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Review Article

Food Fibres: A Solution to Combat Non-Communicable Diseases

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Abstract

The consumption of lots of dietary fibre in every meal is a solution to combat non-communicable diseases. Dietary fiber is a part of plant material in the diet, which is resistant to enzymatic digestion. These materials embrace polysaccharides, non-cellulosic polysaccharides like hemicellulose, cellulose, pectic gums, mucilage and a non-carbohydrate component lignin. The diets rich in fibre like whole cereals, nuts, fruits and vegetables have a positive effect on health since their consumption daily has been related to prevention of different non- communicable diseases. Emerging eating lifestyle has contributed to the chronic diseases such as obesity, cardiovascular diseases, aging and others. The consumption of healthy foods daily is a best solution against these diseases. Dietary fibre rich foods associated with physiological actions in the small and large intestine, having important implications in human health. These properties include water dispersibility and solubility, viscosity effects, bulk, absorption, fermentability, and binding of other harmful compounds such as cholesterol, sugars and fat. These properties may lead to various physiological actions such as reducing cholesterol and alleviating blood glucose elevation, maintaining gastrointestinal health and positively affecting calcium bioavailability and immune function. Furthermore, based on their physiochemical properties, many of the new sources of dietary fibre can help to improve the health benefits of new generations as well as adults. This review aiming to open peoples mind on the health benefits associated with dietary fibers and the way non-communicable diseases can be avoided through consumption of food fibers from different sources.

Keywords: Classification; Dietary fibre; Healthy foods; Non-communicable diseases; Recommended dietary allowances

Introduction

A noncommunicable disease is a non-infectious health condition that cannot be spread from person to person and can persist in the body for long period of time. This is also known as a chronic disease. A combination of genetic, physiological, life style and environmental factors can cause these diseases. Some risk factors include unhealthy diets, lack of regular physical activity, smoking and second hand smoke and excessive use of alcohol. Dietary fiber is a group of non-digestible food ingredients that includes non-starch polysaccharides, oligosaccharides, lignin, and polysaccharides with an associated health benefit [1,2]. The consumption of dietary fiber provides many health benefits like alleviating risk of developing non-communicable diseases such as coronary heart disease [3], stroke [4], hypertension [5], diabetes type 2 [6], obesity [7] and certain gastrointestinal disorders [8]. The inflated consumption of dietary fiber improves blood serum macromolecule concentration [9], lowers blood pressure [10], improves blood sugar management in diabetic disease [11], promotes regularity [12], aids in weight loss [13] and improve immune function [14]. The intake of whole grain foods, vegetables, fruits, legumes, and nuts provide lots of dietary fibres to prevent chronic diseases. Dietary fiber supplements have the potential to play major role in offering the health benefits provided by high-fiber foods. Food fibers have been classified as soluble (fermentable fibers) like pectin, gum, mucilage, β-glucan and Polydextrose; these foods are fermented in the colon. On other hand insoluble fibers include cellulose, resistance starches, chitosan, hemicellulose and lignin which have bulking action but may only be fermented to a limited extent in the colon. Current recommendations for dietary fiber intake are related to age, gender, and energy intake, and the general recommendation for Adequate Intake (AI) is 14 g/ 1000 kcal [15]. This AI incorporates non-starch polysaccharides, sugars (such resistant as starches), lignin, and related substances [16,17]. Using the energy rule of 2000 kcal/day for ladies and 2600 kcal/day for men, the suggested day by day dietary fiber admission is 28 g/day for grown-up ladies and 36 g/day for grown-up men [15].

History of Dietary Fibres

In sixty seven years ago (1953), it is believed that Hipsley was the first researcher to use "dietary fiber" as a non-digestible components that make up the plant cell wall (Hipsley, 1953). These components were including cellulose, hemicellulose, and lignin. The term "dietary fiber" was clearly an attempt to distinguish some property or constituent of the food above and beyond what was then being measured by the crude fiber method. Nineteen to twenty three years later (1972 -1976), Trowell, Burkitt, Walker, Painter, and others adopted Hipsley's concept "dietary fiber hypotheses." [18-21]. This definition is used to describe the remnants of plant cell wall components which are resistant to hydrolysis by human alimentary enzymes. In 1976, Trowell et al broaden definition to include all digestion-resistant polysaccharides (mostly plant storage saccharides), such as gums, modified celluloses, mucilage, oligosaccharides, and pectins. The broadened definition includes cellulose, hemicellulose, lignin, gums, modified celluloses, mucilage, oligosaccharides, and pectins, and associated minor substances, such as waxes, cutin, and suberin. Four years later (1976-1981) co-researchers team including Asp, Schweizer, Furda, Theander, Baker, and Southgate develop methods aimed at quantifying food components to be included in the definition. In 1979 Prosky begins process of developing an international consensus on definition of and methodology for dietary fiber. In 1981, consensus on dietary fiber definition and analytical approach at The Association of Official Analytical Chemists (AOAC) Spring Workshop in Ottawa Ontario, Canada. From 1981to1985 group of researchers (Prosky, Asp, Furda, Schweizer, DeVries, and Harland) validate consensus methodology in multinational collaborative studies. In 1985, AOAC Official Method of Analysis 985.29, Total Dietary Fiber in Foods-Enzymatic-Gravimetric Method adopted. Method and the equivalent AACC Approved Method 32-05 become de facto working definition for dietary fiber. From 1985 to1988 methodology developed and collaboratively studied for insoluble and soluble dietary fiber. In three years later (1991) AOAC Official Method of Analysis 991.42, Insoluble Dietary Fiber in Foods and Food Products, Enzymatic- Gravimetric Method, Phosphate Buffer and the equivalent AACC Approved Method 32-07 first adopted. From 1988 to1994, taking a variety of approaches, Lee, Mongeau, Li, Theander and co-workers develop, validate, and bring to official or approved method status other methods fitting the definition of dietary fiber. Two years consecutively (1992 and 1993) International survey reaffirms consensus on physiological dietary fiber definition and Second international survey reaffirms consensus on physiological dietary fiber definition and re-affirms inclusive components respectively. In two years later (1995), AOAC International Workshop on definition of complex carbohydrates and dietary fiber reaffirms consensus on physiological dietary fiber definition and inclusive components. Finally four years later (1999), definition of dietary fiber remains as "dietary fiber consists of the remnants of edible plant cells, polysaccharides, lignin and associated substances resistant to (hydrolysis) digestion by the alimentary enzymes of humans." This definition identifies a macro-constituent of foods that includes cellulose, hemicellulose, lignin, gums, modified celluloses, mucilage, oligosaccharides, and pectins and associated minor substances, such as waxes, cutin, and suberin. AOAC 985.29/AACC 3205, AOAC 991.43/AACC32-07, and equivalent methods are being used as de facto defining methods for total dietary fiber.

