

INDIAN DIETARY FIBERS, THEIR ROLE IN HEALTH MANAGEMENT AND DISEASE PREVENTION

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ABSTRACT

Dietary fiber, often referred to as roughage or bulk, encompasses the components of plant based foods that elude digestion and absorption within the body. In contrast to nutrients like proteins and carbohydrates which break down in body and get assimilated, the fiber remains undigested as it traverses stomach, small intestine, and colon, eventually exiting in a relatively unchanged state. Fiber is commonly categorized into two types: soluble, which dissolves in water and insoluble, which remains unaffected by water. The presence of dietary fibers holds paramount significance in upholding the sound functioning of body. The constitution of fiber comprises plant elements or substances that traversing the stomach and intestines with minimal alteration. Predominantly fiber serves the purpose of sustaining well-being of the digestive system. There are many Indian plants which serve as the source of fibers. The dietary substances also encompass many fibers obtained from the natural sources. Present article explains health benefits of some dietary fibers obtained from the natural sources.

KEYWORDS: Fiber, Dietary, Plant, Health.

INTRODUCTION

Dietary fiber, also known as roughage, stands as a vital carbohydrate sourced from vegetables, fruits and plants, etc. Foods rich in fiber play a pivotal role in supporting intestinal health and prolonging life. Fiber performs the

valuable task of flushing out detrimental carcinogens and cholesterol from the digestive tract. **Table 1** depicted chief chemical constituent and therapeutic benefits of some dietary fibers.^[1-4]

Table 1: Description of Chief Chemical Constituent and Therapeutic Benefits of Some Important Dietary Fibers.

S. No.	Fiber Source	Chemical Type	Effect on Blood Sugar Level	Lipid Lowering Effect	Role in Weight Management
1	Fenugreek Fiber	Galactomannans, Cellulose and Lignin	Regulate blood sugar levels by suppressing glucose absorption	Helps to lower LDL cholesterol levels due to its soluble fiber content	Support weight loss through enhanced satiety
2	Guar Gum Fiber	β-1,4-galactomannan	Delays carbohydrate digestion, leading to gradual glucose release	Decreases LDL cholesterol levels due to its gel-forming properties	Contribute to weight loss by promoting feeling of stomach fullness
3	Chicory Fiber	Inulin and oligofructose	Decreases absorption of sugar	Helps to lower total and LDL cholesterol due to its soluble fiber content	Supports weight loss by promoting feeling of fullness
4	Aloe Vera Fiber	Acemannan	Improves insulin sensitivity	Helps to lower down triglycerides and LDL cholesterol levels	Supports weight loss by increasing satiety
5	Psyllium Fiber	Mucilage	Forms a gel-like substance that slows sugar absorption	Reduces total and LDL cholesterol levels due to its viscosity	Supports weight loss by promoting feeling of stomach fullness
6	Flax Seed Fiber	Mucilage and lignans	Delays glucose absorption and stabilizes blood sugar levels	Contains lignans that may help to lower LDL cholesterol level	Support weight loss through enhanced satiety

The terms bulk and roughage are synonymous with dietary fiber; however, these descriptors can be misleading due to the existence of certain water-soluble fiber types that exhibit neither bulkiness nor coarseness. Some major sources of fibers are depicted in **Figure 1**.

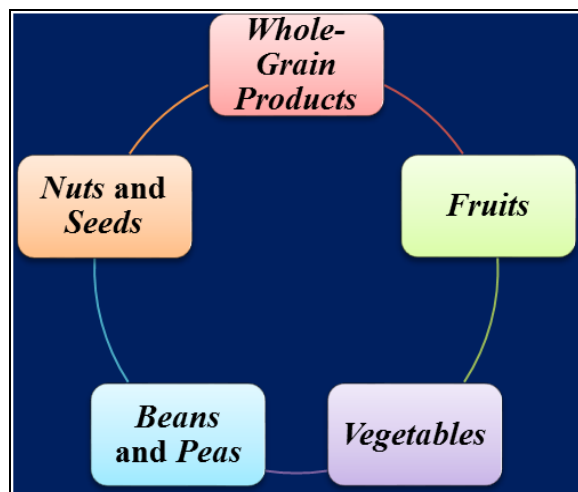


Figure 1: Major sources of fibers.

