

Title Bioprocessing of protein-rich raw material towards improved functionality

Author(s) Laitila, Arja; Karsma, Anni; Rosa-Sibakov, Natalia; Juvonen, Riikka; Sozer, Nesli

Citation 32nd Nordic Cereal Congress "Future Food Security - New Opportunities for Nordic Crops", 7 - 9 September 2015 , Espoo, Finland. Nordic Cereal Association (2015)

Date 2015

Rights This presentation may be downloaded for personal use only.

<p>VTT http://www.vtt.fi P.O. box 1000 FI-02044 VTT Finland</p>	<p>By using VTT Digital Open Access Repository you are bound by the following Terms & Conditions.</p> <p>I have read and I understand the following statement:</p> <p>This document is protected by copyright and other intellectual property rights, and duplication or sale of all or part of any of this document is not permitted, except duplication for research use or educational purposes in electronic or print form. You must obtain permission for any other use. Electronic or print copies may not be offered for sale.</p>
---	---



Bioprocessing of protein-rich raw material towards improved functionality

Arja Laitila, Anni Karsma, Natalia Rosa-Sibakov, Riikka Juvonen & Nesli Sozer

VTT Technical Research Centre of Finland Ltd
arja.laitila@vtt.fi

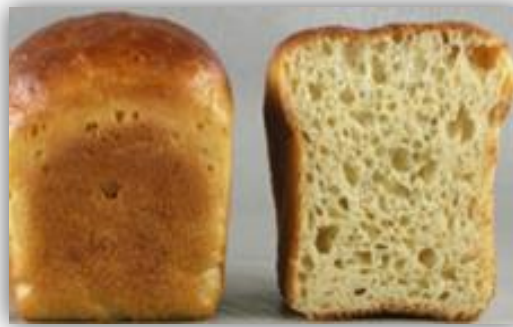
Nordic Cereal
Congress 2015,
Espoo



SUSFOOD

Novel multifunctional plant protein ingredients with bioprocessing (BIOPROT)

1. Improve protein and nutritional functionality of bran and faba bean ingredients by tailored bioprocessing with microbes and enzymes
2. Establish technological functionality of modified plant protein sources in several food categories (pasta, bread and extruded snacks)



ruokaa ja luonnonvaroja

Finnish funding: MMM Makera

- **University of Helsinki, Finland**

- Elisa Arte, Rossana Coda,
Kati Katina (coordinator)

- **University of Bari, Italy**

- Marco Gobbetti, Carlo Rizzello

- **VTT Ltd, Finland**

- Riikka Juvonen, Anni Karsma,
Arja Laitila, Atte Mikkelsen,
Margherita Re, Natalia Rosa-
Sibakov, Nesli Sozer, Irina
Tsitko

- **Central Research Institute of
Food and Feed Control, Turkey**

- Nurcan Aysar Guzelsoy,
Orhan Eren

Faba bean is an excellent source of protein

- High protein content (25-35%)
- Vitamins, minerals, dietary fibre and bioactive compounds
- Low cost: Half the price of soy bean and peas (~200 vs 400 €/t)
- Suitable for gluten-free products
- The **limitations** on using faba beans are the presence of antinutritional factors, a bitter taste and poor technological functionality

UNITED NATIONS
DECLARES 2016 AS
"INTERNATIONAL YEAR
OF PULSES"



