Healthy cereal-based snacks from by-products of the malting and fruit processing industries

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Teagasc
Agriculture and Food Development Authority

The Irish Agriculture and Food Development Authority

Background to the project

- Millions of tonnes of by-products generated from food processing
- Much is disposed of (costly) or used as landfill
- Proven to be valuable sources of healthy compounds

Aim of the project

To utilise nutritious by-products of food processing to generate novel, healthy, cereal-based snacks

Benefits of fruit by-products as a food ingredient:

- Potential nutritional benefits – dietary fibre and bioactivity.
- Potential technical benefits – bulking agent, water binding, gelling, fat replacer.

By-products:

- Brewer's Spent Grain (BSG)
- Apple Pomace
- Orange Pomace

Thank you

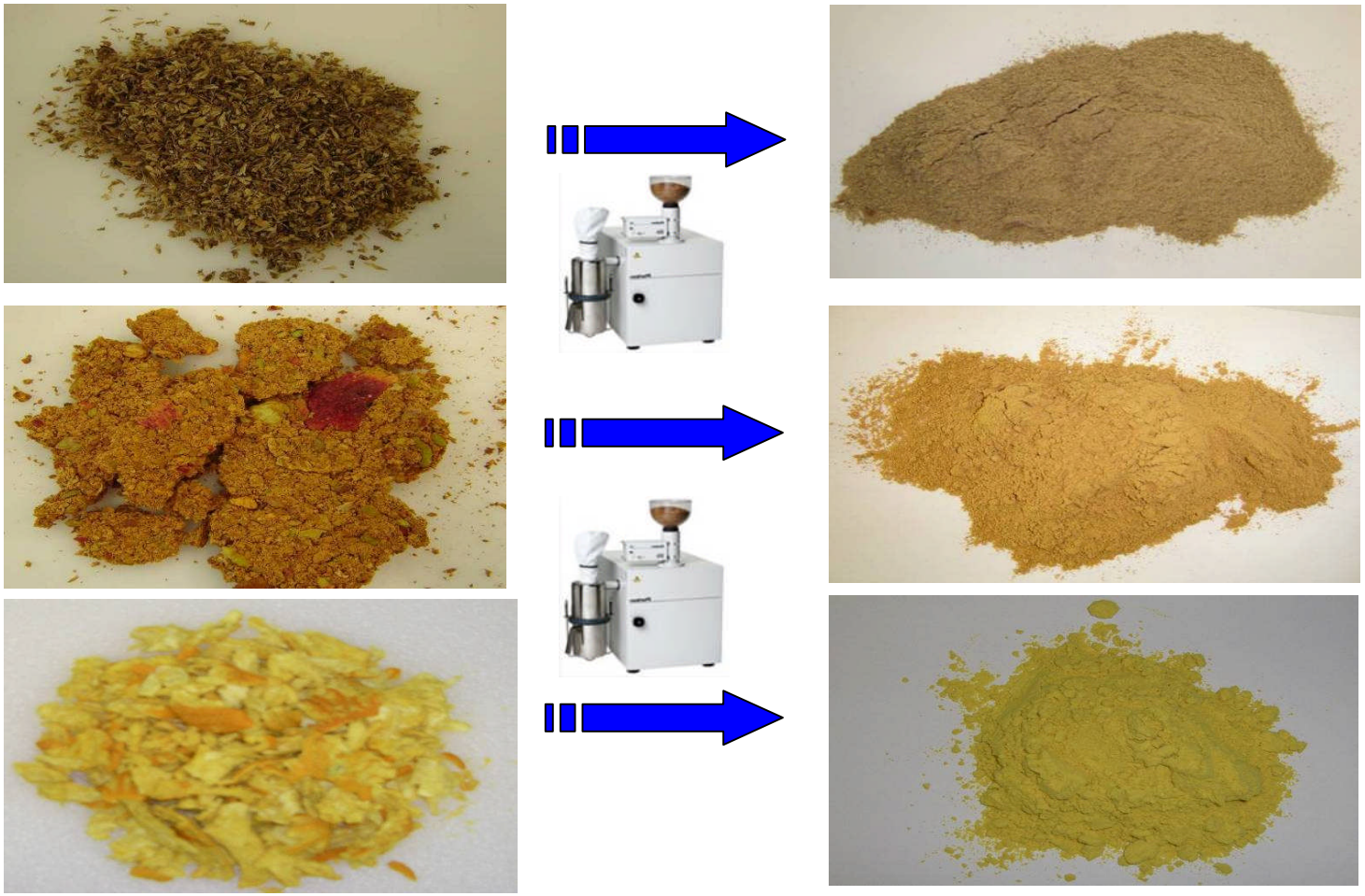
BULMERS IRISH CIDER Original

wild orchard

The Apple Farm

Treatment of the by-products

- **BSG**: Kilned & milled
- **Apple pomace and orange pomace**: Freeze-dried & milled
- Also currently working with fresh, frozen samples to eliminate the cost of freeze-drying



1. Chemical characterization of the milled by-products

- **Moisture**
  (Weight difference, AOAC 925.10)
- **Total Dietary Fibre**
  (Amylase/protease/Amyloglucosidase)
- **Polysaccharides**
  (Saeman hydrolysis)
- **Phenolic compounds**
  (Solid-liquid extraction)
- **Protein digestibility**
  (Onyango *et al.*, 2004)
- **Ash**
  (Weight difference, AOAC 923.03)
- **Starch**
  (Amylase/Amyloglucosidase)
- **Protein**
  (Kjeldhal, AOAC 920.87)
- **Micro**
- **Antioxidant capacity**
  (FRAP/DPPH)
- **Starch digestibility**
  (Onyango *et al.*, 2004)
- **Fat**
  (Weight difference)

2. Functional and rheological characterization of the milled by-products

- Water hydration capacity
- Swelling capacity
- Particle size
- Colour (L*a*b*)
- Water holding capacity
- Oil holding capacity
- Fundamental rheology
- Starch pasting properties

