Exploring the role of prebiotic fibers for satiety and weight management

Eric Chappuis – Senior Nutrition Science Manager – Olygose, France
eric.chappuis@olygose.com

Food Matters Live – London / November 2017
Develop, produce and sell **innovative prebiotic ingredients**:

- from plant-based by-products
- with proven health benefits
- through unique extraction and purification technologies
- with a BtoB commercial approach
Obesity facts

Percentage of adults with obesity: click countries for survey details and definitions

Source: Worldobesity
The multiple facets of weight management

Weight gain

Weight loss

Weight maintenance

Weight re-gain
The gut and health: an old story

« All disease begins in the gut »

Hippocrates (a very long time ago)
Gut microbiota contributes to weight regulation

Key role of GF mice

Alteration in gut microbiota influences energy metabolism

Bariatric surgery & gut microbiota
Gut microbiota & satiety / weight: Mechanisms of action

Torres-Fuentes, 2017
Diet accounts for 57% of gut microbiota variability!

Diet-dependent microbiota modulation strategies
Prebiotics definition

“A substrate that is selectively utilized by the host microorganisms conferring a health benefit”

ISAPP, 2017
Benefits in Humans

Effects of oligofructose on appetite profile, glucagon-like peptide 1 and peptide YY3-36 concentrations and energy intake

Sanne P. M. Verhoef, Diederick Meyer and Klaas R. Westerterp

Doses: 0, 10 or 16 g/d
Benefits in Humans

Research report

Gut hormone release and appetite regulation in healthy non-obese participants following oligofructose intake. A dose-escalation study

Camilla Pedersen a,b, Solenne Lefevre a, Véronique Peters b, Michael Patterson b, Mohammad A. Ghatei b, Linda M. Morgan a, Gary S. Frost a,b,*

HORMONES

Doses: 0, 15, 25, 35, 45 or 55 g/d
Benefits in Humans

ENERGY INTAKE & ANTHROPOMETRICS

Estimated marginal means and SEM for appetite, thirst, and wellbeing scores, energy intake, body weight, and geometric means and 95% CI for nausea and GI symptom scores. VAS were completed in the evening and the scores represent an overall assessment of feelings/symptoms that day.

<table>
<thead>
<tr>
<th>Outcome</th>
<th>0g</th>
<th>15 g</th>
<th>25 g</th>
<th>35 g</th>
<th>45 g</th>
<th>55 g</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hunger</td>
<td>5.4 ± 0.4 *</td>
<td>4.5 ± 0.3 **</td>
<td>3.9 ± 0.3 **</td>
<td>3.8 ± 0.3 **</td>
<td>3.8 ± 0.3 **</td>
<td>3.6 ± 0.3 **</td>
<td>0.003 **</td>
</tr>
<tr>
<td>Fullness</td>
<td>4.9 ± 0.4</td>
<td>5.6 ± 0.3</td>
<td>5.5 ± 0.3</td>
<td>6.0 ± 0.3</td>
<td>5.9 ± 0.4</td>
<td>5.6 ± 0.4</td>
<td>0.464 **</td>
</tr>
<tr>
<td>Thirst</td>
<td>5.6 ± 0.5</td>
<td>4.7 ± 0.4</td>
<td>4.6 ± 0.4</td>
<td>5.1 ± 0.4</td>
<td>5.5 ± 0.4</td>
<td>5.6 ± 0.4</td>
<td>0.406</td>
</tr>
<tr>
<td>Nausea</td>
<td>0.5 (0–1.3)</td>
<td>0.4 (0–1.0)</td>
<td>0.5 (0.1–1.1)</td>
<td>0.7 (0.2–1.3)</td>
<td>0.6 (0.2–1.2)</td>
<td>0.6 (0.2–1.3)</td>
<td>0.974</td>
</tr>
<tr>
<td>GI symptom</td>
<td>0.6 (0–1.5)</td>
<td>1.7 (0.9–2.9)</td>
<td>1.6 (0.9–2.7)</td>
<td>1.9 (1.1–3.1)</td>
<td>2.1 (1.2–3.4)</td>
<td>2.0 (1.1–3.3)</td>
<td>0.228</td>
</tr>
<tr>
<td>Wellbeing</td>
<td>5.5 ± 0.4</td>
<td>6.0 ± 0.3</td>
<td>5.5 ± 0.3</td>
<td>5.0 ± 0.3</td>
<td>4.9 ± 0.3</td>
<td>5.2 ± 0.4</td>
<td>0.295 **</td>
</tr>
<tr>
<td>Energy intake f</td>
<td>8390 ± 656</td>
<td>7983 ± 637</td>
<td>9101 ± 637</td>
<td>8837 ± 637</td>
<td>8647 ± 637</td>
<td>9012 ± 653</td>
<td>0.489 **</td>
</tr>
<tr>
<td>Δ Energy intake</td>
<td>–203 ± 620</td>
<td>482 ± 620</td>
<td>227 ± 620</td>
<td>416 ± 620</td>
<td>511 ± 639</td>
<td>760 ± 760</td>
<td>0.955 **</td>
</tr>
<tr>
<td>Body weight</td>
<td>65.5 ± 2.4</td>
<td>65.4 ± 2.4</td>
<td>–</td>
<td>65.4 ± 2.4</td>
<td>–</td>
<td>65.6 ± 2.4</td>
<td>0.955 **</td>
</tr>
</tbody>
</table>