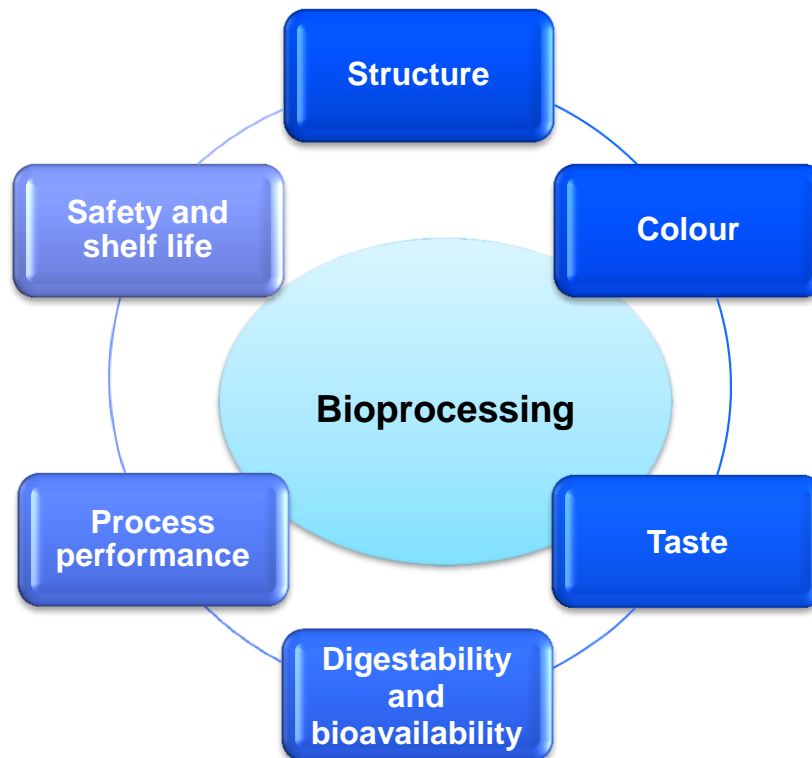
Bioprocessing as a tool to improve the techno-functional and nutritional profile

Enzymatic treatments

- Fast, controlled, targeted actions

Microbial food cultures

- Bacteria (especially lactic acid bacteria), yeasts and moulds
- Versatile, multifunctional actions



This study aimed to improve:

- **protein bioavailability**
- **technological functionality**

1. Enzymatic treatment with phytase



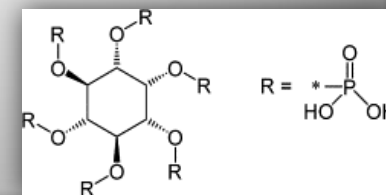
2. Lactic acid bacteria, including exopolysaccharide producing (EPS) bacteria



- Fermented faba bean ingredients in extrusion

Phytic acid

- Strong binding affinity to important minerals
- Forms complexes with proteins decreasing solubility



Microbial EPS such as dextrans

- Selected lactic acid bacteria
- EPS to deliver viscosifying, texturising and emulsifying agents in to foods and beverages
- Effective at low concentrations (0.5-1%, d.w.)
- Health promoting properties
- *In situ* production: Label-free technology for modifying texture and nutritional properties

***Vicia faba* L. var major**
 Dehulling, milling (particle size ca 600 µm)
 Raw material characterisation

Enzyme selection
 Food-grade phytase (Ultra Bio-Logics Inc)

LAB selection
 Indigenous and from other plant sources
L. plantarum, *Lc. lactis*, *W. confusa*
 10⁶ cfu/g

Enzyme treatment
 2, 10 and 20 U (33-167-333 nkat)
 Ratio (s:l) = 1 solid : 2 water
 RT and 55°C; 1,2,4 h

Fermentation
 0.5 kg and 10-15 kg
 33% flour + 62 % water + 5% sucrose*
 (*only EPS production)
 25°C 24 h

