MONASH University

# Module 3
# Summary Factsheet

## 1. Introduction

FODMAPs are found in a wide range of foods including fruit, vegetables, breads, cereals, grains, nuts, seeds, dairy products, processed foods and beverages.

## 2. FODMAP analysis of FOOD

### 2.1 Range of foods tested

Hundreds of foods from a wide range of categories have been tested for FODMAP content. Some of these data are made publically available scientific publications[1-4], and nearly all FODMAP composition data are made available via the Monash University FODMAP Diet™ App.

### 2.2 Food sampling and preparation procedures

The Monash Team established the techniques needed to quantify FODMAP levels in food[1-4]. Briefly, foods are:

- Sampled using methods consistent with Food Standards Australia New Zealand (FSANZ) protocol (FSANZ, Canberra, Australia).
- Prepared as per packet directions (if a processed food)
- Pooled
- Processed to create a homogenised sample.
- Freeze-dried to remove all water content (except milk or powders such as flours).
- Extracted in water at 80°C
- Stored at -20°C (prior to analysis).
- Analysed using HPLC, UPLC and frutcan assays to measure FODMAP content

## 3. Low FODMAP cut offs

Cut-off values to classify foods as low (green), moderate (amber) or high (red) in FODMAPs (Figure 1). Monash has tested the reliability of these FODMAP cut-off values in a number of dietary studies[5-7] and shown that diets designed using these cut-offs lead to clinically and statistically significant improvements in symptom control in people with IBS.

| | LOW (GREEN) |
|---|---|
| Oligosaccharides<br>All foods except grains cereals, legumes, nuts, seeds and plant milks | < 0.20 |
| Oligosaccharides<br>All grains cereals, legumes, nuts, seeds and plant milks | < 0.30 |
| Sorbitol OR Mannitol | < 0.20 |
| Total polyols | < 0.40 |
| Excess fructose | < 0.15 |
| Excess fructose in food where excess fructose is the only FODMAP present | < 0.40 |
| Lactose | < 1.00 |

Figure 1: Low FODMAP cut-off values

## 3.1 The traffic light system

Monash developed a traffic light rating system to communicate the FODMAP content of food with the general public. The system allows us to indicate the FODMAP content of each individual sugar (fructose, sorbitol, mannitol, lactose, fructans and GOS), and the overall FODMAP rating, at different serving sizes. Examples of the manner by which this system is applied are provided in Table 2.

Table 1 - Applying the traffic light rating system to different foods, sugars and serving sizes

| FOOD | RATING OF INDIVIDUAL SUGARS | | | | | | OVERALL RATING |
|---|---|---|---|---|---|---|---|
| | FRUCTANS | GOS | FRUCTOSE | SORBITOL | MANNITOL | LACTOSE | |
| Cherries (1 cup) | | | | | | | |
| Cherries (3 cherries) | | | | | | | |
| Cherries (2 cherries) | | | | | | | |
| Butternut squash (2/5 cup) | | | | | | | |
| Butternut squash (1/2 cup) | | | | | | | |
| Butternut squash (1/5 cup) | | | | | | | |

## 4. FODMAP composition of food

Foods particularly high in each FODMAP subgroup are listed in Table 2. High FODMAP foods and low FODMAP alternatives are summarised in Table 3.

## Table 2 - Foods rich in different FODMAP subgroups

| | FRUCTANS | GOS | SORBITOL | MANNITOL | FRUCTOSE IN EXCESS OF GLUCOSE | LACTOSE |
|---|---|---|---|---|---|---|
| FRUIT | Grapefruit<br>Persimmon<br>Dates<br>Dried fig<br>Dried pineapple<br>Dried mango | | Apple<br>Pear<br>Avocado<br>Apricot<br>Nectarine<br>Plum<br>Yellow peach<br>Blackberries<br>Lychee<br>Fresh coconut | | Apple<br>Pear<br>Mango<br>Boysenberry<br>Fig (fresh)<br>Grapes<br>Watermelon | |
| VEGETABLES | Onion<br>Garlic<br>Leek (bulb only)<br>Artichoke (globe)<br>Artichoke (Jerusalem)<br>Spring onion<br>Bitter melon | Green peas | | Mushrooms<br>Cauliflower<br>Celery<br>Sweet potato<br>Snow peas | Asparagus<br>Sugar snap peas | |
| BREADS AND CEREALS | Breakfast cereal (wheat/rye barley based)<br>Bread (wheat/ rye based)<br>Pasta<br>Pumperkickle bread<br>Barley flakes<br>Cous cous (wheat)<br>Gnocchi<br>Semolina | | | | | |
| PULSES / VEGETARIAN | Falafels | Black beans<br>Borlotti beans<br>Haricot beans<br>Navy beans<br>Red kidney beans<br>Split peas<br>Baked beans | | | | |
| NUTS AND SEEDS | | Cashews<br>Pistachios | | | | |
| DAIRY / ALTERNATIVES | | Soy milk (from soy beans) | Coconut milk | | | Cows' milk<br>Yoghurt<br>Custard<br>Sweetened condensed milk |
| SUGARS / SWEETENERS | | | Sugar-free confectionery | | Honey, high fructose corn syrup | |
| OTHER | Garlic / onion based marinades and sauces<br>Vegetarian mince | Vegetarian mince | | | Fruit juice | |