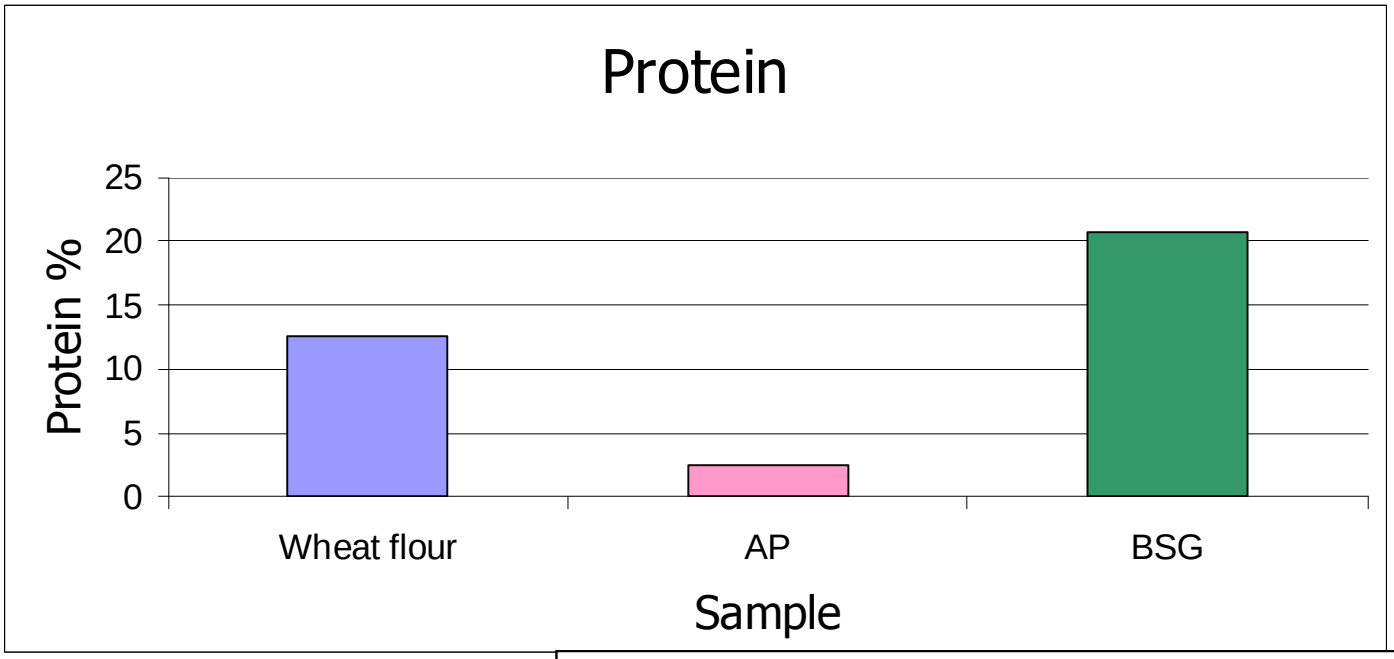
3. Baking and extrusion trials

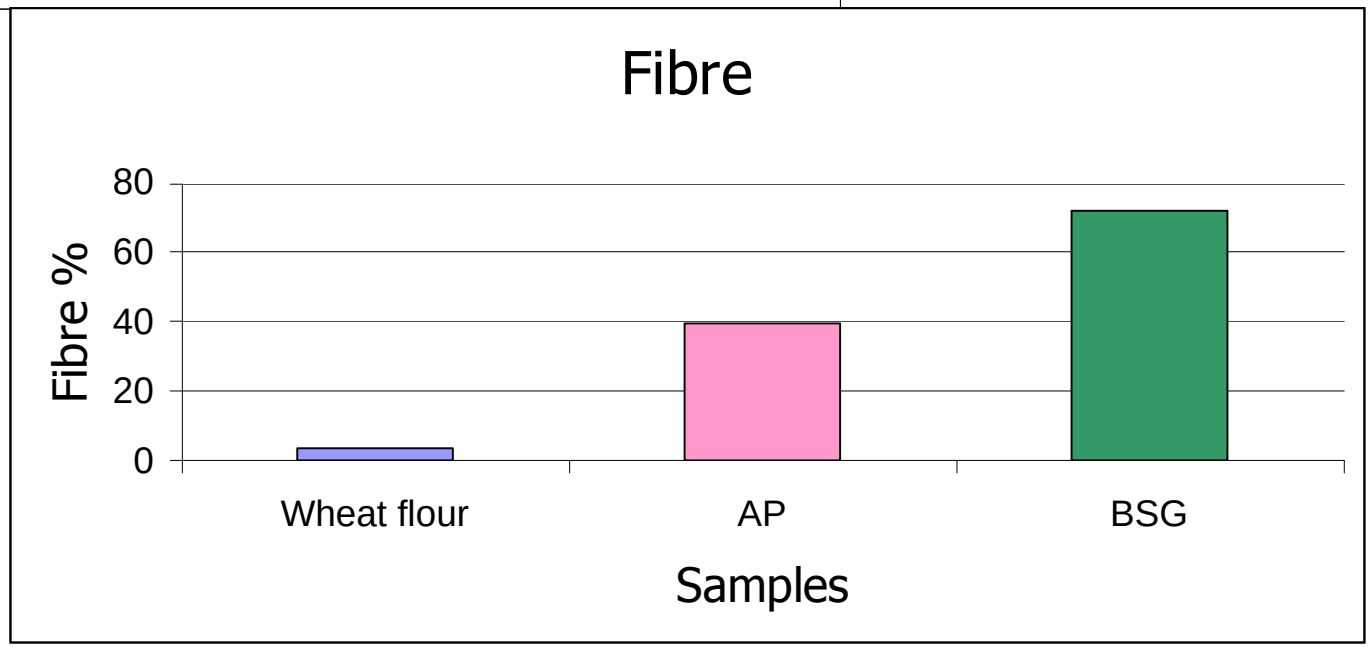
Baked

Extruded

Gluten free

1. Characterization of the milled by-products

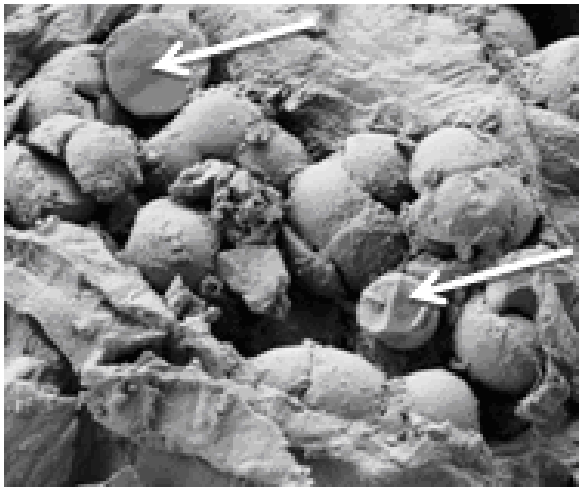




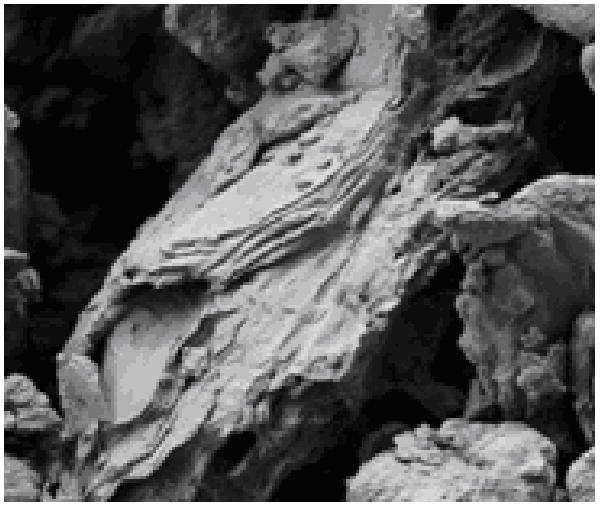
1. Characterization of the milled by-products

Composition	Apple Pomace	Orange Pomace
Fat (%) DM	2.53 +/- 0.26	2.14 +/- 0.33
Ash (%) DM	1.79 +/- 0.02	4.18 +/- 0.08
Carbohydrate (%)	84.76 +/- 0.56	77.78 +/- 0.67
Starch (%)	5.6 +/- 0.0	3.4 +/- 0.0
Calcium (mg/L)	1265 +/- 142	4112 +/- 414
Potassium (mg/L)	2531 +/- 284	4112 +/- 414
Magnesium (mg/L)	126 +/- 14.22	570 +/- 102
Zinc (mg/L)	1.66 +/- 0.62	2.28 +/- 0.41
Iron (mg/L)	8.39 +/- 1.22	9.76 +/- 0.88
Pectin (DW)	8.04 +/-0.08	18.69 +/-0.65

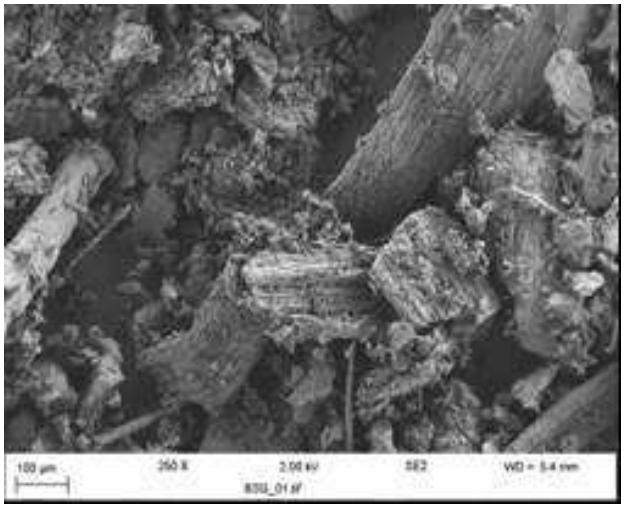
Scanning electron microscopy of the flours



Apple pomace



Orange pomace



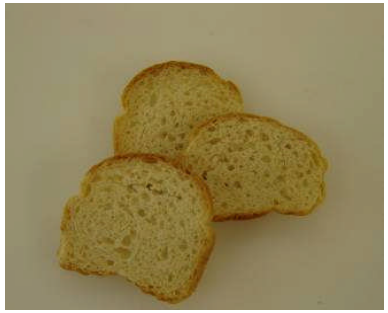
BSG

