ALLERGY AND REACTIVITY REDUCTION PROGRAM

Practitioner Information: Low FODMAP Diet

WHAT ARE FODMAPS?

"FODMAP" is the acronym for Fermentable Oligosaccharides, Disaccharides, Monosaccharides and Polyols, a group of short-chain carbohydrates and sugar alcohols (polyols).[1] These nutrients are ubiquitous in the diet. The key FODMAPs are:

- Oligosaccharides, such as fructans/ fructo-oligosaccharides (found in grains and vegetables) and galactans/galacto-oligosaccharides (found in legumes).
- Disaccharides, such as lactose (found in milk).
- Monosaccharides, such as fructose (found in fruit) .
- Polyols, such as sorbitol (found in sweetened products).

Over the past three decades, evidence has emerged that FODMAPs can play a role in the promotion of irritable bowel syndrome (IBS) symptoms.[2] The restriction of dietary FODMAPs has been shown to be beneficial in reducing the symptoms of IBS and there are emerging benefits of a low FODMAP diet to other functional gastrointestinal disorders, neurological conditions, and immune hyper-reactivity.

WHAT EFFECT DO FODMAPS HAVE IN THE DIGESTIVE SYSTEM?

Although a seemingly diverse group of carbohydrates, FODMAPs share three common functional properties. These properties contribute to their benefits for health, such as their prebiotic effects, but can also render them problematic in some individuals.

- **FODMAPs are poorly absorbed in the small intestine:** Dietary carbohydrates that are in the form of two or more sugar moieties need to be broken down into their individual monosaccharides for absorption across the epithelium. Unlike other forms of carbohydrates (such as glucose), all the FODMAP molecules are generally poorly absorbed in humans. For example, fructose is only absorbed via a slow, low capacity transport mechanism (via GLUT5 receptors), while polyol molecules are too large for simple diffusion. Lactose is poorly cleaved into its two monosaccharides (galactose and glucose) as the hydrolase enzyme required for this reaction in the brush border of the small intestine exhibits a low activity. Oligosaccharides such as fructans and galactans are also difficult to cleave, as humans have low levels of the hydrolases for these particular carbohydrates. The normal gastrointestinal handling of these carbohydrates means that they remain in the distal small and proximal large intestine for longer periods. In susceptible individuals, this can result in gastrointestinal symptoms.
- **FODMAPs are osmotically-active molecules:** The malabsorbed FODMAPs remaining in the intestine can draw water into the lumen via osmosis. This may promote altered bowel movements (such as diarrhoea), luminal distension (bloating) and subsequent gastrointestinal pain.
- **FODMAPs are rapidly fermented by bacteria:** Short chain carbohydrates, such as mono-, di- and oligosaccharides, are rapidly fermented by both commensal and dysbiotic bacteria residing in the intestine. Excessive fermentation can increase the production of gases such as hydrogen, carbon dioxide and methane, resulting in flatulence and bloating.[3]

Figure 1: Examples of Short-Chain Carbohydrates That are Part of the Group Collectively Known as FODMAPs.