Beneficial effects of dietary fibers

- Dietary fibers helps to maintain bowel regularity
- Improves health of heart
- Decreases levels of cholesterol
- Maintains blood sugar levels
- Helps to maintain weight
- Relieves constipation and detoxify body

Dietary fiber, primarily present in vegetables, fruits and whole grains, etc. These fibers possess capacity to prevent or alleviate constipation. Dietary fibers reduce risks associated with diabetes, cancer and heart ailments, etc.^[4-7] The Institute of Medicine recommended daily fiber intake as depicted in **Table 2**.

Table 2: Daily fiber intake.

Age Group	Recommended Fiber Intake
Men below 50	38 grams
Men above 50	30 grams
Women below 50	25 grams
Women above 50	21 grams

Soluble Fiber

This particular type of fiber has the ability to absorb water and undergo a transformation into a gel-like substance as it is digested. This gel formation acts to decelerate the digestive process, inducing a swift sensation of fullness. Consequently, this mechanism contributes to weight loss efforts. Foods abundant in soluble fiber encompass oats, edible plant, peas, legumes, beans, barley, nuts and fruits, etc.

Insoluble Fiber

It avoids dissolution in water and instead resists water absorption, maintaining its original state throughout the digestion process. Insoluble fiber, present in foods like

nuts, cauliflower, whole-wheat flour, potatoes and green beans, etc. These fibers promote regular bowel movements and facilitate smoother digestive processes.^[3-5]

Physiological benefits of high-fiber diet

- ✓ Dietary fibers play a role in normalizing bowel movements by augmenting the weight and size of stool, as well as softening it. This increase in stool volume; reducing the likelihood of constipation and facilitates easier passage, etc. Fiber can help to solidify stool in case of excessive liquefaction of stool.
- ✓ Dietary fibers maintain bowel health; high-fiber diet may decrease susceptibility to conditions like hemorrhoids and other diseases. Furthermore, studies indicated that such a diet could potentially lower the risk of colorectal cancer. Certain types of fiber undergo fermentation in the colon, and researchers are investigating its potential role in preventing colon-related diseases.
- ✓ Dietary fibers lowers the cholesterol levels, mainly soluble fiber contributes to reducing total blood cholesterol levels by decreasing levels of "bad" cholesterol or low-density lipoprotein. Moreover, research suggests that high-fiber foods offer additional cardiovascular benefits such as reducing blood pressure and inflammation.
- ✓ Fibers controls blood sugar levels for individuals suffering from diabetes, particularly those consuming soluble fiber, there's a beneficial impact on slowing sugar absorption. Adopting a diet rich in insoluble fiber may also lower the risk of developing type-2 diabetes.
- ✓ High-fiber foods tend to induce a greater sense of fullness compared to low-fiber alternatives, leading to reduced food intake and prolonged satisfaction. Additionally, high-fiber foods typically require more time to consume and are less calorie-dense, meaning they offer fewer calories for the same volume of food.
- ✓ Research indicates that increasing dietary fiber intake, especially from sources like cereals, correlates with a diminished risk of mortality due to cardiovascular disease and all forms of cancer.^[1-5]

Types of naturally occurring plant fibers^[2-5]

- ✚ Cellulose, Hemicellulose
- ✚ Lignins
- ✚ Beta-Glucans
- ✚ Guar Gum
- ✚ Inulin, Oligofructose, Oligosaccharides, Fructooligosaccharides
- ✚ Pectins
- ✚ Resistant Starch

Cellulose, Hemicellulose

These are forms of insoluble fiber prevalent in cereal grains and the cell walls of numerous fruits and

vegetables. They have the ability to absorb water and increase stool volume, often leading to a laxative effect.

Lignins

Lignins found in wheat and corn bran, flaxseeds, nuts, vegetables and unripe bananas, lignins are insoluble fiber compounds that stimulate the secretion of mucus in the colon while also adding bulk of stools. Their presence can induce a laxative effect.

Beta-Glucans

This highly fermentable fiber is found in oats and barley. It undergoes metabolism and fermentation within the small intestine. While it doesn't act as a laxative, it can add volume to stools. Beta-glucans also function as prebiotics, and their consumption may assist in maintaining normalized blood glucose and cholesterol levels.

Guar Gum

Isolated from seeds, guar gum is a soluble, fermentable fiber. It possesses a viscous, gel-like texture and is often employed as a thickening agent in foods. Metabolized and fermented in the small intestine, it doesn't exert a laxative effect. Guar gum can potentially contribute to blood sugar and cholesterol level normalization.

