Dietary fibre & health

Prepared by

Terry Bolin

MD(NSW), BS(Syd), FRACP, FRCP(Lond), FRCP(Edin), DCH(Lond),

President, The Gut Foundation

Chairman, The Gastrointestinal and Liver Unit,

The Prince of Wales Hospital, Sydney

Alistair Cowen

MMBS, MD,FRACP

Visiting Gastroenterologist, Royal Brisbane Hospital

Melvyn Korman

PhD, MBBS, FRACP

Associate Professor of Medicine

Director of Gastroenterology, Monash Medical Centre, Melbourne

Rosemary Stanton OAM

PhD, BSc, C.Nut/Diet. Grad.Dip.Admin.

Nutrition Consultant

Introduction

The process of digestion and the important role of dietary fibre are now better understood. Recent studies have also shown that some types of starch, known as resistant starch, are at least as important as dietary fibre.
Both fibre and starch play an active part in the health of the colon.

Good food and better nutrition are fundamental to gastrointestinal health.

The wide range of fruits, vegetables, grains, breads, cereals, nuts and seeds which contain dietary fibre may also have important protective effects against many diseases, including bowel cancer.

Fibre is much more than the old idea of roughage.

The physical presence of fibre in the bowel is important but there is extra value from dietary fibre. When fibre and resistant starches reach the colon, they are broken down by 'good' bacteria. During this process, volatile fatty acids are produced. One of these acids—butyric acid—helps keep the cells in the walls of the colon healthy and may also give some specific protection against the proliferation of cancer cells.

Many people restrict high-fibre foods because of fears about flatus. Fermentation of dietary fibre and resistant starch by helpful bacteria does produce gases, but unless this is excessive, it is a normal process and the slight social inconvenience is a small price to pay for eating a nutritious diet.

What is dietary fibre?

Dietary fibre is officially defined as the remains of the edible part of plants and other carbohydrates that are not digested in the small intestine but pass to the large bowel (colon) where most are completely or partially broken down by bacteria. Fibre includes lignin and polysaccharides as well as natural waxy substances found in food.

The plant materials which make up dietary fibre are diverse and difficult to define and measure. Once they reach the large bowel, some, such as pectin and most gums, are totally fermented. Others, such as cellulose, are broken down to varying degrees in different individuals. Lignin is not digested at all.

Starches known as 'resistant starch' also escape digestion in the small intestine and are also broken down by bacteria in the bowel. When bacteria break down dietary fibre and resistant starch, they multiply in the process and contribute to the bulkiness of faeces.

The fermentation process also produces volatile fatty acids which play important roles in the bowel.

Because of the processes involved when it is broken down by bacteria, dietary fibre is much more than simple 'roughage' and its functions extend beyond increasing the weight and volume of faeces.

Dietary fibres can be characterised as soluble or insoluble.

Soluble fibres

—**pectins** (in fruits and seeds)

—**hemicelluloses** (in cereals, fruits, nuts)

—**mucilages** (in seeds and bulking supplements)

—**gums** (in seeds, cereals and as a food additive)

Insoluble fibres

—**lignin** (in wheat bran, legumes, vegetables and some fruits)

—**cellulose** (in vegetables, legumes, cereals, fruits and nuts)

Resistant starch

Starches are made up of many glucose units. Whether starches are digested in the small or large intestine depends on the structure of the starch, the structure of the starchy food itself, the presence of plant cell walls, linkages with proteins or fats, the type of heat used in processing or cooking.

Cooking and subsequent cooling, reheating and processing may also alter the site where starches are broken down.

For example, the starch in a hot potato is digested by enzymes in the small intestine whereas the starch in the same potato allowed to cool, alters its structural alignment and resists being broken down by enzymes, passing instead to the large bowel as 'resistant starch'.

The way rice is cooked also alters its starch and the amount that enters the colon as resistant starch. Rice cooked by the Asian absorption method, in which only sufficient water is used and is totally absorbed by the rice, has more resistant starch than rice cooked in a large volume of water and then drained.

Fermentation of resistant starch in the large bowel may produce much greater quantities of valuable volatile fatty acids than dietary fibre.

Resistant starch may be therefore at least as important as dietary fibre.

Effects of dietary fibre

Official definitions of dietary fibre include reference to its functions: laxation (faecal bulking and softening, increased frequency and/or regulation) as well as its ability to reduce blood cholesterol or blood glucose levels.

Faecal bulk

Faeces consist of approximately 75% water and 25% dry matter, made up of undigested residues plus bacteria and the debris of bacterial cells. Dietary fibre contributes to faecal bulk in different ways.

Lignin passes through the intestine unchanged and increases faecal bulk by its physical presence and by its ability to hold water. Soluble fibres, such as pectin in fruits, hemicelluloses in vegetables, and gums and mucilages in oats, seeds and some fruits increase the population of bacteria, and thus the bacterial content of faeces. Some cellulose is broken down by bacteria and increases bacterial bulk; some is undigested and absorbs water to increase faecal weight.

Resistant starch leads to increased bacterial mass and is therefore an important contributor to faecal bulk. This may be significant, especially in those whose diets are high in rice which has been cooked in such a way that it has a high content of resistant starch, as described earlier.

Volatile fatty acids

The short chain volatile fatty acids—butyric, propionic and acetic acids, produced when bacteria ferment dietary fibre and resistant starch have a number of functions. Butyric acid may give protection against colon cancer.

Propionic acid may stimulate muscular activity in the colon. Each of the volatile fatty acids is available as an energy source for the cells of the colon. They also provide a source of energy for rest of the body, currently thought to be 2-3 calories per gram.

Soluble fibres ferment rapidly in the right colon (also known as the proximal colon); insoluble fibres ferment more slowly during their transit throughout the entire length of the colon.

