

Dietary fiber & LDL Cholesterol

Dietary fibers are the indigestible portion of plant foods that move food through the digestive system, absorbing water. Chemically, dietary fiber consists of non-starch polysaccharides and several other plant components such as cellulose, lignin, waxes, chitins, pectins, beta-glucans, inulin and oligosaccharides.

Uses

Soluble and insoluble fibers

Sources of dietary fiber are usually divided into categories of “insoluble” and “soluble”. Both types are present in all plant foods, with varying degrees of each according to a plant’s characteristics. Insoluble refers to lack of solubility in water, but with passive water-attracting properties that help to increase bulk, soften stools and shorten transit time through the intestinal tract. Soluble indicates a fiber source that would readily dissolve in water.

As will be discussed here, those definitions are too limiting, especially because soluble fiber undergoes active metabolic processing via fermentation that yields end-products with broad, significant health effects.

To conceptualize insoluble and soluble fibers, consider the segments of a plum (or prune) — its thick skin covering a juicy pulp. The plum skin is an example of an insoluble fiber source, whereas soluble fiber sources are inside the pulp. Other sources of insoluble fiber include whole wheat, wheat and corn bran, flax seed lignans and vegetables such as carrots, celery, green beans and potato skins.

One of the most versatile sources of dietary fiber is the husk (hull) of seeds from psyllium grain (*Plantago ovata*), a fiber source with clinically demonstrated properties of lowering blood cholesterol when chronically included in human diets. Psyllium seed husk is 34% insoluble fiber and 66% soluble fiber, providing an optimal division of both types that make it a valuable food additive.

Fermentable fiber

The American Association of Cereal Chemists defined soluble fiber this way: “*the edible parts of plants or similar carbohydrates resistant to digestion and absorption in the human small intestine with complete or partial fermentation in the large intestine*”.

There are several key words in that statement that invite analysis and comment for considering fermentable fiber.

edible parts of plants — indicates that all parts of a plant we eat — skin, pulp, seeds, stems, leaves, roots — contain fiber. Both insoluble and soluble sources would be in those plant components.

carbohydrates — complex carbohydrates, such as long-chained sugars also called starch, oligosaccharides or polysaccharides, are excellent sources of fiber.

resistant to digestion and absorption in the human small intestine — foods providing nutrients are digested by enzymes and acids in the stomach and small intestine where the nutrients are released then absorbed through the intestinal wall for transport via the blood throughout the body. A food resistant to this process is undigested, as insoluble and soluble fibers are. They pass to the large intestine only affected by their absorption of water (insoluble fiber) or dissolution in water (soluble fiber).

complete or partial fermentation in the large intestine — the large intestine is comprised mainly of a segment called the colon within which additional nutrient absorption occurs through the process of fermentation. Fermentation occurs by the action of colonic bacteria on the food mass, producing gases and short-chain fatty acids. It is these short-chain fatty acids — butyric, ethanoic, propionic, and valeric acids — that have such significant health properties.

Short-chain fatty acids

Short-chain fatty acids are used by the intestinal mucosa or absorbed through the colonic wall for portal circulation (supplying the liver) that transports them into the general circulation. Particularly butyric acid has extensive physiological actions that promote health effects among which are:

- Stabilize blood glucose levels by acting on pancreatic insulin release and liver control of glycogen breakdown
- Suppress cholesterol synthesis by the liver and reduce blood levels of low-density lipids (LDL cholesterol) and triglycerides responsible for atherosclerosis
- Lower colonic pH (i.e., raise the acidity levels in the colon) which protects the colon lining from cancer polyp formation and increases absorption of minerals
- Stimulate production of T helper cells, antibodies, leukocytes, splenocyte cytokines and lymph mechanisms having crucial roles in immune protection
- Increase proliferation of colonic bacteria beneficial for intestinal health — bifidobacteria and lactobacilli (serving a probiotic function)
- Improve barrier properties of the colonic mucosal layer, inhibiting inflammatory and adhesion irritants

Summarizing these effects, fermentable fibers yield the important short-chain fatty acids that affect blood glucose and lipid levels, improve the colonic environment and regulate immune responses.

Regulatory guidance on fiber products

On average, North Americans consume less than 50% of the dietary fiber levels required for good health. In the preferred food choices of today's youth, this value may be as low as 20%, a factor considered by experts as contributing to the obesity crisis seen in many first-world western countries.

