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FALL 2020 | VOLUME 28, NUMBER 4

A ROADMAP TO FODMAPs AND SOY

- 🍌 FODMAPs Explained
- 🍌 Soyfoods Can Fit in the Low FODMAP Diet



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FODMAPs: MANAGING IBS SYMPTOMS WITH NUTRITIONAL INTERVENTION

By Jessica R. Biesiekierski, PhD, RNutr

Introduction

In 2005, Monash University in Australia proposed a hypothesis that described grouping dietary short-chain carbohydrates that are slowly absorbed in the small intestine or are non-digestible due to inactivity or lack of enzymes, for an approach in the management of symptoms in irritable bowel syndrome (IBS). Since then, there has been a considerable amount of research across the world aimed at understanding naturally occurring fermentable oligosaccharide, disaccharide, monosaccharide, and polyols (FODMAPs), including efficacy, mechanisms, risks, and applications.

The strength of research supporting specific FODMAP-induced gut symptoms has led to the low FODMAP diet being incorporated into local and international clinical guidelines, including the National Institute for Health and Clinical Excellence guidelines for IBS management in primary care in the U.K. and as second line intervention for the British Dietetic Association guidelines.¹ The diet's popularity has extended beyond the science and clinical world, with bloggers and self-proclaimed health gurus claiming it can treat everything from acne to weight loss. There are increasing numbers of FODMAP cookbooks, online "FODMAP friendly" stores and "FODMAP safe" or "FODMAP certified" products identified by both specialized and major brands.

What are FODMAPs and Where are they Found?

Table 1 provides an overview of the key FODMAP groups and some of the common foods in which they are found. The development of techniques to quantify the FODMAP content of foods has greatly advanced our understanding of food compo-

sition, food processing techniques (i.e., pickling and canning reduce FODMAP content), and ingredient selection. There are now several mobile health technologies or smart phone applications that detail food lists. One recommended, patient-friendly program, that translates evidence and uses scientific measurement is led by the FODMAP creators, Monash University in Australia.² This application has established the most comprehensive global FODMAP database and includes traffic light food lists.

FODMAPs vary in absorptive capacities. Some FODMAPs are partially absorbed by some people (i.e., fructose, lactose, and polyols) and others are malabsorbed by all humans (i.e., fructo-oligosaccharides [fructans] and galacto-oligosaccharides [GOS]). This varied absorption highlights individualized sensitivity to each of the FODMAPs. The absorptive processes and the effects of digestion³ per FODMAP are summarized in Table 2.

Summary of Clinical Evidence

The magnitude of evidence for the clinical efficacy of the low FODMAP diet has surpassed any other dietary intervention for IBS (except for probiotics) and is now supported by a large number of published trials, systematic reviews, and guidelines. More than 10 randomized controlled trials or randomized comparative trials of the low FODMAP diet report improvements in overall gastrointestinal (GI) symptoms, especially abdominal pain and bloating for patients with IBS. Meta-analyzing the data from these trials shows a diet low in FODMAPs provides an adequate response rate of 50–80% in IBS symptoms.^{4,5}

Studies have shown symptom severity scores in IBS subjects are more than halved when following the low FODMAP diet. Symptom resolution is shown almost immediately, but the greatest symptom control is achieved and maintained after 7 days of the low FODMAP diet.⁶ Furthermore, these effects have been shown in patients of all IBS subtypes (i.e., those with diarrhea, constipation, or mixed in their dominating symptom); especially notable is the improvement in stool consistency satisfaction.

What are the Mechanisms?

Studies using ileostomy models⁷ and magnetic resonance imaging (MRI)³ have shown high FODMAP diets or high doses of specific FODMAPs result in increased luminal water in the small intestine. Studies using breath testing⁸ and MRI⁹ have also shown that high FODMAP diets/foods increase colonic gas production as a result of fermentation by the microbiota.

More recently, the upper GI motility response to FODMAPs has been investigated, highlighting that FODMAPs may contribute to upper GI symptoms due to gastroduodenal and gastro-colonic interactions.¹⁰ Psychosocial morbidities are known to be associated with increased levels of postprandial GI symptoms, whereas FODMAPs may affect extra-intestinal symptoms via gut-brain signaling secondary to the development of GI symptoms.

The Soy Connection, funded by farmer checkoff dollars, is produced by the United Soybean Board and the Soy Nutrition Institute. An electronic version of this newsletter can be found at www.soyconnection.com/healthprofessionals/newsletter.

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Content reviewed and approved by the United States Department of Agriculture and this professional journal.



