Glycaemic impact of Oats relevant to diabetes

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Content

- Numbers of people with poor glucose control is rising
- People with poor glucose control are at high risk of diabetic complications, CVD & premature death - at great cost to the NHS
- Oats elicit properties that might contribute to better glycaemic outcomes e.g.
  - Rich in CHO with low-medium CHO GI yet
  - Capable of reducing peak prandial BG & insulin
  - Influences incretin hormones
  - Reduces gastric emptying
NHS SPENDING ON DIABETES 'TO REACH £16.9 BILLION BY 2035'

Wednesday 25 April 2012

A new report published in the journal Diabetic Medicine has projected that the NHS's annual spending on diabetes in the UK will increase from £9.8 billion to £16.9 billion over the next 25 years, a rise that means the NHS would be spending 17% of its entire budget on the condition.

The Impact Diabetes report also suggests that the cost of treating diabetes complications is expected to almost double from the current total of £7.7 billion to £13.5 billion by 2035/6.

Preventable complications

Authored by the York Health Economic Consortium and developed in partnership between Diabetes UK, JDRF and Sanofi Diabetes, the report highlights the large percentage (79%) of NHS diabetes spending that goes on complications — many of which are preventable. Investing in the checks and services that help people manage the condition can save the NHS money in the long term.
Type 1 diabetes develops...
...when the insulin-producing cells in the pancreas have been destroyed because the body has an abnormal reaction triggered by a virus or other infection.

Type 2 Diabetes develops...

1. When β-cells slowly decline in function &/or
2. Body tissues build up a resistance to insulin (& cannot take in sufficient glucose to fuel the body; glucose builds up in the bloodstream)
Sustained periods of hyperglycaemia over 24 hours in a diabetes patient
Major Complications of Diabetes

- Coronary Heart Disease
- Nephropathy
- Neuropathy & consequent amputation
- Nephropathy
Natural History of Obesity Leading to Type 2 Diabetes

Genetic susceptibility
Environmental factors
- Nutrition
- Physical inactivity

Onset of diabetes

Complications
- Atherosclerosis
- Hyperglycemia
- Hypertension

Disability
- Blindness
- Renal failure
- CHD
- Amputation

Death
6.2% UK Population diagnosed with diabetes
0.5 million Undiagnosed
(QOF & AHPO diabetes prevalence model 2013/14)

4.75 million UK people at high risk of getting T2DM
11.5 million people are at increased risk of developing T2DM based on waist circumference/overweight i.e. 1 in 4 adults

55% increase in T2DM in next 25 years

Estimated number of people with diabetes worldwide and per region in 2015 and 2040 (20-79 years)
Attention to diet and physical activity reduces progression to diabetes.

\[ n = 3234 \text{ persons with high fasting plasma glucose. Mean age 51 years; BMI 34.0; 68\% women.} \]

7\% body wt loss & 150 min of exercise wk\(^{-1}\)

\[ \text{Placebo} \]
\[ \text{Metformin} \]
\[ \text{Lifestyle} \]

\[ 31\% \]
\[ 58\% \]

Relevance of Oats to metabolic control in people at risk of or already with diabetes

1. Medium to High CHO content
2. Low-medium glycaemic index (GI; e.g. GI 50-60 units - rolled oats, oat bran)
3. $\beta$-glucan influences BG, satiety & weight management
4. Gut hormone release *and* DPP4 inhibition
5. Amino Acids - muscle tissue mass, EAAs, satiety ... incretin hormone effects
Influence of Oats on Blood Glucose

• Oats contain carbohydrate and consumption increases BG (magnitude based on amount ingested).
• Most soluble starch contained in the groat.
• E.g. Rolled oats: energy per 100 g = 379 kcal; 67g CHO, ~9 g available sugars, most starch
Little evidence that interventions with oats or oat bran affect fasting glycaemia or insulin concentrations.
Effect of dose and modification of viscous properties of oat gum on plasma glucose and insulin following an oral glucose load

BY PETER J. WOOD, JAN T. BRAATEN, FRASER W. SCOTT, K. DOREEN RIEDEL, MARK S. WOLNETZ AND MAURICE W. COLLINS

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50 g CHO with -
- No β-glucan (white circles)
- 1.8g β-glucan (dark circles)
- 3.6g β-glucan empty triangle
- 7.2g β-glucan (dark triangles)

OAT GUM VISCOSITY AND PLASMA GLUCOSE
Mean serum insulin and BG responses in subjects following ingestion of breakfast meals; a test meal with wheat bread, yoghurt and muesli with oat bran flakes containing 4 g of β-glucans & a reference meal with white wheat bread and yoghurt without muesli ( ). Values with different letters are significantly different (P<0.05).

50% decrease in BG response after ingestion of breakfast cereal (35 g CHO) occurs with 4-6 g β-glucan in T2DM.

Peak plasma glucose after the breakfast cereal were 67%, 42% and 38% (P < 0.05) with 4.0, 6.0, and 8.4 g β-glucan, respectively, compared with the continental breakfast.