Freeze drying and milling

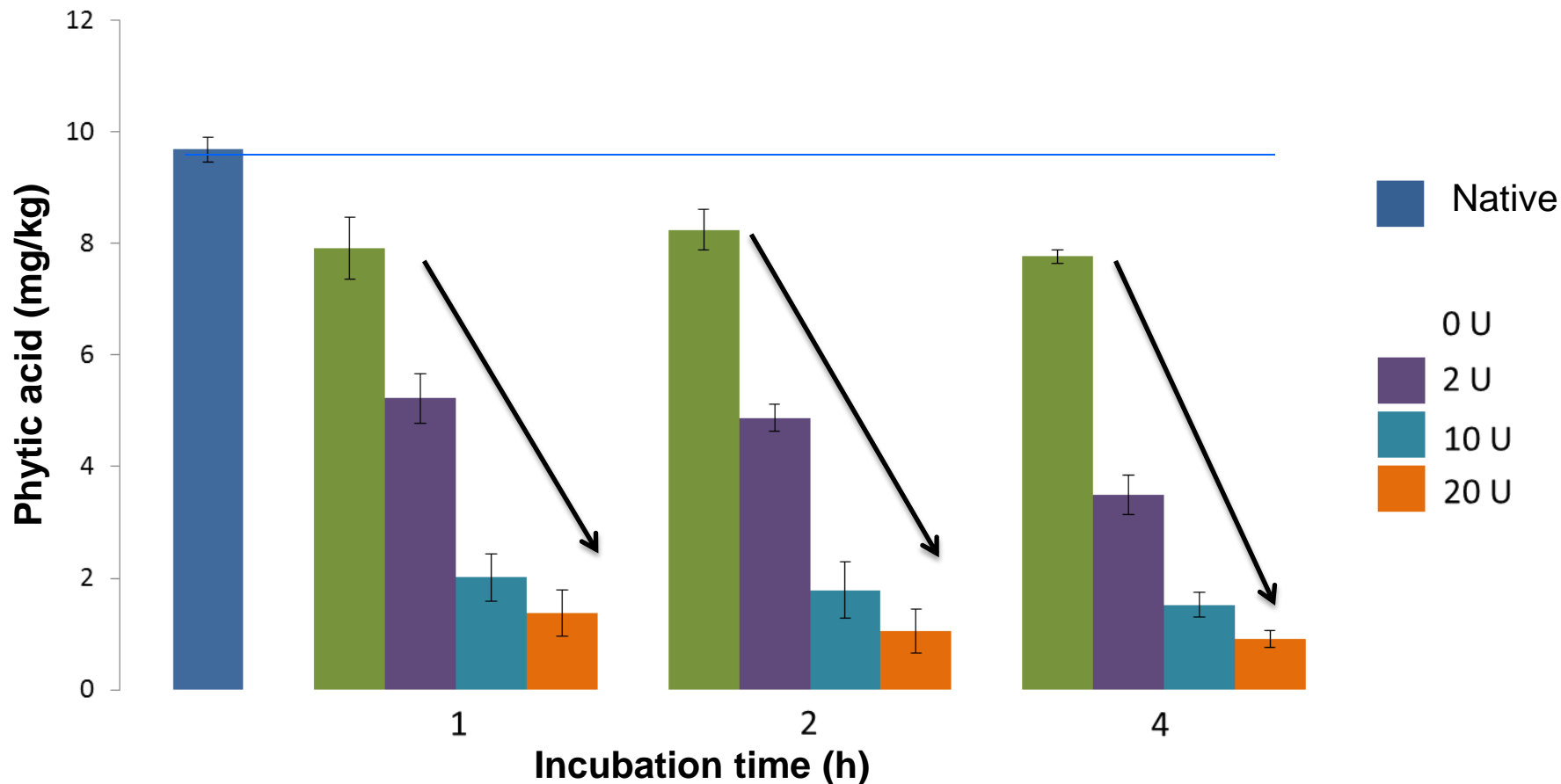
Pasta

Extrusion
 100 -50 – 25 % mixed with rice flour

Baking

LAB = lactic acid bacteria

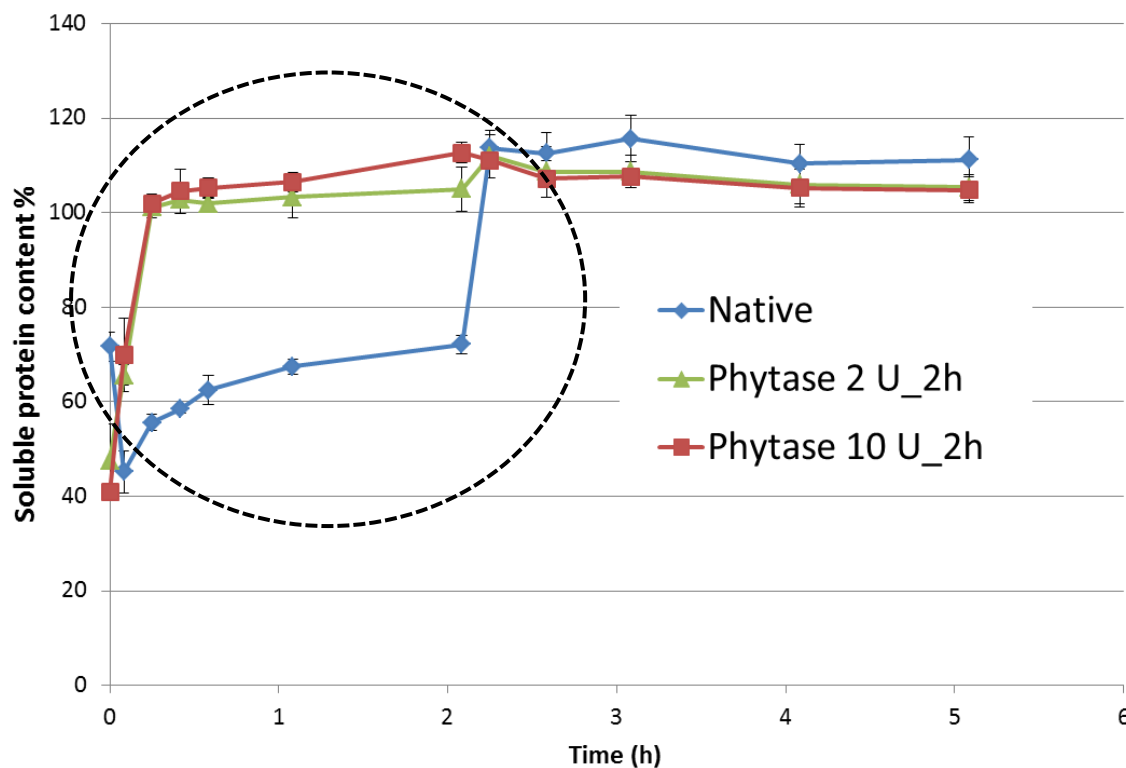
Treatment with food-grade phytase was effective