Total AUC<sub>480min</sub> for appetite ratings, plasma glucose, and gut hormones and energy intake at the *ad libitum* meal and on study days (24 h). Values are estimated marginal means ± SEM or geometric means and their 95% confidence intervals.

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Baseline (0 g)</th>
<th>15 g</th>
<th>35 g</th>
<th>55 g</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hunger (cm min)</td>
<td>1626 ± 217</td>
<td>1755 ± 217</td>
<td>1574 ± 217</td>
<td>1434 ± 221</td>
<td>0.361</td>
</tr>
<tr>
<td>Fullness (cm min)</td>
<td>2636 ± 175</td>
<td>2641 ± 175</td>
<td>2859 ± 179</td>
<td>2952 ± 184</td>
<td>0.154</td>
</tr>
<tr>
<td>Prospective food intake</td>
<td>1938 ± 197</td>
<td>2000 ± 197</td>
<td>1777 ± 201</td>
<td>1683 ± 205</td>
<td>0.242</td>
</tr>
<tr>
<td>Nausea (cm min)</td>
<td>175 (52–592)</td>
<td>94 (28–316)</td>
<td>98 (29–342)</td>
<td>99 (29–342)</td>
<td>0.878</td>
</tr>
<tr>
<td>Energy intake (kj)</td>
<td>4574 ± 389</td>
<td>4693 ± 389</td>
<td>4425 ± 389</td>
<td>4046 ± 393</td>
<td>0.551</td>
</tr>
<tr>
<td>Energy intake (kj)</td>
<td>10,918 ± 16</td>
<td>10,230 ± 612</td>
<td>10,534 ± 612</td>
<td>10,021 ± 631</td>
<td>0.487</td>
</tr>
<tr>
<td>Glucose (mmol min/L)</td>
<td>2571 ± 62</td>
<td>2511 ± 63</td>
<td>2533 ± 62</td>
<td>2614 ± 64</td>
<td>0.325</td>
</tr>
<tr>
<td>Insulin (pmol min/L)</td>
<td>71,449 (51,050–100000)</td>
<td>69,024 (49,317–96,828)</td>
<td>79,068 (56,364–110662)</td>
<td>82,035 (57,810–116145)</td>
<td>0.156</td>
</tr>
<tr>
<td>PYY (pmol min/L)</td>
<td>17,846 ± 2537 f</td>
<td>17,201 ± 2557 f</td>
<td>22,439 ± 2537 f</td>
<td>24,995 ± 2557 f</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>GLP-1 (pmol min/L)</td>
<td>57,411 (43,351–76,033)</td>
<td>53,454 (40,272–70,795)</td>
<td>56,494 (42,658–74,817)</td>
<td>NA</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>PP (pmol min/L)</td>
<td>41,400 (26,485–64,714)</td>
<td>37,239 (23,823–58,210)</td>
<td>32,885 (21,038–51,404)</td>
<td>NA</td>
<td>0.009</td>
</tr>
<tr>
<td>Ghrelin (pmol min/L)</td>
<td>317587 ± 36,072</td>
<td>322080 ± 36,257</td>
<td>291340 ± 36,072</td>
<td>257093 ± 36,409</td>
<td>0.052</td>
</tr>
</tbody>
</table>
**Benefits in Humans**

**APPETITE**

**FOOD INTAKE**

---

**α-Galacto-oligosaccharides Dose-Dependently Reduce Appetite and Decrease Inflammation in Overweight Adults**

Fanny B Morel, Qiuping Dai, Jiayi Ni, Doneal Thomas, Patricia Parnet, and Pascale Fança-Berthon