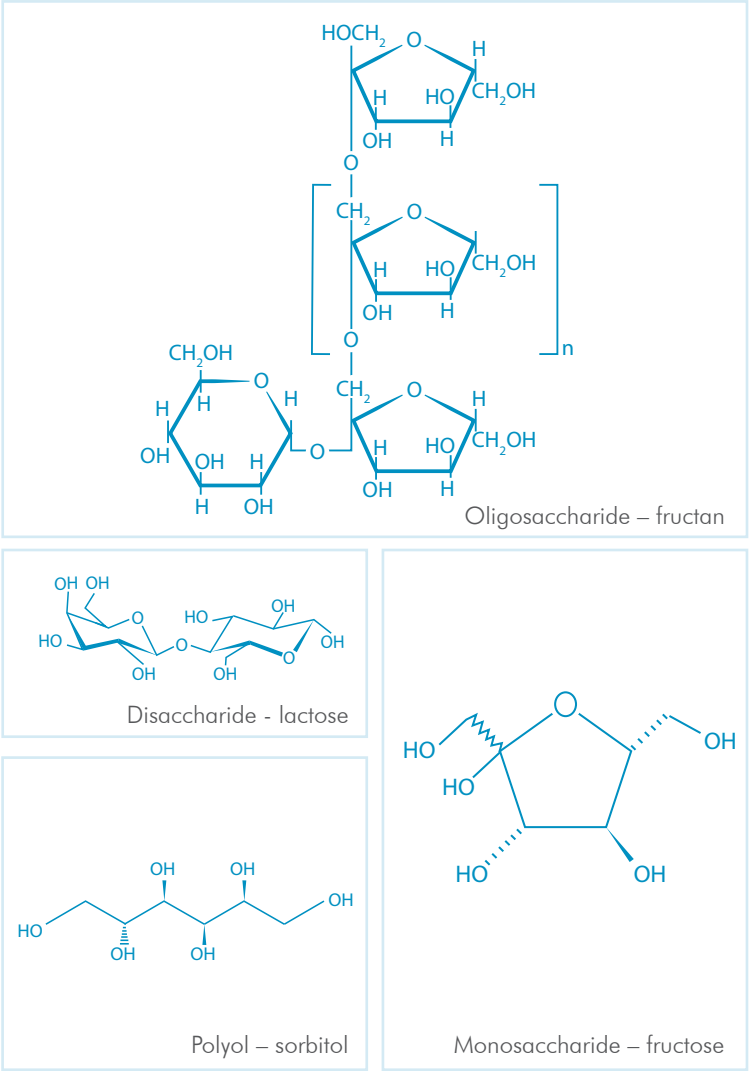


Figure 2 illustrates the effects of FODMAP molecules and how they may contribute to the pathophysiology and symptomatology of IBS symptoms.

It is important to note that FODMAP-containing foods are a normal part of the diet, and do not cause symptoms in most individuals.[5] However, in individuals with functional gastrointestinal disorders, such as IBS, there may be a heightened activation of the enteric nervous system as a response to luminal distension. This can also be combined with altered resident microbiota (dysbiosis) and existing motility dysfunction, which can also be worsened by the presence of FODMAPs in the intestine.

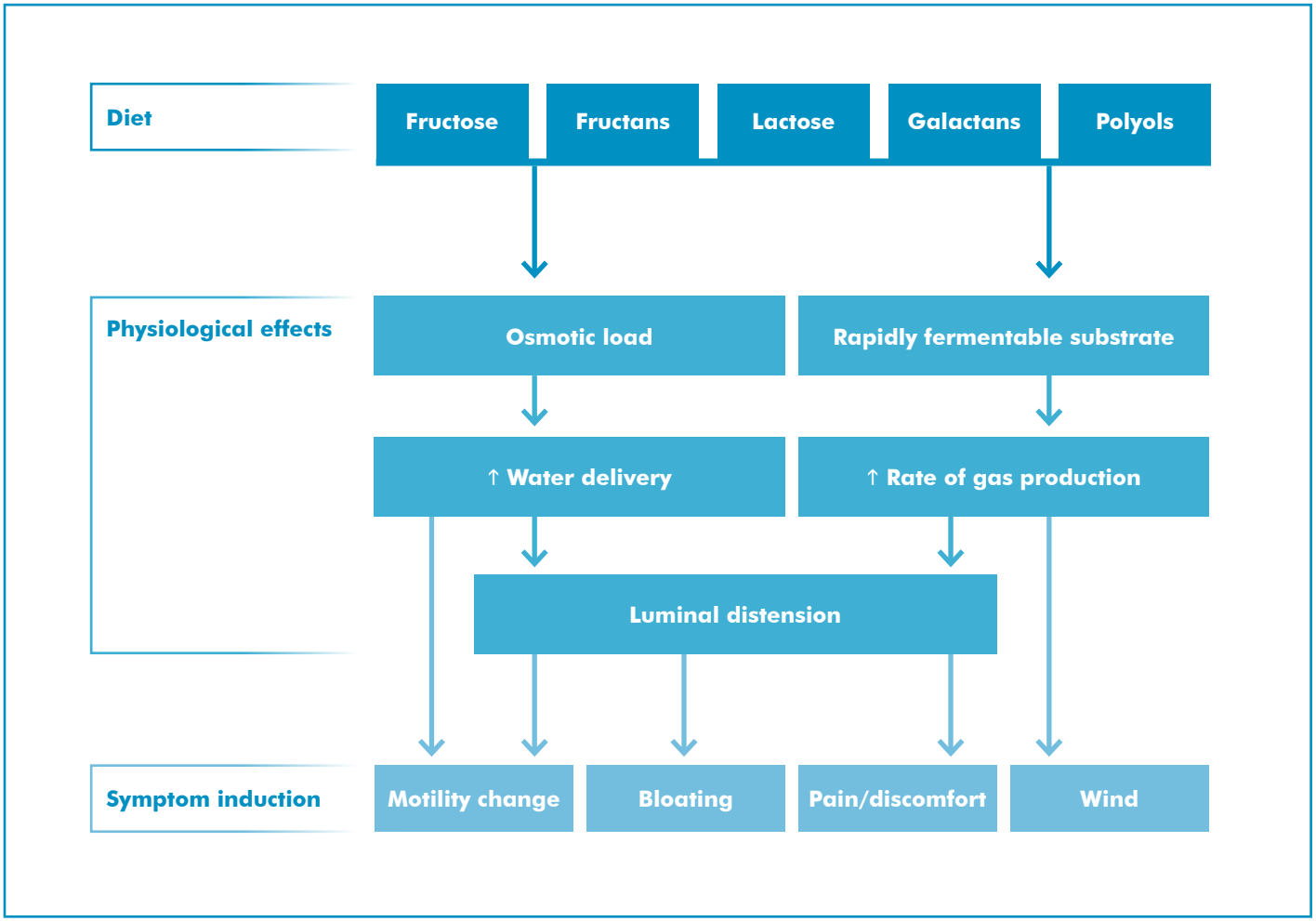
For patients that present with IBS-like gastrointestinal symptoms, a low FODMAP diet may be more effective if it is combined with an appropriate probiotic supplement, such as *Lactobacillus plantarum* 299v.[6,7]

