New Crop Product Functionality

Derek Stewart

Enhancing Crop Productivity and Utilization – JHI
Chair of Food Chemistry – Heriot Watt University
Drivers for crop product functionality

- Mortality ↓: Morbidity ↑
- Western population is living longer but is sicker.
- CVD, Diabetes, (some) cancers, neuro-degeneration and inflammation associated disorders
Functional products from cereals

- Wheat, Barley, Oats and Rye - Major grains for food and feed in Europe
- Worldwide at least 1500 Mtonnes cereal grain produced annually (inc rice).
- Only Barley and Oats contains β-1,3-1,4-glucan, one of the few plant components with an approved health claim.
- β-glucan has been shown to lower/reduce blood cholesterol. “Blood cholesterol lowering may reduce the risk of (coronary) heart disease. The (EFSA) Panel considers that, in order to bear the claim, foods should provide at least 3 g of oat β-glucan per day”. EFSA 2010.
Functional products from cereals

Functional fat replacer in multiple products - mayonnaise, spreads, dips & dressings, sauces, meat products, baked goods, ready meals,

Problem (?)
• Biosynthesis still to be fully elucidated but being addressed.
• The “product” is a MWt distribution of polysaccharides - 31-3100 x 10^3.
• What is the real target?
• Are there actually several targets?

Functional binding agent - meat products, baked goods, ready meals,

Colonic fermentation
Prebiotics

Low
Medium
High MWt

Binding agent
Cholesterol reduction

New breeding targets
Functional products from cereals

• Worldwide: at least 1500 Mtonnes cereal grain produced annually.
• This also generates 2250 Mtonnes of straw. Bran is also generated.
• Previously low values residues they are now increasingly becoming targets for valorisation: feedstock for fuel, chemicals, ingredients etc.
• These approaches (not fuel) have been reinvigorated with the shift towards sustainable production.
• The biorefinery approach (wet, dry solvent etc) is being explored by several groups globally.
Wheat bran wet fractionation stream

Mark Lawther DTI, DK

Main products
Especially for prebiotic content

**Wheat Bran**

- **Insoluble Fraction:** 55-60%
- **Soluble fraction (intermediate):** 40-45%

**Intermediate**

- Xylo-Oligosaccharide: 10-20%
- Soluble Xylans, prebiotics: 10-20%
- Aleurone-rich Protein: 3-4%
- Insoluble Dietary Fibre: 18-25%
- Aleurone Rich Protein, Hydrol.: 3-4%
- Aleurone-rich Oil: 0.5%
- Defatted Aleurone-rich Protein: 3-4%
- DARP, Hydrolyzed: 3-4%
- DGRP, Hydrolyzed: 6-12%
- Germ Oil: 1.5-3%
- Defatted Germ Rich Protein: 6-12%
- GRP Hydrolyzed: 7-15%

**Main products**

- Especially for prebiotic content

* An intermediate product only.
** Can be sold as is or processed further.
• All % figures relate to the cereal bran.

- **Germ Rich Protein** (7-15%)
- **Xylan rich protein** (7-15%)
- **Glucose Syrup** (15-25%)
- **Germ Oil** (1.5-3%)
- **Defatted Germ Rich Protein** (6-12%)
- **Germ Oil** (1,5-3%)
- **Defatted Germ Rich Protein** (6-12%)
Oat bran wet fractionation stream
Mark Lawther DTI, DK

- **Main products**
  - Especially for prebiotic content

- **Insoluble Fraction:** 30%
  - **6**: Oat Bran
  - **6**: Intermediate "Bran"
    - **6.5**: Insoluble Fraction
    - **6**: Soluble Fraction (intermediate): 40-45%
    - **0.5**: Oat Bran

- **Insoluble Fraction:** 30%
  - **7**: Beta glucan 2:
  - **8**: Beta glucan 3, prebiotics:
  - **9**: Aleurone-rich Protein
  - **9**: Insoluble Dietary Fibre: 12 – 15%

- **Soluble Fraction** (intermediate): 40-45%
  - **0**: Oat Bran
  - **1**: Oat maltodextrins 28-31%
  - **2**: Oat Protein: 13-16%
  - **2**: Beta Glucan 14-18%
  - **3**: OP Hydrolyzed 7-10%

- **Defatted Aleurone-rich Protein**
  - **4**: Oat Oil 4-8%
  - **5**: DOP, hydrolyzed 5-8%
  - **5**: Defatted OP 6-10%

- **Aleurone-rich Oil:** 0.5%
  - **11**: Aleurone-rich Oil
  - **12**: Defatted Aleurone-rich Protein
  - **12**: DARP, Hydrolyzed

- **Beta Glucan**
  - **14**: Beta Glucan 14-18%
  - **2**: Beta Glucan 3, prebiotics:

- **Aleurone-rich Protein**
  - **9.5**: Aleurone Rich Protein, Hydrol.
  - **10**: Insoluble Dietary Fibre: 12 – 15%

- **Defatted OP**
  - **6**: Oat Bran
  - **10**: Defatted OP 6-10%

- **Aleurone-rich Oil**
  - **0.5**: Oat Bran

- **Beta Glucan**
  - **14**: Beta Glucan 14-18%

- **Oat Oil**
  - **4**: Oat Bran

- **Units**
  - *An intermediate product only.
  - **Can be sold as is or processed further.
  - **All % figures relate to the cereal bran.
Minor crop wastes also have major value

Blackcurrant

Juice + Pulp → Anthocyanin rich Feedstock
(Food or Pharma)

Age-related Rat Liver Gene Expression Following Blackcurrant Consumption

Increased cerebral arterial flexibility

Neuroprotection via blackcurrant polyphenol pre-incubation

Sample and blackcurrant incubation (ug/ml)

Control  Stressed  7.8  15.6  31.25  62.5  125

ROS production

Increased cerebral arterial flexibility

Control
Black currant extract (0.01 %)

** p<0.0286
* p<0.0354

Flow [mL/min] Tension [g]
Alternative functional potato products

Haulms

Solanesol - antiulcer, anti-hypertension. Intermediate for coenzyme Q10 (CVD, atherosclerosis and cancer.

Spoiled and greening

Calystegines

Chiral pharma feedstocks

Tropane alkaloids - anticholinergics and stimulants
Conclusions

• Crops can be more significantly utilised.

• The decreasing cost of genomes sequencing and advent and utility of high throughput metabolite analysis (metabolomics) should identify many more potential targets.

• The push for sustainability will facilitate the valorisation of lower value crops, waste and spoiled material.

• These alternative functional products will feed into the expanding functional food markets.

• The exploitation of these undervalued resources will need an interdisciplinary approach, in particular the inclusion of socio-economic skill bases.

• Cereal waste exploitation is likely to be an immediate winner particularly in the boom economies e.g. India.