Table 1. Common High FODMAP-containing Foods

CATEGORIES OF FODMAPS		EXAMPLES OF MAJOR SOURCES
Oligosaccharides	Fructo-oligosaccharides (fructans)	Rye, wheat, onions, garlic, artichokes, leeks, chicory, nectarines, peaches, tamarillos, watermelons
	Galacto-oligosaccharides (GOS)	Legumes (e.g., kidney beans), lentils, split peas, chickpeas
Disaccharides	Lactose	Milk, ice cream, yogurt, soft cheeses
Monosaccharides	Fructose (in excess of glucose)	Honey, mangoes, apples, pears, watermelons, high fructose corn syrup (sweetener), artichokes
Polyols	Sorbitol	Sugar free gums, mints, confectionaries, apples, pears
	Mannitol	Mushrooms, cauliflower

Why Doesn't Everyone Experience Symptoms from FODMAPs?

The normal colon relaxes and accommodates gas without causing symptoms. While healthy subjects seem able to tolerate large gas loads, patients with functional GI disorders are less likely to do so. This observation was demonstrated in a study where, despite MRI analysis showing similar changes in small and large bowel contents following FODMAP challenges, only IBS patients (not healthy subjects) reached symptom thresholds.⁹ The individualized threshold at which increased water or gas provokes symptoms varies, largely depending on severity of visceral hypersensitivity, which is influenced by lower pain thresholds, higher somatisation, gut motility, stress, and type and dose of FODMAP consumed. Other proposed models to explain reduced pain thresholds or impaired motility feedback mechanisms in IBS include: the role of altered short-chain fatty acid sensing; bacterial overgrowth, decreased expression or sensitivity of sweet taste receptors; or alterations in GLUT5 expression that may all lead to increased release of hormones (cholecystokinin [CCK], glucagon-like peptide 1 [GLP-1]) known to alter intestinal motor activity or transit.¹¹

Implementation of the Low FODMAP Diet

A medical practitioner should be consulted before implement-

ing any dietary change to ensure necessary investigations of hidden pathological causes are ruled out. For example, IBS-like symptoms can occur in other more serious conditions including celiac disease or inflammatory bowel disease. The low FODMAP diet should then be overseen by an experienced gastroenterology dietitian who understands FODMAP evidence including composition data, dose effects, and common potential nutritional problems.

The protocol for implementation follows a 3-phase approach (see Table 3). First, total FODMAP reduction for 2–6 weeks; second, re-challenge to assess tolerance; third, long-term maintenance.¹² This dietitian-delivered education should allow for personalization and education on FODMAP principles including ways to “switch” high FODMAP-containing foods with low FODMAP foods. At review, re-challenge education should be given based on symptom response with the aim of long-term management of good symptom control and expansion of the diet. Comprehensive counseling and suitable educational resources are considered to have a positive association with adherence. An understanding of food processing can support ingredient label reading and provide tips for flavor enhancement while reducing FODMAP content (i.e., soaking and rinsing of legumes or using only the greens from spring onions).

Table 2. Classification of Main FODMAPs and their Small Intestinal Absorption

FODMAP GROUP	ABSORPTION	EFFECTS TO NOTE
Oligosaccharides (fructans, inulin, GOS)	No absorption, as humans do not produce small intestinal hydrolyses capable of breaking down bonds within polymer chains	>90% of dietary fructans arrive at the large bowel and are highly fermentable. Inulin has shown a sustained rise in colonic gas that increases the luminal diameter of the colon.
Lactose	Reduced absorption in cases of lactose intolerance, which is a condition of lactase deficiency	10–95% depending on ethnicity where there can be an age-specific genetic downregulation of lactase expression. Unabsorbed contents are fermented in the colon.
Fructose (in excess of glucose)	Slow active absorption where glucose aids fructose absorption via GLUT2 or GLUT5 transporters osmotically active monomer	Malabsorption affects 30–40% of healthy people and those with IBS, causing marked distension of the small intestine and drawing water into the bowel contents.
Polyols	Slow passive absorption along the small intestine	Depends on molecular size, intestinal pore size, intestinal transit, and other gastrointestinal conditions. Draws water into the bowel and leads to distension of the small intestine.

Table 3. Low FODMAP Diet 3-Phase Protocol

	1. ELIMINATION	2. DETERMINE SENSITIVITIES/ REINTRODUCTION	3. PERSONALIZATION
Time Frame	2–6 weeks	6–8 weeks	As needed for symptom management
Goal	Remove all high FODMAP foods in attempt to provide symptom resolution	Systematically add FODMAP subtypes back into diet to identify food triggers	Add back successfully reintroduced FODMAP foods to expand diet to personal tolerance

Studies have shown that at long-term follow-up (i.e., between 6 and 18 months), patients often continue an “adapted FODMAP” diet, meaning they reduce intake of only fructans and free fructose. Of those patients, 57% report satisfactory symptom relief compared to their habitual diet.¹³ This result highlights that fructans, in particular, are considered a key FODMAP trigger in the longer-term maintenance of FODMAP diets.

