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Dietary Fiber and It's Health Benefits

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Contents

Abstract

Dietary fibre is that part of plant material in the diet which is resistant to enzymatic digestion which includes cellulose, non cellulosic polysaccharides such as hemicellulose, pectic substances, gums, mucilages and a non-carbohydrate component lignin. The diets rich in fibre such as cereals, nuts, fruits and vegetables have a positive effect on health since their consumption has been related to decreased incidence of several diseases. Increased fiber intake benefits a number of gastrointestinal disorders and it causes an decrease of mineral bioavailability. dietary fiber intake provides similar benefits for children as for adults. The recommended dietary fiber intakes for children and adults are 14 g/1000 kcal. More effective communication and consumer education is required to enhance fiber consumption from foods or supplements.

1. Introduction

Dietary fibre has long history, its term originating with Hipsley (1953) who coined dietary fibre as a nondigestible constituents making up the plant cell wall and further its definition has seen several revisions, dietary fibre was defined as a ubiquitous component of plant foods and includes materials of diverse chemical and morphological structure, resistant to the action of human alimentary enzymes (RM, 1982) .

Dietary fibre consists of remnants of plant cells resistant to hydrolysis (digestion) by the alimentary enzymes of man , whose components are *hemicellulose, cellulose, lignin, oligosaccharides, pectins, gums and waxes* , American Association of Cereal Chemists (AACC) in 2000 defined dietary fibre as the edible parts of plant or analogou carbohydrates that are resistant to digestion andabsorption in the human small intestine with complete orpartial fermentation in the large intestine. Dietary fibrer includes *polysaccharides, oligosaccharides, lignin* and associated plant substances, **soluble** and **insoluble fibres** makeup the two basic categories of dietary fibre. Cellulose, hemicellulose and lignin- are not soluble in water whereas pectins, gums and mucilages- become gummymin water .

Soluble fiber attracts water and turns to gel during digestion. This slows digestion. Soluble fiber is found in oat bran, barley, nuts, seeds, beans, lentils, peas, and some fruits and vegetables. It is also found in psyllium, a common fiber supplement. Some types of soluble fiber may help lower risk of heart disease. insoluble fiber is found in foods such as wheat bran, vegetables, and whole grains. It adds bulk to the stool and appears to help food pass more quickly through the stomach and intestines (Schneeman , 2004) .

Dietary fibers contribute to regulating bowel movement and maintaining the functions of the beneficial bacteria present in it, all of which contribute to maintaining intestinal health. Also, eating fiber can contribute to lowering blood pressure and maintaining normal levels. All of this can reduce the risk of cardiovascular disease (Anderson, 2009) .

While studies are mixed, most seem to point to higher fiber consumption **lowering the risk of cancer**, especially colorectal and breast cancers. For example, in a 2020 review in ***The American Journal of***

Clinical Nutrition, researchers found that higher fiber intake, in particular, the fiber found in whole grains, was correlated with a reduced risk of colorectal cancer. And another 2020 review published in *cancer* found that soluble fiber and fruit fiber had the strongest associations with reduced risk of breast cancer (Kaczmarczyk, 2012).

In people with diabetes, fiber particularly soluble fiber — can slow the absorption of sugar and help improve blood sugar levels. A healthy diet that includes insoluble fiber may also reduce the risk of developing type 2 diabetes , while it's not totally clear why fiber cuts type 2 diabetes risk, the researchers believe that it could be a combination of fiber's favorable effect on blood glucose levels, creating a healthier gut microbiome and lowering inflammation in the body that may help stave off the development of diabetes (Weickert , 2018) .

The benefits of dietary fiber are many, but you should be careful not to eat large quantities of it suddenly, as this causes many annoying side effects, including: bloating and gas , stomach ache , Constipation or diarrhea, depending on which type of fiber was eaten in large quantities , Weight gain, but it is usually temporary (Madar, 1987) .

The **main objective** of this review is to reveal the health benefits of dietary fiber and the foods that contain it as well as the side effects of excessive intake of dietary fiber.

2. Soluble and insoluble dietary fibre

Early chemistry of non-starch polysaccharides extracted different fibre fractions by controlling the pH of solutions; in this context the terms soluble and insoluble fibre evolved. They provided a useful simple categorisation of dietary fibre with different physiological properties, as understood at the time. On the one hand, there are fibres that principally affect glucose and fat absorption. Historically, these were referred to as soluble because many of them were viscous and formed gels in the small intestine (e.g. pectins and ß-glucans). In contrast, types of dietary fibre with a greater influence on bowel function were referred to as insoluble (including cellulose and lignin) (Schneeman, 2004).

