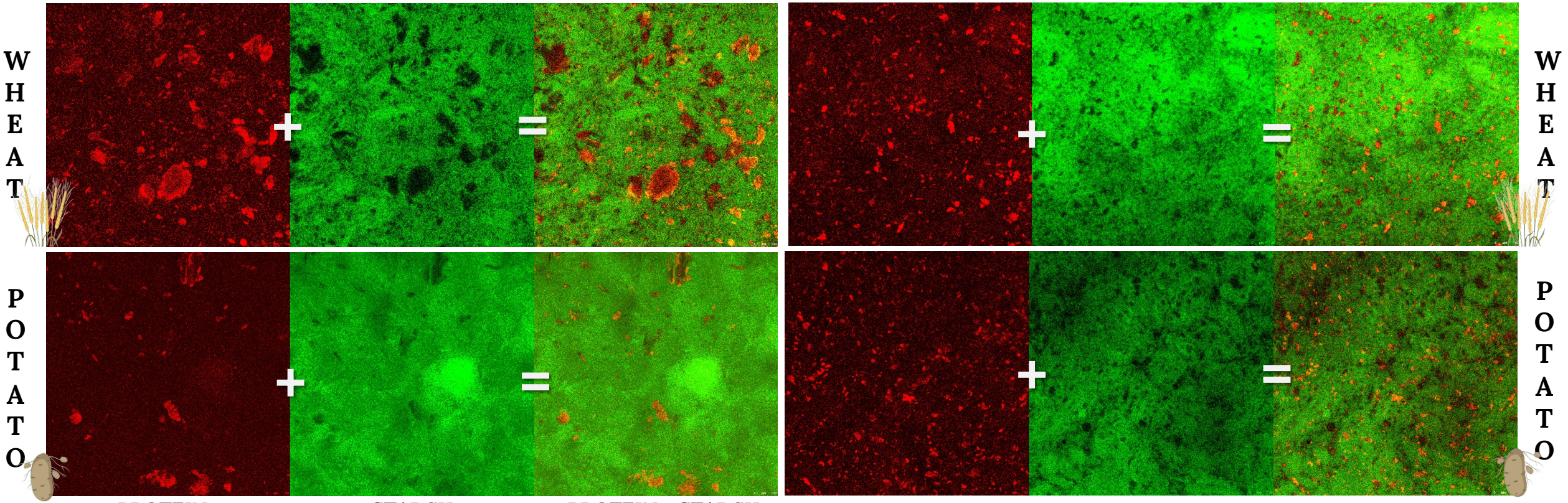
GEL MICROSTRUCTURE

CONFOCAL SCANNING LASER MICROSCOPY

SUNFLOWER 10% ADDITION

LUPIN 10% ADDITION



100 µm

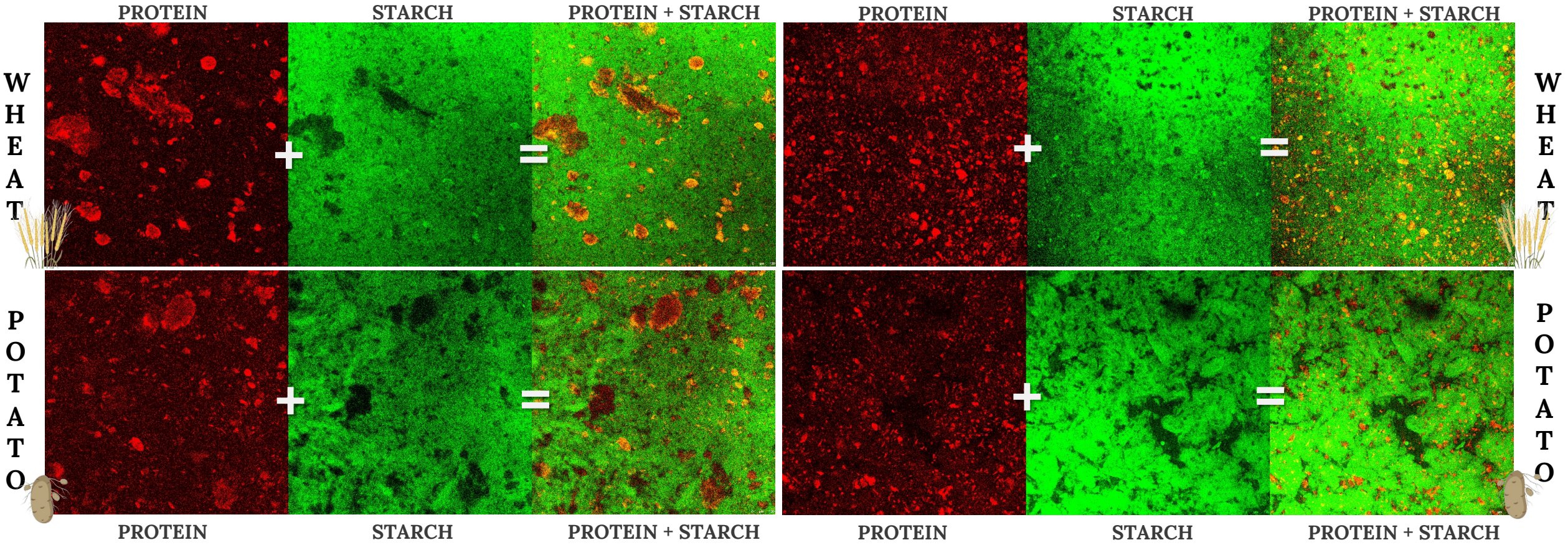
MAGNIFICATION 10x

GEL MICROSTRUCTURE

CONFOCAL SCANNING LASER MICROSCOPY

SUNFLOWER 25% ADDITION

LUPIN 25% ADDITION



100 µm

MAGNIFICATION 10x

SDG – SUSTAINABLE DEVELOPMENT GOALS

Promotes **food security** and **improved nutrition** by **increasing** the availability and accessibility of **alternative plant-based protein sources.**

Demostrates **resource efficiency** and **waste reduction** by using byproducts.

Develops **sustainable food products** that reduce reliance on animal agriculture, **lowering environmental impact and greenhouse gas emissions.**

CONCLUSIONS

- ✓ The **source of protein and starch significantly affects** the **structural characteristics of the mix matrix.**
- ✓ **Sunflower protein forms harder gels** compared to lupin protein, mainly due to the major presence of 11S proteins and the absence of 7S.
- ✓ **Mixed systems with potato starch are weaker** than those with wheat starch, **regardless of the protein type**, due to electrostatic forces between potato starch and proteins.

HIGHLIGHTS THE NEED OF:

Thorough characterization of each raw material.

Further study of protein and starch interactions.

Before their introduction in the food industry to

- **produce high-quality plant protein foods**
- **contribute to achieving the SDG**

SUSTAINABLE DEVELOPMENT GOALS

Interreg
España – Portugal
Cofinanciado por la Unión Europea
Cofinanciado pela União Europeia

MINISTERIO DE CIENCIA, INNOVACIÓN Y UNIVERSIDADES

Cofinanciado por la Unión Europea

AGENCIA ESTATAL DE INVESTIGACIÓN

TRANSCOLAB PLUS

INNOGRAIN Lab

THANK YOU FOR YOUR ATTENTION!

Linkedin.com/in/FlorenciaAgustinaParle/

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