Production of Pulse Protein Concentrates by Dry Fractionation

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Introduction

- Dry milling in combination with air classification (AC) is a sustainable processing technology and was evaluated for generating protein and starch concentrate fractions using whole white pea beans and chickpeas
- Pulses exhibit large size difference between protein bodies and starch making them ideal ingredients for AC'ing (Figure 1)

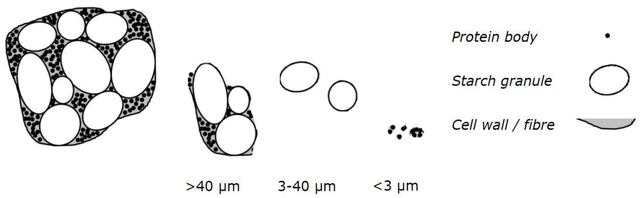


Figure 1. *Schematic drawing of cells of pea and the fragments after milling*

- A rational method for optimal separation of starch granules from protein bodies was investigated to generate protein concentrate fractions at acceptable levels.

Methods

- All milling and AC'ing performed in the 800 ft^2 RCFTR SFCA licensed Dry Fractionation Facility
- Ingredients milled using the Prater-Sterling RotoMill 1300 impact mill and AC'd using the Prater-Sterling MAC-0 Air Classifier (Figure 2)

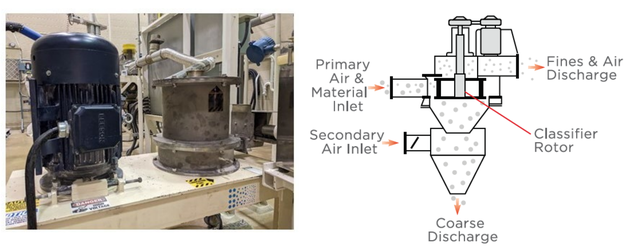


Figure 2. *Picture of Roto1300 impact mill and schematic overview of an MAC-0 air classifier*

Results

- White pea beans and chickpeas milled at 110 kg/h at rotor mill speeds 4640 to 5800 rpm yielded PSD profiles as per Figure 3

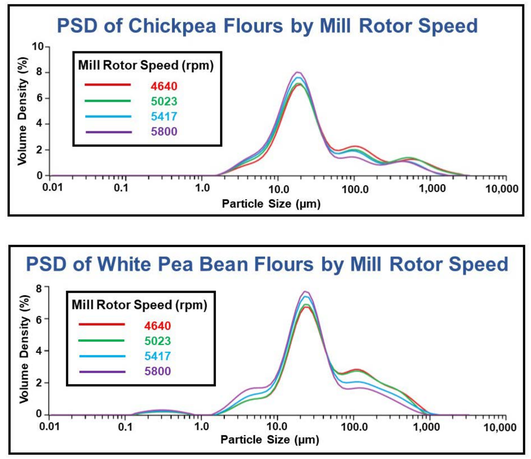


Figure 3. *Plot of percent volume density versus particle size for white pea beans (top) and chickpeas (bottom) as a function of RotorMill 1300 rotor wheel speed*

- Hypothesize that optimal detachment is reached when the PSD curve of flour overlaps maximally with PSD curve of the starch granules
- For both white pea beans and chickpeas maximum PSD overlap observed between respective starch isolates and flours milled at 5800 rpm (Figure 4)

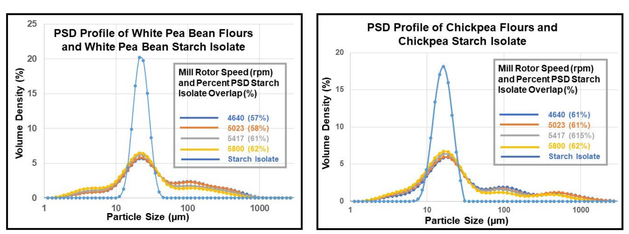


Figure 4. *PSD profile of white pea bean flours and white pea bean starch isolate*

- Milling rotor speed locked at 5800 rpm for all milling plus AC'ing trials
- AC wheel speed varied 3577 rpm to 6438 rpm in preliminary 50 kg scale trials
- AC'ing of chickpeas somewhat challenging due to 6.0% fat content
- Optimal AC wheel speed subjectively determined based on best balance between protein concentrate yield and protein content
- Optimal AC wheel speed determined to be 5723 rpm and 5008 rpm for white pea beans and chickpeas, respectively
- "Production run" at ~400 kg scale for each ingredient performed using optimized parameters (Table 1)

Table 1. *Key air classifying data for white pea beans and chickpeas at ~400 kg scale**

Ingredient	Starting Protein Content (%)**	Protein Concentrate Protein Content (%)**	Protein Concentrate Mass Yield (%)	Air Classifier Wheel Speed (rpm)
White Pea Bean	26.0	55.4	17.6	5723
Chickpea	24.0	49.7	18.4	5008

*feed rate ~110kg/h; primary air = 75%; secondary air = 20% **dry weight basis

- The semi-quantification of VOCs was performed for >40 compounds previously associated with beany characteristics
- Figure 5 shows the VOC concentration levels for two (2) abundant compounds

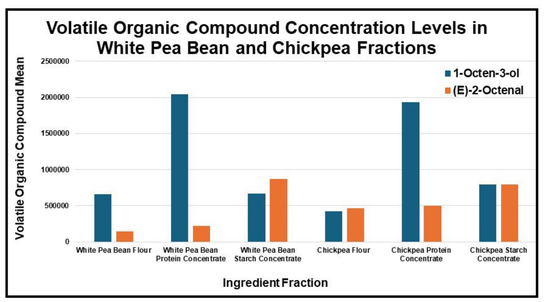
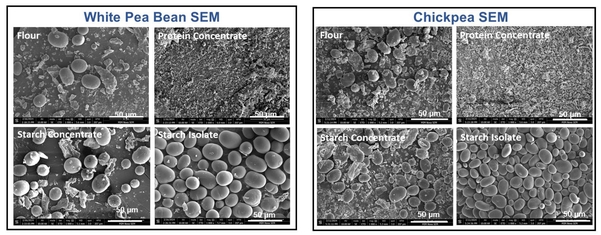


Figure 5. *Quantity of selected "beany" VOCs in chickpea and white pea bean fractions*

- SEM confirms protein concentrate contains smaller particles, typically <25 µm, similar in size to protein bodies, and the starch concentrates and isolates contains individual intact starch granules
- Protein concentrate is a less structured material yielding an ill-defined XRD pattern
- Starch isolate is a uniform material yielding a well-defined XRD pattern



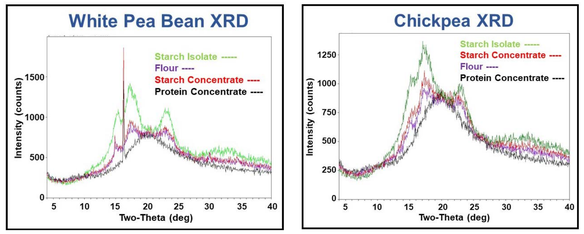


Figure 6. *SEM (top) and XRD (bottom) data of ingredient flours, protein and starch concentrates and starch isolates*

Conclusion

- A rational approach was successfully employed for producing white pea bean and chickpea-based protein concentrates using dry fractionation techniques at ~400 kg scale

Acknowledgment

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