2.1 Pectins

Pectins are polysaccharides that are soluble in hot water and then form gels on cooling. They are composed mainly of chains of galacturonic acid interspersed with units of rhamnose and are branched with chains of pentose and hexose units.They are present in the cell walls and intracellular tissues of fruit and vegetables and are used as gelling and thickening agents in various food products, Although fruits contain the most pectins, they also represent 15-20% of the dietary fibre in vegetables, legumes and nuts (Blanco-Pérez, 2021).

2.2 Lignin

Lignin is not a polysaccharide but is chemically bound to hemicellulose in the plant cell wall and therefore it is intimately associated with plant cell wall polysaccharides.

It also influences gastrointestinal physiology, it is present in foods with a ‘woody’ component such as celery and in the outer layers of cereal grains (Dhingra, 2012) .

2.3 Cellulose

Cellulose is an unbranched and linear polysaccharide consisting only of glucose units, up to 10,000 glucose units per molecule. the linear molecules are packed closely together as long fibres in a structure that is very insoluble and resistant to digestion by human enzymes. Cellulose is a principal component of the cell wall of most plants (Figure 1) and is therefore present in fruits, vegetables and cereals. Much of the fibre in cereal bran is cellulose. cellulose forms about one quarter of the dietary fibre in grains and fruit and one third in vegetables and nuts (Dhingra, 2012) .

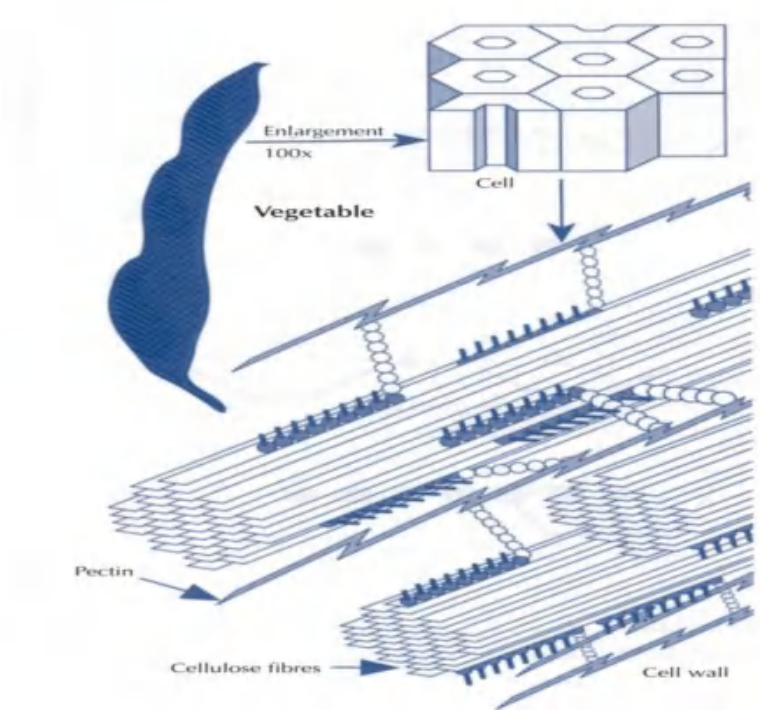

Figure 1. Model of the plant cell wall

2.4 Hemicellulose

Hemicelluloses are polysaccharides that contain sugars other than glucose, and are associated with cellulose in plant cell walls. They include both linear and branched molecules, smaller than cellulose, typically containing 50-200 pentose units (xylose and arabinose) and hexose units (glucose, galactose, mannose, rhamnose, glucuronic and

galacturonic acids). the name hemicellulose therefore describes a heterogeneous group of chemical structures that are present in plant foods in water soluble and insoluble forms. Approximately one third of the dietary fibre in vegetables, fruits, legumes and nuts consists of hemicelluloses (Ebringerová, 2005) .