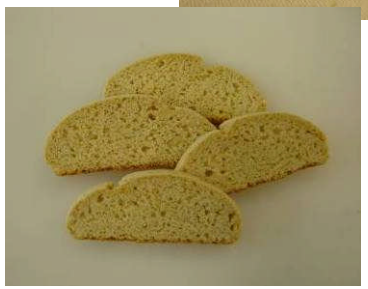
3. Baking and extrusion trials

- ***Breadsticks*** **(15, 25, and 35 % BSG)**
  - Texture, volume, colour, shelf-life, sensory
- ***Crispy slices*** **(0, 15, and 25 % BSG)**
  - Texture, colour, crumb structure, shelf-life, volatile analysis (flavour analysis)
- ***Bread rolls*** **(Pup-loaves) (10, 15 and 20 % BSG)**
  - Texture, volume, colour, crumb structure, shelf-life, sensory, staling properties (DSC-Microscopy)
- ***Scones*** **(10, 20, 30 % apple pomace)**
  - Texture, volume, colour, crumb structure, shelf-life
- ***Gluten-free bread*** **(2-8% orange pomace)**
  - Texture, volume, colour, rheology, crumb structure, shelf-life
- ***Extruded snacks*** **(5-10% apple pomace)**
  - Texture, puffing, structure, sensory
- ***Cake*** **containing orange pomace and reduced levels of fat**
  - Texture, volume, colour, crumb structure, shelf-life

Protein
Fibre
Antioxidants
…..