Classification of food fibers

Dietary fiber can be characterized from various perspectives, for example, structure and solvency. Regarding structure, polysaccharides are arranged into direct or nonlinear particles. Based on dissolvability, they can be separated into solvent or insoluble dietary filaments. Insoluble dietary fiber comprises essentially of cell divider parts, for example, cellulose, lignin, hemicellulose, resistant starch), while dissolvable dietary fiber comprises of non-cellulosic polysaccharides like gelatin, gums, mucilage, β-glucan, polydextrose) [22]. Other essential groupings are by properties, their applications, and based on polysaccharide chemistry.

Resistant starch

In 1980s, Resistant Starch (RS) was proposed and categorized as insoluble fiber as it could not be digested in the small intestine. According to Trowell et al. (1976), RS has been regarded as a type of DF in terms of structure and digestibility in the intestine. RS is one of the great substrates for the development of colonic microbiota and can boost bacterial mass in faeces [23]. Consumption of RS may stimulate the growth of specific bacteria purported to provide beneficial health effects [24]. During its fermentation, some physiologically important metabolites including Short Chain Fatty Acids (SCFAs) such as acetic, propionic, and butyric acids) are formed. Butyric acid is the most important energy source for the colonocyte cell [25]. The beneficial effects of RS on the gastrointestinal tract have also helped it gain recognition as a member of DF in some studies as well as the international food standard setting bodies such as the Codex Alimentarius Commission (Codex) and European Food Safety Authority (EFSA). Codex has given a more explicit clarification with respect to the grouping of RS. On the off chance that RS is normally present in food, it could be delegated DF. However, if it is derived from an artificial synthesis, such as physical, enzymatic, or chemical synthesis, it should provide desirable physiological benefits to be considered as DF [26-28].

Lignin

Lignin is an oxygenated phenyl propane polymer in which complex dehydrogenative polymerization occurs in coniferyl, sinapyl and pcoumaryl alcohols units [29]. Lignin type of dietary fiber is naturally inert and has a greater resistance property than any other naturally occurring dietary fiber [30].

Pectin

Pectin is a galacturonic acid linear polymer linked by α (1, 4) glycosidic bonds. It is a water soluble type of dietary fiber that doesn't undergoes any enzymatic digestion in small intestine but is easily digested by the colon's microbiota. At food point of level, gelling or a thickening agent is the typical properties which make them available as use in food applications. Inside the gut, pectin forms gelling behavior, which gives pectin beneficial and good effects on health point of view such as dumping syndrome [9], lower cholesterol level, helps in lipid metabolism [31], and prevents diabetes [32].

Hemicellulose

Hemicelluloses are similar to cellulose but in terms of size it is smaller than cellulose having chain of glucose monomers linked by β (1, 4) glycosidic linkage. Hemicellulose is branched in nature with variety of sugar moieties like xylose, mannose and arabinose [33].

Cellulose

Cellulose is a polymer of linear glucose monomer chain by β (1, 4) glycosidic linkage and in green plants and vegetables it is cell wall structural component. It is a dietary fiber which is water insoluble and in the small intestine where it is not digested by enzymes. However, it can be digested by producing short chain fatty acids in gut through microbial fermentation to a certain degree. Basically, this class of dietary fiber can be classified into crystalline and amorphous. The crystalline component is large portion of cellulose and insoluble in water due to intra and intermolecular non-covalent hydrogen bonds which gives great mechanical strength to cellulose and makes resistance to microbial decomposition while as the amorphous portion is water soluble and consists of (10-15%) part of total cellulose type of dietary fiber in Table 1 [34].

