The Effects of Pulse Flours and Fractions on Post-prandial Glycemia and Satiety/food intake in Humans

G. Harvey Anderson
Akilen Rajadurai
Muhammad Umair Arshad

(Drs. Rebecca Mollard, Bohdan Luhovyy)

Department of Nutritional Sciences
University of Toronto
Conflicts of Interest

• Consultant to many food and drug companies and associations.
  – Kelloggs, CocaCola, Mead Johnson, Abbott, Nestle, Baxter-Travenol, EliLily, PepsiCo, Kraft, McCain Foods, Maple Leaf Foods, General Mills, McDonalds, Hillshire Brands, Unilever, Heinz, ADM, Healthy Grains Institute, Canadian Sugar Institute.

• Research funded by Agri-Food Canada, Saskatchewan Pulse Growers, Pulse Canada and Dairy Farmers of Canada, Dairy Farmers of Ontario, CIHR, NSERC, MiTACS, General Mills, Kraft, Aginimoto, Alliance for Potato Research and Education.

• Direct the UofT/NSERC Program in Food Safety, Nutrition and Regulatory Affairs (18 Food Industry Members)

• Executive Director of the Centre for Child Nutrition, Health and Development
In 2010, 61% of Canadians were classified as overweight or obese and 1.8 million Canadians had type-2 diabetes (Statistics Canada, 2010).

Need to investigate foods that modulate energy balance and blood glucose


# Whole Pulses vs. Glycemia: Anderson Lab

<table>
<thead>
<tr>
<th>Serving Method &amp; Control</th>
<th>Pulse variety</th>
<th>Blood Glucose iAUC compared with Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Served with Tomato Sauce</td>
<td>White Bread</td>
<td></td>
</tr>
<tr>
<td>Control: White Bread</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Mollard et al. APNM (2011)</strong></td>
<td>Chickpeas, Lentils, Yellow peas</td>
<td>-20%, -9%, -15%</td>
</tr>
<tr>
<td>Served with Macaroni &amp; Cheese</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control: Macaroni &amp; Cheese</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Mollard et al. BJN (2012)</strong></td>
<td>Lentils, Chickpeas, Navy Beans, Yellow Peas</td>
<td>-27%, -30%, -30%, -16%</td>
</tr>
<tr>
<td>Served with Pasta &amp; Tomato Sauce</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control: Pasta &amp; Tomato Sauce</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Mollard et al. APNM (2014)</strong></td>
<td>Lentil, Chickpeas, Navy Beans, Yellow Peas</td>
<td>-44%, -47%, -45%, -30%</td>
</tr>
<tr>
<td>Served with Tomato Sauce</td>
<td></td>
<td></td>
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<td>Control: White Bread</td>
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<td></td>
</tr>
</tbody>
</table>
Strategy to Increase Pulse Consumption

1. Whole Pulses
2. Industrial Processing
3. Pulse Powders
4. Common Foods

- Obesity/T2DM
- Health Benefits?
Do Powder Pulses Retain Low Glycemic Characteristic?

Within-subject, randomized, single-blind and repeated-measures design

Healthy Men
Age: 18-30 years
BMI: 20-25 kg/m²

- Experiment 1: Navy beans
- Experiment 2: Lentils
- Experiment 3: Chickpeas

Whole Canned Pulses
Pureed Canned Pulses
Pulse Powder
Whole Wheat Flour (Control)

Standardized for available carbohydrate (25g from pulses or whole wheat), sodium and weight

Protocol

Finger Prick Blood Samplings for BG

Visual Analogue Scales for subjective appetite

Standard Breakfast

10-12h fasting

4h

Premeal

Postmeal

Treatment

Fixed pizza meal

12kcal/kg of body weight

0 15 30 45 60 90 120 140 155 170 185 200

min
Navy Beans & Blood Glucose

**Premeal**
(0-120min)

**Postmeal**
(120-200min)

Mean Blood Glucose (mmol/L)

Whole Navy Bean, Navy Bean Puree, Navy Bean Powder, Whole Wheat Flour

Time P < 0.0001, Trt P = 0.285, Time*Trt P < 0.0001

Time P < 0.0001, Trt P = 0.018, Time*Trt P = 0.251

Mean SEM, n = 17. Two-way ANOVA with Tukey’s post-hoc test. Values with different superscripts are significantly different, P < 0.05
Lentils and Blood Glucose

![Graph showing mean blood glucose levels pre- and post-meal for different forms of lentils and whole wheat flour.](image)

**Mean ± SEM, n = 12. Two-way ANOVA with Tukey’s post-hoc test. Values with different superscripts are significantly different, P < 0.05**

**Pre-meal (0-120min):**
- Whole Lentil
- Lentil Puree
- Lentil Powder
- Whole Wheat Flour

**Post-meal (120-200min):**
- Whole Lentil
- Lentil Puree
- Lentil Powder
- Whole Wheat Flour

**Statistical Analysis:**
- Time P < 0.0001, Trt P = 0.0001, Time*Trt P = 0.0008
- Time P < 0.0001, Trt P = 0.645, Time*Trt P = 0.438
Chickpea and Blood Glucose

![Graph showing mean blood glucose levels](graph.png)

Mean ± SEM, n = 12 Two-way ANOVA with Tukey’s post-hoc test. Values with different superscripts are significantly different, P < 0.05.
Processing pulses to powdered form does not eliminate the benefits of whole pulses on BG response.