Baked





Breadsticks

Biscuits

Crispy slices

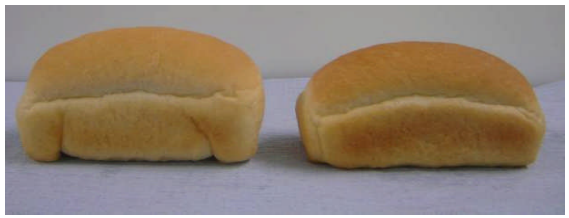
Cake

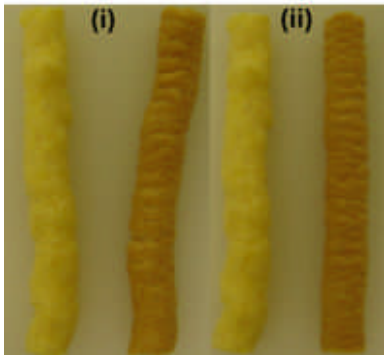
Biscotti

Brioche

Bread rolls

Scones





- Rice
- Corn
- Soya flour
- Wheat semolina

BSG & Apple Pomace

Extruded

- Breads
- Biscuits
- Puffed snacks

Orange & Apple Pomace

Gluten free

Baking Trials - BSG

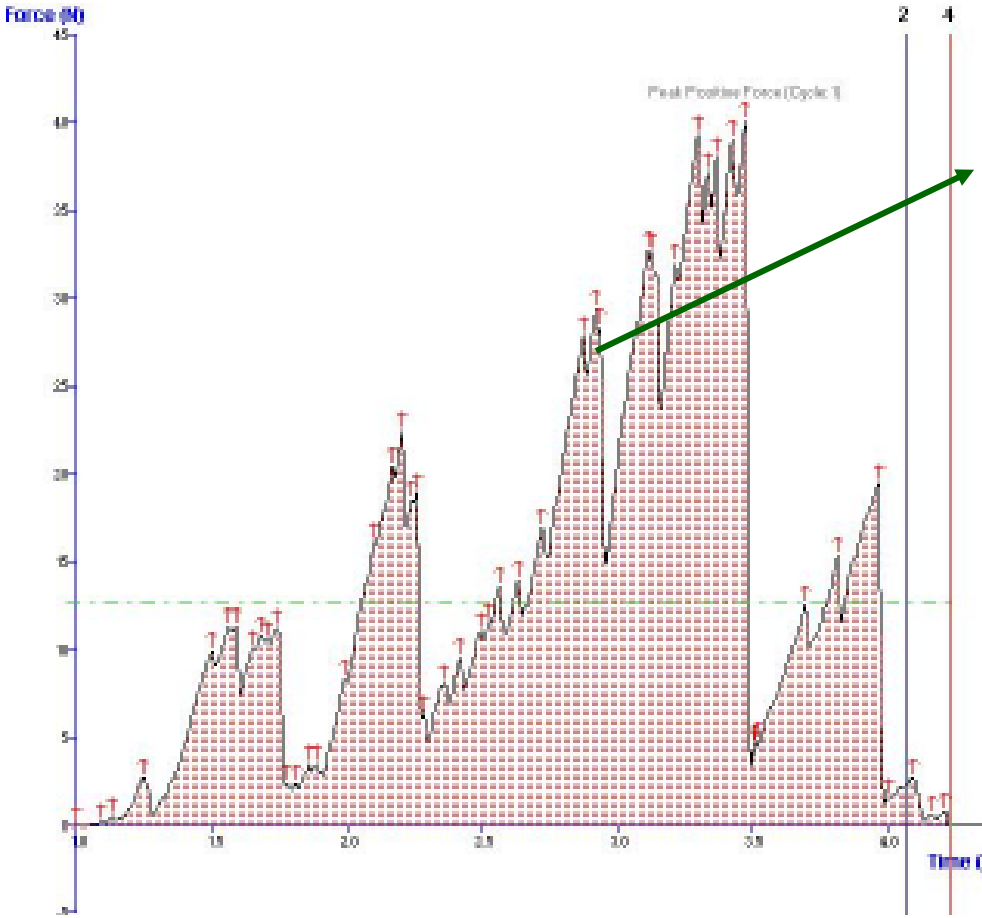
Breadsticks

Baking & Extrusion Trials - Apple Pomace & Orange pomace

