Protein2Food - The Processing Challenge

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Prominent Protein Seminar, Rotterdam, NL

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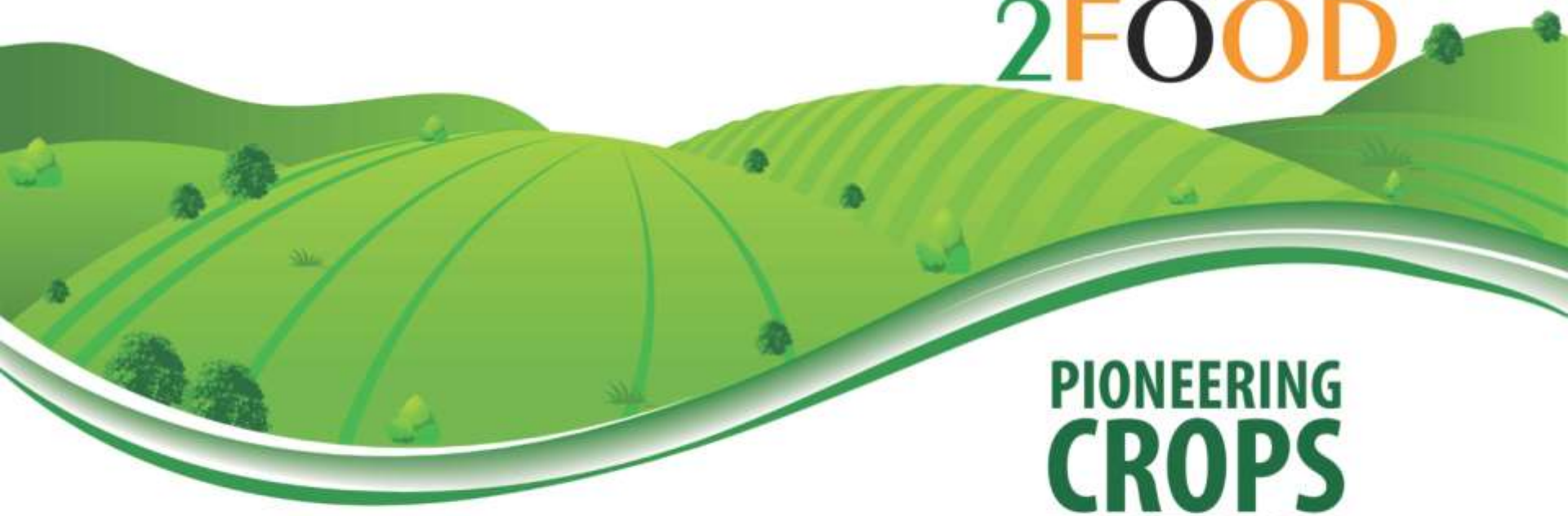

PROTEIN 2FOOD

PIONEERING CROPS FOR FUTURE GENERATIONS

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 635727.

Fraunhofer IVV

In a nutshell

- Research and Innovation Action (RIA)

  TRL 4-5

- Total budget € 8,82 million
- 19 partners (6 SME's)
- 5 year project (2015-2020)

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OBJECTIVES

➢ Development of high quality food protein through sustainable production and processing

- Accelerate protein transition from animal-based protein to plant based protein in Europe with clear impact on reduction of carbon footprint
- Develop high-quality food protein from multi-purpose seed crops and grain legumes and enhance the sustainability of their production and processing.
- Improve food security and human health by produce prototypes of plant-based high value protein food products with exceptional market potential
- Strengthen international research, industrial cooperation and the EU bio-economy by focusing on SME's and small-scale food processing

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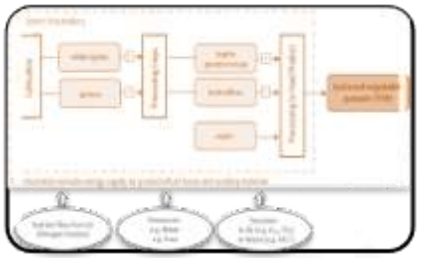
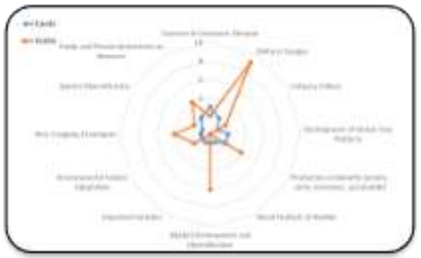
From field to fork