Oligofructose, Oligosaccharides

These soluble, fermentable fibers are sourced from foods like asparagus and onions. They can promote stool bulk with a laxative effect and help to normalize blood glucose levels.

Pectins

Highly fermentable, soluble fiber found in fruits such as apples and berries. Pectins have limited bulking or laxative effects. Their gelling characteristics tend to slow down digestion and can contribute to the regulation of blood sugar and cholesterol levels.

Resistant Starch

This soluble, fermentable fiber is present in legumes, potatoes and unripe bananas. While it modestly increases stool bulk, its laxative impact is minimal. Resistant starch acts as a prebiotic and may aid in the maintenance of blood sugar and cholesterol levels within the normal range.

IMPORTANCE OF SOME NATURAL FIBER

1. Fenugreek Fiber

Fenugreek (*Trigonella foenum-graecum*) has been utilized for quite a long time for both culinary and restorative purposes. It is esteemed for its delightful seeds as well as for its wellbeing advancing properties. The high content of dietary fiber found in fenugreek is one of the most important factors responsible for these properties.

Chemical Composition

Fenugreek seeds are a rich in dietary fiber, basically comprising of both soluble and insoluble components. These various types of polysaccharides offer their own properties.

Soluble Fiber – Galactomannans

Galactomannan which is a one of the hemicellulose is predominant soluble fiber present in fenugreek seeds. Linear chain of mannose units linked by 1,4-glycosidic bonds composed them. Mannose to galactose ratio contributes to the gelling properties of Galactomannan.

Insoluble Fiber - Cellulose and Lignin

Fenugreek seeds also contain insoluble fiber like cellulose and lignin. Cellulose is composed of glucose units which is a linear polysaccharide includes β -1,4-glycosidic bonds. Lignin provides rigidity and structural support.

Role of Fenugreek Fiber in Health Industry

Fenugreek fiber suppresses digestion and absorption of carbohydrates which further causes gradual increment in blood glucose levels after meals. Insulin sensitivity also improves by soluble fiber.

Galactomannans reduces absorption of bile acids and cholesterol in the intestine thus can contribute in the reduction of cholesterol levels in bloodstream. The gel like consistency of fiber helps in the binding of bile acid and cholesterol resulting suppression in cholesterol level.

Formation of bulk in the stool facilitate by insoluble fiber like cellulose and lignin. This promotes regular bowel movements and helps to prevents constipation. The gel-forming property soothes and protects gastrointestinal tract.

Feeling of fullness associated with gel-like consistency of fiber in the stomach that can contribute to the weight management by controlling appetite.^[6-8]

2. Psyllium Husk Fiber

Psyllium husk, obtained from the *Plantago ovata* plant, Psyllium husk contains remarkable amount of dietary fiber which affects digestive health significantly. This natural fiber used as remedy for digestive problems.

Soluble Fiber

Mucilage is the most important component of psyllium husk, which is a complex mixture of polysaccharides, which consists xylose sugar units interconnected with arabinose sugar chains.

Insoluble Fiber

Hemicellulose and cellulose are insoluble fibers present in Psyllium husk; these insoluble fibers involve in the process of bulk formation thus promote regular bowel movements.

Health Benefits of Psyllium Husk Fiber

Psyllium's mucilage softens the stool and promotes regular bowel movements by absorbing water content in the digestive tract. It offers laxative effect thus relieves constipation.

The cholesterol-lowering property offered by the soluble fibers of psyllium husk. Psyllium husk reduces absorption of cholesterol in the intestines thereby suppress risk associated with high level of cholesterol.

Psyllium husk slowing down digestion and absorption of carbohydrates this helps in stabilizing sugar levels and offers benefits for person suffering from diabetes.^[9-11]

3. Aloe vera Fiber

Aloe vera is well known plant used anciently for its therapeutic benefits, its leaves possesses unique fiber contents that contributed towards the several therapeutic benefits. Aloe vera contains fiber within mucilaginous gel; which consist blend of soluble and insoluble fibers.

Soluble Fiber

Acemannan is a soluble fiber component of aloe vera; it comprises complex carbohydrates like polysaccharides. Acemannan also contains mannose sugar units which forms a long linear chain. This fiber offers anti-inflammatory and immune-boosting properties.