Gluten-free bread

Puffed Snacks

‘Crispy’ properties of breadsticks

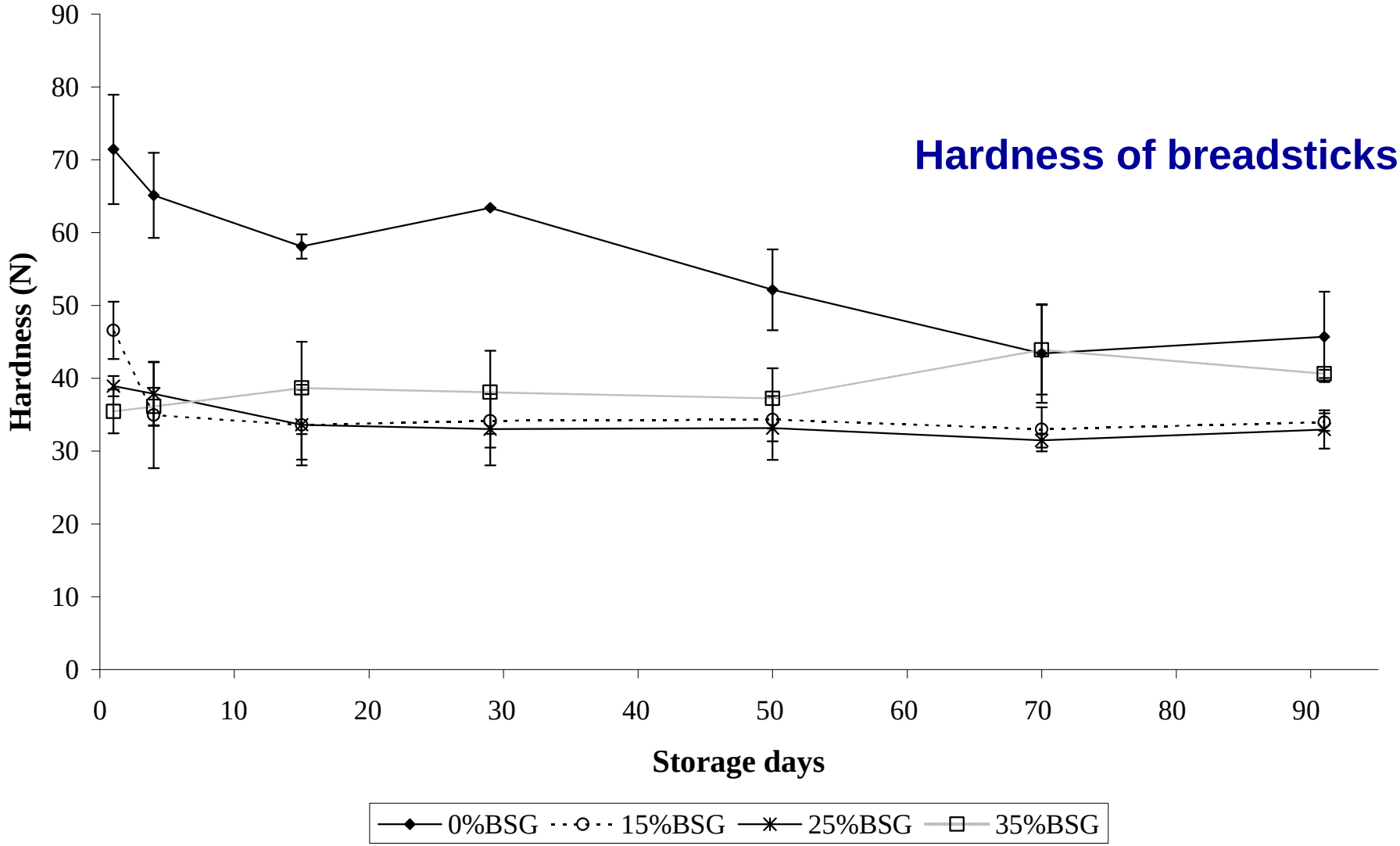


- No of peaks
- Area
- Linear distance
- Crispiness Index (Ci)
- Crispiness Work (Wc)
- Average peak force

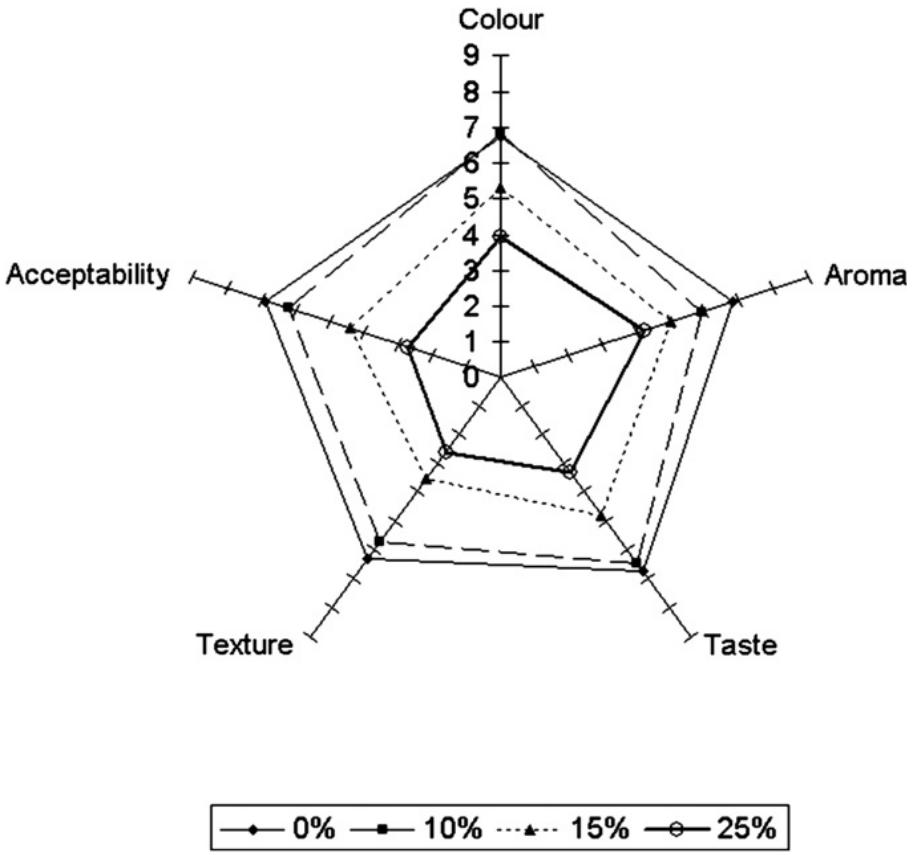
- Loss of crispiness with highest levels of BSG
- 10% BSG addition did not alter texture (crispiness) of the samples

Baking Trials (BSG)

Main outcomes: 90-day shelf life trial for breadsticks (15-35% inclusion)