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WP2 – Protein extraction & fractionation

Specific objectives

- Dry-fractionation processes for the production of protein-rich flours from high quality protein crops and legumes
- Mild aqueous extraction processes for White lupin, faba bean, lentil and quinoa
- Plant-based high value protein food ingredients for the development of innovative food products

Challenges

- Protein enrichment from the seeds
- Sustainability – use of side-streams
- Nutritional quality (high protein, low antinutrients)
- Technological functionality
- Sensory quality

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Dry processing approaches

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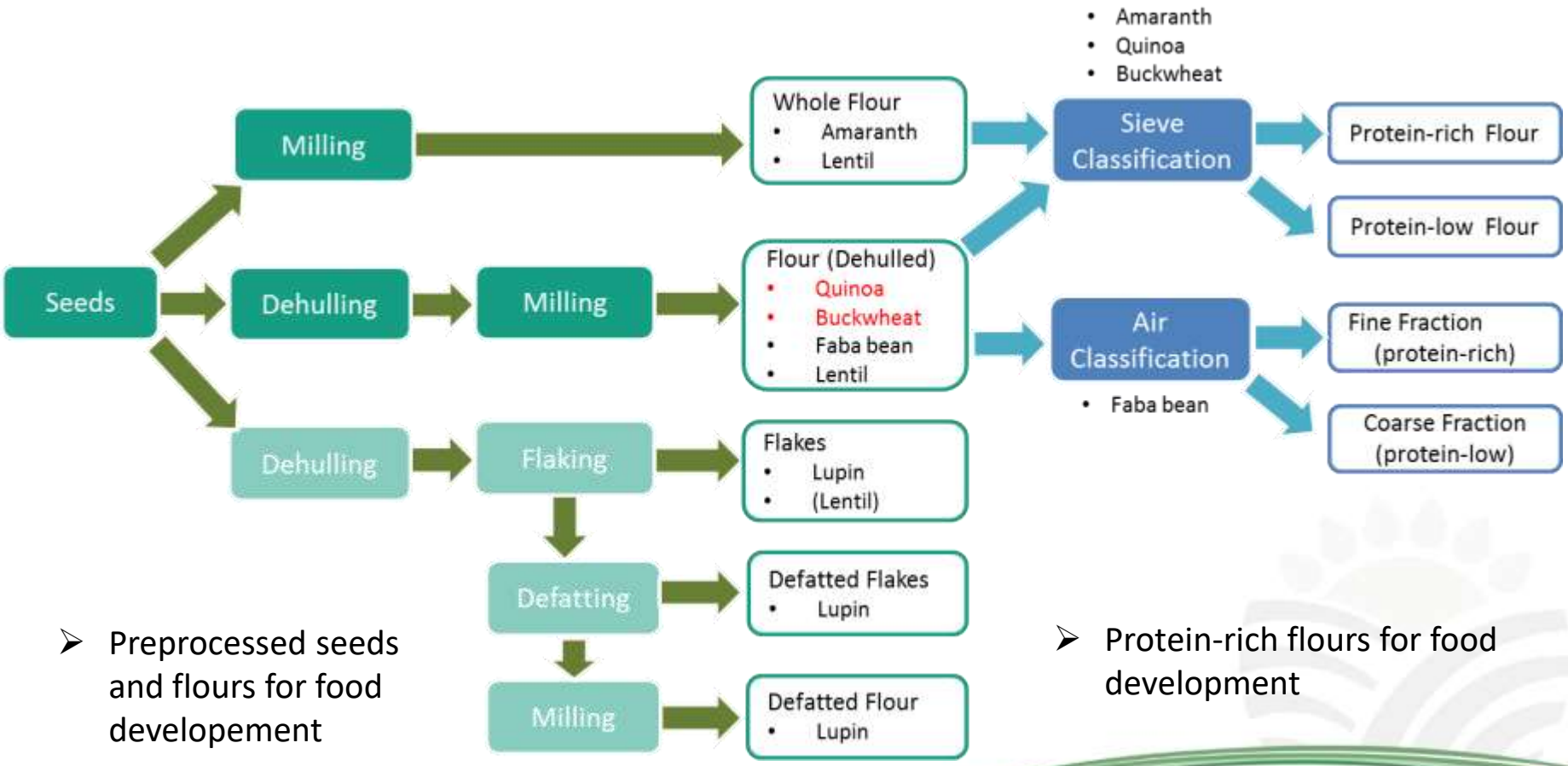

