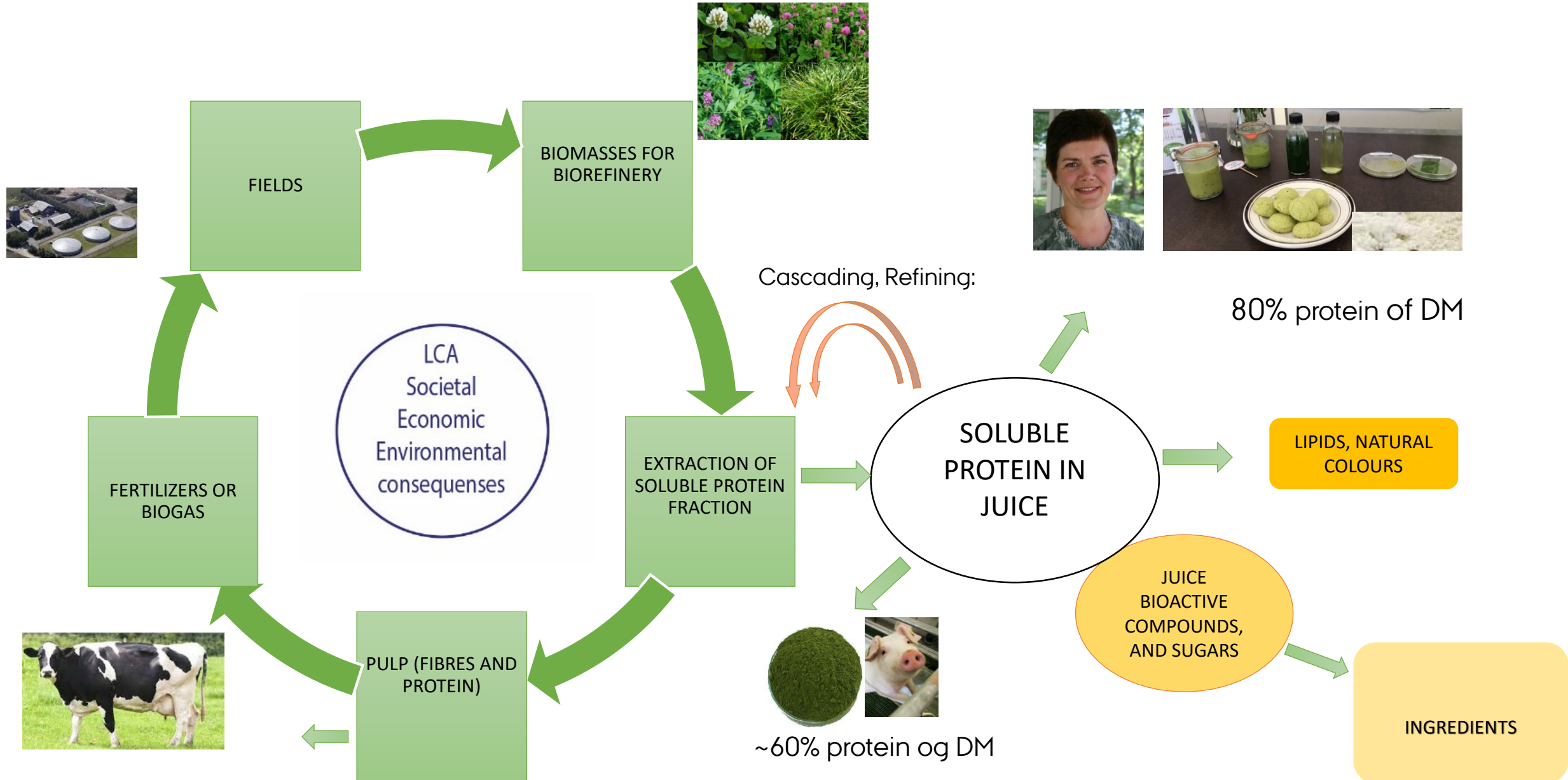


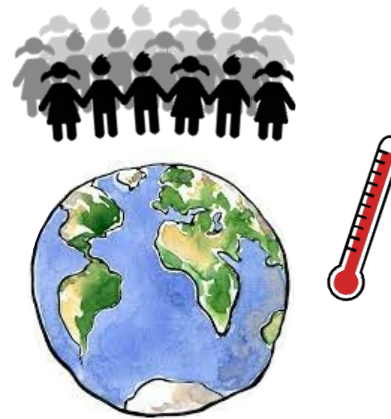
FØDEVARER FRA GRØN BIOMASSE

GREEN BIOMASS – SUSTAINABLE PROTEIN AND INGREDIENTS



WHAT IS MOSTLY NEEDED?

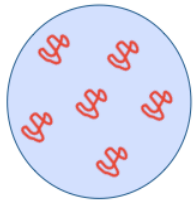
- Dietary transition towards plant-based food
- Sustainable production of high-quality protein
 - Plant-based
 - Local sources



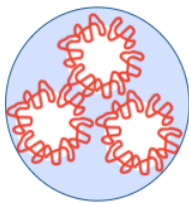
WHAT MATTERS?

- Functionality and taste

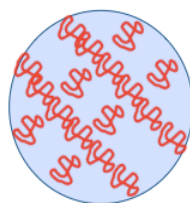
 = Protein  = Water  = Air  = Oil



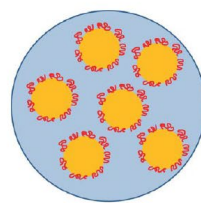
Solubility



Foaming



Gelation







Emulsifier

- Nutritional value

- Amino acid composition
- Bioavailability

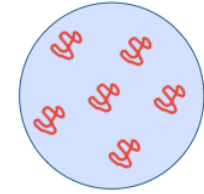
IS THIS NEEDED?



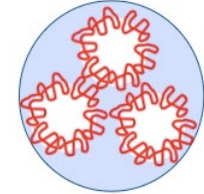
 = protein  = air
 = water  = oil



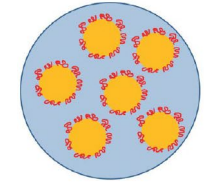
Solubility



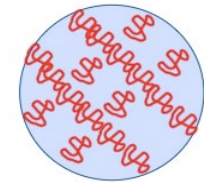
Foaming



Emulsification



Gelling



WHAT DOES THE FOOD INDUSTRY REQUEST?