## Table 3 - High FODMAP foods and low FODMAP alternatives

| | FOOD | HIGH FODMAP FOOD TO AVOID | LOW FODMAP ALTERNATIVE |
|---|---|---|---|
| Fructans | Bread | Wholegrain wheat bread<br>Rye bread | Spelt sourdough bread<br>Gluten free bread<br>Oat sourdough bread (½ serve or 1 slice) |
| | Cereal | Muesli containing wheat<br>Whole wheat grain biscuit | Oats<br>Quinoa flakes<br>Corn flakes (½ serve or ½ cup) |
| | Pasta | Wheat pasta | Gluten free pasta<br>Quinoa pasta |
| | Biscuits | Rye crispbread | Rice cakes – plain |
| GOS | | Baked beans<br>Butter beans<br>Red kidney beans | Chickpeas, canned (½ serve or ¼ cup)<br>Lentils, canned |
| Sorbitol | | Pear<br>Corn<br>Apple<br>Nectarine | Orange<br>Banana (firm)<br>Papaya (yellow)<br>Kiwi fruit, green |
| Mannitol | | Peach (clingstone)<br>Celery<br>Cauliflower | Strawberries (5 medium)<br>Cantaloupe (¾ cup)<br>Capsicum, green<br>Potato |
| Excess fructose | | Asparagus<br>Artichoke (hearts, canned)<br>Sugar snap peas<br>Apple<br>Pear<br>Watermelon | Beans, green<br>Aubergine / eggplant (1 cup or 75g)<br>Carrot<br>Rhubarb<br>Pineapple |
| Lactose | | Cows' milk<br>Custard<br>Evaporated milk<br>Icecream | Lactose free milk<br>Yoghurt (small amounts)<br>Soy milk (soy protein)<br>Whipped cream |

## 4.1 Foods containing multiple FODMAPs

Foods containing multiple FODMAPs may be particularly problematic for people with IBS, as total FODMAP load influences symptom onset, not just the presence of specific FODMAP types. Foods high in multiple FODMAPs are highlighted in Table 4.

## Table 4 - Foods high in multiple FODMAPs

| | OLIGOSACCHARIDES | | | POLYOLS | | |
|---|---|---|---|---|---|---|
| | FRUCTANS | GOS | EXCESS FRUCTOSE | SORBITOL | MANNITOL | LACTOSE |
| Dark rye bread | | | | | | |
| Wheat bread | | | | | | |
| Wheat free muesli | | | | | | |
| Wheat bran | | | | | | |
| Wheat noodles | | | | | | |
| Baked beans | | | | | | |
| Borlotti beans | | | | | | |
| Four bean mix | | | | | | |
| Jerusalem artichoke | | | | | | |
| Beetroot | | | | | | |
| Snowpeas | | | | | | |
| Mushroom | | | | | | |
| Cherries | | | | | | |
| Clingstone peach | | | | | | |
| Nashi pear | | | | | | |
| Packham pear | | | | | | |
| Watermelon | | | | | | |
| Dried apple | | | | | | |
| Dried apricot | | | | | | |
| Dried pear | | | | | | |
| Dried prunes | | | | | | |

## 4.2 Misconceptions re the role of a gluten free diet in managing IBS

- Gluten free and wheat free diets have grown in popularity worldwide. This trend may in part be due to perceived symptomatic improvements on a gluten- and/or wheat-free diet.
- However, these improvements may be incorrectly attributed to gluten, with a number of other food components reduced and/or removed on a gluten free diet, including FODMAPS (in particular fructans).
- Gluten and FODMAPS tend to co-exist in grain and cereal foods (see Figure 2). This pattern might explain the symptomatic benefits that people report on a gluten free diet – these may be wrongly attributed to the removal of gluten and more accurately attributed to a reduction in FODMAP intake.

