HVAD HAR VI GJORT INDTIL NU - HVAD SKAL DER TIL AT FOR AT NÅ FRA FODER TIL FØDEVAREPROTEIN?

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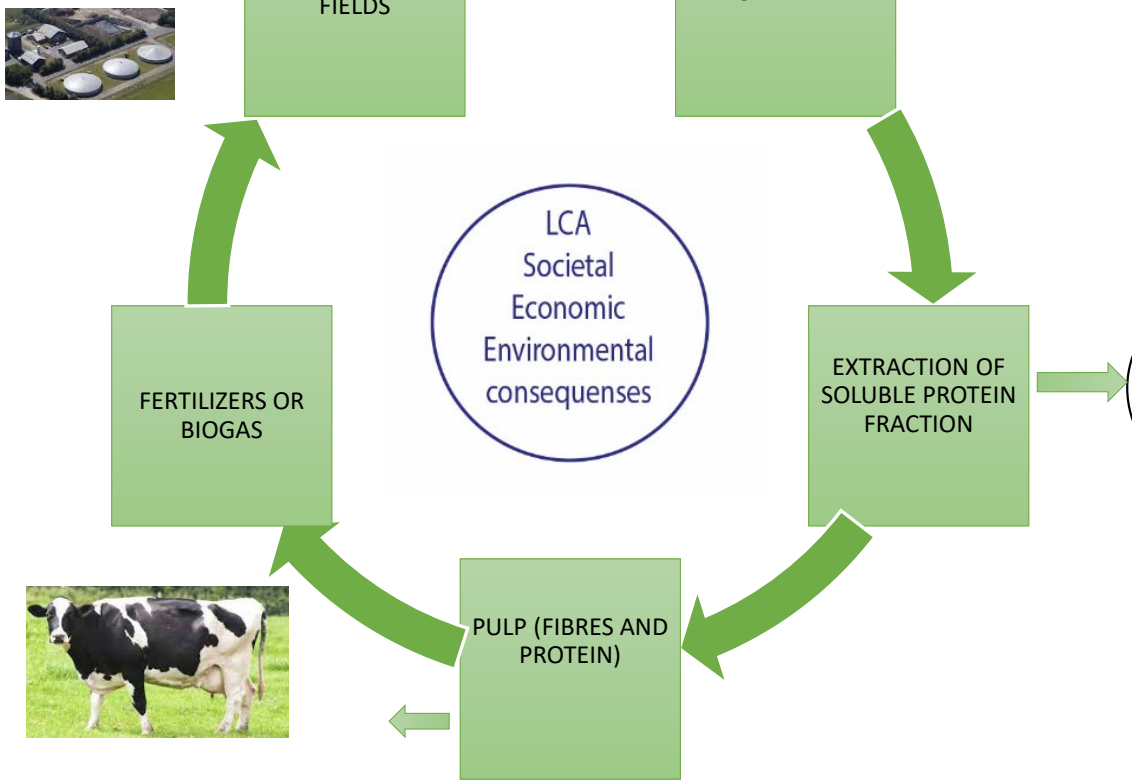
GREEN BIOMASS – SUSTAINABLE PROTEIN FOR FEED?



Is it economical feasible?