Characteristic	Fiber component	Description	Food source
Water insoluble/ less fermentable	Cellulose	➢ Main structural component of plant cell wall ➢ Insoluble in concentrated Alkali ➢ Soluble in concentrated acid	Plants (vegetables, sugar beet, various cereals brans)
	Hemicellulose	➢ Cell wall polysaccharide ➢ Contain backbone of β-1,4 glycosidic linkages ➢ Soluble in dilute alkali	Cereal grains
	Lignin	➢ Non cell wall component ➢ Complex cross-linked phenyl propane polymer ➢ Resists bacterial degradation	Woody plants
Water soluble/ more fermentable	Pectin	➢ Component of primary cell wall with D- Galacturonic acid as principal component ➢ Water soluble ➢ Gel forming	Fruits, vegetables, legumes, sugar beet, potato
	Gums	➢ Secreted at site of plant injury by secretary glands ➢ Food & pharmaceutical use	Leguminous seed plants (guar, locust bean), seaweed extracts (carageenan, alginates), microbial gums (xanthan, gellan)
	Mucilages	➢ Synthesized by plant, prevent desiccation of seed endosperm ➢ Food industry use, hydrophilic, stabilizer	Plant extracts (gum acacia, gum karaya, gum tragacanth)

Table 1: Classification of dietary fibre based on water solubility/fermentability [35].

Source of dietary fibers in various foods

The foods which are rich in fibre are naturally present in whole cereals, vegetables, fruits and nuts. The amount and composition of fibres differ from food to food [36]. A fibre-rich diet is lower in energy density, lower in fat content, larger in volume and richer in micronutrients. The larger the mass of food fiber intake the longer it presence in the stomach may bring a feeling of satiety sooner, although this feeling of fullness is short term [37]. It is suggested that healthy adults should eat between 20 and 35 g of dietary fibre each day. A

few non-starch food give up to 20-35 g of fiber/100 g dry weight and other those containing starch give around 10 g/100 g of dry weight and the substance of fiber of fruits and vegetables is 1.5-2.5 g/100 g of dry weight (Selvendran and Robertson 1994). Lambo et al. (2005) reported cereals to be one of the main sources of dietary fibre, contributing to about 50% of the fibre intake in western countries. Other sources are from vegetables (30-40%), fruits (16%) and the remaining 3% from other minor sources. Dietary fibre content from various food sources is presented in Table 2.

Source	Dietary fibre (g/100 g edible portion)		
	Total	Insoluble	Soluble
Grains			
Barley	17.30	-	-
Corn	13.40	-	-
Oats	10.30	6.50	3.80
Rice (dry)	1.30	1.00	0.30
Rice (cooked)	0.70	0.70	0.00
Wheat (whole grain)	12.60	10.20	2.30
Cellulose powder	95.00	95.00	<1
Wheat germ	14.00	12.90	1.10
Legumes and pulses			
Green beans	1.90	1.40	0.50
Soy	15.00	-	-
Peas, green frozen	3.50	3.20	0.30
Kidney beans, canned	6.30	4.70	1.60
Lentils, raw	11.40	10.30	1.10
Lima beans, canned	4.20	3.80	0.40
White beans, raw	17.70	13.40	4.30
Vegetables			
Potato, no skin	1.30	1.00	0.30
Bitter gourd	16.60	13.50	3.10
Beetroot	7.80	5.40	2.40
Fenugreek leaves	4.90	4.20	0.70
Ladyfinger	4.30	3.00	1.30
Spinach, raw	2.60	2.10	0.50
Turnips	2.00	1.50	0.50
Tomato, raw	1.20	0.80	0.40
Green onions, raw	2.20	2.20	0.00
Eggplant	6.60	5.30	1.30
Cucumbers, peeled	0.60	0.50	0.10
Cauliflower, raw	1.80	1.10	0.70
Celery, raw	1.50	1.00	0.50
Carrot, raw	2.50	2.30	0.20
Broccoli, raw	3.29	3.00	0.29
Fruits			
Apple, unpeeled	2.00	0.20	1.80
Kiwi	3.39	2.61	0.80
Mango	1.80	1.06	0.74
Pineapple	1.20	0.10	1.10
Pomegranate	0.60	0.11	0.49
Watermelon	0.50	0.20	0.30
Grapes	1.20	0.70	0.50
Oranges	1.80	0.70	1.10
Plums	1.60	0.70	0.90
Strawberry	2.20	1.30	0.90
Bananas	1.7	1.20	0.50
Peach	1.9	1.00	0.90
Pear	3.0	2.00	1.00
Nuts and seeds			
Almonds	11.20	10.10	1.10
Coconut, raw	9.0	8.50	0.50
Peanut, dry roasted	8.0	7.50	0.50
Cashew, oil roasted	6.0	–	–
Sesame seed	7.79	5.89	1.90
Flaxseed	22.33	10.15	12.18
Commercial source of high soluble fiber			
Inulin	100.00	0.00	100.00
Pectin	90-100	0.00	90-100
Gums	80-90	0.00	80-90
Fibersol-2RMD	90.00	0.00	90.00

Table 2: Total dietary fibre content of various food sources [38,39].

