Breeding Triple Low Canola

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“Triple Low” Canadian Canola

1. **Low erucic acid oil**
   “less than 2% erucic acid”

2. **Low glucosinolate meal**
   “the solid component of the seed must contain less than 30 micromoles of any one or any mixture of 3-butenyl glucosinolate, 4-pentenyl glucosinolate, 2-hydroxy-3 butenyl glucosinolate, and 2-hydroxy-4-pentenyl glucosinolate per gram of air-dry, oil-free solid”

3. **Ultra low fibre meal**
   “the solid component of the seed must contain less than 2% acid detergent lignin content”

*Brassica napus, Brassica juncea* and *Brassica rapa* species
Rapeseed to canola

- **Late 1940’s to early 1970’s “single low”**
  - oil portion of seed (40 to 44%)
    - industrial use to edible oil – low erucic acid oil varieties
  - meal portion of seed (60%, 36 to 37% protein)
    - problems – palatability and anti-nutritional factors
    - low glucosinolate ‘Brownowski’ identified

- **Mid 1970’s to 1980’s “double low”**
  - low erucic acid oil, low glucosinolate meal
    - “canola < 2 % erucic acid oil, < 30 µmoles/g meal”, GRAS status, 1985

- **Mid 1980’s to late 1990’s**
  - herbicide tolerant (HT) canola
  - hybrid systems in *Brassica napus* canola

- **Trend in western Canadian canola production acreage**
  - 1994: 50% *B. napus* 50% *B. rapa*
  - 2000: 95% *B. napus* 5% *B. rapa*
  - 2006: 98% *B. napus* HT canola (>50% hybrids)
Canola quality mustard: diversification and expansion of *Brassica* production

**Beginning 1950’s**
- potential of *Brassica juncea* investigated by plant breeders, AAFC Saskatoon and animal scientists, University of Saskatchewan
  - yield advantage + resistance to shattering, disease resistance
  - genetic diversity and expansion of production to brown soil zones, hot, dry

**Early 1980’s to 1995**
- development of low erucic acid *B. juncea* – Australia, 1981
- development of low glucosinolate *B. juncea* – Saskatoon, 1985
- improvement of canola quality fatty acid profile *B. juncea* AAFC-SRC & Saskatchewan Wheat Pool (SWP), 1995

**2000 to 2005**
- development and commercialization under contract registration by SWP of *B. juncea* canola
  - (Arid and Amulet, 2002; Estlin, 2005)
### Brassica juncea canola commercial cultivars

<table>
<thead>
<tr>
<th>Cultivars</th>
<th>Yield(^1) (kg/ha)</th>
<th>Oil (%)</th>
<th>Protein (%)</th>
<th>T-SAT(^2) (%)</th>
<th>T-GSL(^3) (µmol/g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Estlin</td>
<td>2650</td>
<td>105.5</td>
<td>45.1</td>
<td>48.6</td>
<td>6.7</td>
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<tr>
<td>Arid</td>
<td>2510</td>
<td>100.1</td>
<td>44.2</td>
<td>49.6</td>
<td>7.0</td>
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<tr>
<td>Q2(^4)</td>
<td>2580</td>
<td>102.7</td>
<td>44.5</td>
<td>47.5</td>
<td>6.9</td>
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<tr>
<td>Sites</td>
<td>18</td>
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</table>

B. juncea canola cultivar ‘Estlin’ rated R for resistance to black leg disease; 0.1 µmoles per gram seed allyl isothiocyanate glucosinolate, 64% C18:1.

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1 – 2003-2004 Combined Data
2 – Total saturated fats (%)
3 – Total glucosinolate content of seed (µmoles per gram seed)
4 – Black seeded B. napus check

Data courtesy: Dr. Derek Potts, Viterra
Low fibre, yellow-seeded *Brassica napus* canola

**Early 1970’s**
- yellow-seeded forms of *Brassica* investigated by plant breeders, AAFC Saskatoon and animal scientists, University of Saskatchewan

**1970’s to 2001**
- non pigmented seed coat sources in naturally occurring *Brassica* sp.
  - *B. abloglabra, B. juncea, B. carinata, B. rapa*
- introgressed into pigmented form of *B. napus* (1970’s to 1998)
- conventional breeding methods; field production; seed quality, disease resistance and agronomic selection strategies (1980’s to 2001)

**2003 to current**
- selection of *B. napus* line YN01-429 (2003)
  - true breeding, yellow-seeded (low fibre), low glucosinolate, low total saturated fat, high oil content, competitive in seed yield with open-pollinated check cultivars, moderate resistance to black leg disease
- establishing genetically diverse yellow-seeded canola gene pools for commercialization into hybrid varieties
# Low fibre, yellow-seeded *Brassica napus* canola