---

**Food intake during test meal, △ day 15 – day 0**

<table>
<thead>
<tr>
<th>Mix of α-GOSs</th>
<th>Control</th>
<th>6 g/d</th>
<th>12 g/d</th>
<th>18 g/d</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight, g</td>
<td>4.7 ± 19.2&lt;sup&gt;a&lt;/sup&gt;</td>
<td>-11.4 ± 16.9&lt;sup&gt;b&lt;/sup&gt;</td>
<td>-22.5 ± 19.1&lt;sup&gt;b&lt;/sup&gt;</td>
<td>-28.8 ± 18.6&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td>Energy, kcal</td>
<td>6.1 ± 20.8&lt;sup&gt;a&lt;/sup&gt;</td>
<td>-12.6 ± 18.6&lt;sup&gt;b&lt;/sup&gt;</td>
<td>-25.7 ± 21.6&lt;sup&gt;c&lt;/sup&gt;</td>
<td>-32.1 ± 22.0&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td>Protein, g</td>
<td>0.2 ± 0.6&lt;sup&gt;a&lt;/sup&gt;</td>
<td>-0.3 ± 0.5&lt;sup&gt;b&lt;/sup&gt;</td>
<td>-0.7 ± 0.6&lt;sup&gt;c&lt;/sup&gt;</td>
<td>-0.9 ± 0.6&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td>Fat, g</td>
<td>-0.02 ± 0.29&lt;sup&gt;a&lt;/sup&gt;</td>
<td>-0.06 ± 0.18&lt;sup&gt;b&lt;/sup&gt;</td>
<td>-0.07 ± 0.10&lt;sup&gt;c&lt;/sup&gt;</td>
<td>-0.14 ± 0.3&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td>Carbohydrates, g</td>
<td>1.5 ± 4.9&lt;sup&gt;a&lt;/sup&gt;</td>
<td>-2.9 ± 4.3&lt;sup&gt;b&lt;/sup&gt;</td>
<td>-6.0 ± 5.0&lt;sup&gt;c&lt;/sup&gt;</td>
<td>-7.4 ± 5.3&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td>Dietary fiber, g</td>
<td>0.1 ± 0.4&lt;sup&gt;a&lt;/sup&gt;</td>
<td>-0.2 ± 0.3&lt;sup&gt;b&lt;/sup&gt;</td>
<td>-0.4 ± 0.4&lt;sup&gt;c&lt;/sup&gt;</td>
<td>-0.6 ± 0.4&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

<sup>1</sup> Values are means ± SDs, n = 22. Labeled means without a common letter differ, P < 0.05. α-GOS, α-galacto-oligosaccharide; △, change.
Benefits in Humans

For the pediatric population, 4 RCTs (n = 232) met the inclusion criteria. In infants, very limited evidence (1 RCT, n = 62) showed no effect of ITF supplementation on energy intake and BW. One RCT involving 97 nonobese adolescents aged 9 to 13 years found a reduced increase in BW in the oligofructose + inulin (8 g/day) group compared with the control group after 1 year. For the adult population, 15 RCTs (n = 545) met the inclusion criteria. Five RCTs found no effect of ITF supplementation on appetite sensations. Eleven RCTs found no effect of ITF supplementation on daily energy intake or energy intake during a meal tolerance test. Among 3 RCTs that assessed the effect of ITF supplementation on BW, 2 RCTs showed a (significant) reduction in BW. Of 3 RCTs that evaluated body mass index (BMI), 1 RCT showed a significant reduction in BMI in subjects supplemented with ITF.

CONCLUSION: Limited data suggest that long-term administration of ITF may contribute to weight reduction.
A high proportion of the potentially relevant literature was excluded because of lack of adequate DF characterization. In total, 49 articles that met these criteria were identified, which reported 90 comparisons of various DFs in foods, beverages, or supplements in acute or sustained-exposure trials. In 51 of the 90 comparisons, the DF-containing material of interest was efficacious for ≥1 appetite-related outcome. Reported differences in material viscosity, MW, or fermentability did not clearly correspond to differences in efficacy, whereas gel-forming DF sources were consistently efficacious (but with very few comparisons),
CONCLUSIONS: The overall inconsistent relations of DF properties with respect to efficacy may reflect variation in measurement methodology, nature of the DF preparation and matrix, and study designs. Methods of DF characterization, incorporation, and study design are too inconsistent to allow generalized conclusions about the effects of DF properties on appetite and preclude the development of reliable, predictive, structure-function relations. Improved standards for characterization and reporting of DF sources and DF-containing materials are strongly recommended for future studies on the effects of DF on human physiology.
How can we explain differences?

Prebiotics characteristics

- Fermentability
- Specific stimulation of microorganisms

Microbiota changes pattern

- Basal microbiota determines « receptivity » to weight loss intervention
- Pattern of microbiota change different among individuals

Study design

- Doses
- Subjects status
- Dietary recommendations and compliance
Research challenges

For microbiota trials

- Inter-personal variation in response
- Basal microbiota generally not considered as an inclusion criteria
- Genetics influences gut microbiota
- Adequacy / reliability of markers

For satiety and weight management trials

- Consistency within and across trials
- Correlation between measures (subjective / objective)
What’s next?

⇒ Evaluate the relationship between satiety improvement and long-term weight maintenance