Fate of dietary fiber in the human digestive system

Fiber is very important for keeping the digestive tack working smoothly. Since we don't digest it, the fiber in food passes into the intestine and absorbs water. The undigested fiber creates "bulk" that the muscles within the intestine can push waste out of the body. Eating enough fiber helps to stop constipation. The mechanism of DF within the body takes place through following explanation here under:

Stomach

The DF mixes with partially digested food in the stomach and absorbs water and turns into a gel. The gel which has been produced in the stomach goes to the small intestine through Gastrointestinal Tract (GIT).

Small intestine

Insoluble fibre draws water from the system and increases the majority and softness of the food mass within the intestine. This decreases the time it takes to travel through the system, making elimination easier. Soluble fiber entraps sugars, fats and cholesterol from the foods hence slowing their absorption within the body. Hydration of fiber allows the formation of gel matrix which increase the viscosity of food mass.

Large intestine

In this, non-digestible fiber (polysaccharide) metabolized by bacteria inhabiting the massive intestine and creates Short Chain Fatty Acids (SCFAs) which are acetic acid, carboxylic acid, and butyric acids or Volatile Fatty Acids (VFAs), H_2, CO_2 and biomass. Therefore, promote regularity and aid bulking hence prevents constipation. The mechanism of dietary fiber within the stomach and little intestine is described in figures 1 and 2 below.

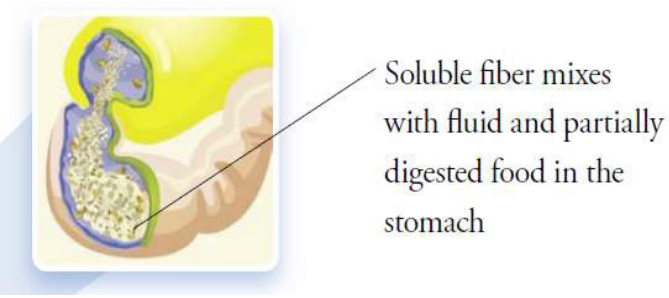

Figure 1: Mechanism of DF in the stomach.

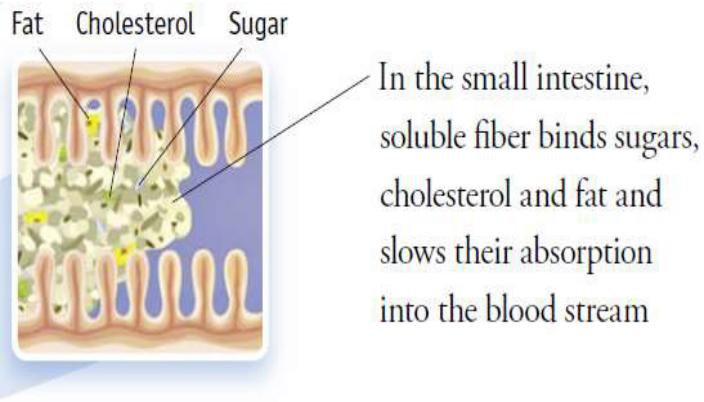

Figure 2: Mechanism of DF in the small intestine.

Health benefits of food fibers against non-communicable diseases

Maintaining Gastrointestinal health: The fiber can increase in stool weight by binding property of huge amount of water [40], which reduces colonic transit time due to increased stool bulk which prevents commonest problem like constipation and lower production of carcinogenic and genotoxic components [41]. Dietary fibers have important function in maintaining immunity in channel particular, by fermentable fiber portion in diet during which T-cell mitogen response and Gut Associated Lymphatic Tissue (GALT) increased [42]. In gut dietary fiber by gut microflora fermentation promoting the health of colonic epithelium so as to increased level of short chain fatty acids, lowering pH in colonic, which inhibits growth of harmful bacteria and promote favorable carboxylic acid microflora growth [43]. The varied components of dietary fibre, especially those related to resistant starch, reach the large intestine virtually unchanged [44]. Increasing the fibre content of the diet increases the faecal energy excretion, principally within the kind of fat and nitrogen. By virtue of its water holding capacity, fibre also helps within the formation of soppy stools with bulk, which may be easily evacuated. Research suggests that fibre from different sources differ in its ability to extend stool weight. Cereal fibre within the kind of bran increases stool weight quite most other fibre sources. The larger the particle size of the bran, the simpler it's. In adulthood constipation problems increased therefore dietary fibre intake is suggested for smooth colon functioning [45].

Prevention of colorectal cancer: High-fat intake has been correlated to the incidence of carcinoma. A high-fibre, diet may reduce the danger of carcinoma in several ways. First, fibre absorbs

water, lowering the concentration of potential carcinogenic (cancer causing) substances within the intestine. Second, since insoluble fibre quickens the movement of waste within the intestine, the colon is exposed to any cancer causing substance within the intestine for a shorter length of your time. Finally, fibre is adjuvant to raise gastro-intestinal movement and results to higher defecation with constipation relief and fewer opportunity of large intestinal cancer [46].