<table>
<thead>
<tr>
<th>Lines</th>
<th>Yield(^1) kg/ha</th>
<th>Oil (%)</th>
<th>Protein (%)</th>
<th>SW(^2) (g/1000)</th>
<th>T-GSL(^3) (µmol/g)</th>
<th>Fibre(^4) (% meal)</th>
<th>ADL</th>
<th>ADF</th>
<th>NDF</th>
</tr>
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<tbody>
<tr>
<td>YN01-429</td>
<td>2030</td>
<td>109</td>
<td>49.1</td>
<td>3.30</td>
<td>12.9</td>
<td>1.3</td>
<td>8.2</td>
<td>14.9</td>
<td></td>
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<tr>
<td>46A65/Q2(^5)</td>
<td>1890</td>
<td>100</td>
<td>45.8</td>
<td>2.77</td>
<td>17.7</td>
<td>5.4</td>
<td>13.6</td>
<td>19.1</td>
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<tr>
<td>Station yrs</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>5</td>
<td>4</td>
<td>4</td>
<td>4</td>
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</table>

1 – Yield at AAFC Saskatoon, Scott and Melfort, 2002-2004; 6 station years
2 – 1000 seed weight (grams per 1000 seeds)
3 – Total glucosinolate content of seed (µmoles per gram seed) by g.c.
4 – Insoluble fibre by Ankom 200 Fibre Analyzer: ADL is acid detergent lignin; ADF is acid detergent fibre (cellulose + lignin); NDF is neutral detergent fibre (hemicellulose + cellulose + lignin + pectin)
5 – Black seeded checks
# Brassica juncea canola meal

<table>
<thead>
<tr>
<th>Meal</th>
<th>Crude Protein (%)</th>
<th>ADF&lt;sup&gt;1&lt;/sup&gt; (%)</th>
<th>NDF&lt;sup&gt;1&lt;/sup&gt; (%)</th>
<th>Crude Fibre (%)</th>
<th>Crude Fat (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>B. juncea</td>
<td>42.4</td>
<td>11.4</td>
<td>18.8</td>
<td>7.7</td>
<td>1.4</td>
</tr>
<tr>
<td>B. napus (black)</td>
<td>39.0</td>
<td>17.0</td>
<td>27.8</td>
<td>11.4</td>
<td>2.5</td>
</tr>
</tbody>
</table>

1 – ADF is acid detergent fibre; NDF is neutral detergent fibre

Data courtesy: Dr. Derek Potts, Viterra & Dave Hickling, CCC
Value of yellow-seeded *Brassica*

- yellow-seeded *B. rapa* had thinner hulls, lower fibre higher oil, than brown-seeded forms *B. rapa*

1982 (J.M. Bell & A. Shires)
- hulls from yellow-seeded *B. rapa* ‘R500’ less NDF and lignin than brown-seeded *B. napus* ‘Tower’
- energy components of hulls more digestible in yellow-seeded ‘R500’

1999 (B.A. Slominski, J. Simbaya, L.D. Campbell, G. Rakow & W. Guenter)
- 2-week growth trial, 4-day old broiler chickens
- significantly lower Feed to Gain ratio with yellow-seeded *B. napus* canola meal than black-seeded *B. napus*
- ~ 6 % (significant) increase True Metabolizable Energy with yellow-seeded *B. napus* canola meal (as previously reported, Slominski, 1977)

2003 (R.T. Zijlstra, D.R. Hickling & J.F. Patience)
- 28-day growth trial, pigs, fed *B. juncea* & *B. napus* canola meal (15%)
- 2.5% increase Feed Efficiency (+5.8% days 22-28) *B. juncea*
- 42 g/d (4.7%) increase Av. Daily Gain (+16.8% days 22-28) *B. juncea*
The future of low fibre, yellow-seeded *Brassica*

Increasing the value chain of Canadian canola

- **Superior value canola meal with increased energy content (6% +)**
  - ultra low fibre (< 2% ADL, < 10% ADF)
  - ultra low glucosinolate meal (< 2 μ moles/g)
  - reduction in anti-nutritional factors (phytate, sinapine)

- **Increased total oil content (50 - 52 %)**
  - superior technological and nutritional quality
    - high stability oils (high oleic and low linolenic)
    - low total saturated fat (< 5%)
  - opportunities for biofuel

- **Multiple species of *Brassica* canola**
  - genetic diversity for sustainable gene pool development & production
  - expanded production area & choice of species to minimize risk

- **Increased value at farm gate, feed industry, crushers, end users**
  - high yielding, disease resistant canola
  - increased seed size and seedling vigour
  - preferred crop production systems of HT hybrids
Global perspective of yellow-seeded *Brassica*

- China
- European Union
- Siberia
- Australia

*We have a choice* to mobilize our Canadian canola industry (as defined by animal and human nutrition researchers, Canadian Grain Commission, chemists, Council, crushers, end-use customers, federal regulators, plant breeders, producers, provincial gov’t, private companies, universities, etc.)

“*Made in Canada*”

- it is time to recognize and acknowledge our achievements
- it is time to be aggressive and position Canada in a competitive, global oilseeds market with the superior quality and potential of “triple low” rapeseed/canola
- what do we have to lose?
Acknowledgements for the vision of low fibre, yellow-seeded *Brassica* for Canada