Insoluble Fiber

Aloe vera also contains cellulose and hemicelluloses as insoluble fibers, these insoluble fibers promote healthy digestion by virtue of their bulk forming property.

Aloe vera's Fiber health benefits

Acemannan interact with immune cells thereby promotes production of cytokines and other immune mediators which results improvement in body's defense mechanisms.

Acemannan offers anti-inflammatory property, it alleviates release of inflammatory mediators therefore reduces process of inflammation and acts as anti-inflammatory agent.

The cellulose and hemicellulose helps in the formation of bulk in stool thus regulates normal bowel movements and prevents constipation. The probiotic nature of acemannan nourishes beneficial gut bacteria and maintains normal functioning of digestive system.^[12-15]

4. Chicory Fiber

Cichorium intybus (Chicory) offers remarkable health benefits due to the presence of inulin and fructo-oligosaccharides contents.

Inulin

Inulin is a long-chain fructan, it possess linear structure along with chains of fructose units. Fructose molecules are linked together at the second carbon of one unit and

the first carbon of the next fructose unit since fructose units are connected by β -2,1-glycosidic bonds. This fiber acquire resistant to digestion by human enzymes due to the presence of this β -2,1-glycosidic linkage.

Fructo-oligosaccharides

Fructo-oligosaccharides are shorter-chain fructans, contain smaller number of fructose units (ranging from 2 to 9 units). Fructo-oligosaccharides having fructose units which form branched structure of β -2,1-glycosidic bonds. The α -1,2-glycosidic bond involve in the formation of terminal unit. This branching and presence of glucose at terminal position make it more water soluble than inulin.

Inulin and Fructo-oligosaccharides exhibit several shared chemical characteristics as follows

1. Inulin and Fructo-oligosaccharides are constructed from fructose units joined by β -2,1-glycosidic bonds. This linkage contributes to their resistance against human digestive enzymes.
2. The fundamental constituents of both inulin and Fructo-oligosaccharides are fructose molecules. The count of fructose units in a molecule determines whether it is categorized as inulin or Fructo-oligosaccharides.
3. Inulin and Fructo-oligosaccharides can create aqueous solutions, although Fructo-oligosaccharides typically display higher solubility due to its shorter chain length and branched configuration. Inulin and Fructo-oligosaccharides are widely employed as functional ingredients in food due to their capacity to enhance gut health and bolster favorable gut microbial contents.

Health Advantages of chicory fiber

The pro-biotic properties of inulin promote the proliferation of advantageous bacteria, fostering equilibrium within the gut microbial contents thus improves digestion and metabolic activities.

The fermentation of inulin produces short-chain fatty acids, which influence hormones associated with appetite regulation and blood sugar management. This process helps in steadying blood sugar levels and the effective control of diabetes. Inulin also elicits a feeling of fullness, thereby support in weight management by reducing excessive eating and feeling of hunger.

The augmented absorption of minerals facilitated by inulin fermentation indirectly promotes bone health by ensuring the optimal utilization of minerals.^[16-19]

INDIAN DIETARY FIBERS^[1-5]

Banana

Bananas excel in providing insoluble fiber, which moderates digestion and delivers a prolonged sensation of fullness. Consuming a banana before engaging in physical activity furnishes a boost of energy, facilitating more effective workouts and sustaining vitality. Beyond

fiber, bananas also contribute potassium, a valuable element for muscle development.

Apples

Apples stand as a notable source of soluble fiber, this fiber content contributes to diabetes management and a decreased risk of gallstones. Additionally, apples play a role in reducing cholesterol levels, thereby aiding in weight loss. Rich in micronutrients with potential health benefits, apples lowers blood pressure and reduces risk of strokes. Apples offer protection against cataracts and effectively curbs sudden hunger cravings.

Guava

Abundant in soluble fiber, guava acts as a natural colon detoxifier, eliminating toxins from the body. Its satiating nature supports weight management efforts. The presence of antioxidants and vitamin C in guava aids in shielding the body against harmful radicals and excessive fat oxidation.

Pears

Nashpati, or pears, emerges not only as a delectable fruit but also as a substantial source of dietary fiber in India. Beyond their fibrous content, pears boast antioxidants and Vitamin C, fortifying the immune system by shielding against harmful radicals. Notably, the presence of boron in pears contributes to the protection against osteoporosis and the maintenance of robust bone health. The natural glucose present in pears furnishes energy, promoting an active lifestyle.