Cheap high quality protein



WHAT DOES THE FOOD INDUSTRY REQUEST?

Cheap high quality protein

- White tasteless powder







WHAT DOES THE FOOD INDUSTRY REQUEST?

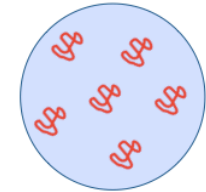
Cheap high quality protein

- White tasteless powder
- High solubility and good functional properties

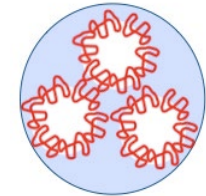


 = protein  = air
 = water  = oil

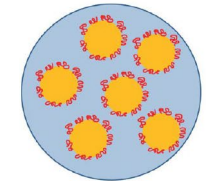
Solubility



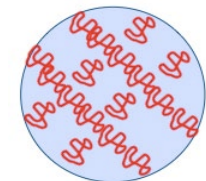
Foaming



Emulsification



Gelling







WHAT DOES THE FOOD INDUSTRY REQUEST?

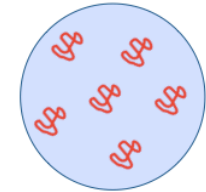
Cheap high quality protein

- White tasteless powder
- High solubility and good functional properties
- High nutritional value
- Low in antinutrients

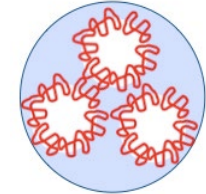


 = protein  = air
 = water  = oil

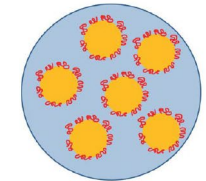
Solubility



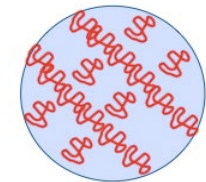
Foaming



Emulsification



Gelling







WHAT DOES THE FOOD INDUSTRY REQUEST?