Rate of digestion

Soluble fibres form viscous gels and may trap nutrients, digestive enzymes or bile acids. This can slow down the rate at which sugars are digested and absorbed, and can have favourable effects on blood glucose in people with diabetes. Gummy fibres, pectin and resistant starch can also help control blood sugar levels. Whole grains in products such as bread also slow down the rate of digestion and help control blood sugar levels.

Satiety *(or feeling full after eating)*

High-fibre foods produce greater bulk in the stomach, increasing the feeling of fullness. Foods high in soluble, viscous fibres have a greater effect in this respect than insoluble fibres. Eating more foods rich in soluble fibre may therefore give greater satiety than insoluble fibre, but for weight control, it makes sense to eat less fat and more foods high in all types of dietary fibre.

Serum cholesterol levels

The ability of dietary fibre to reduce blood cholesterol is small and reducing saturated fat is the best way to control blood cholesterol. Many types of fibre have no effect on cholesterol, but some viscous soluble fibres from pectins, and beta glucans in oats and barley, can restrict the amount of cholesterol and bile acids absorbed from the small intestine and therefore lower blood cholesterol levels.

How fibre effects faecal bulk

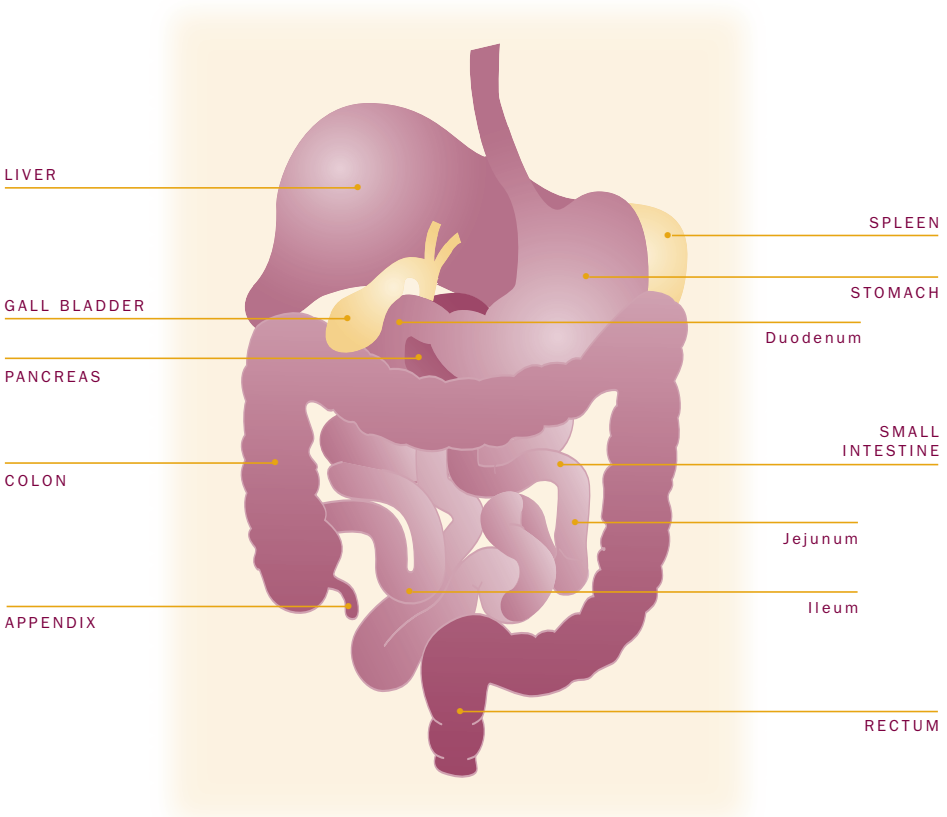
The most obvious short-term effect of dietary fibre is on the stool bulk. This involves:

1 Lignin and some cellulose passing through the colon unchanged. These forms of dietary fibre increase stool weight by their own mass and by their ability to hold water. Wheat bran has a high content of lignin and cellulose.

2 Soluble fibres *(pectins, hemicelluloses, gums and mucilages)* and resistant starch stimulate the growth of bacteria which then increase stool volume. Oats, legumes, fruit and vegetables are sources of soluble fibres and resistant starches are also found in oats, other grains, legumes and some types of bread flour.

There is also a close correlation between stool bulk and transit time through the gut. In general, the greater the bulk, the shorter the transit time.

Digestion and dietary fibre



Digestion starts in the mouth when an enzyme (amylase) in saliva begins the digestion of carbohydrate.

In the stomach, the gastric cells produce hydrochloric acid and enzymes (pepsin) to begin digesting proteins. The stomach acts as a reservoir, allowing small amounts of food to pass to the small intestine. The stomach may take up to four hours to empty; fatty foods empty more slowly than liquid or carbohydrate.

Most digestion continues in the duodenum under the action of pancreatic juice containing enzymes, and bile from the gall bladder. Proteins are broken down by peptidases to dipeptides and tripeptides; fats are converted by lipase to fatty acids; and amylases convert carbohydrates to disaccharides and monosaccharides. These smaller units are then absorbed and pass to the liver, where their metabolism continues.

Most nutrients are absorbed from the duodenum and jejunum but vitamin B12 and bile acids are selectively absorbed from the ileum.

Dietary fibre and some starches escape the enzymes in the small intestine and enter the large bowel where bacteria ferment all the soluble fibre and resistant starch, and some of the insoluble fibre.

Approximately 9 litres of fluid enters the jejunum each day. This includes 5 litres from foods, drinks, saliva and gastric juice plus 4 litres of bile, pancreatic juice and secretions from the small intestine.

Within the jejunum, 4-5 litres of the fluid is reabsorbed and another 3-4 litres is absorbed in the ileum. Approximately 1.5 litres enters the caecum through the ileo-caecal valve each day. The colon then plays a major part in fluid reabsorption and faecal volume is only 100-200 mL a day.