Postprandial insulin increase was only 59–67% (P < 0.01) as high as the continental breakfast after all three levels of β-glucan.

Tappy, L DC 1996 19(8) 831-834
24 week oat bran diet improves post glucose responses to breakfast and lunch in individuals with T2DM
Influence of oat β-glucan on Gastric Emptying
Oat β-glucan (7.5 g, 500 mL, 500 Kcal) decreased postprandial glucose and insulin in T2DM. Gastric emptying delayed by oat β-glucan ingestion in T2DM & non-DM. Gastric emptying delayed by β-glucan in T2DM with HbA$_1$c ≥6.5% or with complications.


Figure 5. Effects of SDF compared to SDF-free meal in HS (a) and DM patients (b) on gastric half-emptying time (T1/2). SDF, soluble dietary fibre; HS, healthy subjects; DM, diabetes mellitus.
Eating increases gut hormones and viscosity of β-glucan in oat bran strongly modified short-term GI physiology.

Juvonen et al., 2009, doi:10.3945/jn.108.099945

<table>
<thead>
<tr>
<th></th>
<th>Low viscosity</th>
<th>High viscosity</th>
<th>P-value²</th>
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</thead>
<tbody>
<tr>
<td>Glucose AUC, mmol·min/L</td>
<td>−31 ± 21</td>
<td>10 ± 19</td>
<td>0.101</td>
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<tr>
<td>Insulin AUC, pmol·min/L</td>
<td>21,050 ± 2264</td>
<td>15,307 ± 1854</td>
<td>0.007</td>
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<tr>
<td>Ghrelin AUC, pmol·min/L</td>
<td>−519 ± 1133</td>
<td>−360 ± 909</td>
<td>0.162</td>
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<tr>
<td>CCK AUC,³ pmol·min/L</td>
<td>449 ± 73</td>
<td>250 ± 44</td>
<td>0.006</td>
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<tr>
<td>PYY AUC, pmol·min/L</td>
<td>668 ± 184</td>
<td>129 ± 161</td>
<td>0.038</td>
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<tr>
<td>GLP-1 AUC, pmol·min/L</td>
<td>189 ± 48</td>
<td>74 ± 20</td>
<td>0.030</td>
</tr>
<tr>
<td>Paracetamol AUC,⁴ µmol·min/L</td>
<td>16,340 ± 1245</td>
<td>14,670 ± 770</td>
<td>0.051</td>
</tr>
</tbody>
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¹ Values are means ± SEM, n = 20 unless otherwise noted.
² General Linear Model with Sidak adjustment.
³ n = 17.
⁴ n = 10.
Diabetes & The "Incretin Effect"

Healthy Patients

Type 2 Diabetics

Reduced Incretin Effect

- Oral Glucose (50 g/400 ml)
- Isoglycemic IV Glucose Infusion

Nauck M et al.
Diabetologia (1986) 29:46-52
Incretin-based therapies

GLP-1 receptor agonists
Mimic native GLP-1

- Exenatide
  (Exendin-based therapy)
- Liraglutide
  (Human GLP-1 analogue)
- Lixisenatide
  (albiglutide, dulaglutide, semaglutide)

DPP-4 inhibitors
Protect native GLP-1 from inactivation by DPP-4

- Sitagliptin
- Vildagliptin
- Saxagliptin
- Linagliptin
- (Alogliptin)

Drucker DJ, Nauck MA. Lancet 2006;368:1696–1705
Effects of Subcutaneous GLP-1 on Gastric Emptying in Type 2 Diabetes

* P < 0.0001

DPP-4 Inhibitors Enhance Incretin and Insulin Secretion

Food intake → DPP-4 inhibitor → DPP-4 → Stomach → GL tract → Intestine

Incretins → Beta-cells → Insulin release

GLP-1 and GIP effects on beta-cells:
- Increases and prolongs GLP-1 and GIP effects on beta-cells:

 Increases and prolongs GLP-1 effect on alpha-cells:
- Decreases glucagon secretion

Net effect:
- Blood glucose

Adapted from:
- Barnett A. Int J Clin Pract 2006;60:1454-70
- Drucker DJ, Nauck MA. Nature 2006;368:1696-705
Peptides released from oat, buckwheat, and highland barley proteins were examined for in vitro inhibitory effects on DPP4. All hydrolysates exhibited DPP4 inhibitory activities, with oat flour demonstrating the highest level of inhibition (IC50, 0.99 mg/mL).

Conclusions

1. Oats contain CHO necessary for RDI
2. Greater $\beta$-glucan content reduces post-prandial peak glucose & insulin acutely & chronically in T2DM – (dose dependent/threshold effects)
3. $\beta$-glucan may decrease gastric emptying via mechanical (viscosity) & GLP-1 mediated mechanisms.
4. People with poor glucose control can benefit from consuming oats products.
Thank you for listening

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