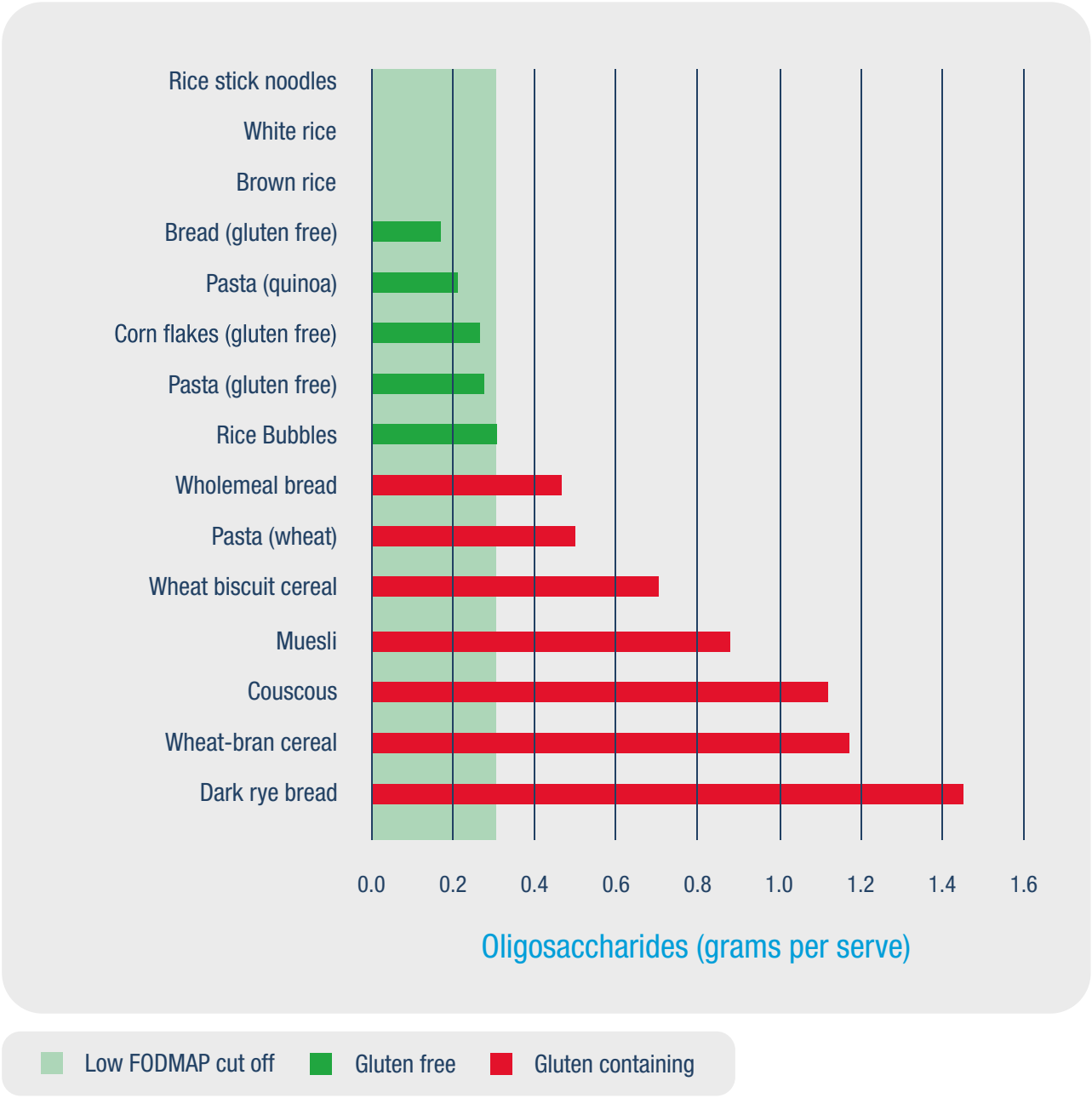


Figure 2: Oligosaccharide content of gluten containing and gluten free grain and cereal foods

## 5. External factors that affect FODMAP composition of food

A number of factors are known to impact on the FODMAP composition of plant foods, including ripeness, storage time, storage temperature, food variety, seasonal variation and climate[8, 9]. FODMAP levels can also vary within the same plant, depending on the part sampled, for instance root, stem, bulb, leaves, or whole plant.