But

Attention must be paid to mesh (particle size)
PULSES

Satiety & Postprandial Glycemia

Protein (BCA,s)

Starch (Resistant & Slowly Digestible)

Fiber (Soluble & Insoluble)
Protein is the component responsible for the short-term effects of pulses in the regulation of postprandial glycemia as well as satiety.
Yellow Pea Protein but not Fibre Fractions reduce Blood Glucose iAUC

AUC for Blood Glucose over two hours after treatments. Mean ± SEM, n=15. One-way ANOVA with Tukey’s post-hoc test; p < 0.05.

Yellow pea protein but not fibre reduces pre and post meal blood glucose

Mean Blood glucose before and after pizza meal served at 30 min
(n=19; P<0.05, two-way ANOVA, Tukey–Kramer post hoc test)

Lentil fractions and short term subjective appetite and post-prandial glycemia in healthy young men

Healthy Men (n=12)
Age: 20-30 years
BMI: 20-25 kg/m²

Study Design & Protocol

**Treatment Soup**
- Lentil Protein Isolate
- Lentil Protein Concentrate
- Lentil Starch
- Lentil Fiber

**Pizza**
(Fixed; 12KCal/Kg body wt.)

Pre-meal blood glucose, insulin & appetite

Post-meal blood glucose, insulin & appetite

<table>
<thead>
<tr>
<th>0</th>
<th>5</th>
<th>15</th>
<th>30</th>
<th>50</th>
<th>65</th>
<th>80</th>
<th>95</th>
<th>110</th>
<th>140</th>
<th>170</th>
</tr>
</thead>
<tbody>
<tr>
<td>VAS</td>
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</table>
Lentil protein isolate reduces blood glucose iAUC

Blood Glucose over 110 min after treatments
(Means ± SEM; n=12. P < 0.05; One-factor ANOVA for treatment and time effect followed by Tukey’s post hoc test)
Lentil protein fractions did not significantly increase serum insulin

Serum Insulin over 110 min after treatments
(Means ± SEM; n=12. P < 0.05; One-factor ANOVA for treatment and time effect followed by Tukey’s post hoc test)
CONCLUSION

Whole pulse consumption has beneficial effects on post-prandial glycemia and satiety responses.

Processing of pulses to powdered form does not eliminate the benefits of whole pulses.

Lentil and pea proteins are the most active component in the regulation of food intake and postprandial glycemia.
Effects of faba bean fractions as ingredients in novel food products on glycemia, appetite and metabolic control (2015-2018)

G Harvey Anderson, University of Toronto
Ravindra Chibbar, University of Saskatchewan
Rebecca Mollard, Richardson Centre
Mehmet Tulbec, Alliance Grain Traders
Michael Sills, Ingredion Inc

Funded by Saskatchewan Pulse Growers, Ag
Future Research

• Define the optimum size of pulse powders for food and physiologic functionality. Develop viable food and meal applications.
• Improve processes for extraction of pulse fractions and advance their food applications for food and physiologic functionality.
• Advance understanding of the chemical structures and properties of pulse proteins, starches and fibres.
Thank You

Financial and in-kind support:

Yellow pea protein reduces food intake at a later meal.

Food intake and Cumulative energy intake at pizza meal served after 30 min.

(n= 19; P<0.05, One-way ANOVA, Tukey–Kramer post hoc test)
Navy Beans Powder suppressed pre-meal appetite more than whole wheat flour

![Bar chart showing appetite levels](chart.png)

Mean SEM, n = 17. Two-way ANOVA with Tukey’s post-hoc test. Values with different superscripts are significantly different, P < 0.05
Lentil Protein Fractions (20 g) suppressed post-meal appetite

C = Control (Tomato Soup)
LPI = Lentil Protein Isolate
LPC = Lentil Protein Concentrate
LS = Lentil Starch
LF = Lentil Fiber

Average Appetite Score before & after fixed pizza meal served at 30 min.

(Means ± SEM; n=12. P < 0.05; two-factor ANOVA for treatment and time effect followed by Tukey’s post hoc test)