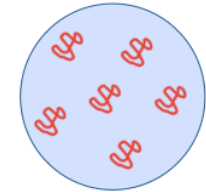
Cheap high quality protein

- White tasteless powder
- High solubility and good functional properties
- High nutritional value
- Low in antinutrients
- Easy to handle and process

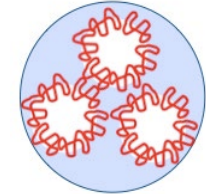


 = protein  = air
 = water  = oil

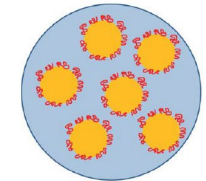
Solubility



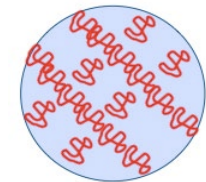
Foaming



Emulsification



Gelling

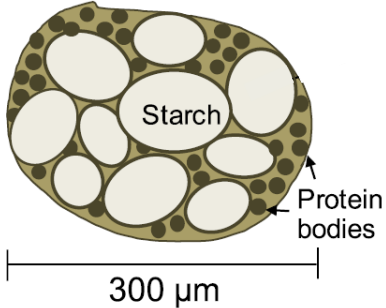


CHALLENGES AND NEEDS

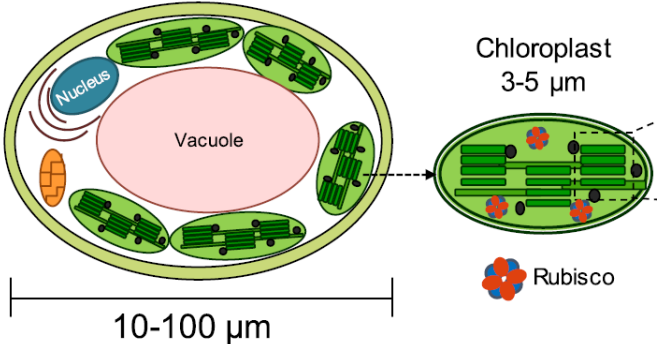
Biorefinery

Optimization of technologies – differs between biomasses

Fragment of legumes



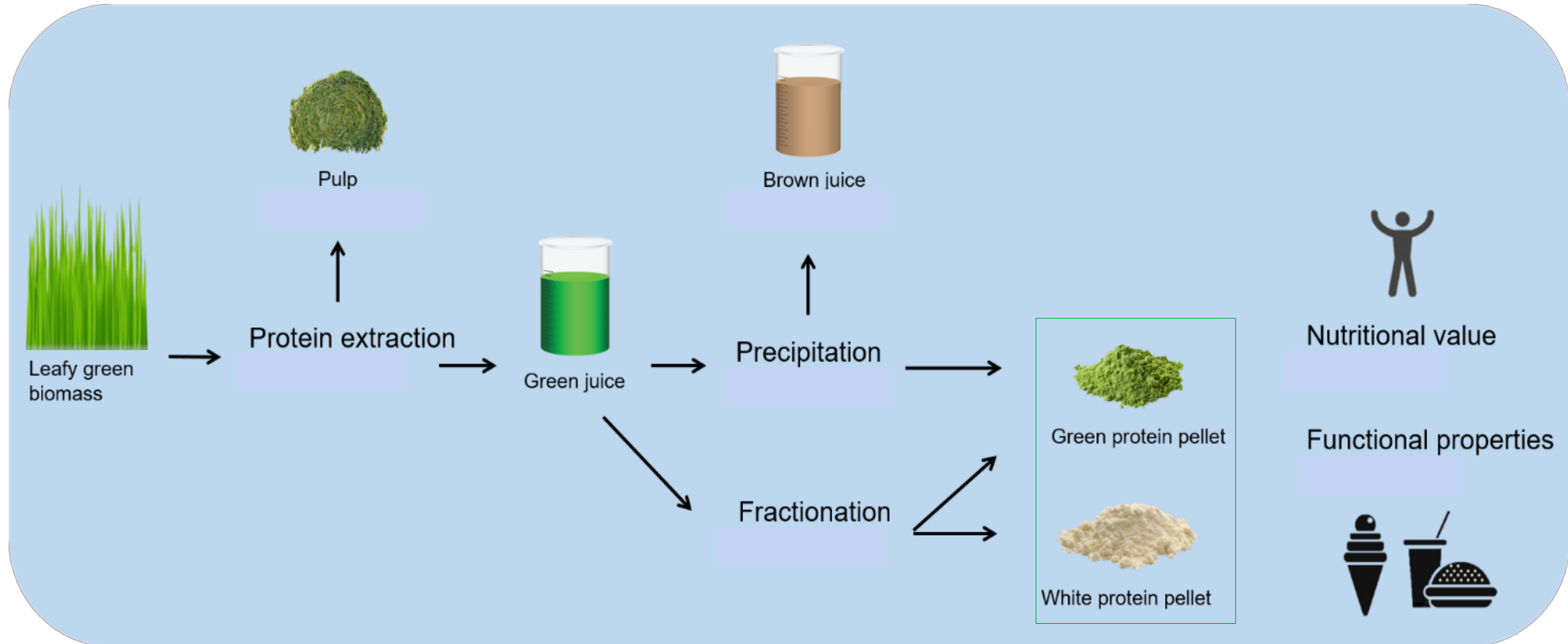
Plant cell