SOLUBLE PROTEIN IN JUICE

~50-60% protein of DM

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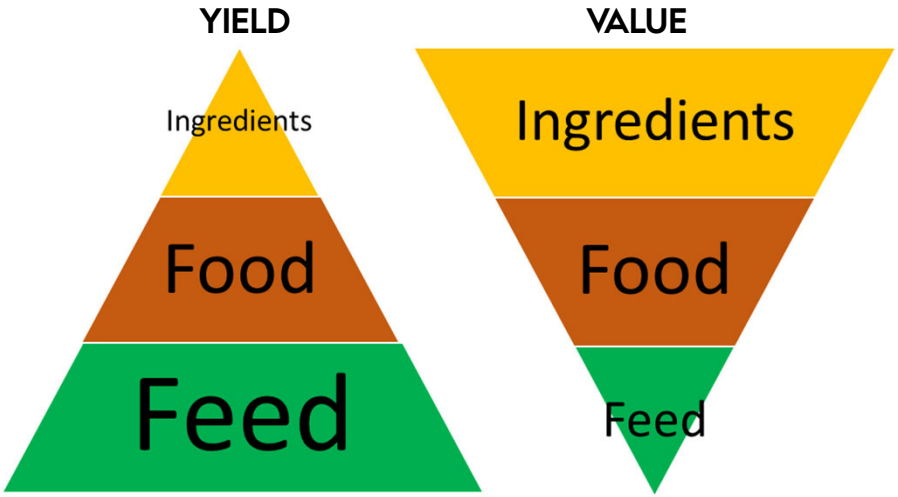
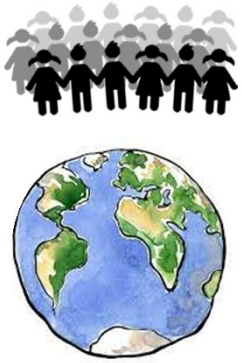
WHAT IS MOSTLY NEEDED?

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





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GREEN BIOMASS – SUSTAINABLE PROTEIN AND INGREDIENTS

FIELDS

BIOMASSES FOR BIOREFINERY

80% protein of DM

Cascading, Refining:

LCA
Societal
Economic
Environmental
consequenses

EXTRACTION OF SOLUBLE PROTEIN FRACTION

SOLUBLE PROTEIN IN JUICE

~60% protein og DM

FERTILIZERS OR BIOGAS

PULP (FIBRES AND PROTEIN)

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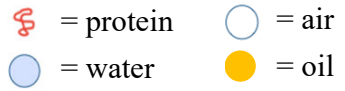
IS THIS NEEDED?

Maybe but.....

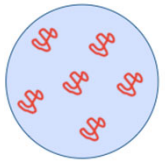
WHAT DOES THE FOOD INDUSTRY REQUEST?

Cheap high quality protein

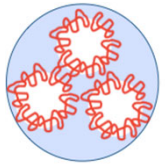
- White tasteless powder
- High solubility and good functional properties
- High nutritional value
- Low in antinutrients
- Easy to handle and process



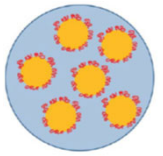
Solubility



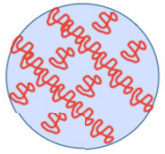
Foaming



Emulsification



Gelling



Nissen et al. (2021). Increased solubility and functional properties of precipitated Alfalfa protein concentrate subjected to pH shift processes. *Food Hydrocolloids* 106874 https://doi.org/10.1016/j.foodhyd.2021.106874

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

Renaudeau et al. (2022). Nutritional values of forage-legume-based silages and protein concentrates in growing pigs. *Animal Sci.* 16: 100572. doi.org/10.1016/j.animal.2022.100572

Tanambell et al. (2022). Use of Membrane Filtration in Fractionating and Concentrating Alfalfa Proteins. Nizo conference

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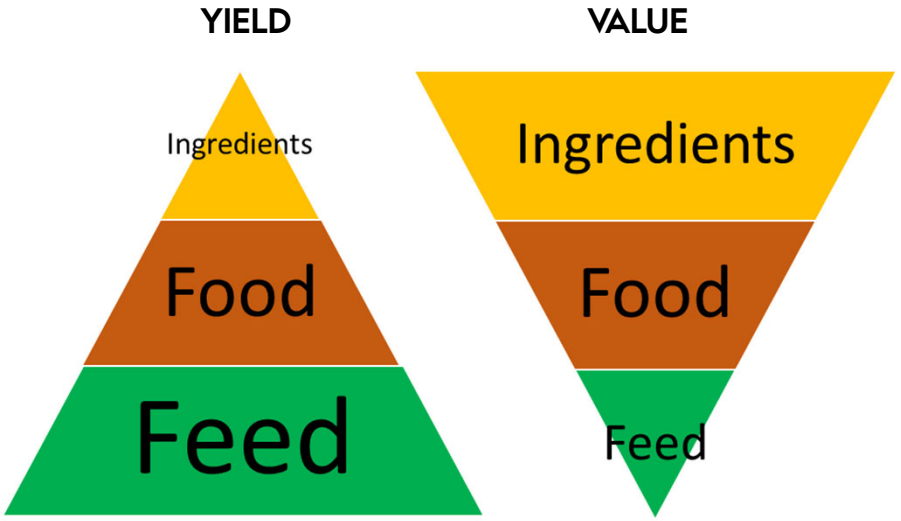
EXAMPLES OF NOVEL BIOMASSES FOR FOOD PROTEIN

