



***Pulse fibre and flours:
New product formulations that meet
consumer demands***



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Formulation considerations

- **Ingredient**
 - water absorption capacity, fat absorption capacity, emulsifying capacity, foaming capacity, foaming stability, viscosity, particle size distribution, particle size uniformity, hydration rates, shelf stability, gelatinization temperatures, interaction with other ingredients, allergens and safety
- **Processing**
 - machineability (dough handling characteristics), energy requirements (SME), water usage, equipment capabilities, value added/by products generated, nutritional composition changes, physico-chemical changes, potential processing treatments/additives
- **End product**
 - density, shelf stability, volume, texture, flavour, loaf volume, colour etc
- **Consumer**
 - cost, health, marketing messages, demographics, needs and demands

Available pulse ingredients

- Whole pulses
- Split pulses
- Flours
- Fibre
- Protein
- Starch



Texturized pea protein

Pulse flours



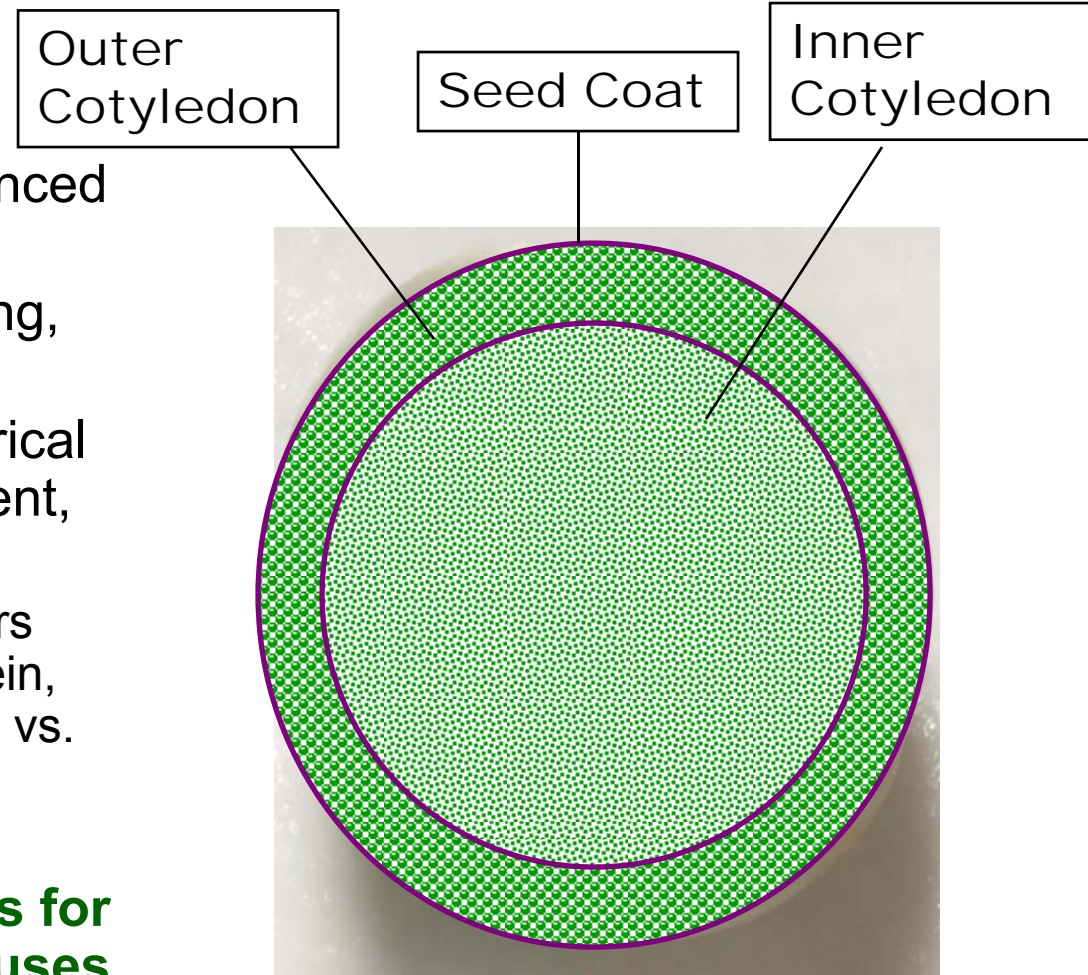
- Whole pulses may be milled into whole or split flours
- Flours can then be incorporated into a variety of food products
 - Convenient and healthy
 - Bread, muffins, cakes, cookies, pasta, noodles, processed meat products, beverages, desserts, salad dressings, snacks, crackers, breadings/coatings
 - Recommended pulse consumption
 - 3 cups/week