NON-GIT CONDITIONS THAT MAY BENEFIT FROM A LOW FODMAP DIET

In addition to assisting in the management of functional gut disorders, preliminary evidence suggests that a low FODMAP diet may have a role to play in cases where patients present with mood and neurological disorders.

Fructose and lactose malabsorption have both been associated with mild depression, and preliminary research has demonstrated the improvement of affective symptoms in depressed patients using a low fructose diet.[8,9] Another study found that subjects with fructose malabsorption showed significantly lower plasma tryptophan concentrations and higher depression scores compared to those with normal fructose absorption. It is suggested that high intestinal fructose concentrations may promote the formation of fructose-L-tryptophan complexes in the gut, reducing tryptophan absorption. As tryptophan is the precursor of serotonin, biosynthesis of the "feel good" neurotransmitter serotonin could be impaired in this situation.[10]

Figure 2: The Role of FODMAPs in the Promotion of Functional Gastrointestinal Disorders.[4]



Some clinicians are also trialling a low FODMAP diet in children with autistic spectrum disorder (ASD), as many of these patients have marked gastrointestinal symptoms and pathology.[11] Recently a study found that, compared to healthy children, children with ASD have deficiencies in the enzymes for disaccharide digestion and do not adequately break down and absorb disaccharides.[12] Additionally, ASD subjects have repeatedly been found to have a higher degree of intestinal dysbiosis, such as overgrowth of *Clostridia* spp and *Candida albicans*.[13] It is suggested that in ASD, undigested carbohydrates (i.e. FODMAPs) are rapidly fermented by dysbiotic organisms, producing propionic acid (a short chain fatty acid) as a metabolite. Propionic acid itself acts as a neurotoxin and induces autistic-like behaviour when administered in animals, highlighting its potential role in the promotion of autistic symptoms.[14]

FOODS TO AVOID AND ENJOY ON A LOW FODMAP DIET

Professor Peter Gibson of the Monash University Department of Medicine, who coined the term FODMAPs and developed the diet, stresses the importance of reducing all types of FODMAPs simultaneously to determine the potential benefits of the diet for each individual.[15] The general principles to adhere to when following a low FODMAP diet are elimination or drastic reduction of all:

- High lactose foods (e.g. milk, yoghurt).
- High oligosaccharide foods (e.g. chickpeas, lentils).
- High fructose foods (e.g. certain fruits and honey).
- High fructan foods (e.g. wheat, onion).
- High polyol and polyol-sweetened foods (e.g. certain fruits and confectionery).

Table 1 gives a more detailed breakdown of foods in each FODMAP category that should be avoided. Where quantities are given, these foods should be avoided only above the given dose. It is recommended to strictly follow the low FODMAP diet for two weeks and then begin a test phase.