- Preprocessed seeds and flours for food developement
- Protein-rich flours for food development

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Dry fractionation - products

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Prototype flours

Raw material	Flour type	Dry matter [%]	Protein [%]*	Starch [%]*	Fat * [%]*	Product yield [%]**
Quinoa	dehulled	90.8	15.7	63.1	8.9	
'Titicaca'	protein-rich (<710µm)	94.9	35.7	20.5	19.5	30
	protein-low (>710µm)	93.4	7.9	74.6	3.0	70
Amaranth	whole	90.6	15.3	65.3	6.7	
(commercial)	protein-rich (<500µm)	93.1	37.5	9.4	16.6	11
	protein-low (>500µm)	93.3	12.6	67.0	4.7	89
Buckwheat	dehulled	89.5	15.5	67.9	3.7	
(commercial)	protein-rich I	92.5	24.2	53.6	6.2	41
	protein-rich II (>710µm)	92.3	20.3	62.5	4.4	28
	protein-low (<180µm)	89.6	8.0	79.9	1.6	31
Faba bean	dehulled	89.0	36.7	41.2	2.8	
'Imposa'	fine fraction	92.3	67.3	5.0	4.6	39
	coarse fraction	91.2	13.9	70.4	1.2	61

* based on DM; ** % w/w

Protein conversion factors: Quinoa, Amaranth N x 5.85, Buckwheat, Faba bean, Lentil N x 6.25

- Flours with 1.5 – 2-fold higher protein content
- Prototype flours for food development

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Lupin - seed processing

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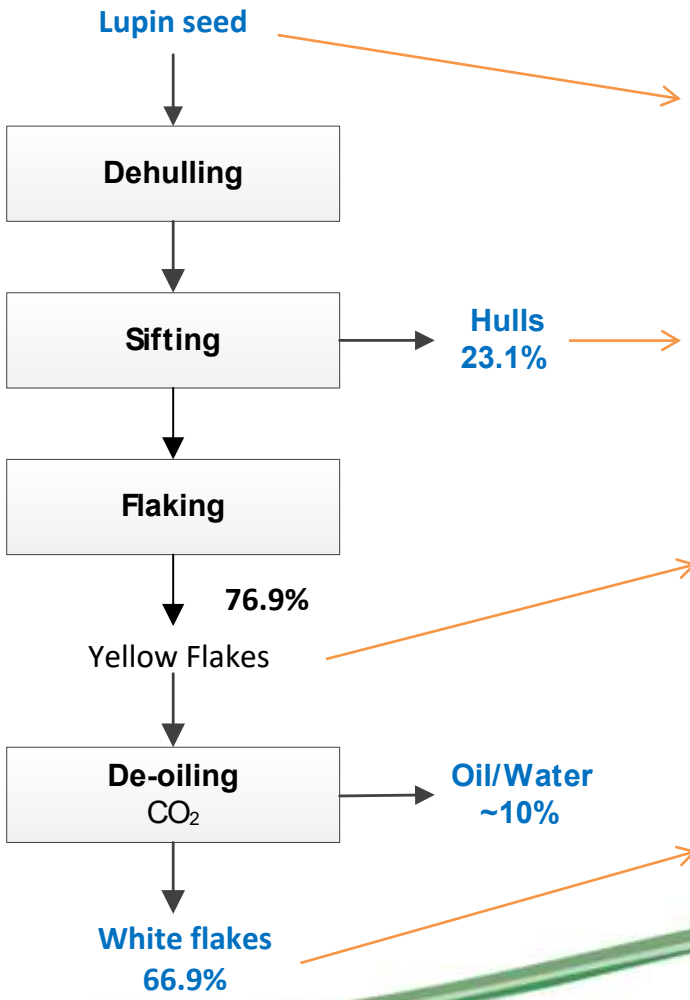
Pre-processing