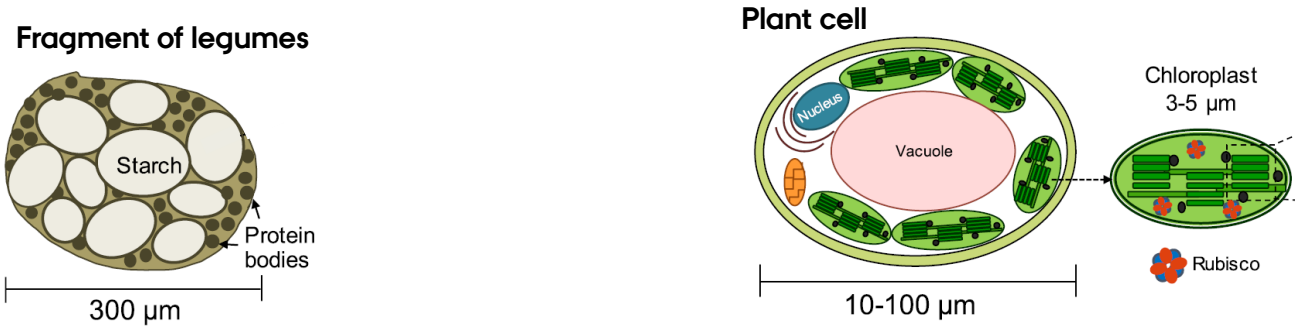
- Underexploited biomass
- Upcycle from feed to food