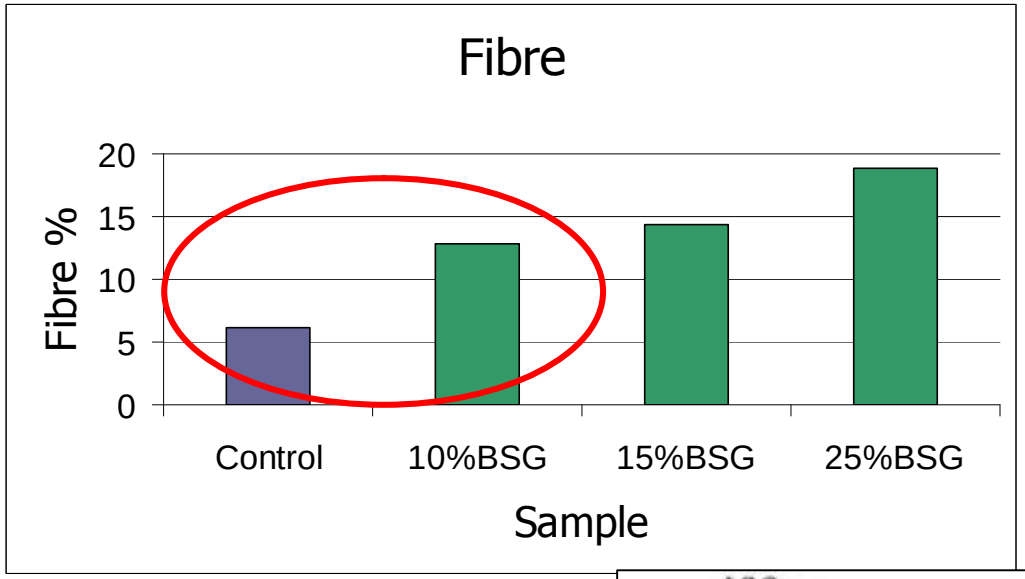


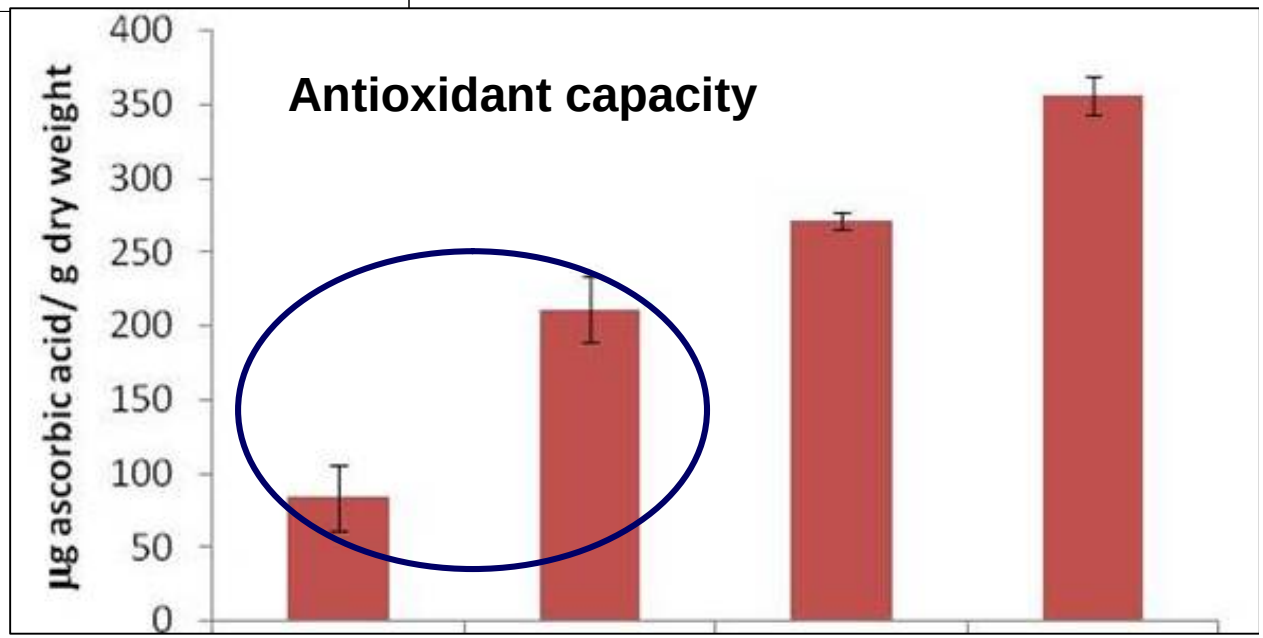
Sensory acceptability of breadsticks



- Panellists distinguished between all samples based on the aroma
- 10% BSG-containing snacks equally acceptable as the control
- Texture and taste most important attributes

Fibre and antioxidant capacity of breadsticks



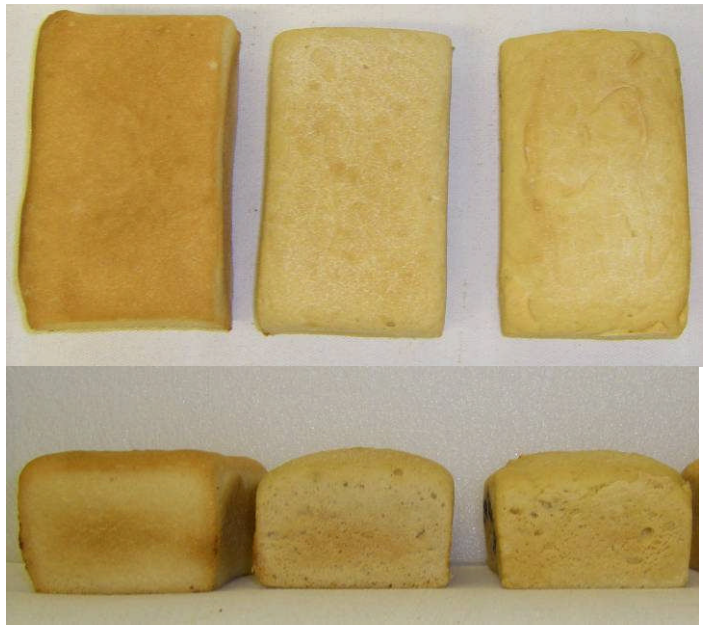


Gluten-free bread trial (Orange pomace)