Phytic acid content in faba beans was reduced up to 89 %

Phytase treatment increased protein release of faba bean

(*in vitro* digestion model Nordlund et al, 2013, *J Cereal Sci*, 58, 200-208)



Phytase treatment

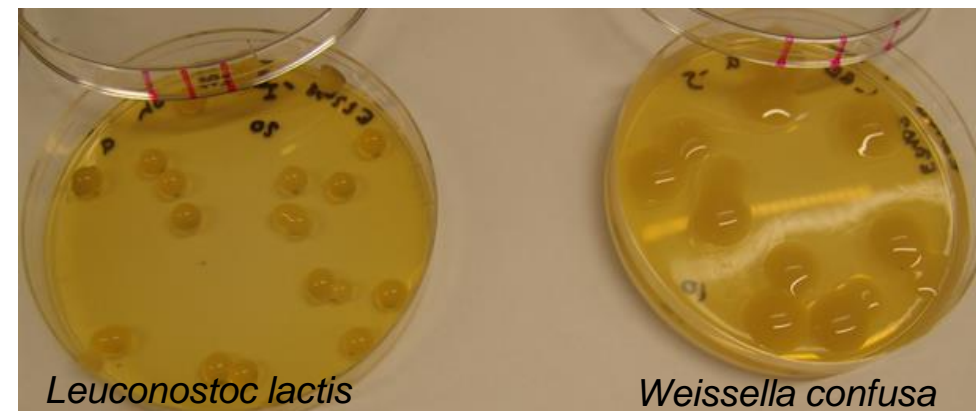
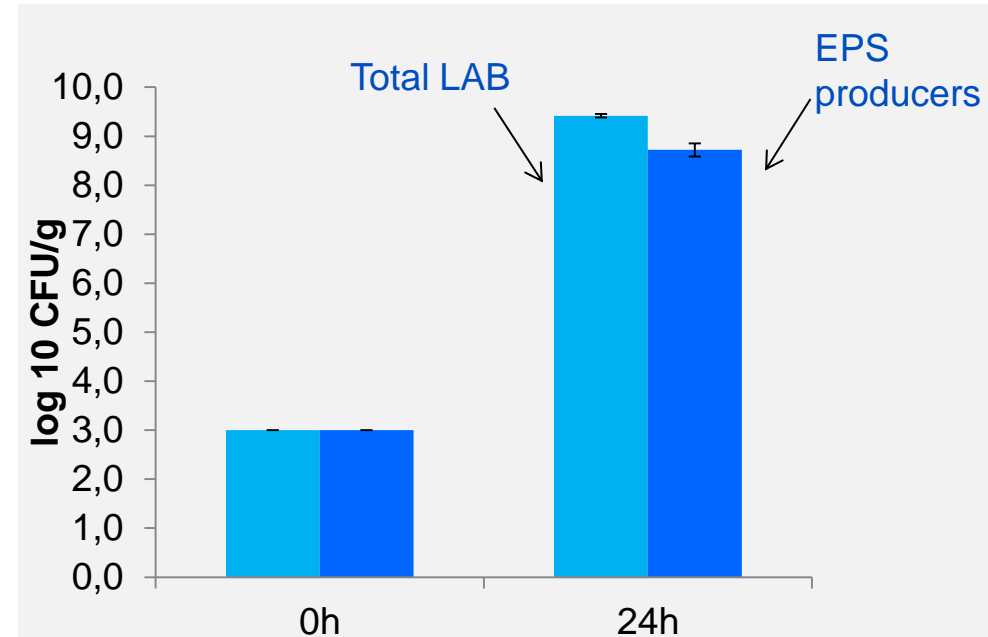
- enhanced the solubilisation and release of protein from faba bean in the gastric stage of *in vitro* digestion
- increased Ca, Mg, Fe, Zn availability (data not shown)



