# Upcycling pea by-products for developing sustainable high quality puffed snacks using extrusion processing

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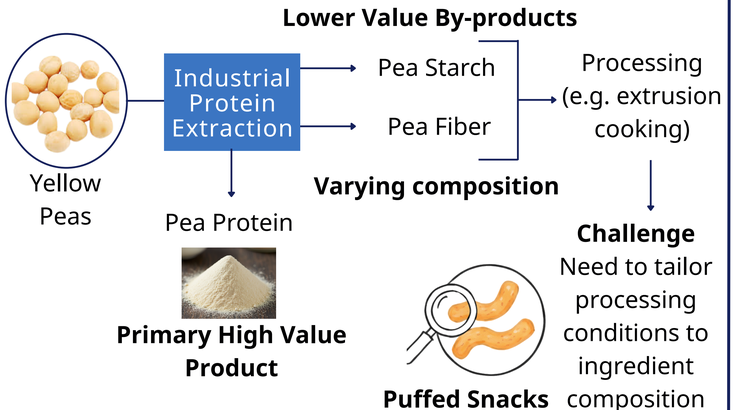
Wet extraction ↓ Protein Rich Fraction

Washing ↑ Sieving

## 1. Introduction

- Canada's plant protein sector is a strategic priority, with a focus on high-value pea protein[1].
- The industrial protein extraction process, however, generates large quantities of starch and fiber by-products[2].
- Key value addition opportunity lies in **"upcycling"** these ingredients into nutritious, extruded puffed snacks.
- Variability in starch and fiber composition after protein extraction remains a key challenge for consistent processing and product quality.




**Goals** **(1):** Find new application for pulse by-products.
**(2):** Reduce waste and increase the economic viability of pulse crops.

## 2. Project Objectives

- Utilization of pea-based ingredients and by-products for developing appealing and nutritious puffed snacks with lower environmental footprint.
- Investigate how variations in the raw material composition and properties impact extrusion processing and final product characteristics.

**Ingredient Composition**

- Pea starch: High Amylose (31-49%)[3].
- High Amylose reduces expansion[4].
- Fiber level and type affect puffing[5].

**Extrusion Processing**

- Conditions impact density and expansion[5].
- Need to study starch-fiber-process interactions.

Expansion = Composition X Processing

## 3. Methodology

Peas → *Dehulling / Milling* → *Pea Flour* + ***Hull Fiber*** → *Air classification* → **Starch-rich Flour** + Protein Concentrate

Pea Flour → *Wet extraction* → Protein-rich Fraction + Starch and Fiber Rich Fraction → *Centrifugation/Screening* → *Neutralization & Drying* → **Inner Fiber** + **Starch Isolate**

***Base Ingredients***

| Ingredient | Protein (%) | TDF (%) | Starch (%) |
|---|---|---|---|
| Hull Fiber | 6.5 | 65 | 6.5 |
| Inner Fiber | 10 | 25 | 45 |
| Starch Isolate | 0.5 | 1.5 | 95 |
| Starch-rich Flour | 13.5 | 6.5 | 60.5 |

Table 1: Base ingredients for extrusion formulas and their composition

***Raw material characterization***

- Proximate composition[6]
- Particle size distribution[7]
- Amylose & amylopectin content[8]
- Thermal & pasting properties[9]
- Water holding capacity[7]

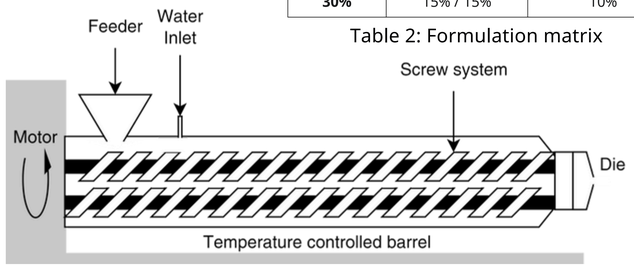
***Blending formulas***

A total of 20 total blends were prepared on a constant 50% corn flour base. This included 2 starch base controls (i.e., isolate and flour) and 18 experimental blends testing 2 Starch bases × 9 Fiber combinations.

| Total Fiber | Fiber Composition (Hull or Inner) | Starch Composition (Isolate or Flour) |
|---|---|---|
| **5%** | 5% / 0% | 45% |
| **5%** | 0% / 5% | 45% |
| **10%** | 10% / 0% | 40% |
| **10%** | 0% / 10% | 40% |
| **10%** | 5% / 5% | 40% |
| **20%** | 20% / 0% | 30% |
| **20%** | 0% / 20% | 30% |
| **20%** | 10% / 10% | 20% |
| **30%** | 15% / 15% | 10% |

Table 2: Formulation matrix

***Extrusion processing***




Extrusion trials will optimize screw speed, temperature profile, and feed moisture to match formulation composition and achieve well-expanded puffed snacks.