2.5 Gums and mucilages

The hydrocolloids comprise a wide range of mixed viscous polysaccharides. They are derived from plant exudates (gum arabic and tragacanth), seeds (guar and locust gums) and seaweed extracts (agar, carrageenans and alginates). mucilages are present in cells of the outer layers of seeds of the plantain family e.g. ispaghula (psyllium). These hydrocolloids are used in small amounts as gelling, thickening, stabilizing and emulsifying agents in certain foods. Some, for example guar gum and ispaghula, are also being investigated and/or used as functional ingredients in foods (Aspinall, 2008) .

2.6 ß-Glucans

ß-glucans are glucose polymers , unlike in cellulose, the linkages between the units are variable, they have a branched structure and are of smaller size. these properties influence their solubility, enabling them to form viscous solutions. ß-glucans are a major component of the cell wall material in oats and barley grains but are present in only small quantities in wheat. They have generated interest as a source of soluble fibre. oat bran has been added to some food products as a source of these ß-glucans (Anderson, 2009) .

3. Food Sources

The major food sources of dietary fibre and indigestible carbohydrates are plant foods such as cereal grains, legumes, vegetables, fruits and seeds, as shown in Table 1. The term whole grain is frequently used in connection with cereals and has recently been redefined by the AACC. In terms of consumption, the major cereal grains are wheat, rice, maize, oats and rye. Minor ones are barley, triticale, millet and sorghum. Buckwheat, wild rice, amaranth and quinoa are not classified as grains botanically, but are associated with them in a dietary context because of their similar composition. The whole grain consists of a protective hull, beneath which are the bran layer, the protein-rich aleurone layer, the endosperm of which 50-75% is starch, and the germ (Buttriss, 2008) .

Table 1. Natural sources of various components of dietary fibre

Fibre component	*Main food source*
Cellulose	**Vegetables, woody plants, cereal brans**
Hemicellulose	**Cereal grains**
Lignin	**Cereal brans, rice and legume hulls, woody plants**
ß-glucans	**Grains (oats, barley, rye, wheat)**
Pectins	**Fruits, vegetables, legumes, sugar beet, potato**
Gums	**Legumes, seaweed, micro-organisms (guar, locust bean, carrageenan, xanthan, gum arabic)**

4. Health benefits

The digestive system is lined with muscles that massage food along the digestive tract – from the moment a mouthful is swallowed until the eventual waste is passed out of the bowel (a process called peristalsis). as dietary fibre is relatively indigestible, it adds bulk to our faeces and keeps the digestive system healthy , It also important for other body functions such as: lowering blood cholesterol keeping our weight under control .

4.1 Colorectal cancer and related factors

Dietary fibre has effects that could contribute to a reduction of the risk of colorectal cancer. These effects include the dilution and binding of carcinogens, changes in the profile of bile salts within the colon, increased speed of gut transit and effects of end products of fermentation of non-digestible carbohydrates and analogous substances (inulin, fructo oligosaccharides, resistant starch, aleurone fibre and wheat bran). short chain fatty acids may modulate expression of cell cycle-regulating proteins and induce self-destruction of colon cancer cells. they also increase the susceptibility of colon cancer cells to cell injury. Other relevant effects include reduced activity of harmful bacterial enzymes, lower levels of phenol and peptide degradation products and the formation of cellular antioxidants and radical scavengers (Kendall, 2010) .

4.2 Coronary heart disease and related disorders

In a recent meta-analysis of ten prospective studies from Europe and the US, dietary fibre intake was inversely associated with the risks of both fatal and non-fatal coronary events. The analysis was adjusted for demographic and lifestyle factors and body mass index. Intervention studies show moderate beneficial effects of dietary fibre on risk factors for coronary heart disease such as blood lipids, blood pressure and arterial wall thickness. According to the US Institute of Medicine (2002) and also the Health Council of The Netherlands (2006), an effect of total fibre intake on the risk of coronary heart disease is plausible enough to serve as a basis for guidelines on dietary fibre intake .

Various mechanisms have been put forward to explain the apparent protective effects of dietary fibre on the cardiovascular system. these include changes in the absorption of cholesterol and in re-absorption of bile acids, alterations in the production of lipoproteins in the liver and changes in the clearance of lipoproteins from the bloodstream. All of these may result in lower plasma levels of total and LDL cholesterol, which would decrease the risk of coronary heart disease. dietary fibre can delay absorption of fat and carbohydrate from the small intestine and can have concomitant effects on insulin metabolism, it may also lower the level of circulating triglycerides and as a result reduce the risk of coronary heart disease (Anderson, 2009) .

