Weight control and satiety effects of flaxseed - A Review

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Which health benefits are you most interested in getting from foods?

- Weight loss/management: 46%
- Increased energy: 35%
- Cardiovascular health: 32%
- Healthy aging: 30%
- Digestive health: 29%
- Mental health: 17%
- Bone health: 17%
- Muscle health: 16%
- Immunity: 15%
- Improved memory/cognition: 14%
- None of the above: 8%

Source: International Food Information Council Foundation
# Global Childhood Obesity

<table>
<thead>
<tr>
<th>Number and proportion estimated to be overweight including obese</th>
<th>2000</th>
<th>2010</th>
<th>2013</th>
<th>2025</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>201,373,649</td>
<td>217,021,142</td>
<td>223,960,366</td>
<td>268,763,283</td>
</tr>
<tr>
<td></td>
<td>12.9%</td>
<td>13.8%</td>
<td>14.2%</td>
<td>15.8%</td>
</tr>
<tr>
<td>Number and proportion estimated to be obese</td>
<td>73,758,613</td>
<td>77,803,878</td>
<td>79,924,797</td>
<td>93,751,692</td>
</tr>
<tr>
<td></td>
<td>4.7%</td>
<td>5.0%</td>
<td>5.1%</td>
<td>5.5%</td>
</tr>
</tbody>
</table>

World Obesity Federation, 2016
Distribution of the EU population aged 18 or over by Body Mass Index, 2014 (%)
<table>
<thead>
<tr>
<th>Weight Management Foods and Beverages Used by U.S. Consumers in the Past Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low sugar 69%</td>
</tr>
<tr>
<td>Low fat 68%</td>
</tr>
<tr>
<td>Low calorie 65%</td>
</tr>
<tr>
<td>Fat-free 62%</td>
</tr>
<tr>
<td>Low carb 57%</td>
</tr>
<tr>
<td>Whole grains 78%</td>
</tr>
<tr>
<td>High fiber 71%</td>
</tr>
<tr>
<td>High protein 66%</td>
</tr>
<tr>
<td>Gluten-free 45%</td>
</tr>
</tbody>
</table>

Natural Marketing Institute, 2016
Flaxseed
(Linseed)
Flaxseed

- Essential fatty alpha-linolenic acid (ALA - omega 3)
- Protein
- Bioactive peptides
- Lignans (phytoestrogens) and other antioxidants
- Dietary fibre
Total Fat  42%

Polyunsaturated Fatty acids

Alpha linolenic Acid  57%  
(C18: 3n-3)

Linoleic Acid  16%  
(C18:2n-6)

Saturates  9%

Source: Flax Council of Canada *Analyzed by the American Oil Chemists' Society's (AOCS) Official Method Am 2-93, which is based on the Federation of Oils, Seeds and Fats Associations Ltd. (FOSFA) Official Method. The American Organization of Analytical Chemists (AOAC) Method 996.06 will produce a lower fat content.
Dietary Fiber
~ 2.5 g / 1 T

7-10% of the DRI

Figure 1. General structure of flax mucilage neutral and acidic fractions — Structure générale des fractions neutres et acides du mucilage de graines de lin (Alix et al., 2008).
High fibre diets
• promote weight loss or prevent weight gain by absorbing water and increasing bulk in the small intestine.
• induce a feeling of fullness and delay gastric emptying.
• associated with increased satiety, reduced hunger and energy intake, and weight loss.

Flaxseed dietary fiber supplements for suppression of appetite and food intake

- Two single-blinded randomized crossover acute studies with 24 and 20 subjects, respectively.
- Iso-caloric (ca. 575 kJ) iso-volumetric drinks:
  - Control: 300 mL of a blackcurrant-flavored sugar-sweetened beverage (Ribena Blackcurrant Squash)
  - Flax drink: Control drink with addition flax fiber extract containing 2.5 g of soluble dietary fibers
  - Flax tablets: Control drink plus flax fiber tablets to equal 2.5 g of soluble dietary fibers

<table>
<thead>
<tr>
<th>Fruit Bowl</th>
<th>g Flaxseed per product</th>
<th>g Fiber per product</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strawberry Bar</td>
<td>1.8</td>
<td>1.4</td>
</tr>
<tr>
<td>Apple and Pear Bar</td>
<td>1.3</td>
<td>1.4</td>
</tr>
<tr>
<td>Orange Bar</td>
<td>1.7</td>
<td>2.0</td>
</tr>
<tr>
<td>Apple and Blackcurrant Bites</td>
<td>1.5</td>
<td>2.0</td>
</tr>
<tr>
<td>Mixed Berry Bites</td>
<td>1.7</td>
<td>2.0</td>
</tr>
</tbody>
</table>
Apparent digestibility of energy, fat and weight gain in growing rats

- Randomized feeding trial - 60 male, growing, Wistar rats, initial weight of ~200 g