Bioprocessing of faba beans with LAB

Faba beans are natural source for exopolysaccharide (EPS) producing LAB

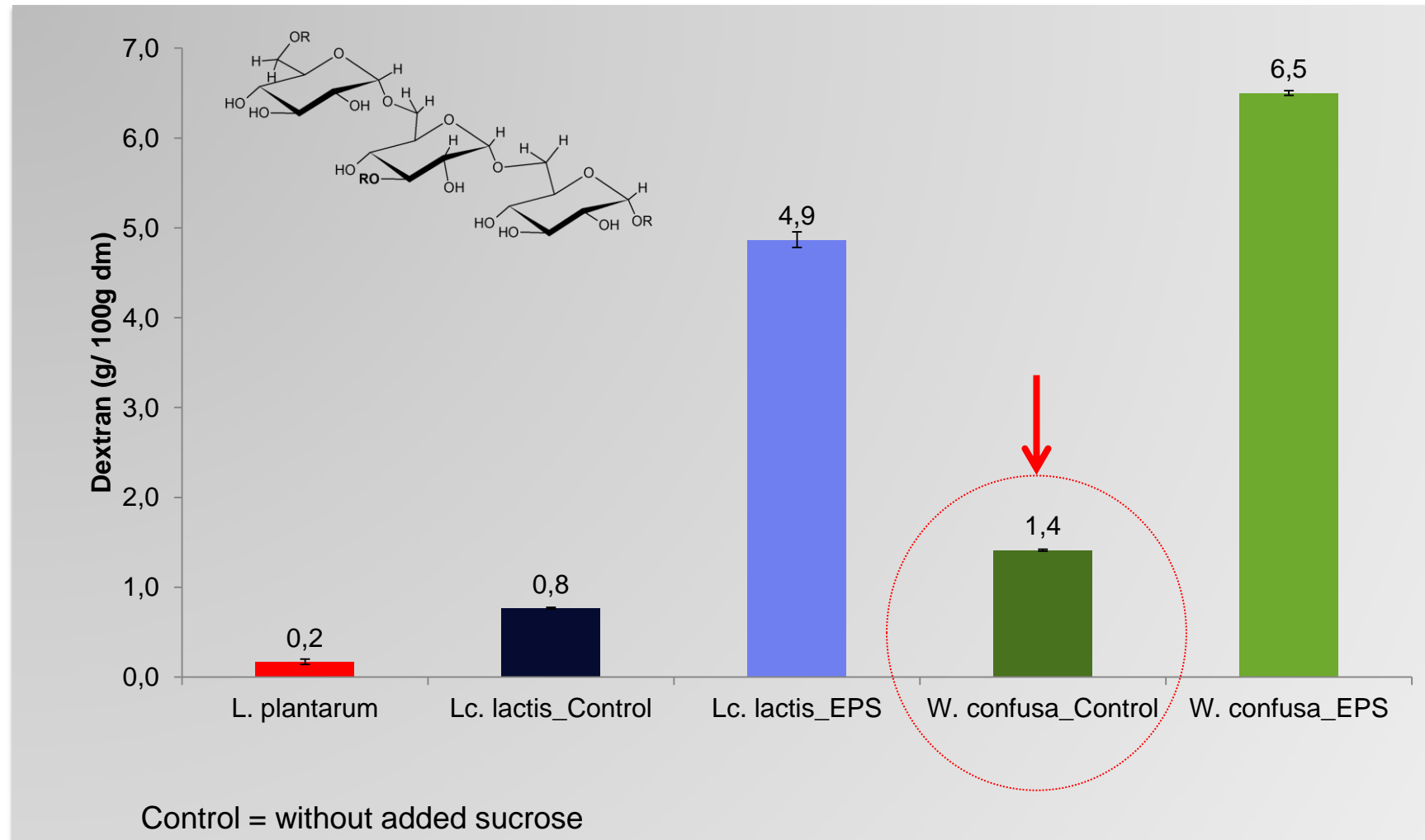
- Intensive LAB growth
 - 100-1000 cfu/g → $>10^8$ cfu/g
- *Weissella* and *Leuconostoc* bacteria isolated and characterised
- *In situ* production of EPS in protein rich matrix ?
- EPS-negative: *Lactobacillus plantarum*
 - Antimicrobial potential
 - Reduction of antinutritive factors and protein modification