Tenorio et al. 2018 *Understanding differences in protein fractionation from conventional crops, and herbaceous and aquatic biomass – Consequences for industrial use*



PROTEIN EXTRACTION – WHY DO WE PROCESS?



Møller et al., 2021: <https://doi.org/10.1021/acs.jafc.1c04289>

EXAMPLES OF NOVEL BIOMASSES FOR FOOD PROTEIN

- Underexploited biomass
- Upcycle from feed to food



WHY PERENNEIAL GRASSES AND LEGUMES?

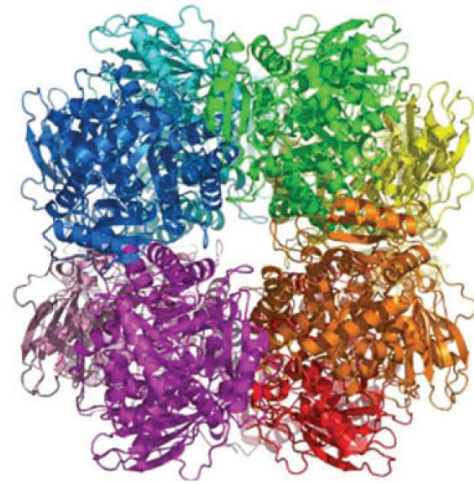
Why leafy legumes and perennial grasses?

- High biomass yield
 - Carbon sequestration and low nutrient leaching
 - Main protein: RuBisCo
 - Essential amino acids
-
- Alfalfa, clovers, ryegrass...



HIGH-QUALITY PROTEIN?

