British Journal of Nutrition (2001), **85**, Suppl. 1, S59–S60
DOI: 10.1079/BJN2000263

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, borborygmi 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

Changes in bowel habit	Diarrhoea
	Increased laxation
Painful symptoms*	Abdominal colic (cramps, stomach ache)
Gaseous symptoms	Abdominal bloating
	Abdominal noise (borborygmi)
	Flatulence
Other symptoms	Nausea
	Loss of appetite
	Thirst
	Headache

* 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

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Table 3. Possible factors that may effect tolerance of LDCs

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

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. Measurement 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 fermentation 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).