Prevention of obesity and diabetes: Fiber-rich, grain diets were shown to enhance insulin resistance and also the risk of diabetes. The consequences of fiber-rich grain diets on weight loss seem to be moderate [47]. An increased intake of DF appears to be useful for the treatment of both obesity and diabetes [48,49]. Fibre-rich food is sometimes satisfying without being calorically dense. Supplementing a standard diet with gel-forming fibres, like gum, results in an increased satiation therefore slower gastric emptying [50]. Recent long-term studies have confirmed the usefulness of viscous fibres as an adjunct to the regular dietary management of obesity (Mors et al., 2000). Except for the beneficial effect of caloric restriction, DF may improve a number of the metabolic aberrations seen in obesity [51]. Gel forming fibres are particularly effective in reducing elevated rarity Lipoprotein (LDL)-cholesterol without changing the High Density Lipoprotein (HDL)-fraction. The impaired glucose tolerance of diabetes manifest is additionally improved. These effects are probably partly related to the gelling property of the fibre, which results in an increased viscosity of the unstirred layer thereby delaying the absorption process [50]. However, it's been shown that dietary gum supplementation is unable to scale back insulin resistance in gross obesity if the overweight status is consistently maintained [52]. DF or foods containing a high amount of DF are very low in caloric content which is only 2-3 calories/g [53]. Thus, a high-fibre diet is suggested for weight reducing regimes and control blood glucose elevation.

Prevention of rectal disorder in adults: A large number of patients suffer from a spread of anal and lower rectal disorders therefore, treatment with a high-fibre diet found to be more beneficial. A soft formed stool, which might be easily passed without straining, usually produces an improvement within the symptoms resulting from these disorders. Most patients with haemorrhoids present with bright red anal bleeding after defaecation. Bleeding and prolapse are often precipitated by a period of constipation and it's possible that straining at stools is the reason behind this condition. High-fibre diet prevents constipation and helps to alleviate this condition [54].

Improve bowel function: DF consists of water-soluble and insoluble plant compounds that are immune to digestion by small bowel enzymes but is fermented to varying degrees by colonic bacteria. DFs are fermented by the microbial flora in colon. Short Chain Fatty Acids (SCFA) are one among the foremost components within the products produced after fermentation and also are chargeable for the lowering of pH in colon. This is often beneficial to health because the reduced pH creates an environment that stops the expansion of harmful bacteria [55-57]. Many physiological effects of fibre are also associated with the degree of fermentation. A rise in DF increases stool weight and also the number of defaecations and reduce bowel transit time. It increases the majority of the faecal mass by virtue of their water holding capacity and also the stools become bulkier and most moist [58]. High-fibre diets therefore go a protracted way within the prevention and cure of constipation. Studies on human subjects have concluded that TDF given at doses starting from 20–26 g helps to normalize and improve bowel function by decreasing the incidence of constipation in elderly population [59,60]. The products of fermentation just like the SCFA also help to accelerate the movement of the faeces through the colon. This action let alone the extra unfermentable residue increase the faecal bulk. Fermentation of soy fibre results in higher proportions of propionate and butyrate than do fermentation of other substrates. Similarly, fermentation of gums ends up in more propionate and butyrate production than do apple pectin. It's going to be possible to pick out fibre sources capable of supporting stipulated amounts of both total and individual SCFA production within the human colon [61].

Prevention of Diverticular disease: Diverticular disease is characterized by protrusions or out-pouches in the wall of the colon. These pouches, or diverticula, are believed to develop from excessive pressure, which weakens the wall of the colon. In many cases, there is no obvious symptom but in some people the diverticula become inflamed and painful. High-fibre foods may help in the prevention of diverticular disease by making a larger soften stool that requires less pressure to pass through the digestive system [54]. There is a profound geographic variation between Asian and western countries with reference to the prevalence and pathophysiology of diverticular diseases [62]. The foremost widely accepted theory of DF's role in diverticular formation states that smaller-volume stool ends up in alterations in colonic motility that produce increased intraluminal pressures [62]. High intraluminal pressures are generated when the colon undergoes 'segmentation', a process during which smooth contraction separates the colon into functionally distinct compartments. This normal physiological process becomes exaggerated in those with low-volume stools, thereby generating markedly elevated intra-segmental colonic pressures that are then transmitted to the colonic wall [63]. The proportion of DF undergoing fermentation will depend on chemical and physical structure of the DF, the microflora present and the residence time in the large intestine. Present evidences suggest, that the DF from wheat bran is less well fermented and contributes to faecal mass by its presence, whereas the thin walled less lignified cell walls of vegetables and fruits are virtually completely digested

and their bulking effect are due to an increased bacterial mass.

Prevention of heart disease:

Systolic and diastolic blood pressures have a decreasing trend under the influence of viscous soluble fiber. Diets that include viscous fiber may play a role in reducing the cardiovascular disease risk, thus contributing to an overall improvement in blood pressure [64]. Nutritional components are generally recommended for their intrinsic nutritional value and their effect on the human body. The clearly beneficial effects of dietary fiber on human health because the bacterial and fungal interaction of β-glucan with epithelial immune cellular-particular receptors were noted together with their contribution to the stimulation of immunological responses [65]. Soluble fibre might even have a function in decreasing coronary heart disease threat via decreasing blood cholesterol reputation in some people [66]. As it passes by the gut, soluble fibre binds to nutritional cholesterol, assisting the body to eliminate it. There are some proofs that soluble fibre can slow the liver's production of cholesterol, similarly to change Low Density Lipoprotein (LDL) debris to make them less of a health risk. A high-fibre weight loss plan combined with a low-fats diet plan, are often a terrific approach to lowering the danger of coronary heart ailment. High-fibre protects toward hyperlipidamia and ischemic coronary heart diseases [67]. Low intake of this dietary component is related to other risk factors of heart disease in susceptible genotypes such as obesity and diabetes. Gums and pectic substances have hypocholesterolemic and hypotriglyceridemic effects. This action of DF may be very critical inside the remedy of atherosclerosis, coronary heart sickness, hypercholesterolemia and hyperlipidemia [68]. Diets wealthy in fibre alter biliary lipid and salt metabolism making bile plenty less saturated with cholesterol. Such bile will be masses less likely to precipitate its LDL cholesterol and shape gallstones. The degree of absorption of common bile acids, lithocholic, deoxycholic and cholic acids relies upon on the kind of raw material, situations of processing and kind of bile acids [69]. DFs with an excessive content of viscous gums, collectively with oats, were showed to reduce LDL cholesterol [50]. Doses of soluble fibre ranging from 3 g to 8 g have been found to induce significant reductions ranging from 2.0% to up to 24% in total and LDL cholesterol in both hypercholesterolemic and non-hypercholesterolemic individuals [70-73]. The Higher intakes of soluble fibre may reduce the incidence of metabolic syndrome characterized by elevated LDL cholesterol levels, decreasing the risk of cardiovascular disease [74,75]. Cholesterol lowering action of soluble DF was explained by Yoshida et al. (2005) [76], as a result of an increased fecal sterol excretion and/or production of short-chain fatty acids previously shown to play a role in the suppression of cholesterol biosynthesis. There is a strong relationship between the amount, and type of DF (soluble type) in the diet and the risk of developing coronary heart diseases. It thus seems prudent to set a dietary recommendation at an intake level that has been demonstrated to have a significant impact on risk of developing the disease in large cohort studies. On this basis, population recommendations should be in the range of 13-15 g/1,000 kcal [77]. In conclusion, evidence shows that soluble fibre reduces the risk of cardiovascular diseases [78].

Prevention of blood glucose elevation: Diabetes is a condition characterized by high glucose levels in the blood. DF has a favourable effect on blood sugar reduction. Soluble fibre delays digestion and absorption of glucose into the blood, which can prevent wide swings in blood sugar throughout the day. A diet rich in carbohydrate and fibre, legumes, vegetables, fruits, and whole cereals, could also be particularly useful for treating diabetic patients due to its multiple effects on different cardiovascular risk factors, including postprandial lipids abnormalities [79]. It has been reported that a greater incidence of diabetes is found in populations that are exposed to affluence and urbanization, than in isolated populations used to hard work and limited food. This may be due to a change in diet, particularly to an increased consumption of refined carbohydrates [80]. However, factors other than diet may play an important role in the development of diabetes. Dietary factors may act indirectly for example through an increased incidence of obesity. Beyond cancer prevention and general digestive health, foods high in fibre tend to be low on the Glycemic Index (GI) [81]. The GI is a measurement of the speed at which food is converted to glucose in the blood stream. High GI foods, like white bread, pasta, sugary snacks and other highly refined products, tend to cause a rapid, dramatic, spike in blood glucose levels, followed by a rapid plummeting down below the first levels of glucose. The raising of blood sugar can contribute to complications in insulin function, even resulting in the onset of type 2 diabetes. Foods which score lower on the GI, like high-fibre foods, release their sugars more slowly and therefore the body gently returns to its original levels [82]. Foods rich in fibre have proved to be useful for treatment of diabetes mellitus. Jenkins et al. (1977) [31], showed that post prandial glycemia and rise in serum insulin after consumption of carbohydrate containing meals were reduced by the addition of guar flour or pectin or both. A high intake of dietary fibre, particularly of the soluble type improves glycemic control, decreases hyperinsulinemia, and lowers plasma lipid concentrations in patients with type 2 diabetes [83,84]. Fibre is beneficial for diabetic patients because absorbed glucose is released slowly into the blood circulation hence resulting in decreased insulin secretion. Diabetic patients are advised to use high-fibre diets because have been revealed to lower insulin secretions. Furthermore, DF has a blood glucose reducing effect as is manifested by a diminished GI [81]. Jenkins et al. (1977) [31], have also shown that post-prandial rise in serum glucose and reduction in insulin with the intake of a high-fibre diet. The opposite fraction of the guar bean, Guar By-Product (GBP), has been studied to work out if it possesses any hypoglycemic

properties. The analysed data indicated that GBP, like gum, possessed hypoglycemic properties due to the various chemical characteristics of those two guar bean fractions. It seems that their hypoglycemic properties are due probably to different mechanisms [85]. Low dose of guar gum may help to improve glycemic control in diabetic patients. In contrast, in postprandial studies, meals containing sufficient quantities of β-glucan, psyllium, or gum have decreased insulin and glucose responses in both healthy individuals and patients with T2DM. Diets enriched sufficiently in soluble fibre may additionally improve overall glycemic control in T2DM. Insoluble fibre has little effect on postprandial insulin and glucose responses. In some studies, insoluble fibre has been related to less weight gain over time. A long-term data from trials focusing on DF recommended a minimum fibre intake of 25 g/day to support a diet rich in whole grains, fruits and legumes so as to decrease the danger of obesity, the metabolic syndrome and T2DM [86]. Increased intake of viscous fibre results in a gradual reduction in fasting glucose levels in diabetics. Therefore, long-term high-fibre, low fat diet in gestational diabetes is usually recommended [87].