CHALLENGES AND NEEDS

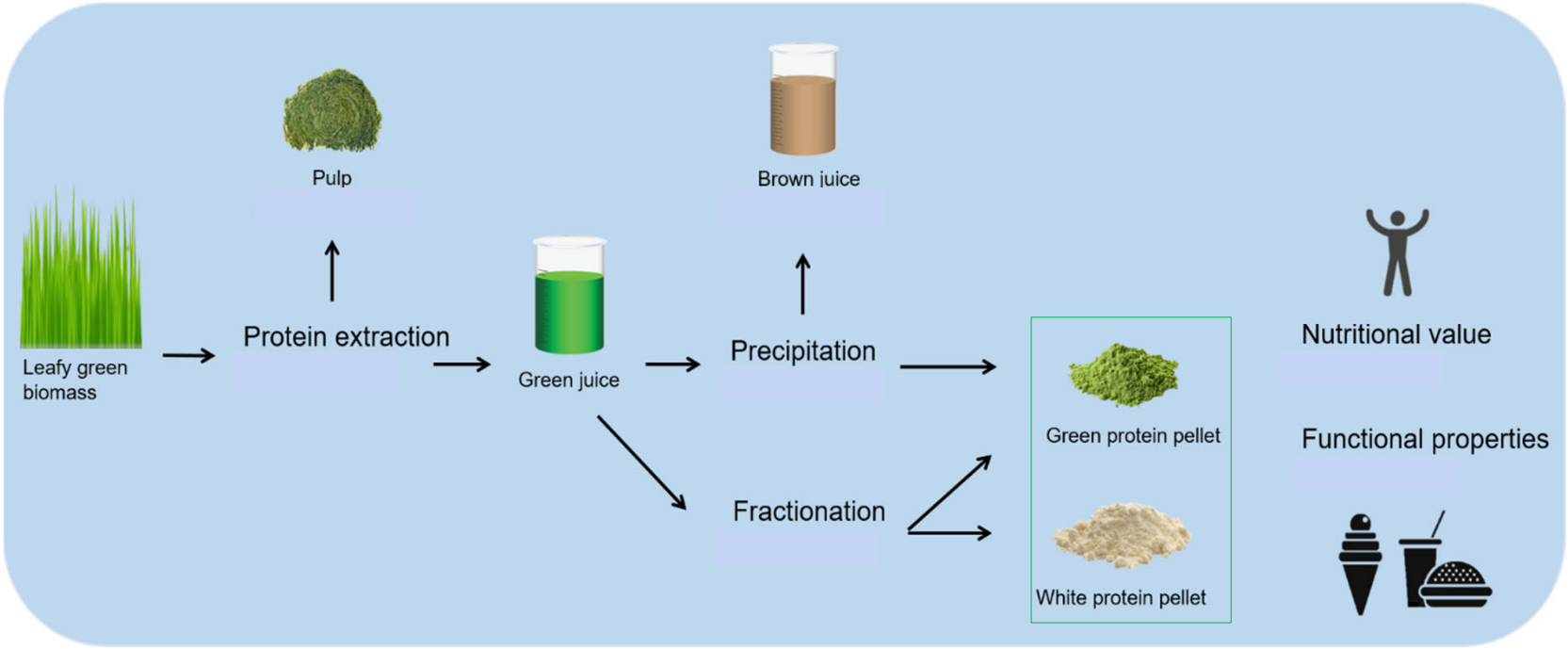
Biorefinery

Optimization of technologies – differs between biomasses



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?



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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

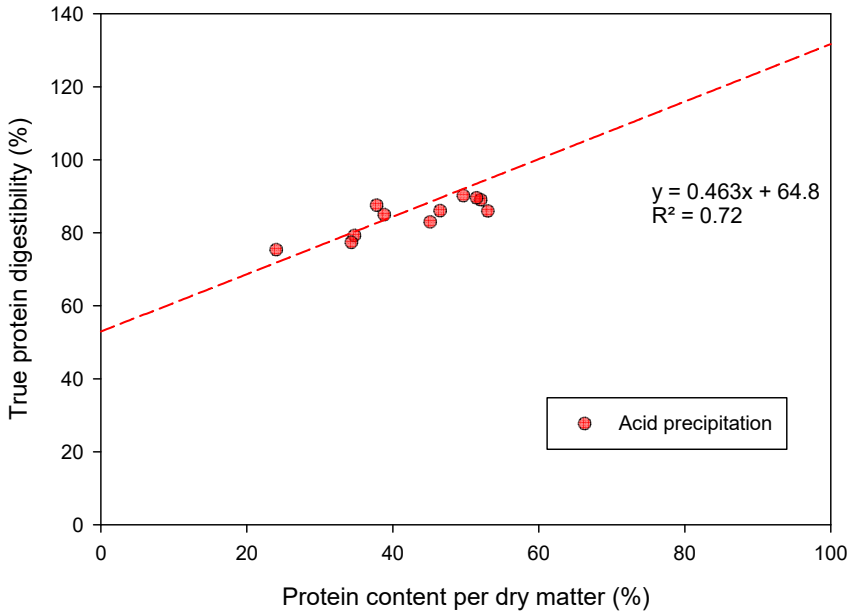
Amino acid (g / 100 g protein)	RuBisCo^	Alfalfa protein concentrate (40% of DM)#	FAO/WHO
Lysine	**6.5**	**7.3**	5.7
Threonine	**5.3**	**5.4**	3.1
Cysteine + methionine	**3.4**	**3.3**	2.7
Valine	**6.7**	**6.0**	4.3
Isoleucine	**4.9**	**4.8**	3.2
Leucine	**9.4**	**9.4**	6.6
Phenylalanine + tyrosine	**12.8**	**6.3***	5.2
Histidine	**3.9**	**2.6**	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