Recognizing the growing scientific evidence for physiological benefits of increased fiber intake, regulatory agencies such as the US Food and Drug Administration (FDA) have given approvals to food products making health claims for fiber.

In clinical trials to date, these fiber sources were shown to significantly reduce blood cholesterol levels and so are important to cardiovascular health.

Soluble (fermentable) fiber sources gaining FDA approval are

- Psyllium seed husk (7 grams per day)
- Beta-glucan from oat bran, whole oats, oatrim or rolled oats (3 grams per day)
- Beta-glucan from whole grain or dry-milled barley (3 grams per day)

Other examples of fermentable fiber sources (from plant foods or biotechnology) used in functional foods and supplements include inulin, fructans, xanthan gum, cellulose, guar gum, fructooligosaccharides (FOS) and oligo- or polysaccharides.

Consistent intake of fermentable fiber through foods like berries and other fresh fruit, vegetables, whole grains, seeds and nuts is now known to reduce risk of some of the world's most prevalent

diseases — obesity, diabetes, high blood cholesterol, cardiovascular disease, and numerous gastrointestinal disorders. In this last category are constipation, inflammatory bowel disease, ulcerative colitis, hemorrhoids, Crohn's disease, diverticulitis and colon cancer — all disorders of the intestinal tract where fermentable fiber can provide healthful benefits.

Although many researchers believe that dietary fiber intake reduces the risk of colon cancer, one study, conducted by researchers at the Harvard School of Medicine of over 88,000 women, did not show a statistically significant relationship between higher fiber consumption and lower rates of colorectal cancer or adenomas.[1]

Guidelines on fiber intake

The American Dietetic Association (ADA) recommends a minimum of 20-35 g/day for a healthy adult depending on calorie intake (e.g., a 2000 cal/8400 kj diet should include 25 g of fiber per day). The ADA's recommendation for a child was that intake should equal age in years plus 5 g/day for children (e.g., a 4 year old should consume 9 g/day). No guidelines have yet been established for the elderly or very ill. Patients with current constipation, vomiting, and abdominal pain should see a physician. Certain bulking agents are not commonly recommended with the prescription of opioids because the slow transit time mixed with larger stools may lead to severe constipation, pain, or obstruction.

The British Nutrition Foundation has recommended a minimum fiber intake of 12-24 g/day for healthy adults. [1]

Sources of fiber

Current recommendations suggest that adults consume 20-35 grams of dietary fiber per day, but the average American's daily intake of dietary fiber is only 14-15 grams. [2] The ADA recommends trying to get most of your dietary fiber from foods you eat, as an important part of consuming variety, nutrition, synergy between nutrients, and possibly phytonutrients. Soluble fiber is found in many foods, including:

- legumes (peas, soybeans, and other beans)
- oats, rye, and barley
- some fruits (particularly apples, bananas), and berries
- certain vegetables, such as broccoli and carrots
- root vegetables, such as potatoes and yams (the skins are insoluble fiber)
- psyllium seed (only about 2/3 soluble fiber).

Legumes also typically contain shorter-chain carbohydrates that are indigestible by the human digestive tract but which are digested by bacteria in the large intestine (colon), which is a cause of flatulence.

Sources of insoluble fiber include

- whole grain foods
- bran
- nuts and seeds
- vegetables such as green beans, cauliflower, zucchini, celery
- the skins of some fruits, including tomatoes

Fiber supplements

There are many types of soluble fiber supplements available to consumers for nutritional purposes, for the treatment of various gastrointestinal disorders, and for such possible health

benefits as lowering cholesterol levels, reducing the risk of colon cancer, or losing weight. Soluble fiber supplements are particularly beneficial for Irritable Bowel Syndrome symptoms such as diarrhea and/or constipation, and abdominal pain (Van Vorous, 2000)[*verification needed*]. Prebiotic soluble fiber supplements (acacia, FOS, inulin) are a promising area of treatment for inflammatory bowel disease (Seidner, 2005)[*verification needed*] such as Crohn's disease and ulcerative colitis, and Clostridium difficile (May, 1994)[*verification needed*], due to the short-chain fatty acids they produce, and subsequent anti-inflammatory actions upon the bowel.