Prevention of Alzheimer's disease: Alzheimer's disease affected an estimated 4.7 million Americans in 2010, and its prevalence is predicted to almost triple in coming decades [88]. Several factors contribute to the danger of developing Alzheimer's disease include older age, genetic factors (especially the presence of the APOEε4 allele), case history, a history of head trauma, midlife hypertension, obesity, diabetes, and hypercholesterolemia [89]. Environmental factors like luck of exercise, cigarette smoking, oxidative stress and aspects of assorted diets in Western countries are now of considerable importance when considering the danger for Alzheimer's Disease (AD). The consumption of high fat and High Cholesterol Diets (HFHC) has clearly been related to increased plasma cholesterol and oxidative stress in various tissues of the body. In various animal models of AD, a powerful correlation has been found with HFHC diets and increased brain Amyloid Beta (Aβ) levels. The molecular mechanisms underlying the AD cholesterol connection are important within the prevention of the disease since considerable evidence indicates that cellular cholesterol levels, intracellular cholesterol transport and cholesterol esterification play an important role in Aβ generation and programmed cell death pathways. Specific diets and extending lifespan with avoidance of programmed cell death pathways have become an urgent therapeutic intervention for anti-aging related diseases including AD [90]. In Western countries, age related diseases such as obesity and diabetes have become common as risk factors for appetite dysregulation, atherosclerosis and AD [91]. The Western diet is known to be high in fat and cholesterol with effects on the liver and brain lipid homeostasis and marked effects on peripheral amyloidosis [91]. Therefore the consumption of high dietary food fibers revealed to prevent aging related diseases including AD [90].

Improving absorption of minerals: Dietary fibre intake influences the mechanisms by which nutrients are absorbed in the diet. It may influence the bioavailability of nutrients, microbial composition and gastrointestinal functions [92]. Diets rich in fibre, specifically those food items rich in anti-nutrients e.g. phytates, seem to decrease the absorption of several minerals in the small intestine especially iron, calcium, magnesium and zinc [93]. In the large intestine, fermentation of dietary fibre and other non-digested carbohydrates by anaerobic bacteria's produce gas, including hydrogen, methane, and carbon dioxide, which may cause flatulence. Flatulence and abdominal fullness has been observed when consumption reaches high levels (75-80g/day), which is fairly unlikely to be consumed in most people's diets [93]. Thus, dietary fibre can cause Gastro Intestinal (GI) discomfort, but mainly when consumed at high levels. Another concern is that diets that contain large amounts of dietary fibre tend to be bulky and have low energy density. Therefore, in individuals with a low appetite, high fibre diet may satisfy appetite too promptly, making it difficult to meet energy and nutrient requirements [93]. Thus, it's suggested that consumption of naturally fibre rich food including whole grains, fruits and vegetables should be encouraged instead of relying upon functional fibre supplements. This increases the nutritional value of the diet by providing other micronutrients as well as reduces the likelihoods of experiencing any potential negative effect.

Prevention of breast cancer: Dietary fiber has been recognized to prevent carcinoma by preventing intestinal reabsorption of estrogens and increase fecal excretion of estrogens [94]. The systematic review and meta-analysis of epidemiological studies including a complete of 6,62,421 participants, it absolutely suggested that dietary fibre consumption is significantly related to a reduction risk of breast cancer, particularly in post-menopausal women. This study showed a 12% decrease in breast cancer risk with dietary fibre intake. Dose-response analysis showed that for every 10 g/day increment in dietary fibre consumption, the risk of breast cancer reduced around 4% [95]. With relation to the type of fibre, a meta-analysis suggested that soluble fibre had a strong inverse association with breast cancer risk (9% risk reduction), however, no such association was found with regard to insoluble fibre intake [96]. High intake of fibre during adolescence was also related to 16% lower risk of overall carcinoma and 24% reduced risk of carcinoma before menopause. However, many prospective studies have reported no statistically significant association between fibre intake and carcinoma risk [97-100].

Prevention of gastric cancer: Dietary fiber consumption has additionally been recommended to be related with diminished gastric malignancy hazard. In a meta-examination directed by Zhang et al. (2013) [101], which included 580,064 subjects, a portion reaction investigation related a 10 g/day increase in fiber admission with a critical (44%) decrease in gastric malignancy

hazard. Bravi et al. (2009) [102], additionally found a backwards connection between stomach disease hazard and different sorts of fiber nonetheless, a converse affiliation was found for fiber from vegetables, and less significantly from natural product however not from grains [102].