Potential Hazards of the Low FODMAP Diet

There are a number of challenges with the low FODMAP diet. It can alter the gut microbiota, impact nutrient intake, be complex to understand, and require adequate clinical support. In addition, not all patients will respond.

Many FODMAPs have prebiotic actions (especially fructans, inulin, and GOS) which have diverse health benefits including immune modulation, production of short-chain fatty acids, and maintenance of epithelial integrity. Therefore, an alteration in the gut microbiota may be expected in those consuming the low FODMAP diet. Several studies using heterogenous methods have examined the effect of the low FODMAP diet on gut microbial communities. Consistent findings have emerged including reductions in *Actinobacteria* and relative abundance of the genus *Bifidobacteria*.^{14,15} While the downstream effects or health consequences of these microbiota changes are unknown, it is not advisable to restrict FODMAPs unnecessarily. The co-administration of a multi-strain probiotic may also help to modulate effects¹⁶ and re-introduction of FODMAPs via fructan supplementation may attenuate some of these changes.¹⁷

Some studies have assessed nutritional adequacy of the low FODMAP diet and have highlighted lower energy, calcium, and fiber intakes. Therefore, particular attention should be paid towards adequate calcium (i.e., encourage consumption of lactose-free options and non-dairy sources of calcium), vegetarian diets (i.e., encourage consumption of soy products, eggs, and other high protein grains such as quinoa), and any overlapping health conditions (i.e., ensure grains and cereal alternatives are consumed by those with diabetes).

However, the low FODMAP diet, when delivered by a specialist dietitian, can be of high dietary diversity,¹⁸ and long-term “adapted FODMAP” diets have been shown to be nutritionally adequate.¹³ Adjunct therapies including the use of enzymes (i.e., lactase for lactose or α -galactosidase for GOS) can help reduce symptoms.¹⁹

Complexities of FODMAPs include their co-existence with many other foods including other non-digestible carbo-

hydrates (i.e., starch polysaccharides) and the overlap of wheat fructans with gluten proteins; especially in cases of patients self-reporting non-celiac gluten/wheat sensitivity (NCGS). There is often confusion in understanding the difference between gluten-free and low FODMAP diets. The wheat restriction on a low FODMAP diet is not as strict as the gluten restriction required for celiac disease and fructans rather than gluten has been shown to induce symptoms for the suggested NCGS entity,²⁰ further highlighting the low FODMAP diet as the recommended approach in IBS and NCGS.²¹

In cases when the low FODMAP diet has led to inadequate symptom response, other dietary approaches can be attempted. Predictors of response continue to be researched, where likely candidates are bacterial profiles, including fecal volatile organic compounds²² or metabolomic activity.²³

Take Home Message

There is convincing clinical evidence for utilizing the low FODMAP diet as a treatment strategy for symptoms in patients with IBS. The diet should be implemented in symptomatic patients only and should be led by a trained gastroenterology dietitian with mechanistic understanding of absorptive capacities and awareness of the patient’s severity of visceral hypersensitivity. There should be interpretation of comprehensive food lists, acknowledging that many foods have more than 1 FODMAP and that individual tolerance levels for each FODMAP will vary among patients. Long-term dietary restriction is not encouraged, and both reintroduction and liberalization of the diet should continue while maintaining symptom control. Despite the low FODMAP diet commonly being utilized for weight loss, it is not suitable for this purpose. Additionally, for the healthy person, there are many health benefits of consuming high FODMAP, prebiotic foods. 🍌

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SOYFOODS CAN FIT IN THE LOW FODMAP DIET

By Kate Scarlata, MPH, RDN, LDN

What are FODMAP Carbohydrates?

Saccharides can be broken into different types of carbohydrates depending on their chain length. FODMAPs are small-chain carbohydrates that are commonly malabsorbed in the small intestine and can trigger digestive distress in those who experience visceral hypersensitivity (a sensitive gut), such as in irritable bowel syndrome (IBS). It is important to note that foods containing FODMAPs can be healthy, do not cause painful gastrointestinal (GI) symptoms in those with a healthy gut, and should be enjoyed liberally in those who can tolerate them.

The Low FODMAP Diet: Who Might Benefit?