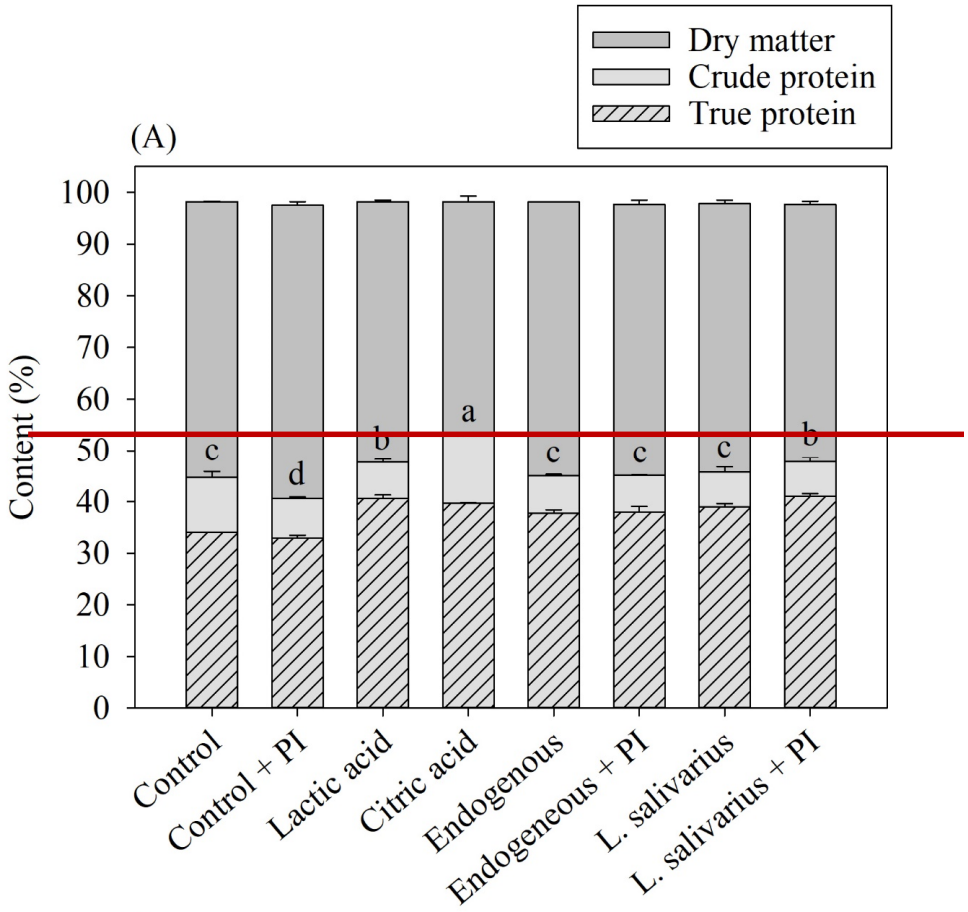
PROTEIN CONTENT – PROTEIN DIGESTIBILITY

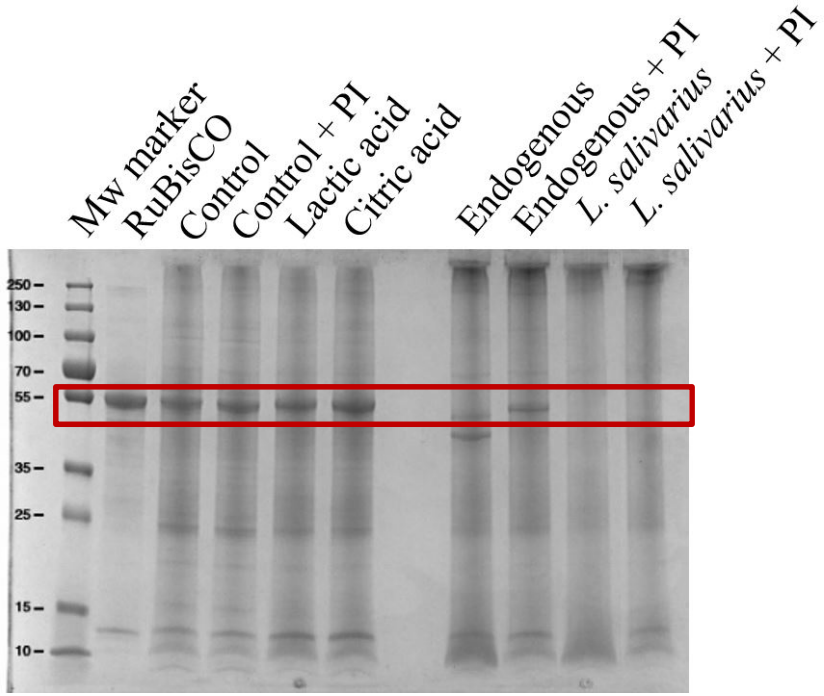
- Protein extraction to increase concentration and digestibility
  - Remove fibers, ash and antinutritional factors



