Gut Feelings: Considering and Capturing Tolerance to Nondigestible Carbohydrates

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<table>
<thead>
<tr>
<th>Relationship (prior 48 months)</th>
<th>Interest</th>
</tr>
</thead>
<tbody>
<tr>
<td>Employee</td>
<td>University of Illinois Urbana-Champaign</td>
</tr>
<tr>
<td>Grant/Research Support</td>
<td>Almond Board of California, Bio-Cat, California Walnut Commission, Foundation for Food and Agriculture Research, General Mills, Hass Avocado Board, National Honey Board, Tate &amp; Lyle, USDA</td>
</tr>
<tr>
<td>Consulting/Advisory Board</td>
<td>Bobbie Baby, DSM, Haleon</td>
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</table>
Outline

1. Tolerance to nondigestible carbohydrates
2. Considerations for assessing tolerances
3. Tools and resources for assessing tolerance
Tolerance is the self-reporting of various gastrointestinal symptoms.

**Gastrointestinal Effects**

- Objective Effects/Function
  - Transit Time
  - Stool Frequency
  - Stool Consistency
  - Stool Weight
  - Stool Moisture Content

- Subjective Effects/Self-Report
  - Gastrointestinal Symptoms
    - Burping
    - Abdominal Pain/Cramping
    - Bloating/Distension
    - Flatulence (Gas)
    - Nausea
    - Reflux (Heartburn)
    - Borborygmi (Rumbling)
  - Stool Ease of Passage
  - Gastrointestinal Quality of Life

Tolerance
Nonstarch polysaccharide classifications:
- solubility
- viscosity
- fermentability

Solubility and Viscosity Affect Tolerance

Nondigestible Carbohydrates

Fermentability Affects Tolerance

Range of tolerable intakes of NDCs

**NDC Category**
- Soluble, viscous, fermentable
- Soluble, viscous, nonfermentable
- Soluble, nonviscous, fermentable
- Both soluble & insoluble
- Resistant starch

**Mysonhimer AR & Holscher HD.** Gastrointestinal effects and tolerance of nondigestible carbohydrate consumption. *Advances in Nutrition.* 2022;13(6):2237-2276
### NDC health benefits, therapeutic doses, and tolerable intake recommendations

<table>
<thead>
<tr>
<th>NDC</th>
<th>Health Benefit</th>
<th>Therapeutic Dose (g/d)</th>
<th>Tolerable Intake (g/d)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alginate</td>
<td>↓ Post-prandial blood glucose</td>
<td>1.5-8</td>
<td>3.75</td>
</tr>
<tr>
<td>Guar gum</td>
<td>↓ Blood cholesterol</td>
<td>≥ 15</td>
<td>11.4</td>
</tr>
<tr>
<td>Psyllium husk</td>
<td>↓ Coronary heart disease</td>
<td>≥ 7</td>
<td>15</td>
</tr>
<tr>
<td>Inulin</td>
<td>Improved laxation</td>
<td>15-50</td>
<td>5</td>
</tr>
<tr>
<td>FOS and OF</td>
<td>↑ Mineral absorption</td>
<td>10-15</td>
<td>7.8</td>
</tr>
<tr>
<td>Polydextrose</td>
<td>↓ Energy intake</td>
<td>12-25</td>
<td>12</td>
</tr>
<tr>
<td>GOS</td>
<td>↑ Intestinal calcium absorption</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>Soy fiber</td>
<td>↓ Blood cholesterol</td>
<td>10-26</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td>Improved laxation</td>
<td>8.2-26</td>
<td></td>
</tr>
<tr>
<td>Resistant starch</td>
<td>↑ Calcium absorption, retention, and bone formation</td>
<td>10-20</td>
<td>12</td>
</tr>
</tbody>
</table>
Perspective: Assessing Tolerance to Nondigestible Carbohydrate Consumption

Hannah D Holscher • Bruno P Chumpitazi • Wendy J Dahl • George C Fahey Jr • DeAnn J Liska
Joanne L Slavin • Kristin Verbeke • Show less

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Tolerance Assessment Recommendations

Measures

- Capture baseline symptoms before acute challenge or during a lead-in period.
- Acute tolerance studies (one-time challenges): monitor symptoms for at least 0-48 hours.
- Acclimation studies: Assess tolerance outcomes over >14 days.
- Adequate washout period.

Intervention

- Fully report the NDC characterization and how the NDC is consumed.
- Negative comparators should match the food product but contain no NDC ingredient.
- Positive controls.

Population

- Consider age, health, diet, lifestyle, and medication when establishing inclusion/exclusion criteria.

Outcome

- Assess subjective participant-reported symptoms via standard gastrointestinal questionnaires as the primary tolerance measures.
- Objective outcome parameters can complement gastrointestinal questionnaires, not replace them.

Over the past **24 hours**, indicate the severity of the following factors:

<table>
<thead>
<tr>
<th>Factor</th>
<th>0 (Absent)</th>
<th>1 (Mild)</th>
<th>2 (Moderate)</th>
<th>3 (Severe)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Burping</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Cramping/pain</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Distension/bloating</td>
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<tr>
<td>Flatulence/gas</td>
<td></td>
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<tr>
<td>Nausea</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Reflux (heartburn)</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Rumblings</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

Did you have any bowel movements **today**?  Yes ☐  No ☐  
(If Yes, please complete the following):

<table>
<thead>
<tr>
<th>Time (AM/PM)</th>
<th>Consistency*</th>
<th>Ease of Passage**</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1 2 3 4 5 6 7</td>
<td>1 2 3 4 5</td>
</tr>
</tbody>
</table>

## Gastrointestinal Tolerability Questionnaire

<table>
<thead>
<tr>
<th>Question</th>
<th>Answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Did you experience any nausea in the past 7 days?</td>
<td></td>
</tr>
<tr>
<td>Yes, how would you rate the amount of nausea?</td>
<td></td>
</tr>
<tr>
<td>No more than usual</td>
<td></td>
</tr>
<tr>
<td>Somewhat more than usual</td>
<td></td>
</tr>
<tr>
<td>Much more than usual</td>
<td></td>
</tr>
</tbody>
</table>

- [ ] Yes
- [ ] No

Tolerance Assessment: Tools

Gastrointestinal Symptom Rating Scale (GSRS)

A **validated tool** that queries symptoms over the past week
- Developed as a disease-specific instrument\(^1,2\)
- Norm values for the general population are available\(^3\)

The GSRS has been used in healthy adults consuming NDC.\(^4-6\)

4. Dennis-Wall JC. J Funct Foods. 2019; 60: 103438
Key Takeaways

1. NDC differentially affect tolerance.
2. Important to assess tolerance.
3. There are tools available.