Combining dietary fibres to reduce intestinal gas production in patients with IBS

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Consumption of dietary fibre has been associated with multiple beneficial outcomes. For example, it reduces the risk of cardiovascular disease by lowering cholesterol and improving glucose homeostasis, and it improves digestive comfort with looser and more frequent stools. Furthermore, dietary fibre can potentially lower the risk of colon cancer, although evidence from intervention studies supporting the latter is considered insufficient to serve as a basis of guidelines for dietary fibre intake.[1] More recent studies indicate that dietary fibre also exhibits immunomodulatory properties and may affect mood and cognition.[2]

In addition to enhancing bulking in the colon and increasing the viscosity in the intestinal lumen, production of short-chain fatty acids by colonic microbial fermentation is believed to be an important mechanism underlying these health benefits.[3] However, fermentation of dietary fibre concomitantly increases the production of gases, in particular hydrogen and to a lesser extent methane and carbon dioxide. Hydrogen primarily results from the reoxidation of reduced pyridine nicotinamide-adenine-dinucleotide (NADH) and flavine-adenine-dinucleotide (FADH) nucleotides, which is essential to maintaining the luminal redox balance. Accumulation of hydrogen, which would restrict further fermentation, is prevented by hydrogenotrophic microbes that convert hydrogen into acetate (acetogens), methane (methanogenic archaea) and sulfate (sulfate-reducing bacteria).[4]

Patients with IBS poorly tolerate the gas production associated with consumption of readily fermentable dietary fibre. Unlike previously thought, recent studies that quantified colonic gas and colonic volume using MRI concluded that patients with IBS do not produce excessive gas compared with healthy subjects, but rather, they have increased sensitivity to the colonic distension induced by a 'normal' level of gas.[5]

Since its introduction in 2004 by the Monash group, a diet low in fermentable oligosaccharides, disaccharides, monosaccharides and polyols (FODMAPs) has become a commonly used therapeutic option in patients with IBS because it results in reduced gas production and concomitant abdominal discomfort. Clinical response rates vary between 50% and 80%, depending on the control condition

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used.[6] Recently, the American College of Gastroenterology recommended a limited trial of a low-FOPMAP diet to improve symptoms in patients with IBS.[7] Similarly, the national guidelines for the dietary management of IBS in the UK advise considering a low-FODMAP diet when basic diet and lifestyle measures (eg, NICE guideline advice) have been unsuccessful.[8]

Despite the encouraging reduction in symptoms, a major concern associated with the use of low-FODMAP diets is the limited intake of fermentable carbohydrates and the subsequent impact on the microbial composition and activity.[6] In a gnotobiotic mouse model, chronic or intermittent dietary fibre deficiency resulted in expansion of mucus-degrading bacteria and led to erosion of the colonic mucus barrier because the gut microbiota used the mucus glycoproteins as a nutrient source.[9] A recent systematic review showed that a low-FODMAP diet generally reduces the proportion of the health-associated bifidobacterium, although it is unclear whether this effect persists over time or has any detrimental effects on long-term colonic health.[10] Therefore, low-FODMAP diets are typically restricted in time.

In *Gut*, Gunn *et al* propose an alternative to a low-FODMAP diet to reduce the gas production induced by consumption of the readily fermentable prebiotic inulin.[11] Using MRI to quantify colonic gas, the authors elegantly showed that addition of psyllium to inulin reduces in vivo gas production induced by inulin in patients with IBS. Psyllium is a dietary fibre with remarkable characteristics as it forms a gel that is preserved during its passage through the large bowel.[12] It contains a highly branched arabinoxylan consisting of a xylose backbone and arabinose-containing and xylose-containing side chains. In contrast to arabinoxylans from cereal grains such as wheat and oats that are extensively fermented, psyllium is only poorly fermentable due to an as yet unidentified structural feature.[13] Other gel-forming dietary fibres such as pectins and guar gum are more readily fermentable and might not necessarily share the gas-reducing properties of psyllium.

Although the underlying mechanism is not completely clear and needs further investigation, the authors hypothesise that the increase in viscosity induced by psyllium delays the delivery of inulin to the colon and restricts mixing of the chyme, thereby impeding access of the colonic bacteria to the inulin. Because the study period was limited to 6 hours after intake of the fibres in order not to compromise the patient's comfort, it was not possible to establish whether inulin fermentation was reduced or only delayed. Prolonged monitoring, as well as additional measures such as quantification of residual inulin in stool samples or measurement of circulating short chain fatty acids (SCFAs) to estimate the extent of inulin fermentation, might solve this question.

Delayed and more gradual fermentation of inulin may be sufficient to improve the abdominal comfort of the patients with IBS and might even be preferred over decreased fermentation. Indeed, as the prebiotic effects of inulin largely depend on its fermentation in the colon, suppression of fermentation might also abolish the associated health benefits and is not warranted. Gradual fermentation of carbohydrates may not only result in lower (but prolonged) hydrogen concentrations but may also facilitate the removal of hydrogen from the intestinal lumen. Due to the limited mucosal diffusion and low solubility of hydrogen in water, a considerably higher fraction of hydrogen (65%) is excreted in breath at low rates of carbohydrate fermentation and production of hydrogen (<200 mL/day), relative to high production rates (>500 mL/day), where only 25% of produced hydrogen reaches the breath.

These promising results may trigger development of new dietary guidelines for patients with IBS that maintain the benefits of dietary fibre intake without suffering from abdominal discomfort. Additional studies that further elucidate the mechanisms of action and that investigate which fibre combinations successfully deliver these benefits are highly welcome.

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