Food combining

Many people believe that proteins and carbohydrates cannot be digested if they are combined at the same meal. This theory arose from the idea that proteins need an acid environment and carbohydrates an alkaline medium for their digestion. However, only the first stage of protein digestion needs the acidity of the stomach. Further digestion of proteins, fats and carbohydrates occurs from enzymes operating in the alkaline environment of the small intestine. The food combining (or more correctly 'food separating') theories ignore the facts of normal digestion. The body is designed to cope with mixtures of nutrients from birth when it digests breast milk with its combination of protein, fat and carbohydrate. The process is similar when humans digest the milk of other animals, cereals, grains, nuts and seeds—all of which contain protein and carbohydrate within the same food.

What happens in the colon?

Within the large bowel or colon, bacteria ferment fibre, mucus and resistant starch.

During this process:

—**the bacteria** grow and multiply;

—**gases** such as carbon dioxide, hydrogen and methane are produced; and

—**volatile fatty acids** (acetic, propionic and butyric acid) are generated.

Flatus

Intestinal gas arises when bacteria normally present in the colon ferment dietary fibre, resistant starch and any food that escaped digestion in the small intestine.

Dietary fibre and flatulence

Between 500 and 1500 mL of flatus is produced every 24 hours. There are no reports of significant differences in the volumes generated by men and women. However, men report more emissions than women (12 times a day for men and 7 times a day for women; with a range for both sexes of between 2 and 30).

The number of emissions depends on the fibre content of the diet, with higher fibre levels generating more flatus. The usual emission volume is about 90 mL. There is little relationship between the number of times a person passes flatus and the total volume, suggesting that the size of emissions varies among individuals because of different sensitivities to gaseous distension of the rectum.

The amount of flatus produced varies widely throughout the day and night. Some people produce greater volumes in the morning, others in the evening. Larger volumes tend to follow meals. Less is produced during sleep.

Foods and flatus

Some people are unwilling to consume enough dietary fibre to avoid problems such as constipation because they are worried about flatus.

It is true that the more fibre consumed, the more gas produced.

It is also true that some foods are more potent sources of gas than others. Vegetables such as onions, legumes (dried beans and peas) and brassicas (cauliflower, Brussels sprouts, cabbage and broccoli) are common culprits. Some people find that other foods also give them extra flatus. However, production of gas is normal and the major problem is social embarrassment.

In those with a deficiency of lactase, the natural sugar (lactose) in milk ferments. If more than a small glass of milk is consumed, there may be a lot of gas accompanied by abdominal distension and, sometimes, pain.

Sugar alcohols such as sorbitol, mannitol, maltitol and xylitol, sometimes used as sugar substitutes in calorie-reduced confectionery, low-kilojoule jellies and other foods can also cause problems. At least half the population is intolerant to a 10 gram dose of sorbitol—the amount in 4 or 5 sorbitol-containing mints or a tablespoon of some carbohydrate-modified jams. Sorbitol is also a natural ingredient in apples and pears and excessive consumption of these fruits—usually as juice—may increase flatus. Some medicinal syrups, multivitamins, expectorants and bronchodilators may also include sorbitol.

Gases produced

The major gases produced include:

Nitrogen mostly swallowed from air. Most is reabsorbed in the stomach and small intestine, but about one third of the total volume of gas in the colon is probably nitrogen.

Oxygen also swallowed and almost totally reabsorbed in the stomach and duodenum, causing anaerobic (without oxygen) conditions in the small intestine and colon.

Carbon dioxide produced from the interaction between gastric hydrochloric acid, dietary fatty acids and bicarbonate from the duodenum and pancreas is present in the small intestine.
The interaction of fermentable material and organic acids with bacteria in the colon also produces carbon dioxide in the colon.

Hydrogen produced throughout the colon as bacteria ferment fibre, resistant starch and any unabsorbed sugars (lactose or sucrose) or sugar alcohols such as sorbitol. As with all gases present in the colon, some hydrogen is reabsorbed from the colon and expired from the lungs. The remainder is used by bacteria in the colon or passed as flatus. The amount of hydrogen expired from the lungs can be measured in a breath hydrogen test to assess absorption of sugars.

Methane made by methane-producing bacteria, commonly present in the left colon. These bacteria reduce carbon dioxide and hydrogen to methane, consuming 5 parts of gas (4 hydrogen and 1 carbon dioxide) in the process.
Not everyone produces methane.
In theory, those who do should have less flatulence than those who do not. Methane can also be measured in the breath.

Hydrogen sulphide produced by some bacteria that change sulphate to sulphide. It is the major cause of smelly gas.

Acetate produced by bacteria from carbon dioxide and hydrogen. It is also generated when bacteria ferment soluble fibre and resistant starch.

Measuring breath hydrogen

Hydrogen is produced throughout the colon. Sugars which ferment rapidly may produce more hydrogen than carbohydrates which ferment slowly.
An increase in hydrogen in the breath indicates that hydrogen is being produced from bacterial fermentation.
To test breath hydrogen production, a non-absorbable synthetic sugar such as lactulose is used to measure the transit time from mouth to caecum—usually about 90 minutes.

The same principle is used to test if there is any malabsorption of lactose, sucrose or sorbitol from the diet.
If absorption is impaired, unabsorbed sugar reaches the caecum where it is

fermented, producing hydrogen which is subsequently reabsorbed and expired in the breath.

Why some flatus is offensive

More than 99% of the gaseous composition of flatus is odourless and consists of hydrogen, carbon dioxide, methane and nitrogen. There is dispute over which volatile compounds are responsible for faecal odour but there is little doubt that hydrogen sulphide accounts for most of the aroma. Other substances such as methyl sulphides also contribute, accounting for the different types of aromas which follow eating certain foods. In general, faecal odour does not indicate any underlying disease.

It is difficult to measure hydrogen sulphide but there is a correlation between the production of methane, which is colourless and odourless, and hydrogen sulphide; individuals produce one or the other.