Table 1: Foods to Avoid For a Low FODMAP Diet.[16,17]

FODMAP	FOODS TO AVOID
Fructose	Fruits: apples, boysenberries, cherries (>3), figs, pears, nashi pears, peaches, mango, watermelon, tamarillo, tinned fruit, dried fruit, large serves of fruit. Vegetables: asparagus, artichokes, sugar snap peas. Sweeteners: honey, fructose (>5g daily*), high fructose corn syrup, agave. Drinks: fruit juice, soft drinks sweetened with fructose, sparkling wine, dessert wine, ciders, rum.
Fructans	Fruits: custard apples, nectarines, peaches, persimmon, rambutan, tamarillo, watermelon. Vegetables: artichokes, asparagus (>3), beetroot (>4 slices), brussel sprouts (>½ cup), broccoli (>½ cup), cabbage - savoy (>1 cup), chicory root, corn (>½ cob), fennel (>½ cup), garlic, leeks, okra, onions, peas (>⅓ cup), radicchio lettuce, snow peas (>10), spring onion (white part). Cereals: wheat, rye, barley products (bread, pasta, couscous, crackers, biscuits), inulin. Nuts: cashews, pistachios, almonds (<10).
Galactans	Legumes: all (chickpeas, lentils, dried/canned beans, baked beans, whole soy beans). Drinks: soy milk.
Lactose	Milk: cow, goat and sheep. Cheese: fresh (cottage, ricotta, cream cheese, mascarpone). Other dairy products: yoghurt, ice cream, custard.
Polyols	Fruits: apples, apricots, avocado (>¼), blackberries, cherries (>3), longan (>10), lychees (>5), nashi pears, nectarines, pears, peaches, plums, prunes, watermelon, coconut water. Vegetables: cauliflower, celery (>1 stick), mushrooms, snow peas, sweet potato (>½ cup). Sweeteners: sorbitol (420), mannitol (421), xylitol (967), maltitol (965), isomalt (953).

*Up to 5 g daily of fructose may be consumed if taken with meals.[18]

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Many alternative foods can be consumed while following a low FODMAP diet. Table 2 provides a list of suitable foods which can be enjoyed.

IMPLEMENTING THE LOW FODMAP DIET REST AND TEST PHASES

It is not generally recommended that people follow a low FODMAP diet for life; restricting dietary intake of a wide array of foods should generally be avoided if possible to reduce the risk of nutrient deficiencies. As discussed, FODMAPs are a normal part of the diet and have benefits for health, such as providing fibre and prebiotics for gastrointestinal health.

A low FODMAP diet is recommended for patients presenting with primarily gastrointestinal symptoms as part of the Allergy and Reactivity Reduction Program. Strict adherence to the diet for a period of time is followed by systematic testing of food groups one-by-one, to identify which foods can be tolerated in modest amounts. A suggested protocol is as follows.

REST PHASE

In the rest phase, the patient should follow the low FODMAP diet with strict elimination of all high-FODMAP foods for at least two weeks. Relevant symptoms should be monitored and recorded on a daily basis using the symptom tracker.

Table 2: Suggested Alternative Foods That Can Be Consumed on a Low FODMAP Diet.[19,20]

FOOD GROUPS	FOODS TO ENJOY
Fruit	Banana, blueberries, grapefruit, grapes, honeydew melon, kiwifruit, lemons, limes, mandarins, oranges, passionfruit, paw paw, pineapple, raspberries, rock melon, tomatoes.
Vegetables	Alfalfa, bamboo shoots, bean sprouts, bok choy, carrot, cabbage (common), capsicum, choko, choy sum, eggplant, green beans, lettuce, chives, parsnip, potato, pumpkin, radish, silver beet, spring onion (green only), squash, zucchini.
Cereals	Gluten-free products, spelt, corn, oats, polenta, quinoa, rice (note: gluten is not a FODMAP but commonly occurs with fructans).
Nuts	(<1 handful daily) macadamias, peanuts, pecans, pine nuts, pumpkin seeds, sesame seeds, sunflower seeds, walnuts .
Dairy/dairy alternatives	Milk and cheeses: lactose-free cows' milk, rice milk, almond milk (inulin free), most cheeses (e.g. brie, camembert, cheddar, fetta). Other dairy products: butter, yoghurt (lactose-free, coconut), dairy free gelati, sorbet.
Sweeteners	Sugar (sucrose), glucose, maple syrup, golden syrup, stevia, sucralose.
Meats	Beef, lamb, kangaroo, poultry, eggs, tofu, tempeh (up to 160 g per day).