- Essential amino acids: Lysine and methione often limiting in plants
- RuBisCo fulfills the amino acid recommendation from FAO/WHO
 - RuBisCo constitute up till 60 % of the soluble protein fraction



RuBisCo

Amino acid (g / 100 g protein)	RuBisCo [^]	Alfalfa protein concentrate (40% of DM) [#]	FAO/WHO
Lysine	6.5	8.5	5.7
Threonine	5.3	6.3	3.1
Cysteine + methionine	3.4	6.3	2.7
Valine	6.7	7.0	4.3
Isoleucine	4.9	5.7	3.2
Leucine	9.4	11.0	6.6
Phenylalanine + tyrosine	12.8	7.3*	5.2
Histidine	3.9	3.1	2.0

[^]Møller et al. (2021). Biorefinery of green biomass – how to extract and evaluate high quality leaf protein for food? *J. Agric. Food Chem.* 69 (48), 14341 – 14357

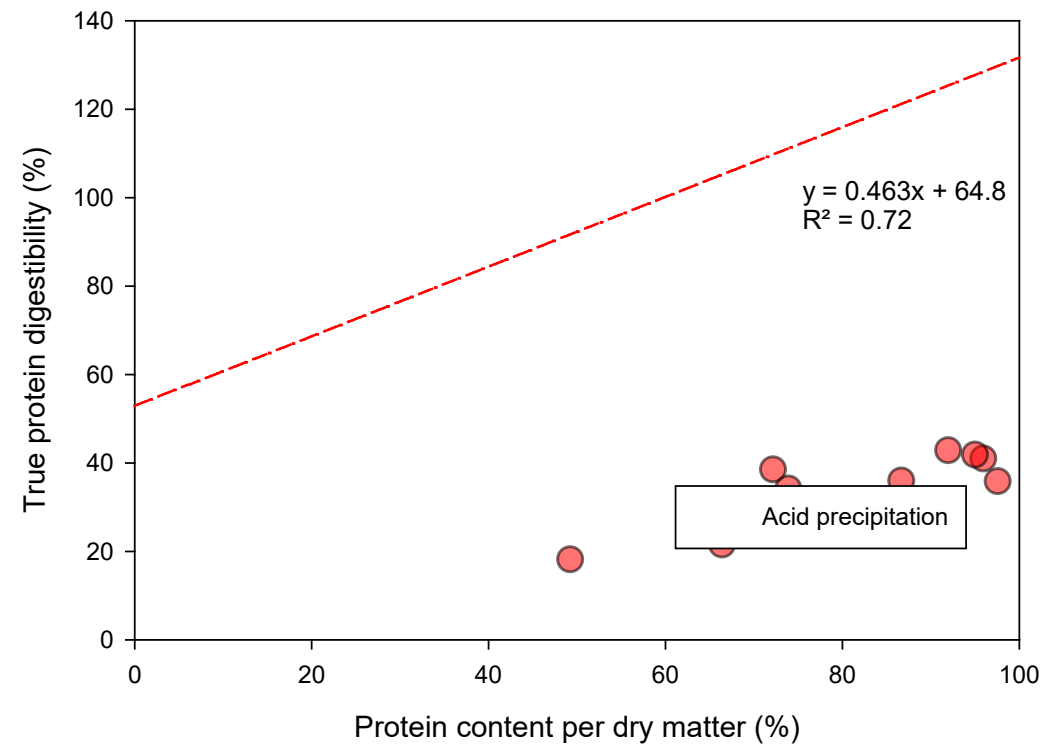
<https://doi.org/10.1021/acs.jafc.1c04289>

[#]Nissen et al. (2022). Protein recovery and quality of alfalfa extracts obtained by acid precipitation and fermentation. *Bioresource Technology Reports*

<https://doi.org/10.1016/j.biteb.2022.101190>

PROTEIN CONTENT – PROTEIN DIGESTIBILITY

- Protein extraction to increase concentration and digestibility
 - Remove fibers and antinutritional factors



Møller et al., 2021: <https://doi.org/10.1021/acs.jafc.1c04289>

EXAMPLES OF ANTINUTRIENTS

Anti-nutritional factors

Saponins

Phytic acid

Lectin

Protease inhibitor

Others.....