Lupinus albus

cv. Dieta



Protein/DM: 38.1%

Fat/DM: 14.1 %

Protein/DM: 18.4%

Fat/DM: /

Protein/DM: 44.2%

Fat/DM: 16.7%

Protein/DM: 49.2%

Fat/DM: 3.5%

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Lupin protein extraction

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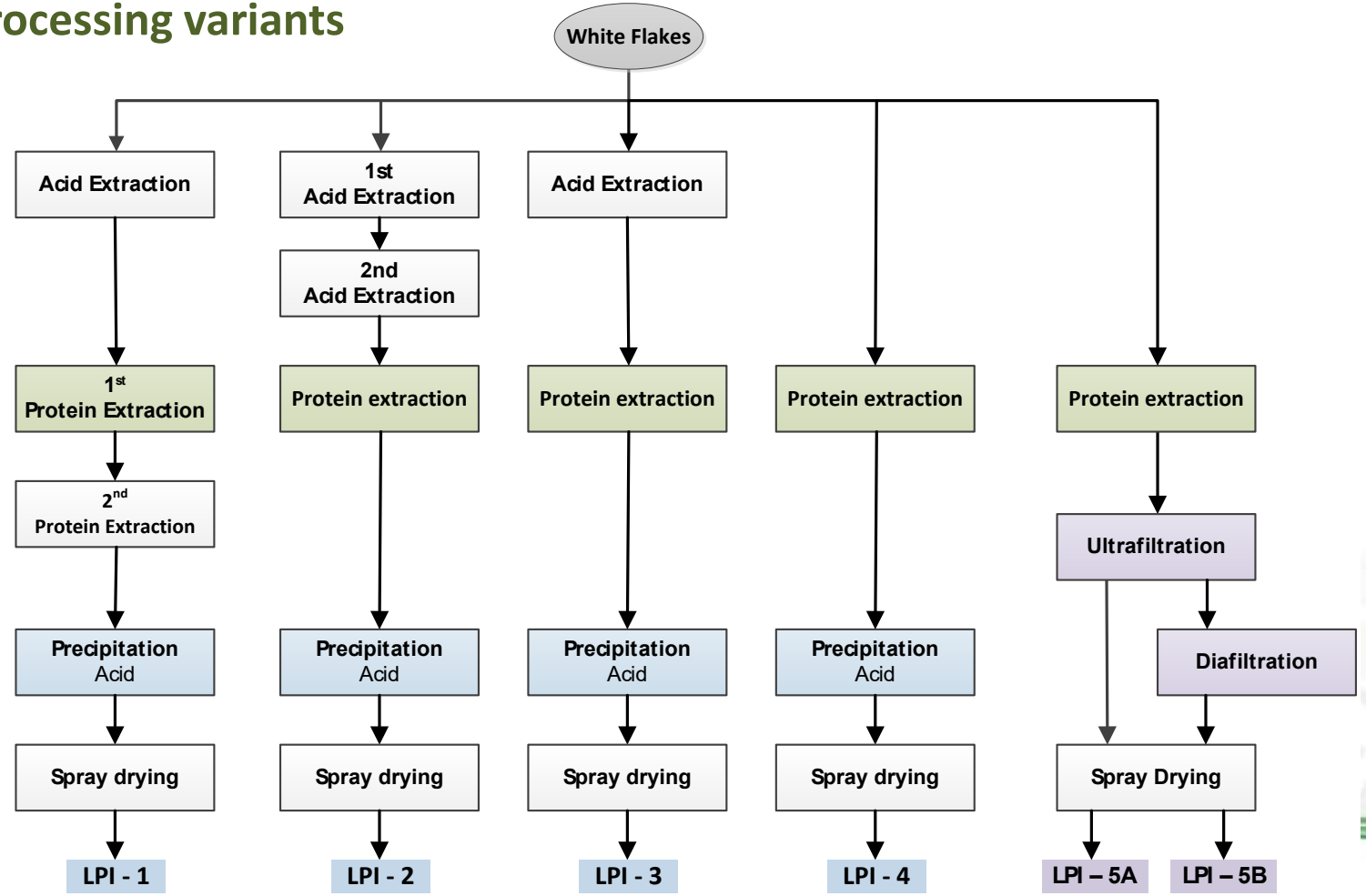
Processing variants