Young children rarely produce methane. The colonic bacteria begin to produce it by about three years of age, and its production increases slowly throughout childhood to the early teens before reaching adult levels.

Probiotics

Billions of micro-organisms (or microflora) live in the large bowel. Some beneficial types break down dietary fibre and resistant starch. It is only when undesirable bacteria multiply to high levels that the flora of the large bowel is a problem. Fermented products such as yoghurt contain bacteria. Most of these do not survive passage through the stomach and small intestine to reach the colon and exert no positive or negative effects.

However, there are some strains of micro-organisms that can survive the journey through the gastrointestinal tract, reaching the colon and multiplying there. Some of these micro-organisms can destroy some harmful microbes and prevent undesirable substances attaching themselves to the walls of the large bowel. These 'good' colonising bacteria added to some fermented products are called probiotics.

The research on benefits of probiotics is still at an early stage and many of the claims made or implied for some products have little backing.

However, researchers have confirmed that several strains of bacteria added to yoghurt can reach the large intestine and some strains of lactobacillus may reduce rotavirus, a major cause of infant diarrhoea. Other probiotics may reduce undesirable side effects of antibiotics.

Prebiotics

Prebiotics are substances that protect probiotics as they travel through the intestine on their way to the bowel. Research into prebiotic substances is continuing, but some types of starch and compounds such as inulin (found in chicory and Jerusalem artichokes) are currently being added to foods. Their full value is not yet established.

Disorders connected with a lack of dietary fibre

The most obvious effect of dietary fibre is on stool bulk.

On a Western diet, the average stool weight is about 100 to 150 grams per day. In vegetarians, this increases to about 225 grams per day. Daily faecal weight for rural Africans eating very high fibre diets may be 400 grams or more.

The amount of fibre in the diet is also correlated with intestinal transit time. On a typical low-fibre Western diet, transit time is 24-36 hours; rural Africans have a much shorter transit time whereas some studies from the UK show transit times of 60 hours.

Constipation

Constipation is a significant problem in communities where fibre intake is low, but is virtually unknown when the diet is high in fibre. At the other extreme, constipation is common among residents of nursing homes where the diet is generally low in fibre. Increasing high-fibre foods such as wholemeal bread greatly reduces constipation and laxative use.

Constipation refers to the consistency of the stools and any difficulty in passing them rather than the frequency of bowel movements. In many people, defecation occurs every 3-5 days. In more severe cases, it may only occur every 7-14 days.

It is not necessary to open your bowels every day. Many people pass a normal motion every second, third or fourth day, while others may pass two or three a day.

There are many possible causes of constipation. If the onset is recent, you need to exclude possible causes such as bowel cancer. Constipation may also be due to medications such as analgesics, antidepressants, narcotics and iron tablets. Conditions such as hypothyroidism or hypercalcaemia, neurological disorders (spinal cord lesions) and psychiatric disturbances, including depression, may also be related to constipation.

Most people with severe constipation are young or middle-aged and almost exclusively female. Constipation may have been present from infancy, sometimes beginning in the teens, often after restrictive diets or cyclical bouts of dieting or following abdominal surgery. Constipation may also start during pregnancy. Often there is no obvious precipitating cause.

There is increasing evidence that constipation exists because of a combination of poor muscular contractions in the colon, abnormalities of gut hormones, or both. This may cause a slow gut transit time, which can be measured by swallowing radio-opaque

markers or having a study in a department of Nuclear Medicine, usually in a hospital.

In those who have anal sphincter dysfunction or disturbance of pelvic floor muscles, the major problem is in evacuating the rectum.

In simple constipation, the first, and usually the only, step required is to ensure an adequate intake of dietary fibre from a wide variety of sources, including fruits and vegetables and wholegrain products.

Many people who think they are eating a high-fibre diet do not reach the levels of fibre needed to prevent constipation. It may also help to drink plenty of water and have regular meals.
If constipation persists, a bulking agent should also be used.

When constipation does not respond to simple measures, it is important to review possible organic causes.
This will probably require examination of the colon. Some people with severe constipation will need to be referred to a gastroenterologist or colo-rectal surgeon with a special interest in constipation. Motility tests, transit studies and electromyography may be necessary.

It is best to avoid long-term use of laxatives as they can produce serious damage to the nerves in the colon. In younger people, if a high-fibre diet and a simple laxative do not help, specialist evaluation is advisable. For elderly people, Lactulose may help.

For Australians of all ages, and especially women, constipation is so common that everyone needs to know how to achieve a high-fibre intake with minimal use of laxatives.

Haemorrhoids

Haemorrhoids are common and occur at any age in peoples of all races, both sexes and all occupations. Anything that increases pressure within the pelvis, such as pregnancy, is likely to provoke haemorrhoids.

There is also a direct association between haemorrhoids and a highly-refined, low-fibre diet. The constipation this causes leads to straining at stool. Increasing the fibre content of the diet will prevent constipation and relieve the symptoms of haemorrhoids. Haemorrhoids can also be made worse by diarrhoea.

Symptoms of haemorrhoids can usually be helped by:

—**high-fibre diet**,
—**prevention of straining**,
and, if necessary,
—**use of faecal softening agents** and/or drugs to relieve spasm in the bowel (available on prescription).

Injection sclerotherapy or banding may also be needed and persisting prolapsing haemorrhoids may need surgical intervention.

If an older person (over 45 years of age) has rectal bleeding, investigation with colonoscopy is essential.

Irritable bowel syndrome

This syndrome is characterised by pain and altered bowel habit. The pain comes from the colon and is lower abdominal and often left-sided. Defaecation or passing wind relieves it. The bowel habit may be erratic. Constipation is common and diarrhoea may also occur. There is no test to diagnose irritable bowel syndrome and a doctor needs to investigate the problem to exclude any potentially serious diseases as a cause, especially in older people.