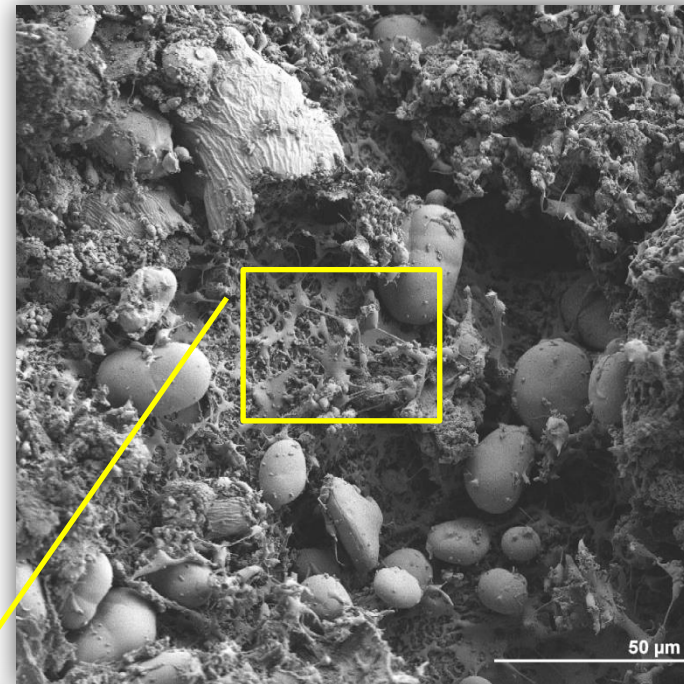
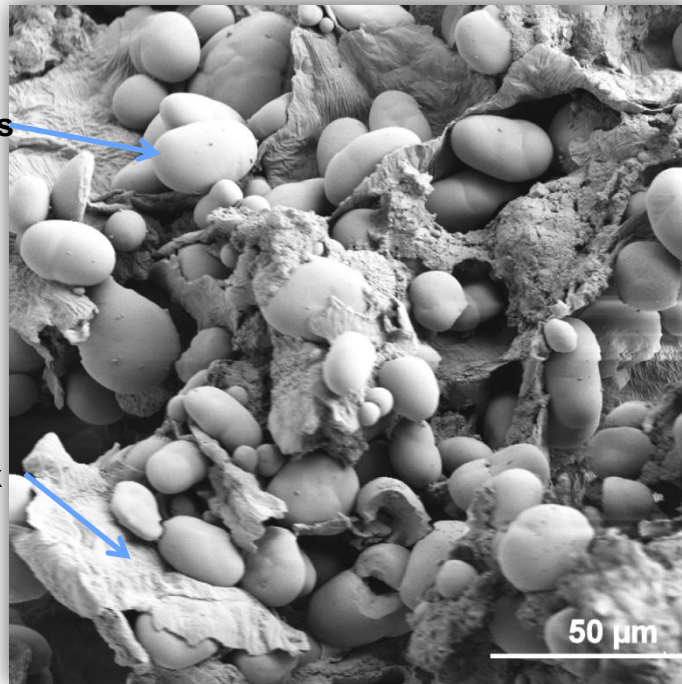
***Lactobacillus plantarum* E76 (EPS-negative) vs *Weissella confusa* E3403 after 24h fermentation**