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Lupin protein extraction

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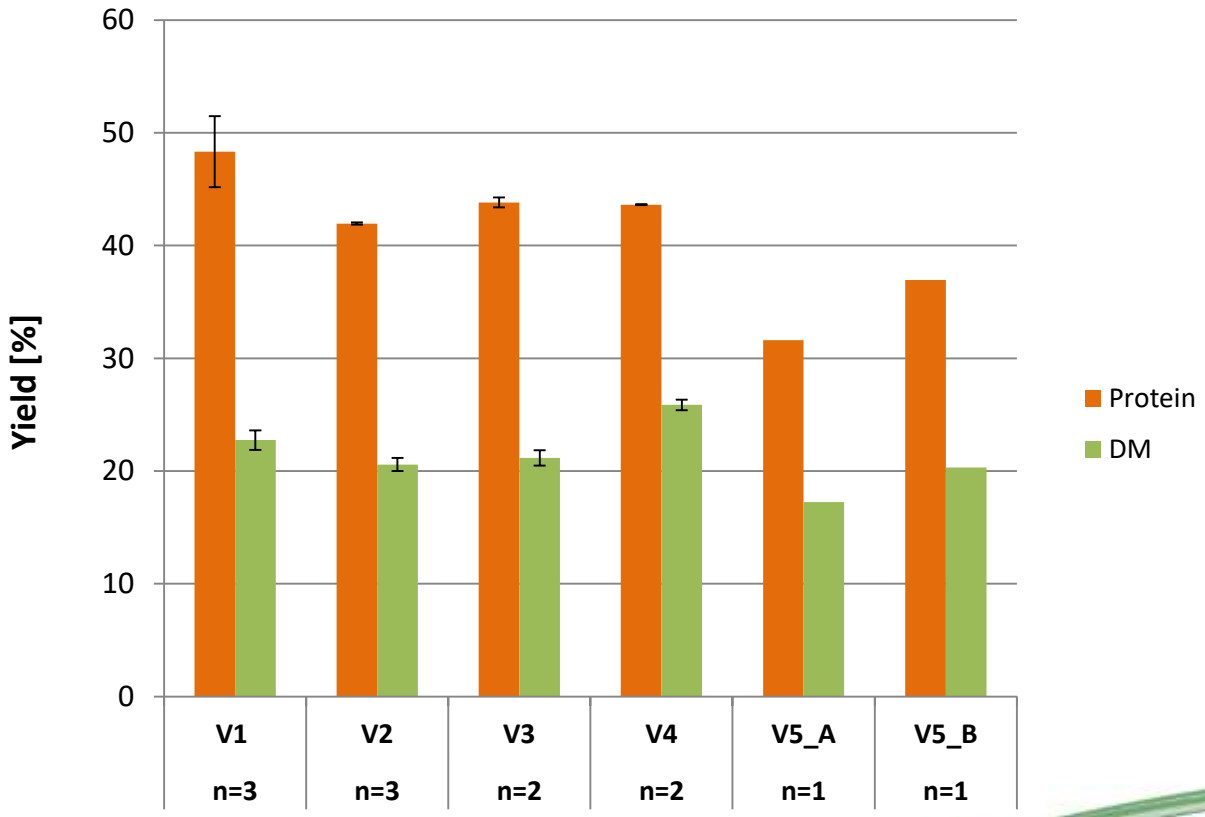
DM and protein yields



- Protein isolates:
  85 – 90% protein on DM
- Protein yields:
  32% (5A) – 48% (1)
- Side stream fractions
  - Nutritional fiber:
    26-35% protein on DM
  - Acid soluble fraction:
    8-9% protein on DM

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Lupin protein extraction

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Analytical evaluation of LPI

Lab scale White lupin (Dieta)	Protein* [% DM]	Protein Solubility [%]	Emulsifying Capacity [ml*g^{-1}]
V 1	89.3	80.5	483
V 2	90.1	79.7	498
V 3	89.1	80.7	458
V 4	85.3	76.2	455
V 5A	84.5	85.1	423
V 5B	89.2	95.7	438
Pilot scale			
White lupin (Butan)	89.7	65.1	245
Blue lupin (Boregine)	98.8	71.1	530