We investigated:

- Level of pomace addition (0-8%)
- Dough proofing times (35-50 min)
- Water addition (85-100%)

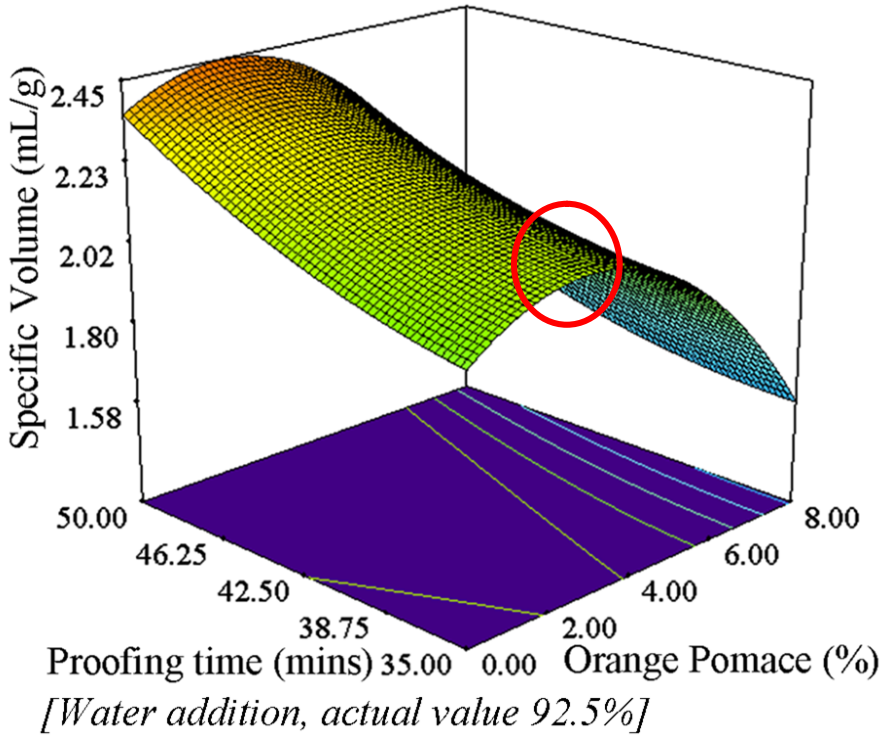
Response surface design & validation



We measured:

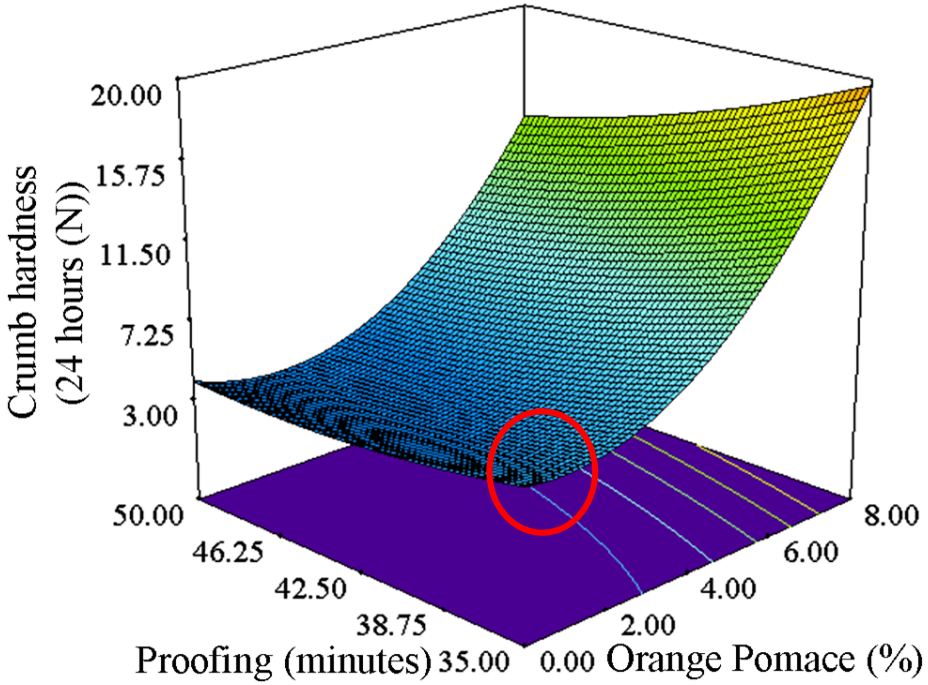
Dough rheology, loaf volume, crumb grain, crumb structure and microstructure, texture, sensory properties

Loaf volume



[Water addition, actual value 92.5%]