Food intolerance is common as it impacts about 15–20% of the global population.¹ For those living with IBS (a chronic GI condition that presents with bloating, abdominal pain, and alternation in bowel habits) a diet low in FODMAP carbohydrates is showing great promise for symptom management. IBS impacts up to 20% of Americans.² Food-related symptoms are common in IBS. In fact, one survey of nearly 200 patients with IBS revealed that up to 84% perceived eating *any* food resulted in digestive distress.³ Similar to IBS, people with celiac disease and inflammatory bowel disease may also experience food-related GI symptoms. Research has shown that reducing FODMAP carbohydrates may benefit symptom control in people living with these conditions when IBS symptoms prevail.^{4,5}

Despite patient complaints of food-related GI symptoms in IBS, for years the medical community had very little to offer in regard to nutritional intervention to calm gut pain. There was little science to support the use of diet for therapeutic benefit in IBS until the novel low FODMAP diet was introduced by a research group at Monash University in Melbourne, Australia, in 2005 (referenced in the previous article). With growing interest and numerous randomized controlled trials to date, the low FODMAP diet has been shown to be an effective therapy, managing GI symptoms in more than 50% of IBS patients.^{6,7}

As outlined in the lead article, the low FODMAP diet is a 3-phase nutritional approach. Despite its high degree

of effectiveness, it is a nuanced diet with a high level of dietary modification that should involve the help of a FODMAP knowledgeable registered dietitian nutritionist for best compliance and improved success rate.⁸

How do FODMAPs Cause GI Distress in IBS

IBS is a digestive condition characterized in part by a hypersensitive intestine. Poorly absorbed FODMAP carbohydrates can produce varying degrees of osmotic effects in the gut (water is pulled into the intestinal tract) due to their small size, contributing to luminal distention which can trigger GI symptoms in those with IBS. Moreover, gut microbes feast on these unabsorbed carbohydrates producing gas, short-chain fatty acids and various metabolites. The stretching of the intestinal tract via the extra water and gas in the gut prompts cramping and gut symptoms. Gut microbe-derived metabolites via FODMAP fermentation may also play a role in symptom induction, but this area needs to be studied further.⁹

How Do Soy-based Foods Fit a Low FODMAP Diet?

There are many soy-based foods that are suitable for the low FODMAP diet such as firm tofu, soy cheese, plain tempeh, edamame, soybean oil, soy sauce, miso, and some soymilk.¹⁰ Food processing, fermentation, and maturity of the plant can impact the FODMAP content of soyfoods. For low and high FODMAP soyfoods examples, see Table 1.

Because FODMAPs are water-soluble carbohydrates, draining off the liquid, as is done with firm tofu, reduces the FODMAP content compared to silken tofu. The liquid contains the water-soluble oligosaccharides from the soybeans. The fermentation process utilized to make tempeh reduces its FODMAP content.¹¹ Natto, a fermented soybean dish, has yet to be tested for FODMAPs and soy yogurt has been tested as high FODMAP.

Products that utilize soy protein versus the whole soybean will be lower in FODMAP carbohydrates as well. For example, soymilk made with the whole soybean is high FODMAP versus soymilk made with isolated soy protein which is low FODMAP.^{10,12} Isolated soy protein may be lower in FODMAPs if the protein component is only present (i.e., there is no residual fiber that may contain oligosaccharides in the product), but this ingredient has yet to be formally tested. Textured vegetable soy protein is high in FODMAPs.¹⁰ Soynuts and soynut butter contain the whole mature soybean and are likely high in FODMAPs. As previously mentioned, the maturity of a plant may also play a role in the FODMAP content of the food. For example, edamame has less FODMAPs than the mature soybean.

Consuming an alpha galactosidase enzyme supplement with 300 GALU (galactosidic units) along with foods such as soybeans that have high amounts of galacto-oligosaccharides has been shown to mitigate IBS symptoms.¹³ This over-the-

Table 1. Low and High FODMAP Soy-based Foods

LOW FODMAP	HIGH FODMAP
<ul style="list-style-type: none">■ Soy cheese■ Tempeh (plain)■ Firm tofu■ Soymilk (made with soy protein)■ Soybean oil■ Soy sauce■ Miso■ Edamame	<ul style="list-style-type: none">■ Soy yogurt■ Silken tofu■ Textured vegetable protein■ Soymilk (made with the whole soybean)

Unknown FODMAP Status: Natto, soynuts, soynut butter

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counter supplement may offer another way for those with IBS to expand their soy intake, but should be done under the supervision of a healthcare provider.

Summary

The low FODMAP diet is a 3-phase, evidence-based nutritional intervention utilized for IBS symptom management. There are many soy-based foods that are low FODMAP and suitable for consumption during the elimination phase of the diet. As an individual goes through the reintroduction and personalization phase of the diet to identify his/her personal triggers, more soyfoods may be incorporated in the diet as tolerated. FODMAP intolerance is variable per person and the goal of the diet is to provide as much diet variety as possible to enhance food-related quality of life and overall health, while managing GI distress. The oligosaccharides component of soybeans offer prebiotics (food for beneficial probiotic microbes in the gut) which may positively impact the individual's gut microbiome and health. Alpha galactosidase enzyme supplements with the consumption of a soy-rich meal may offer improved tolerance to high FODMAP soyfoods in those with IBS. 🍱

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