### 5.1 International differences in FODMAP composition of food

The majority of publically available FODMAP composition data is based foods grown and/or manufactured in Australia. However, there are probably International differences in FODMAP composition of food due to differences in regional crop varieties[10] and a unique regulatory environment that influences permitted food ingredients, food additives and labelling practices.

#### 5.1.1 USA specific differences in FODMAP content

Implementing a low FODMAP diet in the USA presents unique challenges due to factors related to food supply and cultural trends. For instance:

- high-fructose corn syrup is widely used as a sweetener in processed foods
- high FODMAP ingredients such as onion and garlic are prevalent in US processed foods, but not always clearly labelled the ingredients.
- large portion sizes are common and this drives up FODMAP intake.
- Many consumers rely heavily on takeaway meals, restaurant meals, pre-prepared and convenience foods[11-13]. However, the FODMAP composition of these items is often unknown.
- Commercial diet programs in the US promote a high FODMAP intake from high-fibre breads, granola/muesli bars, yoghurt smoothies, shake mixes and unlimited quantities of fruit and vegetables
- Protein powders, shake mixes, probiotics, vitamin and fibre supplements that are marketed to US consumers often contain inulin, FOS, fructose and polyols.

## 5.2 Effect of ingredient selection on FODMAP content

Ingredient selection has a major impact on the FODMAP content of processed foods.

For example:

- cereal grain products made from rice tend to be very low in FODMAPs, whereas products made using durum wheat (such as couscous and pasta); rye (such as bread and crispbread) and soy flour (such as bread) tend to be high in FODMAPs[4, 20].
- soy milks made from soy protein tend to be low in FODMAPs, soy milks made from soy beans tend to be high in the FODMAP, GOS (raffinose and stacchyose). This is due to high GOS content of soy beans.

Table 5 highlights high FODMAP ingredients commonly added to processed foods that may result in a high FODMAP food product.

### Table 5 - Foods high in multiple FODMAPs

| FRUCTOSE | POLYOLS | FRUCTANS |
|---|---|---|
| • Fructose<br>• High fructose corn syrup<br>• Honey<br>• Fruit juice<br>• Fruit juice concentrate<br>• Fruit pieces*<br>• Crystalline fructose<br>• Agave syrup<br>• Fruit sugar<br>• Dried fruit | • Sorbitol<br>• Mannitol<br>• Xxylitol<br>• Isomalt<br>• Erythritol<br>• Fruit juice<br>• Fruit juice concentrate<br>• Dried fruit | • Garlic / garlic salt / garlic powder / garlic extract<br>• Onion / onion salt / onion powder / onion extract<br>• Wheat*<br>• Rye*<br>• Inulin<br>• Fructan<br>• Fructooligosaccharide (FOS)<br>• Chicory / chicory root extract / chicory root powder |

*If a main ingredient

## 5.3 Food processing techniques that affect FODMAP content

A number of food processing techniques are known to affect FODMAP content, including boiling, straining, canning, pressing and fermentation.

- Food processing techniques that involve water (e.g. boiling, canning, pressing and straining) lower FODMAP content via the leaching of water soluble FODMAPs (fructans and GOS) into the surrounding liquid.
- The effect pressing and straining on FODMAP content is demonstrated in tofu, with the lower FODMAP content of firm versus silken tofu attributed to the former having undergone pressing that removes the fructan and GOS containing liquid. By contrast, silken tofu which is typically un-pressed, has a higher water and FODMAP content.
- During the fermentation process, fermenting microorganisms (e.g. lactobacilli) feed on FODMAPs (e.g. fructans and GOS), lowering the content of these FODMAPs. Consequently, longer fermentation times result in a greater reduction in fructan and GOS content.
- Processes that involve fermentation can also cause an increase in the sugar polyol, mannitol as this is a by-product of fermentation. This is observed during the sourdough bread making process[14], and in the pickling process, using vegetables such as cabbage (sauerkraut).
- Other food processes thought to affect FODMAP content include pickling, activation and ‘sprouting’ with the greatest reduction observed with pickling.

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