- Diets (n = 10 per group):
  - Low DF control (C)
  - 5% DF from cellulose (5-CEL)
  - CEL + 5% DF from whole (5-WF) or ground flaxseed (5-GF)
  - CEL + 5% DF from flaxseed DF extract (5-DF)
  - CEL + 10% DF from flaxseed DF extract (10-DF)

• Faecal excretion increased with increasing DF content
  ▫ highest in 10-DF

• Apparent fat digestibility - lowest with 10-DF diet and decreased with
  ▫ increasing DF amount
  ▫ DF bioavailability (5-WF vs. 5-GF)
  ▫ proportion of viscous DF (5-GF vs. 5-DF)

• 10-DF
  ▫ lowest final body weight
  ▫ reduced body fat
Lignans

- **Secoisolariciresinol diglucoside (SDG)**
  - Polyphenol, phytoestrogen
  - Exerts weak estrogenic or antiestrogenic effects in mammalian tissue

- **Precursor of mammal lignans**
  

- **Flaxseed richest source**
  - 375 mg/100g

- **Reduced visceral (abdominal) fat in mice receiving a high fat diet with SDG (0.5 or 1.0%)**
  
Lignan complex effects on metabolic syndrome composite score in older adults

- 100 subjects (ca 50 years)
- Flaxseed lignan (543 mg/d) or placebo
  - Plus a 6 month walking program
- 6 risk factors for metabolic syndrome (fasting glucose, HDL cholesterol, TAG, abdominal adiposity, blood pressure, and inflammatory cytokines) measured at baseline and 6 months

Lignan complex effects on metabolic syndrome composite score in older adults

- **Men on flaxseed lignan reduced**
  - diastolic blood pressure (~ 6mm Hg)
  - metabolic syndrome score

- **Women on flaxseed lignan reduced**
  - diastolic blood pressure (~ 7mm Hg)

- **No effects on metabolic syndrome score**
  - Less effective in postmenopausal women due to reduced estrogen receptor numbers ??
Alpha-linolenic acid (18:3n-3) and Inflammation

Flaxseed Supplementation in Metabolic Syndrome Management

- 44 patients with metabolic syndrome (MetS)
- Lifestyle advice + 30g brown milled flaxseed daily vs. only lifestyle advice
- 12 weeks

- % of individuals with MetS decreased from baseline:
  - 50% in control
  - 82% in flaxseed group

Mean changes (95% CI) from baseline in metabolic characteristics by treatment group

<table>
<thead>
<tr>
<th>Change from baseline</th>
<th>Flaxseed group (n = 22)</th>
<th>Control group (n = 22)</th>
<th>p value $^1$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight (kg)</td>
<td>$-9.2$ (-11.45, -7.04)</td>
<td>$-3.15$ (-3.76, -2.54)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>WC (cm)</td>
<td>$-9.5$ (-18.72, -0.28)</td>
<td>$-3.25$ (-4.54, -1.95)</td>
<td>0.003</td>
</tr>
<tr>
<td>Blood pressure (mmHg)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Systolic</td>
<td>$-6.09$ (-10.09, -2.09)</td>
<td>$-2.6$ (-4.95, -0.24)</td>
<td>0.136</td>
</tr>
<tr>
<td>Diastolic</td>
<td>$-2.86$ (-4.23, -1.49)</td>
<td>$-1.1$ (-3, -0.8)</td>
<td>0.144</td>
</tr>
<tr>
<td>FBS</td>
<td>$-6.36$ (-8.68, -4.04)</td>
<td>$-2.75$ (-4.19, -1.3)</td>
<td>0.46</td>
</tr>
<tr>
<td>Insulin</td>
<td>$-4.66$ (-6.6, -2.73)</td>
<td>$-0.96$ (-1.33, -0.59)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>HOMA-IR</td>
<td>$-1.3$ (-1.8, -0.8)</td>
<td>$-0.32$ (-0.43, -0.21)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>QUICKI</td>
<td>0.03 (0.02, 0.04)</td>
<td>0.006 (0.004, 0.009)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Triglyceride</td>
<td>$-64.36$ (-83.5, -45.22)</td>
<td>$-10.65$ (-18.23, -3.06)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Total cholesterol</td>
<td>$-28.9$ (-41.88, -16.63)</td>
<td>$-13.9$ (-17.83, -9.97)</td>
<td>0.709</td>
</tr>
<tr>
<td>LDL-C</td>
<td>$-19.7$ (-30.47, -8.93)</td>
<td>$-12.24$ (-17.26, -7.23)</td>
<td>0.636</td>
</tr>
<tr>
<td>HDL-C</td>
<td>$1.09$ (-2.49, 4.67)</td>
<td>0.05 (-2.37, 2.47)</td>
<td>0.480</td>
</tr>
</tbody>
</table>
Potential mechanisms by which flaxseed promotes weight management

- Metabolic Syndrome composite score
- Central Adiposity
- Inflammation
- Satiety
- Energy Intake

SDG Lignan
- α linolenic acid
- Dietary Fiber

Weight Management
THANK YOU

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