***Product quality evaluation***

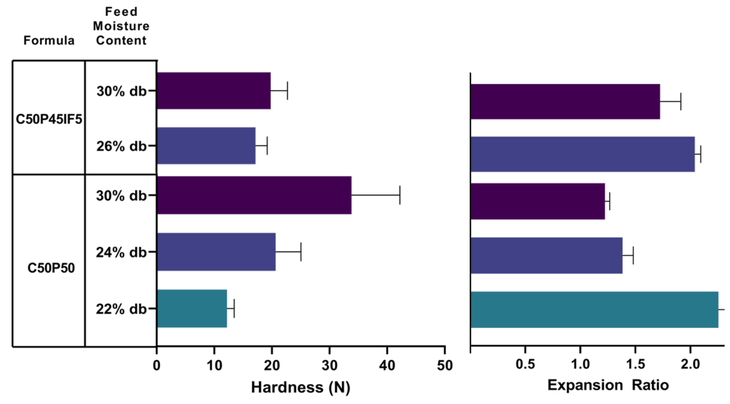
- Texture analysis[9]
- Color measurements[9]
- Microstructural imaging[10]
- Starch digestibility[11]
- In-vitro glycemic index[11]

For the purpose of this poster, only preliminary results from formulations containing 50% corn flour with 50% pea starch isolate **(C50P50)** or 45% pea starch isolate + 5% pea inner fiber **(C50P45IF5)** are presented.

Extrusion trials were conducted under varying barrel temperature profiles (80–120 °C / 90–130 °C), screw speeds (200 and 250 rpm), and feed moisture levels (22–30%).

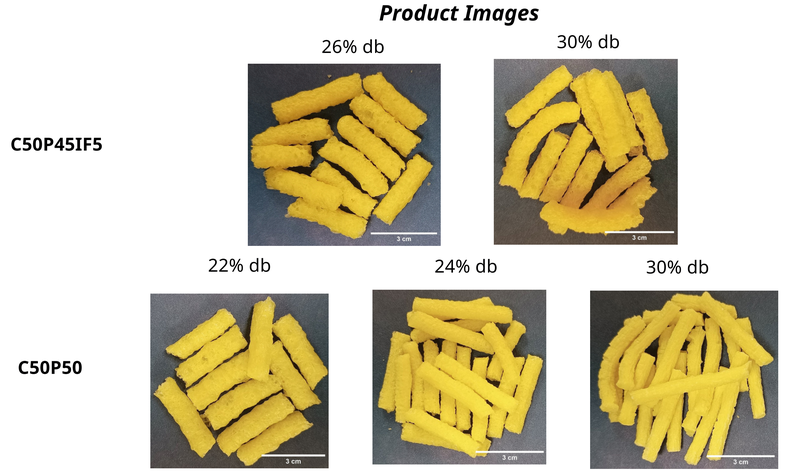
## 4. Preliminary Results

Extrudates were evaluated for physical properties including hardness, and expansion index as indicators of product quality.




- Reducing feed moisture decreased hardness and increased expansion ratio, producing more expanded, lighter products.
- The decrease in hardness at lower feed moisture levels was less pronounced in fiber-containing formulations.
- Incorporating 5% fiber further reduced hardness and promoted expansion, possibly by providing bubble nucleation sites.

***Product Images***




## 5. Conclusion

Changes in texture, expansion, and appearance suggest that processing should be tailored to ingredient composition for improved puffed snack quality. Next steps will systematically explore the effects of formulation, feed moisture, and fiber type on expansion, texture, microstructure, and nutritional quality of these puffed snacks.

*Acknowledgements*

*References*