TEST PHASE

The test phase may be commenced after at least two weeks or more in the rest phase, when a significant reduction of symptoms has been achieved. The goal is to then systematically reintroduce each FODMAP to determine the level of individual FODMAP consumption that a person can comfortably tolerate. Researchers and dieticians working in the field of FODMAPs agree that systematically reintroducing FODMAPs is an important component of the program to develop an eating plan that maximises variety and health.[21,22]

A five week step-wise process for the test phase is outlined in Table 3. Each week a carbohydrate type is tested, which includes three doses of the FODMAP-containing food, separated by a symptom monitoring day between each dose. FODMAP reactivity is dose dependent, and due to individual variability in tolerance, some people may be able to tolerate all three doses, while others may react after only the first dose.[23] For some individuals with particularly low or high tolerances, the serving sizes below can be adjusted to better define tolerance levels.

If symptoms are experienced following a challenge, these should be allowed to resolve before the next challenge is commenced. It is recommended to continue to avoid all FODMAPs (with the exception of the food being tested) for the duration of the five week reintroduction phase, even if a particular FODMAP appears to be well-tolerated. This is to ensure that there are no residual additive effects of any other FODMAP class on the one being tested.

After the five week testing phase, it is recommended to consume all the well-tolerated FODMAP classes at intended dietary levels for one week to determine the tolerance of the FODMAP combination. Symptoms should continue to be monitored closely during this time. If there is a return of symptoms, then it is recommended to eliminate these FODMAP groups again until symptoms resolve. The combination of FODMAPs should then be reintroduced at a lower dose.

Table 3: The Test Phase of the Low FODMAP Diet.[24]

		Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Week 1	Mannitol and sorbitol (polyols)	½ cup of mushrooms, 4 dried apricots and monitor symptoms	Monitor symptoms	½ cup of mushrooms, 4 dried apricots and monitor symptoms	Monitor symptoms	½ cup of mushrooms, 4 dried apricots and monitor symptoms	Monitor symptoms	Monitor symptoms
Week 2	Lactose (disaccharide)	250 mL of milk or 200 g of yoghurt and monitor symptoms	Monitor symptoms	250 mL of milk or 200 g of yoghurt and monitor symptoms	Monitor symptoms	250 mL of milk or 200 g of yoghurt and monitor symptoms	Monitor symptoms	Monitor symptoms
Week 3	Fructose (mono saccharide)	2 teaspoons of honey and monitor symptoms	Monitor symptoms	2 teaspoons of honey and monitor symptoms	Monitor symptoms	2 teaspoons of honey and monitor symptoms	Monitor symptoms	Monitor symptoms
Week 4	Fructans (oligo saccharide)	2 slices of wholemeal wheat bread and monitor symptoms	Monitor symptoms	2 slices of wholemeal wheat bread and monitor symptoms	Monitor symptoms	2 slices of wholemeal wheat bread and monitor symptoms	Monitor symptoms	Monitor symptoms
Week 5	Galactans (oligo saccharide)	½ cup of lentils or legumes and monitor symptoms	Monitor symptoms	½ cup of lentils or legumes and monitor symptoms	Monitor symptoms	½ cup of lentils or legumes and monitor symptoms	Monitor symptoms	Monitor symptoms

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MAINTENANCE PHASE

If specific FODMAP aggravations are identified during the test phase, it is recommended your patient moves onto the maintenance phase of the program to determine their threshold of tolerance for each food group ongoing. Table 1 provides a list of the foods grouped by FODMAP type to be used as a reference during this time.

HOW TO IMPLEMENT THE MAINTENANCE PHASE

- The first step in developing tolerance is to eliminate all aggravating food items that were identified during the *Rest and Test* option. This elimination phase lasts for 1 to 2 months depending upon the severity of the reaction you experienced for each food item.
- Next, with the help of your Practitioner to determine the order, follow the step-wise process detailed below when introducing each food item, so you can establish what your actual tolerance level is based on any response you may experience (Table 4). This then forms the template for your ongoing enjoyment of these food items in future.

Table 4: Implementing the Maintenance Phase.

STEP 1	
Eat the aggravating food 1/7 for four weeks. (Minimum five days apart.)	If an aggravation occurs – eliminate the food again for two weeks before repeating Step 1. If no aggravation occurs during the four weeks of eating it – move to Step 2.

STEP 2	
Eat the aggravating food 2/7 for four weeks. (Minimum three days apart.)	If an aggravation occurs – eliminate the food again for two weeks before repeating Step 2. If no aggravation occurs during the four weeks of eating it – move to Step 3.

STEP 3	
Eat the aggravating food 3/7 for four weeks. (Minimum two days apart.)	If an aggravation occurs – eliminate the food again for two weeks before repeating Step 3. If no aggravation occurs during the four weeks of eating it – maintain at three times a week ongoing.

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