Pulse flour

- Flour characteristics influenced by several variables
- Outer cotyledon cells oblong, compact arrangement
- Inner cotyledon cells spherical and more loose arrangement, many intercellular spaces
 - Inner layer cotyledon flours finer particles, lower protein, ash and fiber more starch vs. outer cotyledon

Use of specified flours for defined end uses



Wheat-flour blends

- Wheat based products ideal for pulse incorporation
 - Pulse lack gluten
 - Impact texture
- Use of higher wheat protein quality in formulation?
- Other formulation considerations

Fibre functionality

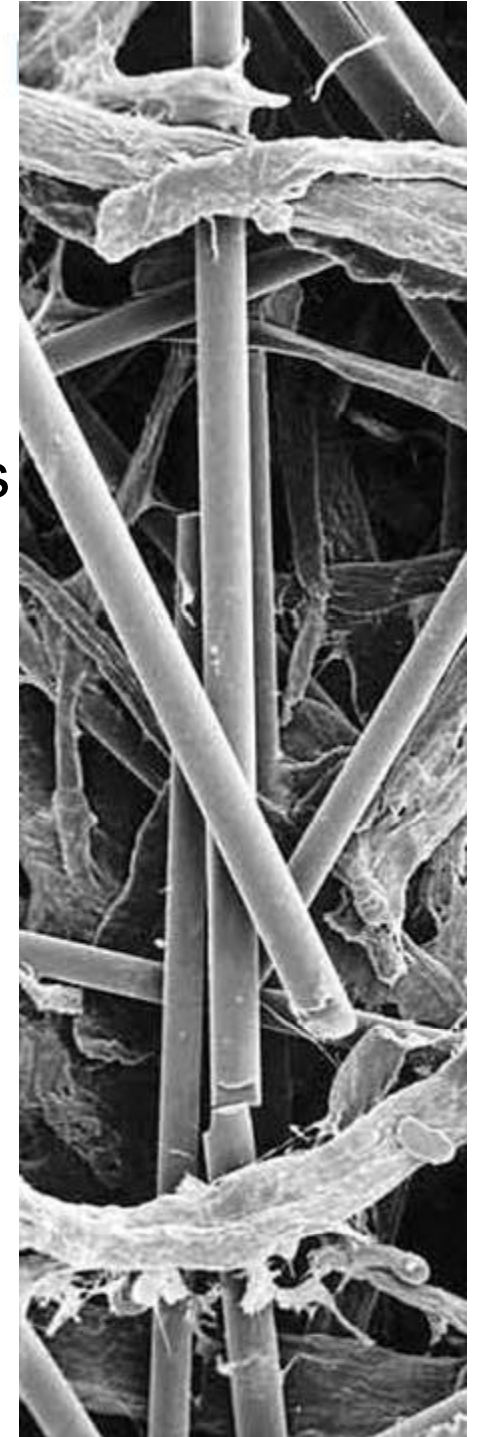
- Hydration
- Rheological Properties
- Fat/oil retention
- Surface area characteristics and porosity
- Particle size
- Bulk volume
- Ion exchange capacity

Opportunities and challenges

- Concentrated fibre source
- Role of water in the formulation
- Colour
- Texture/flavour
- Regulations
- Fat replacement
- Other functional properties

Pulse fibres


- Inner fibre (cotyledon)
 - cell wall polysaccharides varying degrees of solubility
 - arabinose-rich pectins (26%)
 - hemicellulose (22%),
- Outer fibre (seed coat/hull)
 - water-insoluble polysaccharides
 - some pectins
 - Primarily cellulose (69%)
- α -galacto-oligosaccharides
 - raffinose, stachyose, verbascose



α -galacto-oligosaccharides

- Raffinose family oligosaccharides (RFO)
 - Raffinose, stachyose and verbascose
 - 2 to 10 g/100 g dry weight
 - Variation due to genetic, environmental, and seed maturity factors
- Potential oligosaccharide benefits
 - Soluble carbohydrates
 - lower blood cholesterol
 - regulate blood glucose levels
 - Prebiotic potential
- Isolated and purified RFO
 - utilized by selected beneficial colon bacterium strains in *in vitro* tests.
 - RFO significantly influenced the growth of bifidobacteria in the colon of rats.