4.3 Type 2 diabetes mellitus

Some cohort studies show an inverse association between total dietary fibre intake and the risk of type 2 diabetes mellitus, whereas other such studies do not. the US Institute of Medicine, and more recently the Health Council of The Netherlands, have looked into these findings, as well as into studies on risk factors for diabetes. they concluded that total dietary fibre possibly decreases the risk of type 2 diabetes. The evidence that dietary fibre from whole grain food, or perhaps the consumption of such foods as a whole, decreases the risk of type 2 diabetes is stronger than that for total dietary fibre.

The rise in blood glucose level that occurs following the ingestion of carbohydrates is referred to as the glycaemic response. Rapidly digested and absorbed starches and other carbohydrates derived from starch induce a large and rapid glycaemic response, which subsequently evokes a rapid and large insulin response , The concept of glycaemic index (GI) has been developed to classify foods according to the glycaemic response they evoke, expressed per amount of food containing a standard amount of carbohydrates (Kendall C. E., 2010) .

5. Adverse effects

5.1 Compromised energy intake

Diets that contain large amounts of dietary fibre tend to be bulky and have a low energy density. therefore, in individuals with a limited appetite, such as very young or very old persons, such diets will potentially satisfy appetite too readily and therefore make it difficult to achieve adequate intakes of energy and nutrients (Schweizer, 2005) .

5.2 Gastrointestinal discomfort

There are reports of flatulence and abdominal fullness when dietary fibre is consumed at very high levels (75- 80 g/day), but this is hardly relevant for the level of consumption of dietary fibre seen in most people's diets apart from this, dietary fibre has been reported to cause gastrointestinal discomfort in some people with irritable bowel syndrome.

For example, subjects in experimental studies with an intake of 10- 50 g/day of inulin or fructo-oligosaccharides have reported symptoms of gastrointestinal distress, including laxation, flatulence, bloating and abdominal cramping , at lower levels of intake (5-10 g/day), the only reported effects were bloating and flatulence (Borkoles, 2022).

5.3 Decreased mineral bioavailability

The fermentation of fibres in the colon is associated with the release and solubilization of minerals, which facilitates colonic absorption. In contrast with this, diets rich in certain other types of dietary fibre, particularly those associated with phytate, seem to decrease the absorption in the small intestine of several minerals, notably iron, calcium, magnesium and zinc, this has been seen in both animal and human studies. Phytate binds with these minerals thereby potentially reducing their availability for absorption from the small intestine (Buttriss, 2008) .

6. Consumption

The 2010 Dietary Guidelines for Americans recommends 14 grams of fiber per 1000 calories consumed. So, if you consume a 2,500 calorie diet, you should eat approximately 35 grams of fiber per day. also, fiber intake may vary depending on age and gender.

While the 2010 Dietary Guidelines for Americans serves as a general guide to healthy eating, the Dietary Reference Intakes (DRIs) provide standard recommended amounts for nutrients , in 2002, the Food and Nutrition Board of the National Academy of Sciences Research Council issued DRIs for fiber (Table 2). previously, no national standardized recommendation existed. the new DRIs represent desirable intake levels established using the most recent scientific evidence available (Dhingra, 2012) .

Table 2. Dietary Reference Intakes (DRI) for Fiber.

Age	g / day Fiber
Children	
1-3 years	19
4-8 years	25
Males	
9-13 years	31
14-50 years	38
51+ years	30
Females	
9-18 years	26
19-50 years	25
51+ years	21
Pregnancy	10

7. Conclusion

Dietary fibre consists of remnants of plant cells resistant to hydrolysis (digestion) by the alimentary enzymes of man , whose components are hemicellulose, cellulose, lignin, oligosaccharides, pectins, gums and The major food sources of dietary fibre and indigestible carbohydrates are plant foods such as cereal grains, legumes, vegetables, fruits and seeds.

Dietary fibre has effects that could contribute to a reduction of the risk of colorectal cancer, also dietary fibre intake was inversely associated with the risks of both fatal and non-fatal coronary events and the dietary fibre from whole grain food, or perhaps the consumption of such foods as a whole, decreases the risk of type 2 diabetes is stronger than that for total dietary fibre.

If you consume a 2,500 calorie diet, you should eat approximately 35 grams of fiber per day. also, fiber intake may vary depending on age and gender.

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