Dry Fractionation for Production of Plant Protein Concentrates

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Introduction

- New Canadian dietary guidelines emphasize the consumption of “protein-rich foods – especially from plants”
- Incorporating more plant-based proteins into the Canadian diet requires innovation to bring new, healthy and tasty foods to market
- Pulses are a common source of dietary protein as they have a high protein content (>20 g protein/100 g dry matter)
- A sustainable method to obtain protein concentrates from pulses is dry fractionation, using milling and air classification techniques

Dry Fractionation & Pulse Morphology

- Milling can disentangle protein bodies and other cellular compounds into flour with particles of different composition
- In peas, cotyledon cells consist of starch granules (>20 µm) embedded in a matrix of protein bodies (1-3 µm) surrounded by a fibre-rich wall (Figure 1)

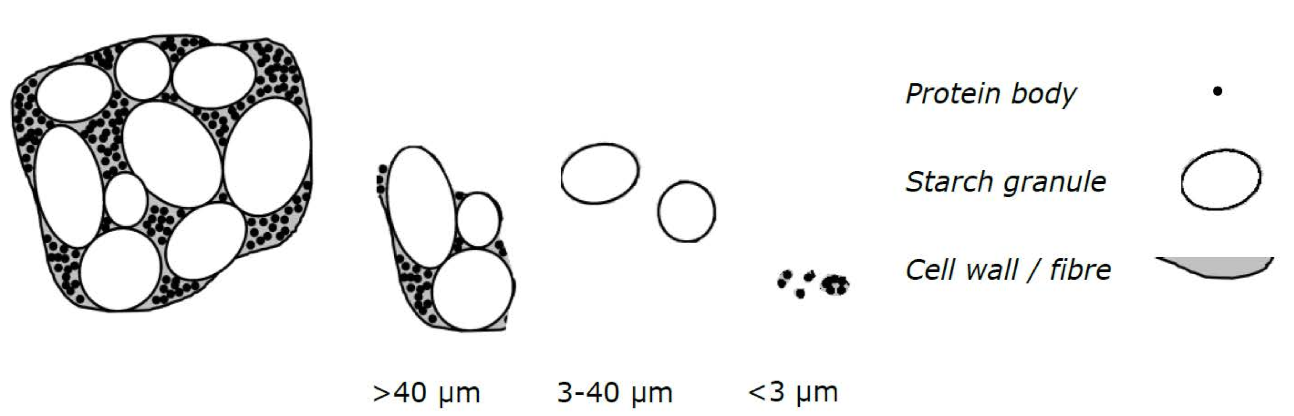

Figure 1. *Schematic drawing of pea cells the fragments after milling*

- The air classification after milling separates smaller protein-rich fragments from larger starch granules or fibre-rich particles
- An air flow fluidizes the milled flour in a separation chamber
- A classifier wheel submerged in the bed selects the small particles and allows these to form the fine (protein-rich) fraction
- Larger particles are rejected by the classifier wheel making up the coarse (starch-rich) fraction (Figure 2)
- The protein content of the pulse fine fraction varies between 50 and 70 g protein/100 g dry matter