Legumes

Legumes offer plant-based protein along with dietary fiber. These fibers boost nutritional supply in body. Legumes provide sustained energy due to their significant fiber and carbohydrate content.

Broccoli

Broccoli supplies high fiber content, contributing to a thriving and balanced gut environment by enhancing beneficial gut bacteria. This vegetable also enhances skin health and texture, while its anti-inflammatory attributes safeguard blood vessel linings, promoting heart wellness. Broccoli aids in the development of lean muscle. Additionally, broccoli can be a fantastic choice for those seeking weight loss benefits.

Carrot

Carrots are a nutritional powerhouse containing both soluble and insoluble fiber, along with essential vitamins such as A, K, C, and B₆, as well as potassium. They actively prevent night blindness and various eye-related issues. Furthermore, carrots are rich in carotenoids that help to regulate blood sugar levels and manage diabetes. Being low in calories, they are an excellent addition to diet for reducing calorie intake.

Coconut

Coconut is rich in insoluble dietary fiber and beneficial fatty acid. It contributes to lowering cholesterol levels and enhancing heart health. Coconut plays a role in reducing the risk of diabetes and regulating blood sugar levels. Moreover, coconut can elevate metabolic rates, aiding in the accelerated burning of calories and fats.

Sweet Potato

Sweet Potato offer key vitamins like C and D, which contribute to healthy skin and strong bones. They support optimal heart function and help to alleviate stress. The presence of carotenoids in sweet potatoes enhances immunity and combats aging. These root vegetables contain both soluble and insoluble fibers that provide a quick sense of fullness and hunger control.

Papaya

Papaya contributes to ocular health by preventing various eye-related conditions, such as macular degeneration. Moreover, it plays a role in reducing cholesterol levels. The consumption of papaya also counteracts the effects of aging and provides protection against arthritis.

Onion

Among India's fiber-rich vegetables, onions stand out as a prominent source. They also contain vital compounds which hinder the formation of cancerous cells within the body. Onions bolster the immune system; regulate blood sugar levels, thus mitigating the risk of diabetes. The antioxidant properties of onions contribute to fat burning and aid in weight loss properties.

Cauliflower

Cauliflower plays a role in meeting daily dietary fiber requirements of body. It contains choline, a compound that enhances brain health, and demonstrates the ability to combat tumor cells and reducing the risk of cancer. Moreover, cauliflower contributes to immunity enhancement and the mitigation of aging signs like skin wrinkles. It also proves effective in supporting weight loss process.

Cluster Beans

Cluster beans (*Gubar Fali*) offer a substantial amount of soluble fiber and are beneficial in the treatment of anemia. They contribute to bone and dental health; also enhances strength of bone and teeth.

Green Peas

Green peas boast a high fiber content that aids in addressing ailments such as Alzheimer's, eye-related issues and arthritis, etc. They also contribute to collagen production; promoting healthy and smooth skin. Green peas can be consumed without excessive concern about calorie intake. This quality aids in weight maintenance by curbing excessive fat accumulation.

Parsnip

Parsnips (*Chukander*) offer a substantial amount of soluble fiber that plays a pivotal role in regulating blood sugar levels. This fiber content helps in weight management by facilitating the burning of excessive fat. Furthermore, parsnips contribute to heart protection, immunity enhancement and the maintenance of optimal blood pressure. Beyond these benefits, parsnips are advantageous for promoting eye health and preventing congenital disabilities.

Cabbage

Cabbage boosts cognitive function, increasing alertness and concentration. Its ability to enhance keratin production leads to improved hair and skin health. Additionally, cabbage aids in stabilizing blood sugar levels, due to its soluble fiber content that supports in weight loss process.

CONCLUSION

Dietary fiber encompasses the elements present in plant-based foods that resist absorption within the body. Unlike nutrients such as proteins and carbohydrates that break down and are assimilated by the body, fiber remains undigested as it passes through the stomach, small intestine, and colon, eventually exiting in the body in a mostly unchanged state. Fiber can be divided into two main types: soluble fiber, which dissolves in water, and insoluble fiber, which remains unaffected by water. The dietary fiber is extremely important for maintaining the proper functioning of the body. The primary role of dietary fibers is to support the well-being of the digestive system. Numerous Indian plants serve as sources of fiber, and dietary substances encompass a variety of fibers obtained from natural sources. These dietary fibers not only promote general health but also prevent diseases.

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