Dietary fibre contents (total, insoluble and soluble) of raw pulse seeds

Pulses 	Dietary fibre content (g/100 g)		
	Total dietary fibre	Insoluble fibre	Soluble fibre
BEANS, DRY <i>Phaseolus vulgaris</i> a, b, c	23 – 32	20 – 28	3 – 6
CHICKPEAS <i>Cicer arietinum</i> c, d, e	18 – 22	10 – 18	4 – 8
LENTILS <i>Lens culinaris</i> c, d	18 – 20	11 – 17	2 – 7
PEAS, DRY <i>Pisum sativum</i> d, f, g, h	14 – 26	10 – 15	2 – 9

From: Tosh and Yada, 2009

^a Granito et al., 2002, ^b Kutos et al., 2003, ^c Perez-Hidalgo et al., 1997, ^d Dalgetty & Baik, 2003, ^e Rincon et al., 1998, ^f Borowska et al., 1998, ^g Martin-Cabrejas et al., 2003, ^h Wang et al., 2008

Fibre comparisons

	Total DF (%)	% of which is soluble
*Barley bran	50-70	3-9
*Oat fibre	85-90	1-3
*Oat bran	22	50
*Rice fibre/bran	75	4
*Wheat bran	45-55	2-6
*Pectin	90-100	90-100
Whole Pea (Dalgetty and Baik, 2003)	20	43.5
Pea hull fibre (commercial pea fibre product)	89.3	7.2

**Pomeranz in functional properties of Food Component*

Effect of processing

- Studies on the processing effects on content and composition
 - Required: physicochemical modifications to improve pulse fibre functionality
 - Behaviour in food systems?
- Processing changes insoluble:soluble dietary fibre ratio (IDF/SDF)
 - Modification of cell wall polysaccharides
 - Nutritional and functional implications
 - Dehulling, germination, soaking, fermentation, cooking, enzymatic treatment, extrusion, and thermal processing

Cakes

- Chickpea-wheat flour blends
- Fibre/protein fortification
- Reduced volume and symmetry
- Firmer, gummier, and less cohesive cake texture
 - Are the most optimal ingredients being used?

Baked Goods

- Fibre enrichment with pulse hulls
 - Cakes, cookies, muffins
 - Moisture content increased as the level of hull incorporation increased,
 - Loss of characteristic cookie texture and increased softness
 - Loss of cake and muffin volume
 - but no significant effect on cake characteristics.
 - Correlation between the hemicellulose content and characteristic cookie properties
- Pea fibre formulations best suited for cookie enrichment
 - Functional ingredient at levels up to 30%



Bread formulations

- Chickpea flour (ground raw chickpeas) in wheat bread formulations
 - 20 and 40% total flour
- No acceptability differences from control
- Dietary fibre contents of the two formulations loaves were 7.4 and 8.5%, compared to 3.6% for the control
- Lower predicted glycemic index



Bread

- With increasing levels of pea hulls
 - Water retention capacity of the composite flours increased
 - Delay in staling
 - Crust colour became lighter and more yellow
 - Loaf and specific volumes decreased
 - A satisfactory high-fibre formulation containing about 15% TDF (compared to 3% TDF in the control) was obtained with 15% (by weight) of pea hulls.
- Effect of adding both soluble and insoluble fibres
 - Pea hull fibre increased water absorption without affecting dough consistency and stability, but when combined with pea cotyledon fibre, dough consistency improved