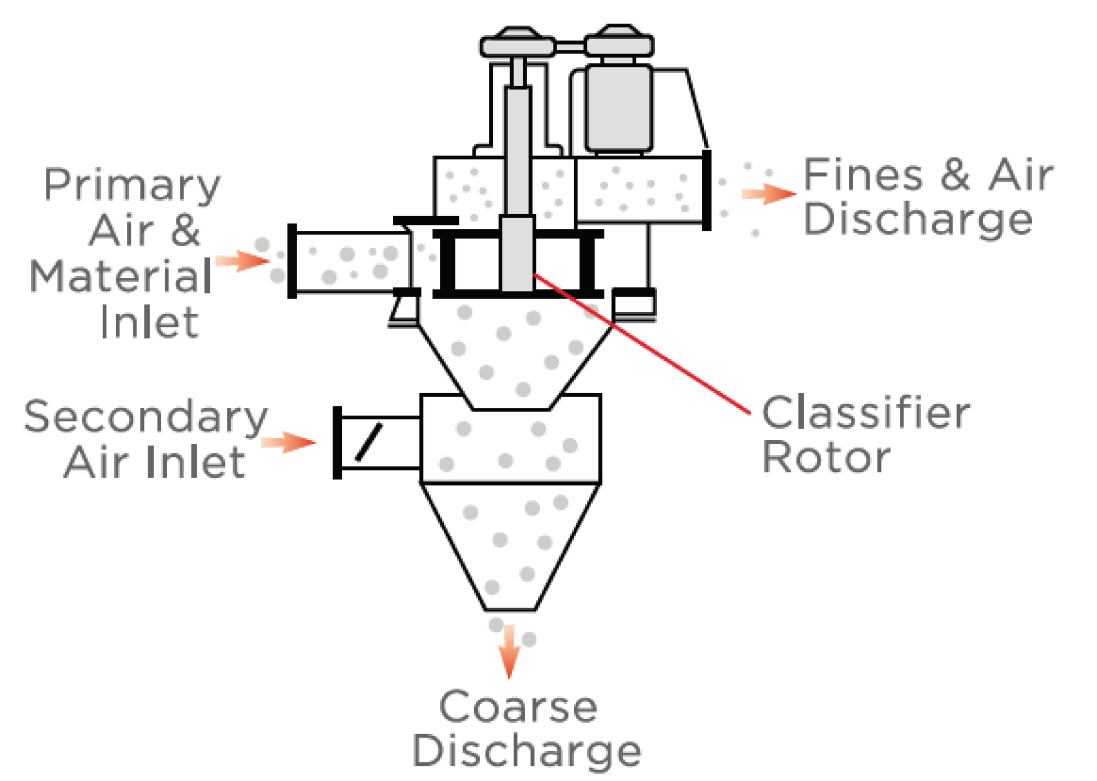

Figure 2. *Schematic overview of an air classifier*

RCFTR Dry Fractionation Facility

- 800 ft^2 with in-house air aspiration and dust collection system
- Power supply to support a variety of pilot food processing equipment
- Safe Food for Canadians Act licensed in July 2021
- RCFTR has two pilot mills M-21 Prater-Sterling and RotorMill 1300 with milling capacity of >200 kg/h

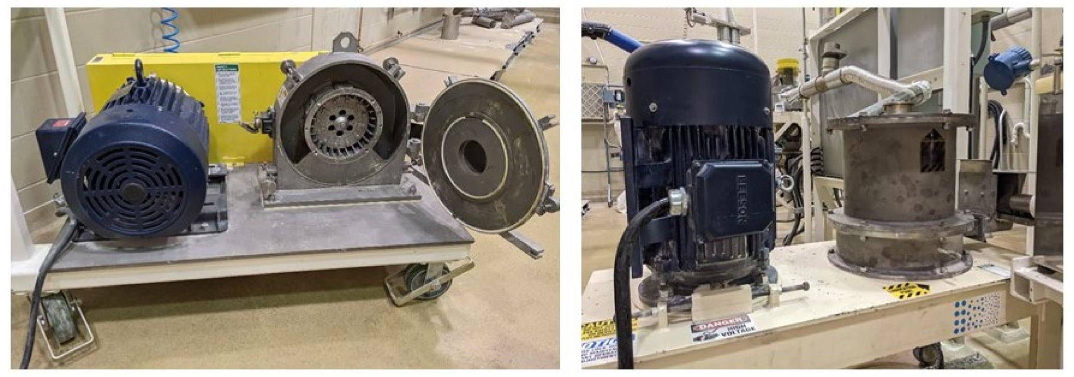

Figure 3. *RCFTR M-21 Prater-Sterling (left) and RotorMill 1300 (right) mills*

- Mills can generate flours with a variety of particle size distribution profiles depending on screen sizes and/or power settings (Figure 4)