Increasing dietary fibre and using a bulking agent may be the only treatment needed. Those who have diarrhoea should still increase dietary fibre intake.

To manage more persistent irritable bowel syndrome:

—**exclude** organic disease,
—**understand** the physiological processes involved,
—**know** what a high-fibre diet really is,
—**use** bulking supplements.

If these measures are not enough to relieve symptoms, a prescription drug to relieve spasm in the bowel may be needed. Those who are anxious about the condition may find minor anti-depressant drugs helpful.

Diverticular disease

Diverticular disease is unknown in rural Africans who eat a high-fibre diet, but is common in Western societies where many people have a low fibre intake. It is much less common in vegetarians.

Intraluminal pressure is likely to be much higher if the colon has a narrow diameter (associated with low faecal weight) than if the colon has a wider diameter (associated with high daily faecal weight). Increased intraluminal pressure may be a major factor in the development of diverticular disease.

Long term management of diverticular disease is based on:

—**a high-fibre diet**,
—**bulking supplements**,
—**prescription drugs** to relieve spasm in the bowel,
—**antibiotics** for episodes of acute diverticulitis.

Bowel cancer

The cause of bowel cancer is unknown but there is good evidence that dietary and other environmental factors promote it, at least in genetically-susceptible individuals.

Australia has amongst the highest incidence of bowel cancer in the world.

In Africa, Asia and much of Latin America, the risk of bowel cancer is one-tenth that of affluent Western countries such as Australia. This may be related to diet. When moving from a country where the incidence of bowel cancer is low, within two generations, migrants assume the incidence of their

new country. This occurs in Japanese migrants to Hawaii and in Greeks and Italians migrating to Australia. Bowel cancer usually occurs after the age of 40 and develops from a benign polyp that may take many years to grow.

The risk of bowel cancer increases with diets high in fat and red meat and low in fruits, vegetables and dietary fibre. High beer consumption has also been linked with bowel cancer and polyps, as has smoking.

Some of the recommendations from the Australian Dietary Guidelines may help reduce the risk. Advice to eat less fat, consume only moderate amounts of alcohol and eat more vegetables, fruit, bread and high-fibre cereal products is important. Foods rich in calcium, such as low-fat dairy products, may also help reduce the risk although more research studies are needed to confirm this.

Dietary fibre may reduce the risk of bowel cancer by:

—**increasing the bulk of faeces** passed and therefore diluting the concentration of potentially cancer-causing substances in the bowel;

—**reducing transit time** through the large bowel and reducing contact between cancer-causing substances and the lining of the bowel;

—**altering bacterial metabolism** to decrease production of cancer-causing substances such as some bile acids;

—**generating production of short chain fatty acids** such as butyrate which are protective against bowel cancer.

In discussing dietary fibre and bowel cancer, the effect of resistant starch is important. Starches that pass to the large bowel are broken down by bacteria and generate butyrate which helps keep the cells lining the bowel healthy and may also reduce the chances of cancer-causing substances creating damage.

The role of dietary fibre in reducing bowel cancer suggests a relationship between bowel cancer and a low-fibre diet. Stool weight is low in many Western populations and parallels a high incidence of bowel cancer. An analysis of stool weight in 20 population groups in 12 countries has shown that larger stools correlate with less cancer and stool weight increases with a higher intake of starch and dietary fibre.

A diet high in dietary fibre is usually also low in fat and this may be an added advantage. Many studies have also shown that a diet high in vegetables and fruits reduces the risk of bowel cancer in some way that is not related to their fibre content. Vegetables and fruit contain many thousands of compounds which may have anti-cancer properties and these are currently being investigated. Studies have already shown that cruciferous vegetables and some of the hundreds of carotenoids that occur together in fruits and vegetables

have a protective effect. Trials using supplements of beta-carotene, the best known of the carotenoids in fruits and vegetables, however, have shown no benefit, and some potential problems. Supplements are almost certainly not the answer in this respect; you need to eat fruits and vegetables.

As well as the protection from fruits, vegetables and dietary fibre, there is also evidence that increased physical activity, higher levels of dietary calcium, and the ratio of polyunsaturated omega 6 to omega 3 fatty acids may also be important. The ideal ratio of fats is different from the typical western diet and can be achieved by eating more fish and smaller quantities of concentrated polyunsaturated fats.

Diabetes

People with type 2 diabetes benefit from an increase in dietary fibre and resistant starch. Soluble fibres found in oats, barley, legumes, seeds, nuts, fruits and vegetables may be particularly helpful. Most of these foods also release their glucose slowly into the bloodstream. A high-fibre diet is also likely to be low in fat and this is a further advantage.

Raised blood cholesterol

Some soluble fibre found in oats, psyllium and barley, and also the pectin from certain fruits, can reduce blood cholesterol. Although many people enthusiastically promoted oat products a few years ago, foods like oat biscuits or oat bran muffins cannot undo the damage of foods high in saturated fat. Foods high in soluble fibre have benefits for those with high levels of cholesterol in the blood, but a diet low in saturated fat is even more important.

Bulking supplements

An increase in dietary fibre may not be enough to cure the symptoms in those with irritable bowel syndrome, diverticular disease or troublesome constipation.

Bulking supplements may be useful, although they will make constipation worse when constipation is associated with a condition known as megacolon.

Unprocessed wheat bran

Wheat bran is a cheap and concentrated source of dietary fibre. It achieves its faecal bulking effect because of its water-holding capacity. Coarse bran is much more effective in this regard than finely milled bran. To increase stool bulk, 2 tablespoons of unprocessed bran per day can be added to a high-fibre diet. Larger quantities are not advisable as bran can interfere with the absorption of some minerals.

Some people with diverticular disease, reflux oesophagitis associated with hiatus hernia or delayed gastric emptying may have side effects from unprocessed bran. These may include increased reflux symptoms, epigastric fullness and discomfort, excessive flatus, anal irritation and abdominal distension. Unprocessed bran also seems to make symptoms worse in irritable bowel syndrome.