Intensive dextran production during faba bean fermentation

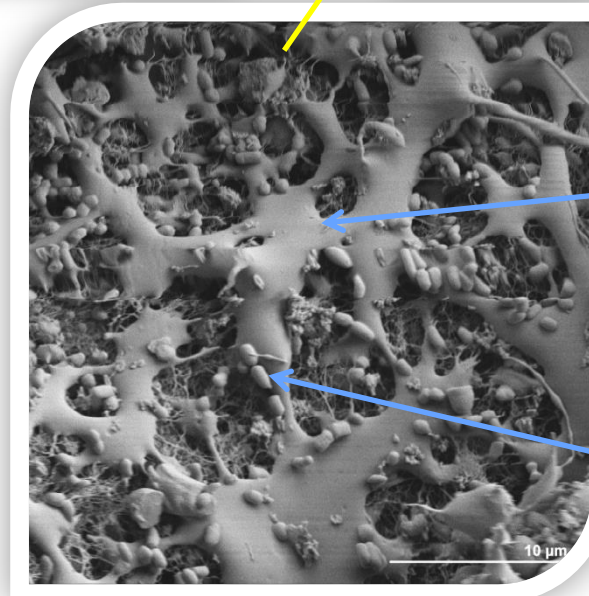


FESEM micrographs after 24h fermentation



EPS negative
L. plantarum

In situ produced dextran



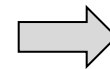
Polymeric EPS matrix

Weissella bacteria

EPS = exocellular polysaccharide

Fermentation releases proteins from the cell wall matrix and significantly increases the amount of free amino acids (AA)

Total free amino acids	
Sample	g/kg
Control	5.7
<i>L. plantarum</i>	7.6
<i>Lc. lactis</i>	10.4
<i>W. confusa</i>	9.8



Fermentation had a positive impact on amino acid profiles
 →The amount of essential AAs increased

