Workshop: physiology and tolerance of LDCs

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Gastrointestinal symptoms

Although it is accepted that consumption of low-digestible carbohydrates (LDCs) can have undesirable gastrointestinal effects in some individuals, few tolerance studies are comparable in terms of symptom definition or the methodology adopted. This workshop considered the main gastrointestinal symptoms that can occur following consumption of LDCs and if current symptom definitions were wholly appropriate. The study protocols that should be adopted to investigate the gastrointestinal (GI) tolerance of LDCs were discussed and what affects tolerance, such as host factors and types of LDC ingested. The workshop debated if the occurrence of GI symptoms following consumption of LDCs outweighed their perceived functional benefits.

Possible gastrointestinal symptoms following consumption of LDCs

GI symptoms following consumption of LDCs arise from their osmotic effect in the GI tract and their fermentation by colonic bacteria. These effects may lead to changes in bowel habit and uncomfortable abdominal symptoms due to intestinal gas. The main symptoms that arise from ingestion of LDCs may be generally classified as: (a) changes in bowel habit; (b) painful sensations; (c) gaseous symptoms; (d) other symptoms such as nausea (Table 1). The workshop agreed that GI symptoms following consumption of LDCs by individuals were subjective in nature and therefore difficult to assess. Wind, diarrhoea, borborygm and bloating are experienced by many individuals unrelated to LDC dietary intake and may be considered as a normal occurrence by them. The workshop therefore agreed that the occurrence of GI sensations or changes in bowel habit over and above what individuals perceive as ‘normal’ should be used to define GI symptoms.

Because GI symptoms are difficult to measure the workshop agreed that double-blind, controlled cross-over studies should be used to assess the GI responses of individuals following consumption of LDCs. Furthermore, any association between different symptoms and the occurrence of more than one symptom, i.e. multiple symptoms should be considered.

Table 1. Potential gastrointestinal symptoms following consumption of LDCs

<table>
<thead>
<tr>
<th>Changes in bowel habit</th>
<th>Diarrhoea</th>
<th>Increased laxation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Painful symptoms*</td>
<td>Abdominal colic (cramps, stomach ache)</td>
<td></td>
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<tr>
<td>Gaseous symptoms</td>
<td>Abdominal bloating</td>
<td>Abdominal noise (borborygm)</td>
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<td>Flatulence</td>
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<tr>
<td>Other symptoms</td>
<td>Nausea</td>
<td>Loss of appetite</td>
</tr>
<tr>
<td></td>
<td>Thirst</td>
<td>Headache</td>
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</tbody>
</table>

* Symptoms associated with excretion of stools may be reduced in severity.

Bowel habit

There is great variability amongst individuals in bowel habit. The normal range is from three bowel movements per week to three per day, with a modal frequency of one per day. Changes in bowel habit may be assessed by a variety of means. Stool collection provides useful data in terms of stool weight and consistency but is difficult to achieve except in controlled diet studies and is not practical in community-based investigations. In community studies, bowel movement frequency, consistency, urgency and

Table 2. Potential health benefits of LDCs

| Reduced cariogenicity | Reduced energy intake | Increased satiety | Glycaemic control | Reduced lipid absorption | Reduced serum LDL | Prebiotic effects | Antineoplastic effects | Increased laxation | Improved calcium absorption | Reduced diffusion of ammonia into portal blood |
other observations such as stool colour and odour may be
recorded in diaries by study participants. Such data are
useful in determining changes in bowel habit following
consumption of LDCs.

Intestinal gas
Colonic fermentation of LDCs may lead to a rapid build up
of intestinal gas and the symptoms of abdominal colic,
bloating, abdominal noise (borborygmi) and flatulence. The
workshop considered that each of these symptoms could be
subjectively measured in terms of frequency, severity and
duration by use of subject diaries and interview. Measure-
ment of abdominal girth was also identified as a useful
index of abdominal bloating. Because gases are absorbed
across the colonic mucosa and excreted via the lungs breath
hydrogen and methane analyses were seen as useful
techniques in the assessment of gastrointestinal fermenta-
tion following consumption of LDCs.

Benefits and disadvantages of LDC consumption
The workshop considered the potential health benefits
following consumption of different LDCs compared to the
potential disadvantages in terms of GI symptoms. The
workshop broadly agreed that the benefits of LDC
consumption outweighed their disadvantages (Table 2). The
workshop agreed that GI symptoms following
consumption of LDCs were often transient compared to
the lasting benefits derived from their consumption and
those individuals that find themselves sensitive to the
effects of LDC ingestion can reduce or stop their intake
with no further effects. However, LDCs in different product
applications have different potential health benefits, for
example polyols in sugar-free products are non-cariogenic
whereas fructo-oligosaccharides are promoted as more
prebiotic in nature.

Factors that affect tolerance
The workshop discussed some of the factors that affect
tolerance of LDCs in view of the presentations made by Drs
Marteau and Livesey (p.S17–S21 and S7–S16). It is
apparent that GI tolerance does not depend solely on the
type of LDC or the dose ingested but on many other factors.
These are summarised in Table 3. However, the effect on
GI tolerance of LDC consumption pattern, naturally
occurring LDCs in the diet and interactions with other
dietary components requires further research (Cummings
et al.).

Reference
Cummings JH, MacFarlane GT & Englyst HN Prebiotic digestion
and fermentation. American Journal of Clinical Nutrition (In
press).

### Table 3. Possible factors that may effect tolerance of LDCs

<table>
<thead>
<tr>
<th>Host factors</th>
<th>Type of LDC</th>
<th>Dietary factors</th>
<th>Drug treatment</th>
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</thead>
<tbody>
<tr>
<td>Composition of colonic flora</td>
<td>Chemical characteristics</td>
<td>Consumption pattern</td>
<td>Antibiotics</td>
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<tr>
<td>Psyche</td>
<td>Molecular weight</td>
<td>Amount ingested</td>
<td></td>
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<tr>
<td>Age</td>
<td>Sugar composition</td>
<td>Frequency</td>
<td></td>
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<tr>
<td>Gender</td>
<td>Degree of polymerisation/branching</td>
<td>Consumption with liquids/solids</td>
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<tr>
<td>Menstrual cycle</td>
<td>Resistance to upper intestinal hydrolysis</td>
<td>Other LDCs in diet</td>
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<tr>
<td>Pregnancy</td>
<td>Degree of upper intestinal absorption</td>
<td>Naturally occurring LDCs</td>
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<tr>
<td>Diseases</td>
<td>Fermentability of LDC in colon</td>
<td>LDCs added as ingredients to foods</td>
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<td>Irritable bowel syndrome</td>
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<td>Coeliac disease</td>
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<td>Diabetes</td>
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<td>Inflammatory bowel disease</td>
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<tr>
<td>Gastrointestinal transit time</td>
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<td>Enzyme activity</td>
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<td>Visceral sensitivity</td>
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