SAPONINS

Anti-nutritional factors

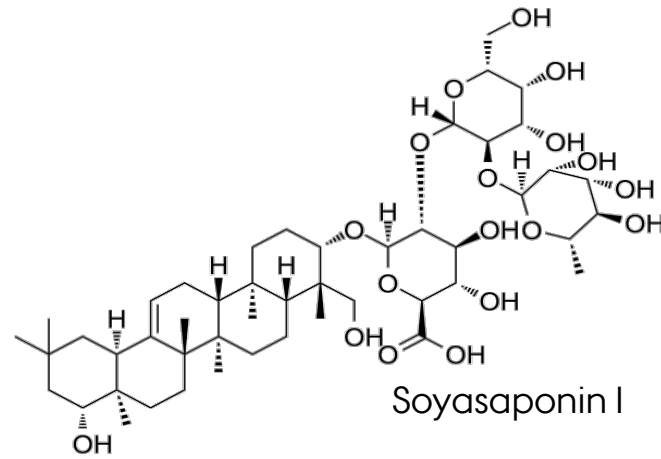
Saponins

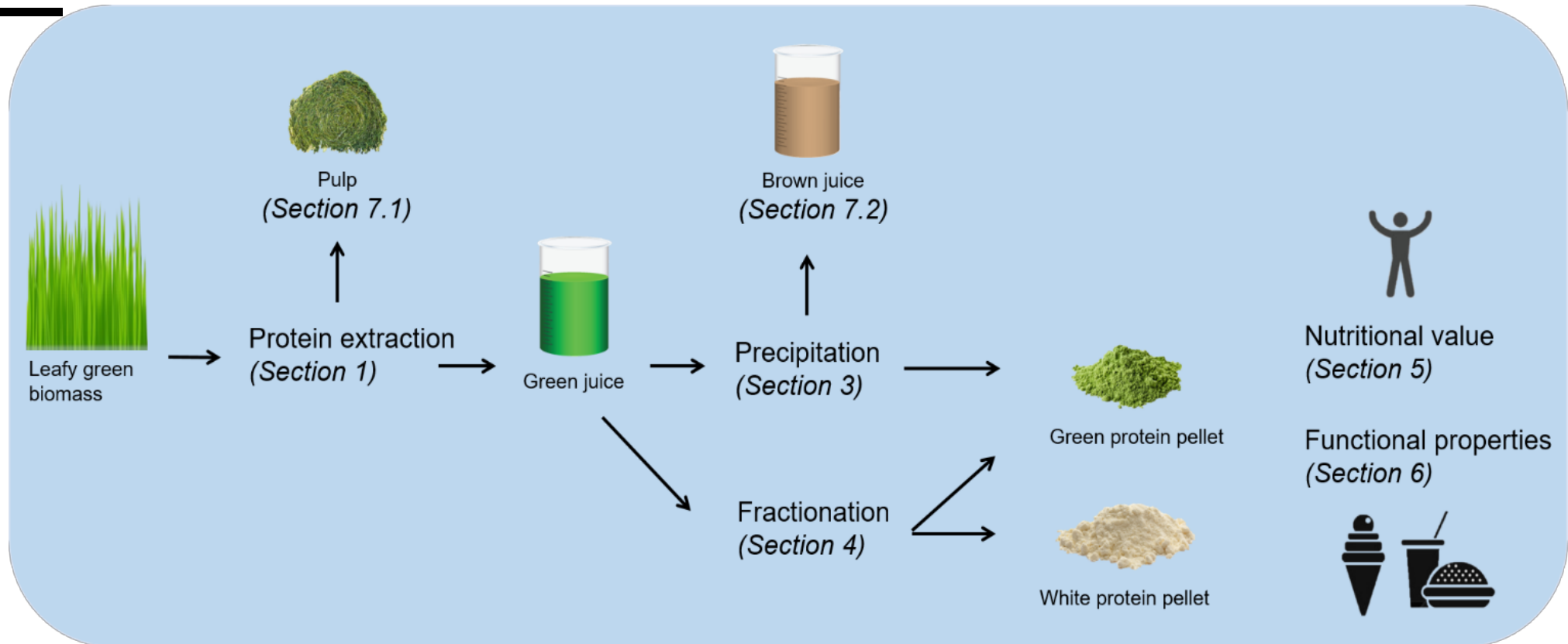
Phytic acid

Lectin

Protease inhibitor

Others.....