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

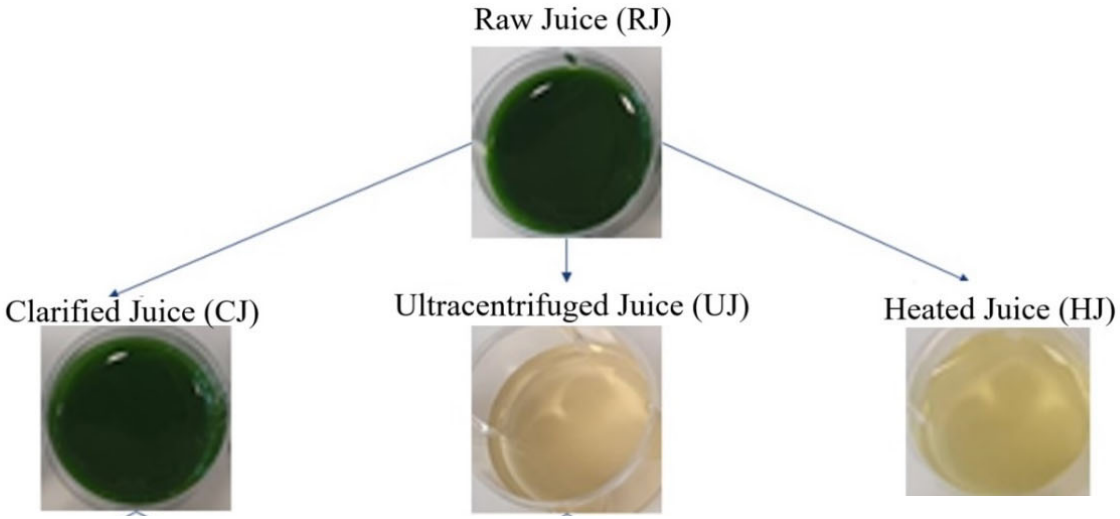
FERMENTATION AND ACID PRECIPITATION





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

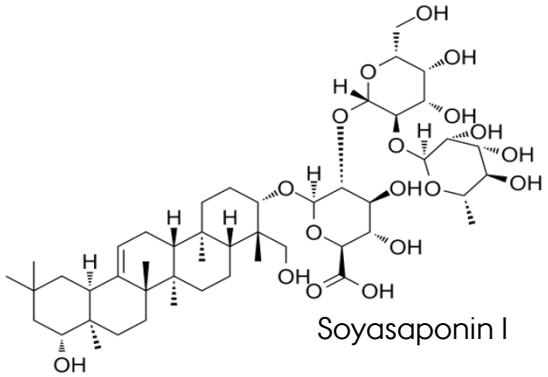
REMOVAL OF GREEN COLOR



Tanambell, H, Møller, AH, Roma, L, Corredig, M, Dalsgaard, TK. Submitted manuscript

SAPONINS

Anti-nutritional factors
Saponins
Phytic acid
Lectin
Protease inhibitor
Redox enzyme



Soyasaponin I

Saponins high in acid precipitated alfalfa protein concentrate

Other separation technologies are needed

Sofie Freud (2022), BSc. Assessment and Analysis of Triterpenoid Saponins in Alfalfa – Fate of Saponins during Alfalfa Protein Extraction

Tanambell et al. (2022). Use of Membrane Filtration in Fractionating and Concentrating Alfalfa Proteins. Nizo conference
Tanambell et al. (2022). Submitted manuscript

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EXAMPLES OF ANTINUTRIENTS

Anti-nutritional factors
Saponins
Phytic acid
Lectin
Protease inhibitor
Redox enzyme

Enzymatic browning

Amer & Juul *et al.* (2021). Improved solubility of proteins from white and red clover - inhibition of redox enzymes *Int J Food Sci Tech* 56, 302–311 doi.org/10.1111/ijfs.14632

Tanambell *et al*. (2022). RuBisCO from Alfalfa – Native Subunits Preservation through Sodium Sulfite Addition and Reduced Solubility after Acid Precipitation Followed by Freeze-Drying. *LWT,* 154, 112682, https://doi.org/10.1016/j.lwt.2021.112682