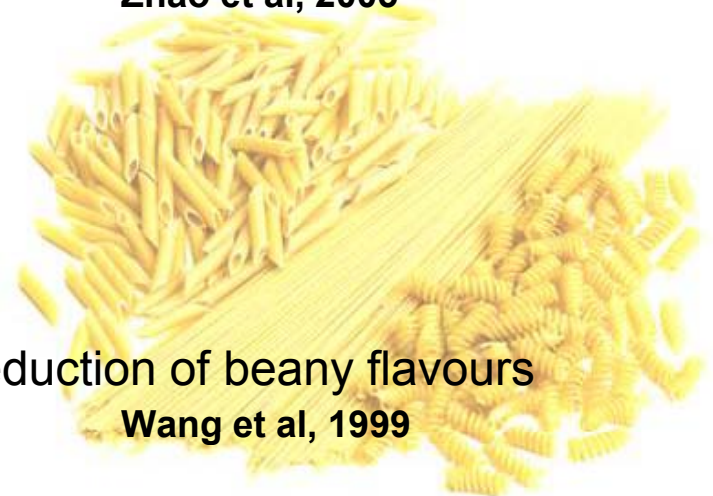
Pasta

- **Conventional processing**
- Green and yellow pea, lentil, and chickpea flours
 - 15% green pea or lentil flour, and 20% chickpea or yellow pea flour determined as acceptable
 - Darker colour, beany off-flavour, and firmer texture pulse spaghetti characteristics
 - Flavour improvements with pre-cooked flours