Source: Prolupin

* N*5.7

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Lentil protein extraction

Fraunhofer IVV

Process optimisation

- S:L-ratio
- pH
- T
- Salt

- pH
- T

Lentil Flour → **Aqueous Extraction & Centrifugation** → **Precipitation & Centrifugation** / **Ultrafiltration** → **Drying** → **Protein isolate**





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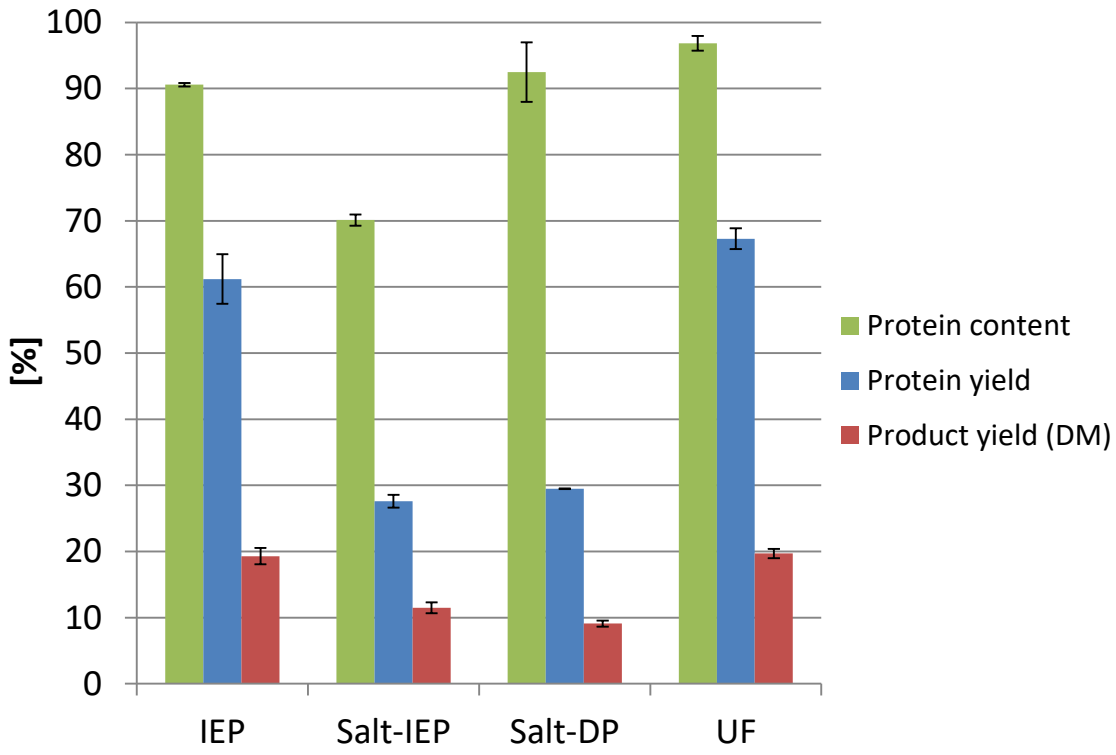
Lentil protein extraction

Fraunhofer IVV

Yields and protein content of isolates (lab-scale)



- Protein conc./isolates:
  69 – 96% protein on DM
- Protein yields:
  28% (Salt IEP) – 67% (UF)
- Side stream fractions
  - Fiber-/Starch fraction:
    5-8% protein on DM
  - Acid soluble protein:
    28-32% protein on DM