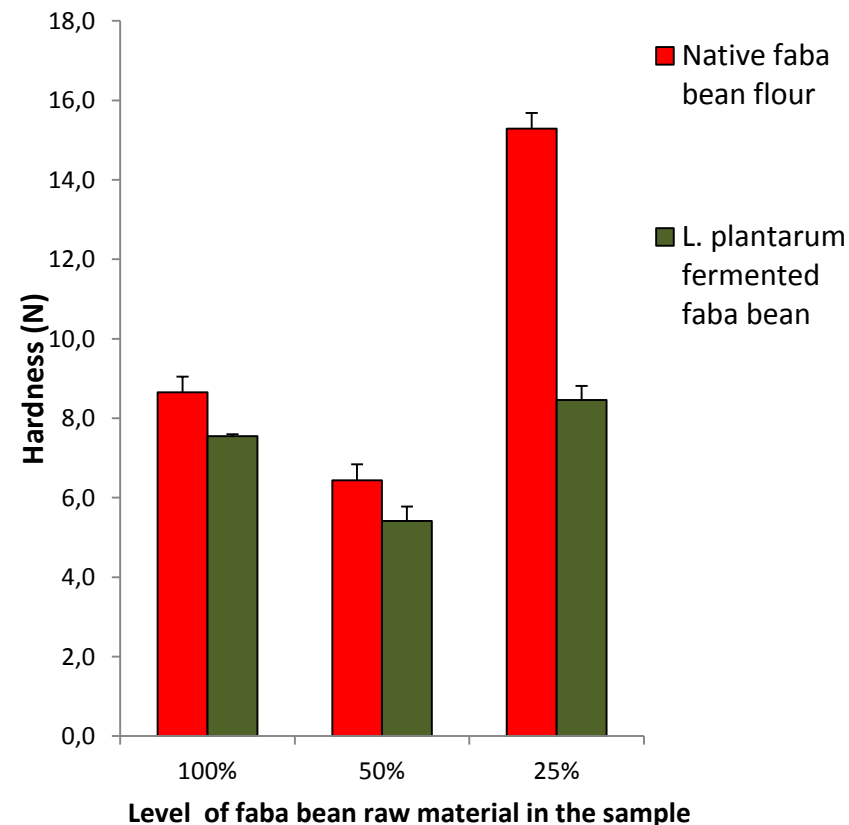


Bioprocessed faba bean ingredients in extrusion

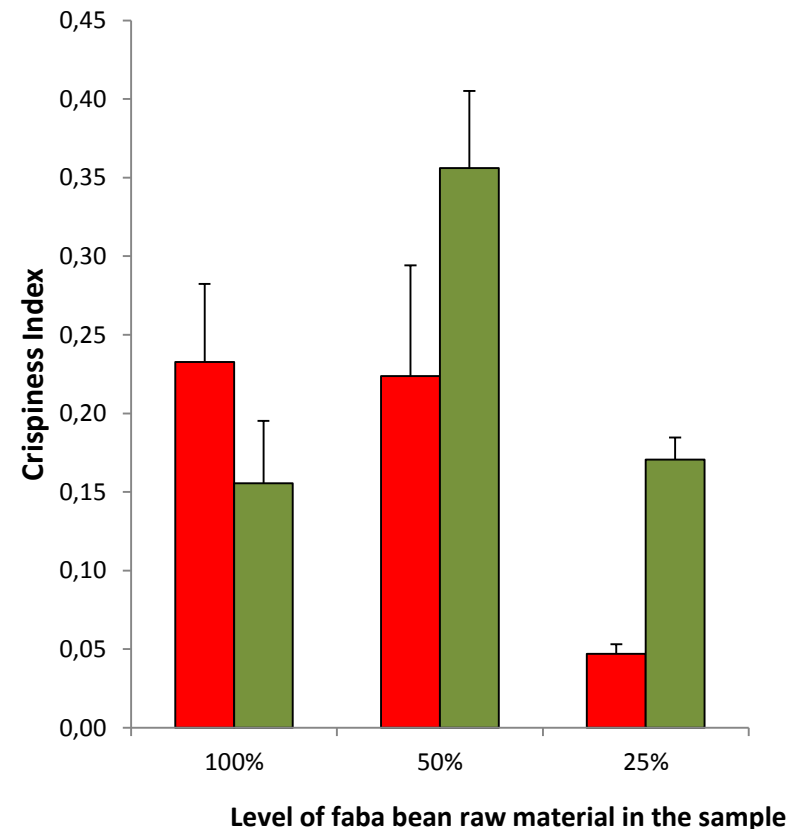


Fermentation with *L. plantarum* improved mechanical properties of extruded snacks

Decreased hardness



Increased crispiness (50 and 25% addition)



In protein-rich material, no additional impacts with EPS producers

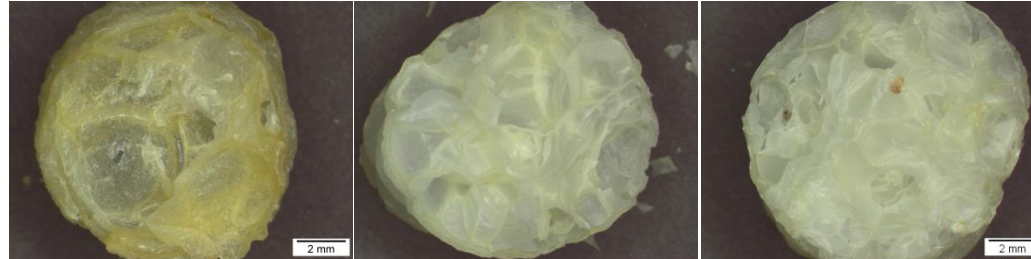


100 %

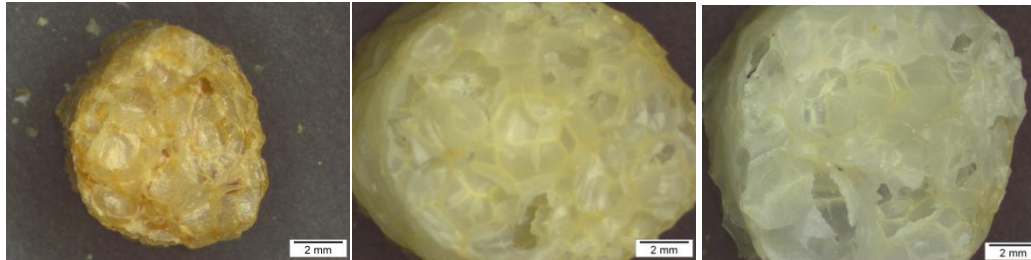
50 %

25 %

Native faba



L. plantarum
fermented



W. confusa
fermented
(EPS)



Challenge: Burning (Maillard reaction), especially with EPS producing LAB

Future: Other applications such as in baking

Benefits of faba bean bioprocessing



Enzymatic treatments

- Phytase treatment as a fast tool to increase
 - protein solubility
 - mineral availability



Microbial food cultures

- Release of proteins and modification of amino acid profile by fermentations
- Reduction of antinutritional compounds
- Biocontrol
- Faba beans provides an excellent base for EPS production → functionality in other applications such as baking, vegetable pastes

Take home messages

- Well-characterised microbes and enzymes as a tool for improving nutritional profile and functional properties of protein-rich legume ingredients and products

→ New product innovations





TECHNOLOGY «FOR BUSINESS»