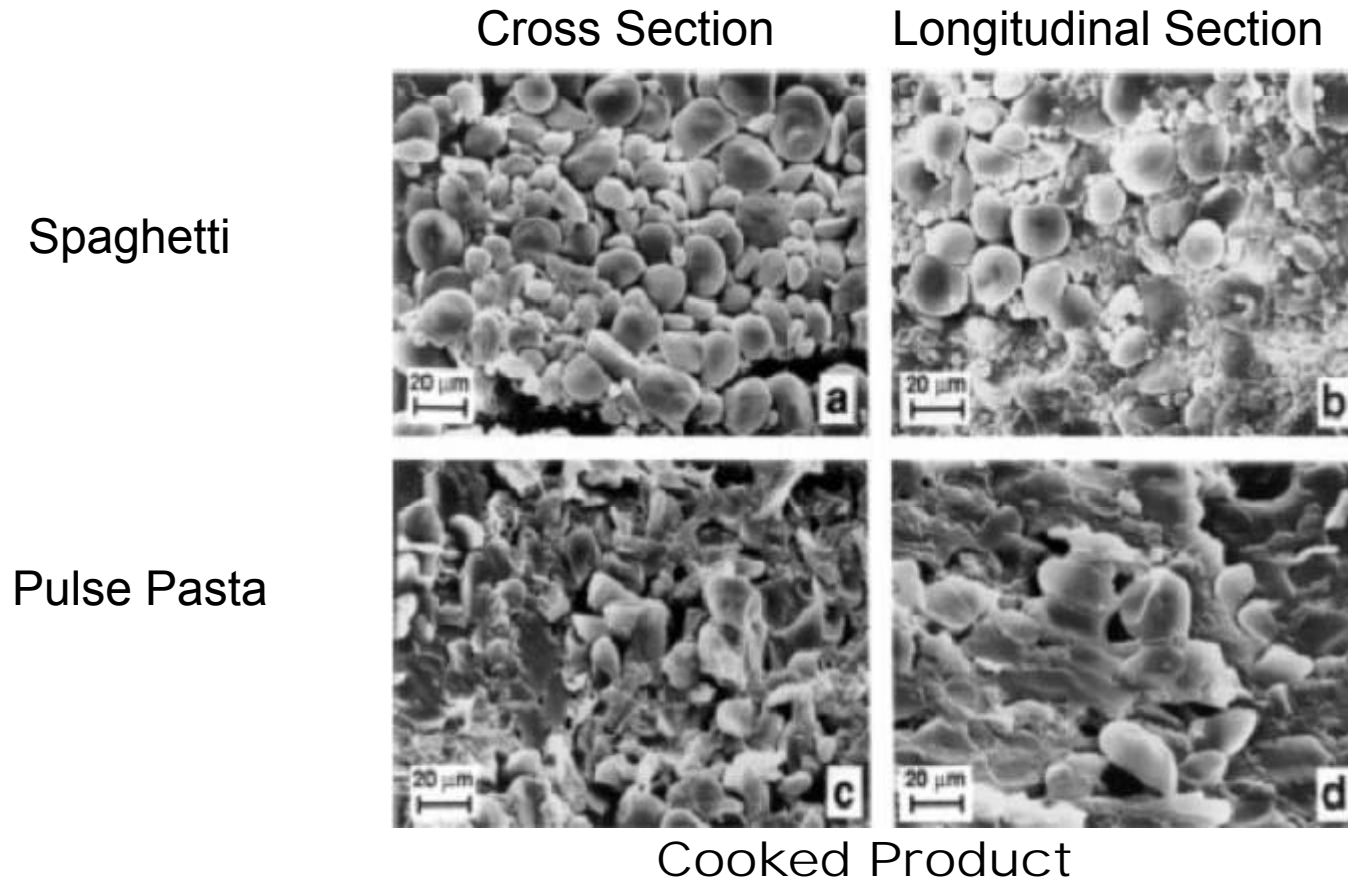
Zhao et al, 2005

- **Extrusion processing**
- 100% Starch enriched yellow pea flour
 - Value added protein/fibre fraction
 - Gluten free applications
 - Benefits of extrusion: gelatinize starch, reduction of beany flavours

Wang et al, 1999



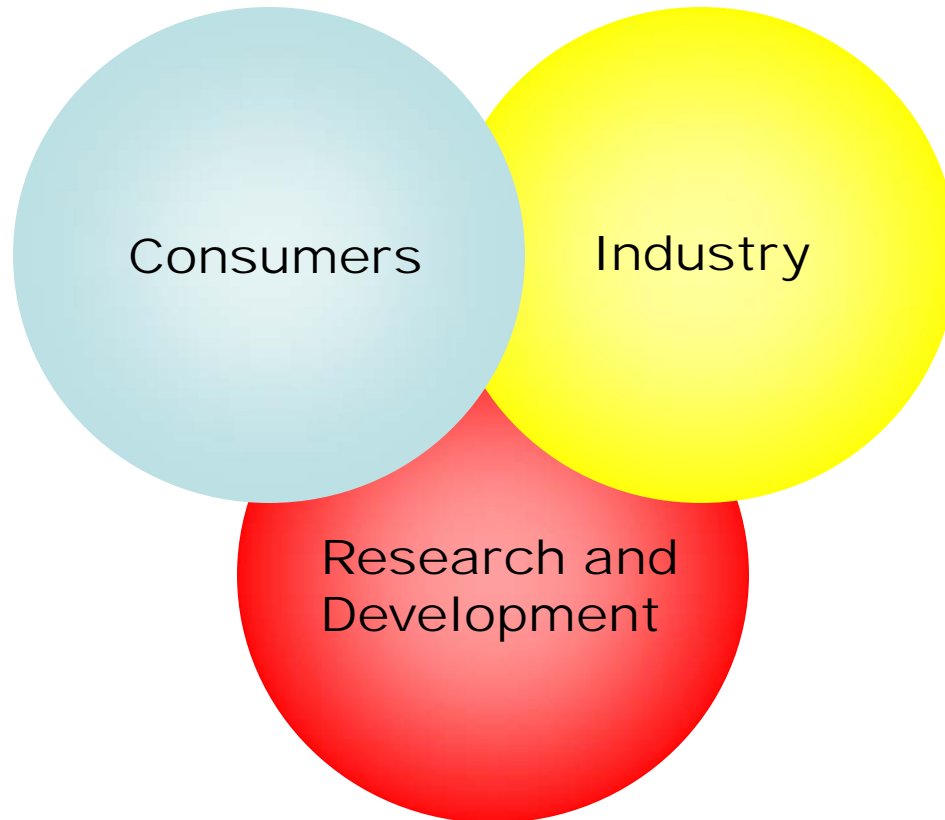
Effect of Processing: Extrusion



Pasta

- Commercial high-fibre pasta products (e.g., Catelli Plus) containing pea hull fibre
- Addition of pea hull fibre caused a moderate reduction in spaghetti firmness,
 - Similar to the whole wheat sample
 - Disrupting effect of the mainly insoluble particulates on the protein-starch matrix of pasta.
- Protein-fibre matrix within raw pasta containing pea fibre appeared to be less developed than the unenriched control
 - Discrete starch granules were more “uncovered”
- Cooked pasta containing 15% pea fibre appeared to have a highly porous structure
 - Explains decreased firmness and elasticity measurements at that level of fibre incorporation
 - Pasta with 7.5 to 12.5% pea fibre showed no significant differences from the control in these characteristics.

Looking forward...



Acknowledgments

Some material for this presentation was adapted from: S.M. Tosh and S. Yada. Dietary fibres in pulse seeds and fractions – characterization, functional attributes, and applications. Submitted to *Food Research International*, 2009.”