STUDIES FROM GREEN BIOMASS – FOOD PROTEIN

Food Hydrocolloids 119 (2021) 106874



International Journal of Food Science and Technology 2020

Original article

Improved solubility of proteins from white and red clover – inhibition of redox enzymes

Bashar Amer,¹ Louise Juul,^{1,2} Anders Hauer Møller,^{1,2,3} Hanne Søndergård Møller¹ & Trine Kastrup Dalsgaard^{1,2,3*}



Contents lists available at ScienceDirect

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journal homepage: www.elsevier.com/locate/lwt



RuBisCO from alfalfa – native subunits preservation through sodium sulfite addition and reduced solubility after acid precipitation followed by freeze-drying

Hartono Tanambell,^{a,b} Anders Hauer Møller^{a,b,c}, Milena Corredig^{a,b}, Trine Kastrup Dalsgaard^{a,b,c,*}



Article

Simultaneous Determination of L- and D-Amino Acids in Proteins: A Sensitive Method Using Hydrolysis in Deuterated Acid and Liquid Chromatography–Tandem Mass Spectrometry Analysis

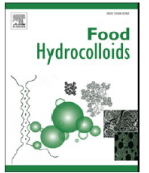
Marianne Danielsen^{1,2,*}, Caroline Nebel¹ and Trine Kastrup Dalsgaard^{1,2,3}



Contents lists available at ScienceDirect

Food Hydrocolloids

journal homepage: www.elsevier.com/locate/foodhyd



Increased solubility and functional properties of precipitated Alfalfa protein concentrate subjected to pH shift processes

Signe H. Nissen^{a,b}, Jesper M. Schmidt^a, Sandra Gregersen^{a,c}, Marianne Hammershøj^{a,b,c}, Anders H. Møller^{a,b,c}, Marianne Danielsen^{a,b,c}, Lene Stødkilde^{b,d}, Caroline Nebel^a, Trine K. Dalsgaard^{a,b,c,*}

JOURNAL OF
**AGRICULTURAL AND
FOOD CHEMISTRY**

pubs.acs.org/JAFC

Review

Biorefinery of Green Biomass—How to Extract and Evaluate High Quality Leaf Protein for Food?

Anders Hauer Møller, Marianne Hammershøj, Natalia Hachow Motta dos Passos, Hartono Tanambell, Lene Stødkilde, Morten Ambye-Jensen, Marianne Danielsen, Søren K. Jensen, and Trine K. Dalsgaard*



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journal homepage: www.sciencedirect.com/journal/bioresource-technology-reports



Protein recovery and quality of alfalfa extracts obtained by acid precipitation and fermentation

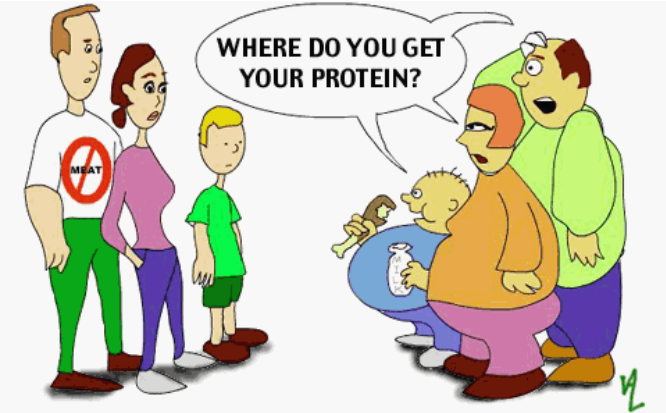
Signe Hjerrild Nissen^{a,c}, Mette Lübeck^b, Anders Hauer Møller^{a,c,d}, Trine Kastrup Dalsgaard^{a,c,d,*}



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