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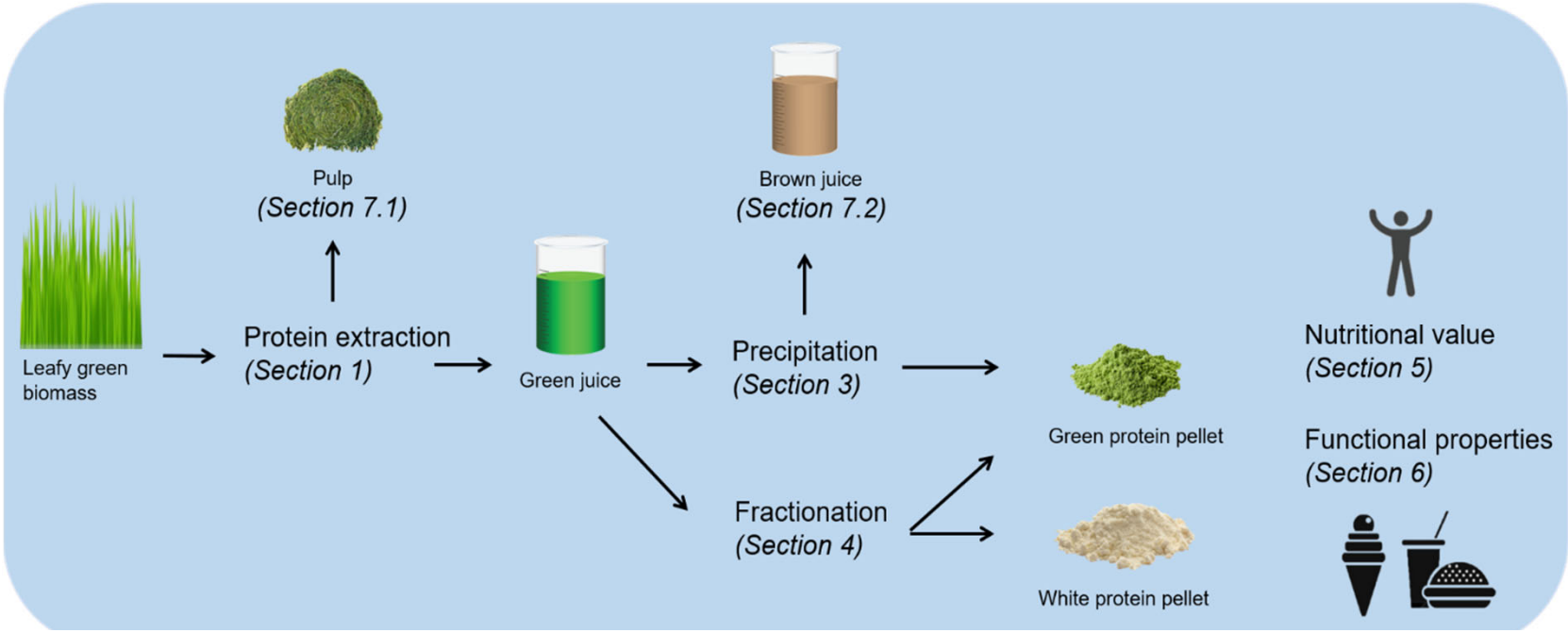
THAT'S WHY WE BIOREFINE



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ACKNOWLEDGMENTS

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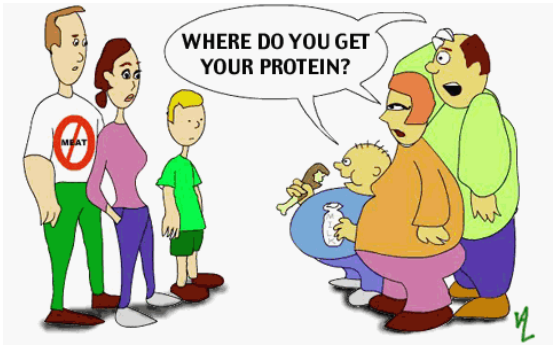
CiFOOD CENTRE OF INNOVATIVE FOOD RESEARCH



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