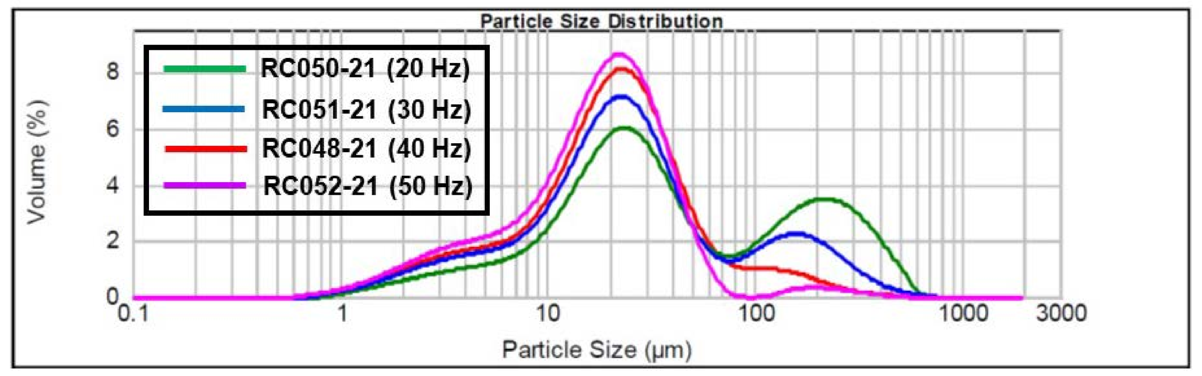

Figure 4. *Plot of percent particle volume versus particle size for split yellow pea flours as a function of RotorMill 1300 power setting (20 Hz, 30 Hz, 40 Hz, 50 Hz)*

Air Classifying at the RCFTR

- RCFTR has a pilot MAC-0 Prater Sterling Air Classifier with processing capacity of >150 kg/h
- Mill type, mill screen size, mill power, air classifying power and primary and secondary air are key variables in determining optimal balance between fine fraction yield and protein content

Table 1. *Key air classifying data for split yellow peas and split fava beans*

Ingredient	Starting Protein Content (%)*	Fine Fraction Protein Content (%)*	Fine Fraction Yield (%)	Air Classifier Power (Hz)
Split Yellow Pea	~26	50-55	20-25	25-30
Split Fava Bean	~32	60-65	20-25	30-35

*dry weight basis

- Figure 5 shows scanning electron microscopy (SEM) images of milled and air classified split yellow peas
- The images visually confirm that the fine fraction contains smaller particles, typically <25 µm, similar in size to protein bodies, and the coarse fraction contains individual intact starch granules

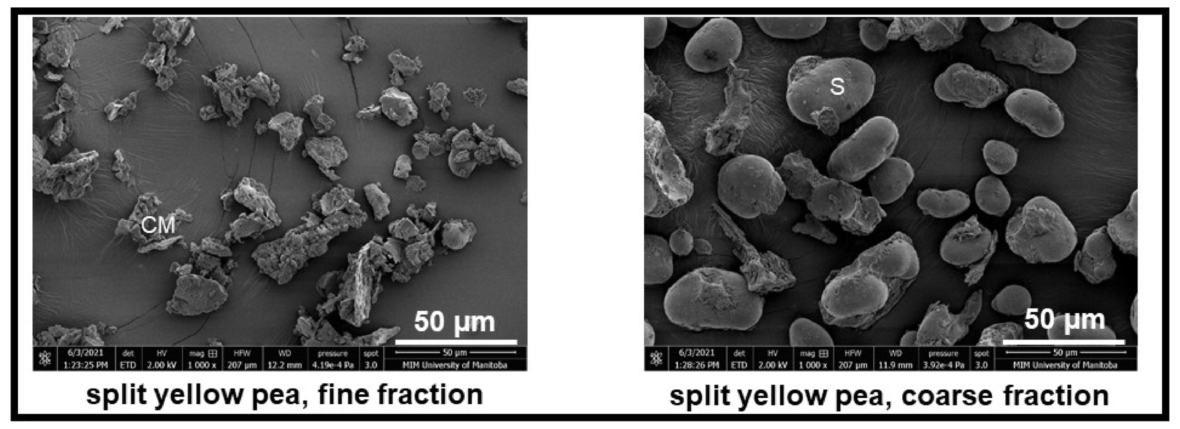

Figure 5. *SEM of M-21 Prater-Sterling and MAC-0 Air Classifier split yellow pea fine and coarse fractions. Clusters of cellular material (CM) and starch granules (S) are labelled.*

Conclusion

- Dry fractionation is a sustainable technique capable of producing plant-based protein-rich food ingredients
- Pea and fava bean morphology is ideal for generating protein-rich fractions using dry fractionation techniques
- Separation of the protein bodies from the starch granules may be achieved using the appropriate milling and air classifying parameters

Acknowledgment

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References

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- Richardson Centre for Food Technology and Research, University of Manitoba. (2022) Pilot Scale Milling and Air Classifying of Dehulled Fava Beans. Unpublished RCFTR internal report.

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