Pharmaceutical agents

Many people are not prepared to increase their dietary fibre intake enough to relieve their symptoms because they find increased intestinal gas a problem. Some proprietary products to increase stool bulk are convenient and easy for those who are unwilling or unable to eat high-fibre foods, and can minimise gastrointestinal symptoms.
The appropriate dose varies for different people.

The following types of fibre supplements are available:

Bran fibre supplements fibre derived from the outer layers of a variety of cereal grains. These have similar effects to unprocessed wheat bran, but may be more palatable. However, with some products, the recommended dose may not provide enough fibre to be effective.

Psyllium also known as Plantago ovata and Plantago ispaghula.

The fibre in the seeds and husks of the mucilaginous plant Plantago ovata can hold large quantities of water. This is the principal component of *Agiofibe, Fybogel* and *Metamucil*. Breakfast cereals, which incorporate psyllium, are also available.

Psyllium fibre supplements may have fewer side effects than unprocessed bran. Reflux symptoms are less, there is often less flatus and anal irritation is rarely a problem.

The ratio of soluble to insoluble fibre is also important. A diet containing a wide variety of foods has approximately 25-30% soluble and 70-75% insoluble fibre. Plantago ovata seeds contain mainly insoluble fibre while the husks are primarily soluble fibre. *Metamucil* and *Fybogel* are made largely from the husks of Plantago ovata and contain a greater proportion of soluble fibre. *Agiofibe*, in contrast, is predominantly seeds with a small amount of husk and a ratio of soluble to insoluble fibre that is approximately the same as in a normal varied diet. Adequate fluid intake is important to prevent oesophageal obstruction.

Sterculia a mucilaginous gum derived from a plant and the principal component of *Normacol* and several other commercial preparations has similar properties to psyllium. Adequate fluid intake is important.

With each of the bulking agents, there is the same dilemma concerning their mode of action as exists with dietary fibre. The mucilaginous bulking agents may be valuable partly by their gel-forming action and ability to absorb water. They may also be fermented by colonic bacteria and increase the mass of 'good' bacteria in the bowel.

The most commonly used bulking agent is Plantago husk, sometimes combined with whole Plantago seeds. The latter are more effective in increasing faecal wet and dry weight compared with an equivalent dose of Plantago husk or wheat bran. These proprietary preparations should not be seen as an alternative to increasing foods high in dietary fibre, but may be a useful adjunct. With some people, their ease of administration outweighs the disadvantage of their cost.

Australian adult men report eating foods that contain 26 grams of fibre a day. Women report 20 grams. Adding a bulking supplement may increase this to 35 grams a day, close to the optimal intake of dietary fibre thought to be protective against some diseases. Bulking supplements may be of value in constipation and also for the diarrhoea and variable bowel habit of irritable bowel syndrome.

Increasing fibre intake

A high fibre diet involves much more than taking unprocessed wheat bran. Variety is always important and it is best to choose a wide selection from the different categories of foods that contribute dietary fibre.

Dietary fibre is also a marker of nutritional value. Foods that are good sources of fibre almost always contain a range of vitamins, minerals and other essential nutrients. By contrast, low-fibre foods are often high in fat and do not make a positive nutritional contribution to the diet.

Dietary fibre occurs in plant foods. These include:

—Breads, cereals, grains and products made from grains such as breakfast cereals and pasta,

—fruit, vegetables and legumes (dried peas and beans), nuts and seeds.

Most foods within these categories contribute dietary fibre, but some foods have more than others.

For example, white bread contains some dietary fibre, but wholemeal has up to four times as much. Some highly processed breakfast cereals have very little fibre whereas others are excellent sources.

The best food choices are:

Breads, cereals and grains
Choose wholegrain, wholemeal, white with added fibre (usually from legume husks or oat bran), multigrain, wholemeal Lebanese or pita breads. Some soy and linseed breads are especially high in fibre (with up to 5 grams/slice).

English style muffins made with wholemeal flour, with added oats, bran, and wholegrains.

Cake-style bran muffins (these are usually high in fat).

Wholegrain crackers such as *Ryvita* or brown rice cakes, wholemeal *Vita Wheat* or other wholemeal crackers (check the fat content as some have more disadvantages from their fat than they have advantages from fibre).

Cakes, biscuits and scones made with wholemeal flour.

Breakfast cereals
Processed bran cereals (*Soy and Linseed Bran, All-Bran, Bran Flakes, Sultana Bran*).

Rolled oats (traditional or quick cook), oat bran porridge, wholemeal porridge.

Unprocessed wheat bran (not more than 2 tablespoons), rice bran cereals, oat bran (can be made into a porridge).

Wheatgerm
Wholewheat breakfast cereals *(Weetbix, Vita Brits, Mini Weets, Ready Wheats, Bran Bix, Fruity Bix, Weeties)*, natural muesli, muesli flakes (some toasted mueslis are high in fat, check the label).

Grains and grain foods
Oats, millet, rye, barley, buckwheat, cracked wheat (called bulgur or burghul), brown rice, cornmeal (or polenta), couscous. Pasta—white, spinach or wholemeal.

Legumes
Dried peas, chick peas, lentils, split peas. Baked beans, black eyed beans, broad beans, butter beans, Lima, kidney, mung, navy and soy beans (Legumes can be dried, quick cook or canned).

Root vegetables
Potatoes, beetroot, carrots, celeriac, Jerusalem artichoke, kohlrabi, kumara, parsnips, sweet potatoes, turnips, yams.

Other vegetables
All, but especially asparagus, beans, broccoli, Brussels sprouts, cabbage, cauliflower, various Asian greens, leeks, mushrooms, peas, snow peas and spinach.

Fruits *(include the skin where practical)*
All, but especially apples, apricots, bananas, berries (all kinds), dried fruits (especially dried apricots, prunes), figs, guava, kiwi fruit, mandarin, mango, oranges, pear, plums, quince, rhubarb.