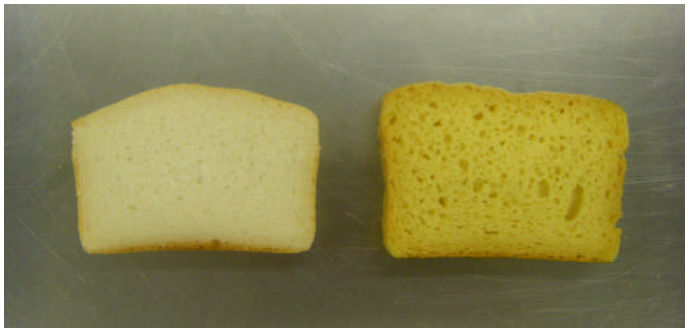
Crumb hardness



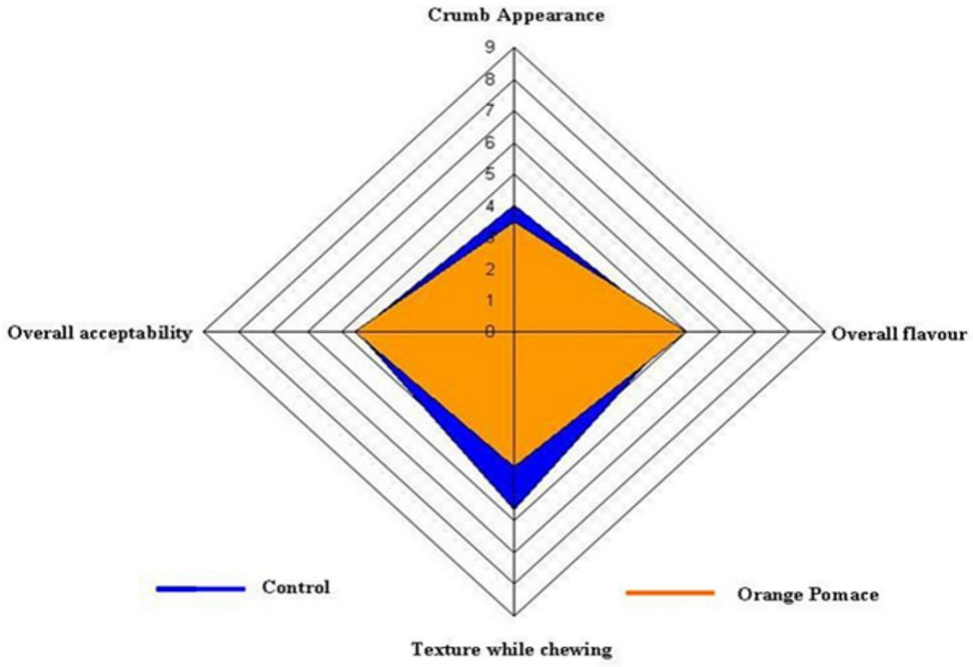
[Water addition, actual value 92.5%]

Optimisation of gluten-free bread formulation

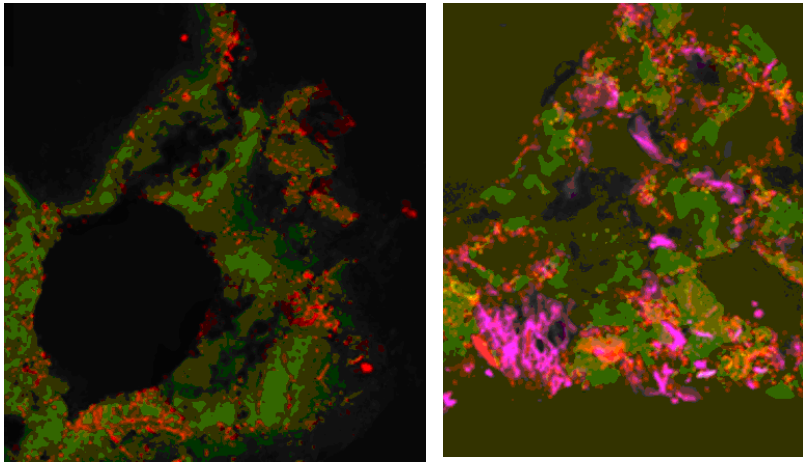
- 5.5% orange pomace addition
- 94.6% water addition
- 49 min proofing time



Control & Optimised bread



Sensory analysis



Microstructure

Doubled dietary fibre content

Puffed snacks / extrusion trial (Apple pomace)

Extrusion:

- Creates a high temperature, high pressure and shear force environment
- Modifies moistened expansible starchy material to produce a puffed end-product
- Products such as breakfast cereals, flat breads and puffed snacks

We investigated:

- Apple pomace (0-10%) + corn flour (blend)
- Die head temperature (150-200^{o}C)
- Screw speed (60-100 RPM)

We measured:

- Expansion ratio, bulk density, porosity, moisture.
- Texture and ***Acoustic Characteristics*** – hardness, acoustic energy

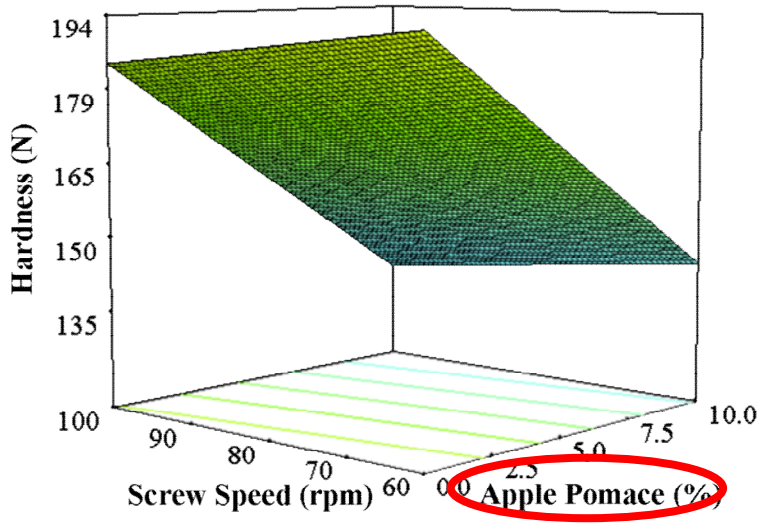
Optimisation of puffed snack formulation

Apple Pomace addition:

- Affected the texture and acoustic properties
  - Decreased hardness
  - Increased crispiness
- Excess AP detrimental effects on extrudate characteristics

Optimised formulation and process:

- 7.7% apple pomace
- 69 RPM screw speed
- 150^{o}C die head temperature




RONDO DOGE
The Apple Farm
Strawberry Jam
Karmine
BULMERS
IRISH CIDER
Original
wild orchard

Thank you!

Many thanks to

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Anastasia Ktenioudaki

Sofia Reis

Emily Crofton

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