N*6.25

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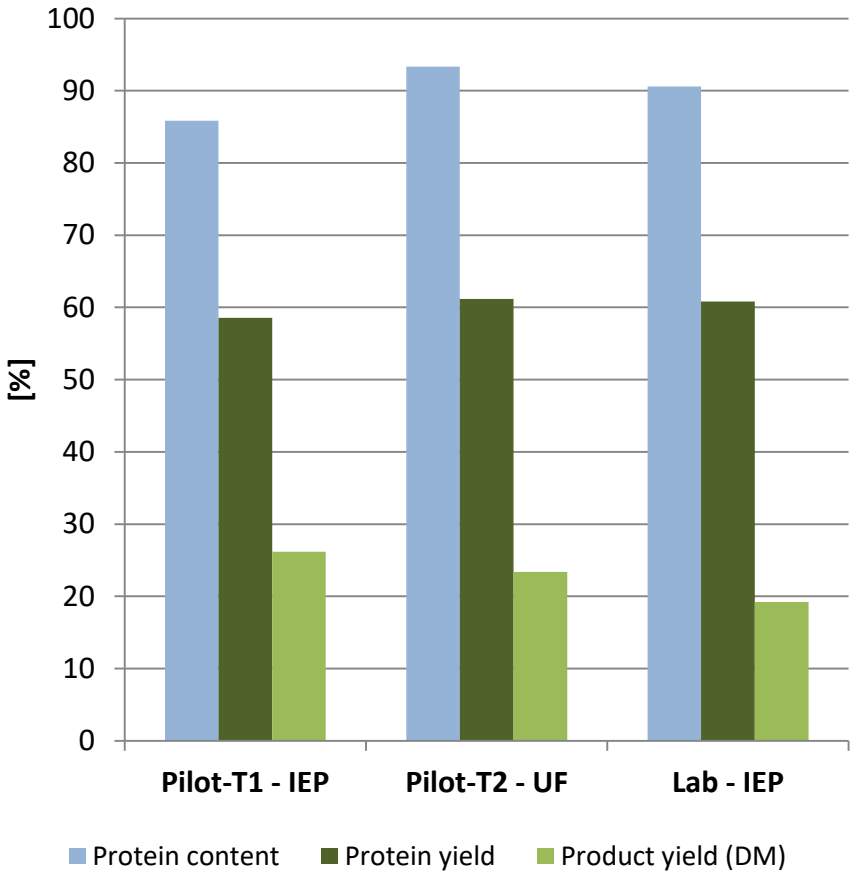
Lentil protein extraction

Pilot scale implementation



- High protein yields of ~ 60%
- Yields comparable to the lab
- Isolates with high protein contents
- Good protein solubility and emulsifying capacity

Isolate	DM [%]	Protein [%]*	Starch [%]*	Protein-solubility [%]	EC [ml/g]
IEP	95,6	85,9	0,4	40.0	580
UF	94,8	93,4	< 0,2	45.9	505

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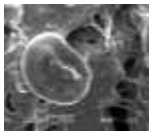
WP3 –Food processing

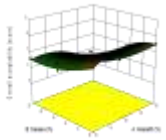
Plant-based High-protein raw materials

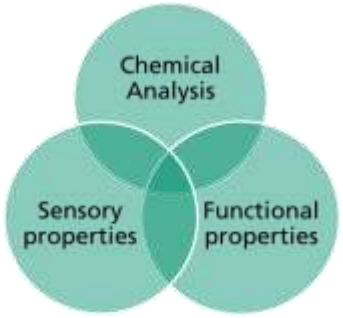
- Flours
- Concentrates
- Isolates

- ✓ Quinoa
- ✓ Buckwheat
- ✓ Amaranth
- ✓ Lupin
- ✓ Faba bean
- ✓ Lentil

Food processing investigation







Protein solubility

Protein network investigation

Control (potato starch) | 2% HPMC | 0.25% Locust bean gum

Food prototyping

Plant-based protein-rich foods

Faba bean IVV 15 %

- ✓ Meat alternatives (spread-like meat, meat analogue),
- ✓ bakery products,
- ✓ pasta,
- ✓ beverages (vegetable milk, smoothies),
- ✓ infant foods (powder infant formulas)

Development of vegetarian spread-like meat substitutes

Development of different types of spreads:

- Optimized amino acid composition by combinations of quinoa/ faba bean and buckwheat/lupin
- High in protein (20% of the energy value is provided by protein)
- Different flavours (Curry, Chives and Tomato)
- Excellent texture and good sensory properties
- Feasible with standard meat pilot plant equipment

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Conclusions and outlook

- ✓ Dry processing provided protein-rich flours (1.5-2-fold higher protein content) of high quality protein crops and legumes for food development
- ✓ Developed solutions for the mild aqueous bioprocessing of lupin and lentils enable the production of novel ingredients with high protein content, low content of antinutrients and good sensory properties
- ✓ The novel protein fractions can be used as ingredient toolbox for the development of innovative protein-rich food prototypes

- ➢ Process development for the production of protein isolates from faba bean and quinoa – optimisation and scale-up
- ➢ Assessment of side-streams
- ➢ Application of protein-rich fractions for development of meat analogues and breakfast cereals

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Thank you for your attention

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