Nuts and seeds
All kinds of nuts, plus pepitas, sesame and sunflower seeds.

Low fibre foods

These foods should form only a minimal part of the diet.

—**Refined cakes, biscuits, crackers and pastries.**

—**Fruit juices**
(eat the whole fruit to provide fibre).

—**Vegetable juice**
(good products but not a substitute for vegetables).

—**Foods high in saturated fats**
(these foods can displace high-fibre foods).

—**Sugary foods**
(the fibre content is usually low).

Fluids

Dietary fibre absorbs water and it is always important to drink plenty of water. The exact quantity depends on your size, how active you are and the temperature. Try to drink enough so that, except for first thing in the morning, your urine is almost colourless. Yellow urine indicates that you are not drinking enough.
Most people need 6-8 cups of water a day. Athletes usually need much more. You can count tea, coffee and juices as fluid, but it is best to restrict coffee to 2-3 cups a day.

Filling or fattening?

Foods high in dietary fibre are usually filling. Some people confuse 'filling' with 'fattening'. Foods that are high in fibre are usually filling, but are rarely fattening, unless consumed with fat.

A bowl of porridge, for example, is much more filling than a bowl of cornflakes, yet each has a similar number of kilojoules. Eating more filling foods can help reduce the total amount consumed and can be valuable for those trying to restrict kilojoules. Fibre itself, however, does not cause a loss of body fat. Neither do laxatives.

How much fibre?

The average Australian man claims to be consuming foods that provide 26g of fibre a day. The average woman reports foods that would provide 20g of fibre a day.

These figures are higher than in countries such as the United States and the United Kingdom, and may reflect higher consumption of breakfast cereals such as *Weetbix* (the biggest selling breakfast cereal in Australia).

However, many Australians are constipated, which means either that people are reporting that they eat more fruits and vegetables than they actually consume, or it may mean that the average consumption misses the extremes.

The amount of dietary fibre usually recommended is 30 grams a day.
A little more may be better and many people habitually consume 40-50 grams without problems. Any increase in dietary fibre should occur gradually to prevent excessive flatus.

Food sources of dietary fibre

Fruit

Apple, *1 medium, cored*	150g	3.0
Apricot, *each*	70g	1.5
Avocado, *½ small*	80g	1.0
Banana, *1 small*	120g	2.5
Berries, *average, ½ punnet*	100g	4.5
Cherries, *weighed with stones*	100g	1.5
Figs, *raw, each*	60g	1.5
Fruit salad, *average serve*	200g	3.5
Grapefruit, *½ medium*	125g	1.0
Grapes, *black or green*	100g	1.0
Guava, *1 medium*	95g	5.0
Kiwi fruit, *1 medium*	100g	3.5
Mandarin, *1 large*		2.5
Mango, *1 medium*	250g	5.0
Melon, *1 cup*		1.5
Nectarine, *1 average*	110g	2.5
Orange, *1 medium*	180g	3.5
Passionfruit, *1 average*	40g	3.0
Pawpaw,	100g	2.5
Peach, *1 medium*	140g	2.0
Pear, *1 medium*	160g	4.0
Pineapple, *1 slice*	120g	2.5
Plum, *yellow flesh, 2 average*	180g	3.5
Prunes, *6 medium*		4.5
Quince, *½ medium, cooked*		8.5
Raisins or sultanas,	20g	1.0
Rhubarb, *stewed, ½ cup*		4.0

Vegetables

Artichoke, *Jerusalem*	100g	3.0
Asparagus, *fresh, 8 thin or 4 thick spears*	120g	2.0
Beans, *green, runner or French*	100g	2.5
Beans, *dried, cooked, average, 1 cup*		11.0
Broad beans, *½ cup fresh, with pods, cooked*		5.0
Broccoli, *average serve*	100g	4.0
Brussels sprouts, *average serve, 5*	100g	3.5
Cabbage, *Savoy or white, raw, 1 cup*	80g	3.0
Capsicum, *red or green, raw, ½ medium*	90g	1.5
Carrot, *raw, 1 medium*	120g	4.0
Cauliflower, *cooked, average serve*	100g	2.0
Celery, *raw, 1 stick 20cm long*	50g	1.0
Chinese greens	100g	3.0
Corn on the cob, *1 average, 150g without husk*		5.0
Corn, *canned, 1 cup*	125g	4.0
Cucumber, *green, ½ cup slices, peeled*	50g	0.5
Eggplant, *grilled or fried*	100g	2.5
Leek, *sliced, ½ cup raw*	45g	1.5
Lettuce, *radicchio, 2 leaves*		0.5
Mushrooms, *fresh*	100g	2.5
Onion, *1 medium*		2.5
Parsley, *½ cup chopped*	30g	1.5
Parsnip, *sliced, steamed, ½ cup*	75g	2.0
Peas, *frozen, cooked, ½ cup*	80g	4.5
Peas, *snow or sugar-snap*	100g	4.0
Potato, *1 medium cooked*	150g	2.5
Pumpkin, *average piece, cooked*	85g	1.5
Silverbeet, *cooked, ½ cup*	60g	2.0
Spinach, *cooked, ½ cup*	70g	4.5
Sweet potato, *orange, cooked, average piece*	100g	2.5
Tomato, *raw, 1 medium*	160g	2.0
Yam, *baked average piece*	75g	3.5
Zucchini, *green or yellow, 1 medium*	90g	1.5

Nuts and seeds

Almonds, *whole, 20 nuts*		3.5
Brazil nuts	50g	4.5
Cashews, *raw or roasted*	50g	3.0
Chestnuts	50g	3.0
Coconut, *fresh*	50g	6.0
Hazelnuts	50g	5.0
Linseeds, *1 tablespoon*	10g	3.0
Macadamia	50g	3.0
Peanuts	50g	4.0
Peanut butter, *1 tablespoon*		1.5
Pecans	50g	4.0
Pine nuts, *1 tablespoon*	15g	1.0
Pistachios, *shelled*	50g	4.5
Pumpkin seeds *(pepitas)*	50g	12.5
Sesame seeds, *1 tablespoon*	10g	1.0
Sunflower seeds, *1 tablespoon*	15g	1.5
Walnuts, *½ cup*	50g	3.0
Popcorn, *1 cup*		1.0
Corn chips, *50g*		5.0

Grains and grain products

Barley, *cooked, 1 cup*	180g	6.5
Bulgur, *cooked, 1 cup*	250g	10.5
Macaroni, *cooked, 1 cup*	150g	2.0
Noodles, egg, *cooked, 1 cup*	160g	1.5
Pasta, *spinach, dry*	100g	4.5
Polenta, *dry corn meal*	100g	3.0
Potato, *flour*	100g	2.0
Rice, *brown, cooked, 1 cup*	160g	3.0
Rice, *white, cooked, 1 cup*	175g	1.5
Semolina, *cooked, 1 cup*	230g	1.5
Spaghetti, *cooked, 1 cup*		3.0
Spaghetti, *wholemeal, cooked, 1 cup*	150g	6.0

Breakfast cereals

All-Bran, *½ cup*	40g	11.5
Bran, *unprocessed, 2 tablespoons*	12g	5.5
Branflakes, *1 cup*	40g	6.5
Cornflakes, *1 cup*	30g	1.0
Just Right, *1 cup*	45g	5.0
Mini wheats, *15*	30g	3.5
Muesli flakes, *1 cup*	40g	3.5
Muesli, *natural, average, ½ cup*	60g	6.0
Multi-bran, *½ cup*	35g	12.5
Puffed wheat, *1 cup*	22g	1.5
Rice bran, *crunchy, ½ cup*	55g	14.0
Rolled oats, *½ cup raw*	55g	4.0
Sultana Bran, *1 cup*	45g	7.5
Sustain, *1 cup*	60g	5.0
Vogel's Soy & Linseed	45g	13.5
Weetbix or Vita brits, *2 biscuits*	30g	3.5
Weeties, *1 cup*	35g	4.0
Wheat germ, *2 tablespoons*	18g	3.5

Bread

Bread roll, *white, average*	60g	2.0
Bread roll, *wholemeal, average*	60g	3.5
Burgen Soy and Linseed, *2 slices*		9.5
Fibre-increased, *2 slices*	56g	2.5
Foccacia, *average piece plain*	80g	2.0
Fruit loaf, *1 slice*	30g	1.0
Mixed grain, *1 slice*	28g	1.5
Muffin, *English, 1*	65g	1.5
White sliced, *2 slices*	56g	1.5
Wholemeal, *2 slices*	60g	4.0
Crispbread, *puffed wholemeal, 4*	22g	1.5
Crispbread, *wholemeal, 4*	25g	3.0
Vita Wheat, *4*	25g	3.0

Low fibre meals	fibre (g)	High fibre meals	fibre (g)
Breakfast			
Cornflakes	1	Porridge (or weetbix)	4
Milk	0	Milk	0
2 slices white toast	1	2 slices wholemeal toast	5
Lunch			
Sandwich, *white bread*	2	Sandwich, *wholemeal*	5
meat with tomato sauce	0	chicken and salad	3
Chocolate bar	0	Apple	3
Dinner			
Grilled chops	0	Grilled chops	0
Chips	2	Jacket potato	2.5
Salad	3	2 or 3 vegetables	8
Ice cream	0	Fruit salad	4
Snacks			
Fruit, *1 piece*	3	Fruit, *1 piece*	3
Crisps	0.5	Wholemeal bread,*1 slice*	2
Sweet biscuits	0.5	Rye crackers	2.5
Total fibre	13		42

Fibre fallacies

Myth	Fact
Fibre equals unprocessed bran	Fibre is much more than bran. There are many different types of dietary fibre; wheat bran does not contain them all.
If some bran is good, more must be better	Large amounts of wheat bran are undesirable for several reasons. These include the presence of phytic acid which can bind minerals and also the chance of taking in large quantities of pesticide residues if bran is eaten by the cupful rather than the tablespoon. 2 tablespoons per day is wise; more is not.
Eating fibre is a good way to lose weight	Foods high in fibre are usually low in fat and fit well into a weight reduction program. However, eating large quantities of dietary fibre or taking laxatives to lose weight is useless for loss of body fat and potentially harmful.
Fibre equals roughage	The idea that fibre enters one end of the gastrointestinal tract and emerges from the other is simplistic and incorrect. Some types of fibre are 100% fermented and work by increasing colonic bacteria which then add to faecal bulk.
Salads are a good source of fibre	Salad vegetables are good sources of vitamins but most are not high in dietary fibre. Peas, beans, broccoli, corn and spinach are better sources of fibre than celery, cucumber and lettuce.
Fibre is visible	Not always. Wholegrain fibres can often be seen but soluble fibres such as pectin and gums have no obvious fibrous appearance.

Dietary fibre & health

was written by gastroenterologists, Professor Terry Bolin, Professor Melvyn Korman and Dr Alistair Cowen and nutritionist Dr Rosemary Stanton.

For more information on the dietary fibre content of specific foods, see find out about fibre by Rosemary Stanton, published by Allen & Unwin.

Additional copies of Dietary fibre & health are available from:

The Gut Foundation
C/– Gastrointestinal Unit
The Prince of Wales Hospital,
Randwick NSW 2031
Telephone (02) 9382 2749
Facsimile (02) 9382 2828
gutfound@gut.nsw.edu.au

or by contacting Flordis Pty Ltd
Freecall 1800 334 224
customerservice@flordis.com.au
www.flordis.com.au

For further information visit The Foundation's website:
www.gut.nsw.edu.au