Weight control: Several studies have shown that there's a positive association between low dietary fibre intake and a high BMI and increasing the intake of dietary fibre significantly reduces the danger of gaining weight and fat in women [103-107]. This effect could also be attributed to the flexibility of providing satiation. Viscous soluble fibres prolong the intestinal phase of digestion and absorption, and increase the time-course of post-absorptive signals [108]. The viscous nature and water holding capacity of the fibre hamper the speed of digestion and absorption of macronutrients [109]. This will intensify hormone release during the alimentary period, impacting metabolic pathways of food intake regulation. Average bite size, eating rate and overall ad-libitum energy consumed have been shown to get influenced when the viscosity is increased [110]. The mechanisms by which insoluble fibres that survive transit through gut, which may alter satiety and hunger cues, can be different from soluble fibres. Rather than modifying the rate of gastric emptying, insoluble fibres may affect satiety through changes in gut hormones or intestinal transit rate [108]. Table 3 below summarizes functions and benefits of dietary fiber on human health.

Functions	Benefits
Adds bulk to the diet, making feel full faster	May reduce appetite therefore weight loss which prevent obesity
Attracts water and turns to gel during digestion, trapping carbohydrates and slowing absorption of glucose	Lowers variance in blood sugar levels hence prevent type 2 diabetes
Lowers total and LDL cholesterol	Reduces risk of heart diseases
Regulates blood pressure	May reduce onset risk or symptoms of metabolic syndrome and diabetes
Speeds the passage of foods through the digestive system	Facilitates regularity and alleviate constipation and diverticular disease
Adds bulk to stool	Alleviates constipation
Balances intestinal pH and stimulates intestinal fermentation production of short-chain fatty acids	May reduce risk of colorectal cancers

Table 3: Functions and benefits of dietary fibre on human health. (Source: (Weickert and Pfeiffer, 2018)).

Recommended Dietary Allowance (RDA) for Dietary fiber

The RDA is the average daily dietary intake level that is estimated to meet the nutrient requirement of nearly all healthy individuals (97.5%) in a particular group but, since, there is no biochemical assay to reflect the dietary fibre nutritional status therefore, remains insufficient information to determine the Recommended Dietary Allowance (RDA) for fibre [111]. Additionally, dietary fiber isn't considered as a supplement as there is no inadequacy state, which is the reason in many nations an AI has been created which has been seen to give different physiological advantages. World Health Organization (WHO) proposes an admission of >25g of fiber every day [112]. Different food and wellbeing related associations support meeting the proposals through an eating regimen wealthy in vegetables, fruits and products of grain oats. Lion's share of nations suggest an admission of 25-35 g/day of dietary fiber for grown-ups and the proposal range from 18-38g/day [113]. It is constantly proposed to meet the suggestions by burning-through nutrients that are wealthy in normal dietary fiber as these nutrients are additionally a decent wellspring of different supplements including different nutrients, minerals, and phytochemicals and antioxidants. There is a lack of data on the effects of dietary fibre in children and it is generally recommended that children under two years of age do not consume fibre-rich foods at the expense of energy dense foods [93]. Table 4 beneath sums up day by day suggested dietary fiber admission every day in different gathering of individuals.

Life stage	Age	Males (g/day)	Females (g/day)
Infants	0-6 months	Not determined	Not determined
Infants	1-12 months	Not determined	Not determined
Children	1-3 years	19	19

Children	4-8 years	25	25
Children	9-13 years	31	26
Adolescents	14-18 years	38	26
Adults	19-50 years	38	25
Adults	51 years and older	30	21
Pregnancy	All ages	-	28
Breast feeding	All ages	-	29

Table 4: Recommended Dietary Allowance (RDA) for Dietary fiber [112].

Conclusion and Recommendations

The intake of adequate quantities of dietary fiber can lead to improvements in gastrointestinal health, and reduction in susceptibility to non-communicable diseases such as diverticular disease, heart disease, cancer, diabetes et al. Increased consumption of food fibers has also been associated with increased satiety and weight loss. The research studies have been evident that non-communicable diseases can be prevented or cured using combination of healthy diets rich in fiber and regular physical exercise. The healthy lifestyle behavior, if taken by every member in the family, society and communities these diseases will be combated. The risks of having over-weight, cardiovascular disease, diabetes, and other chronic diseases will not harm any people if lifestyle will be changed towards healthy foods. Therefore, it is recommended to adhere with the following guidelines so as to alleviate non-communicable diseases.

- Minimize your intake of saturated fats and trans fats. Saturated fat is found primarily in dairy products, meats, and certain oils (coconut and palm oils).Trans fats are found in many snack pastries and fried foods and are listed on labels as "partially hydrogenated oils." Olive and fish oil are the best with omega 3 fatty acids against cholesterol and other related non-communicable diseases.
- Vegetables, nuts, legumes (beans, peas, and lentils), fruits, and whole grains should replace meats and dairy products as primary staples of the diet. Vegetables and fruits should be eaten first in each meal at least half an hour before meal. This makes the body full therefore you will eat little food which will not increase body weight.
- Although aluminum's role in non-communicable disease remains a matter of investigation, those who desire to minimize their exposure can avoid the use of cookware, ant-acids, baking powder, or other products that contain aluminum.
- Include aerobic exercise in your routine, equivalent to 40 minutes of brisk walking at least 3 times per week.
- Drink plenty of water (2-3 liters per day) but drink at least two glasses of water half an hour before meal. Water will act as an appetite suppressants therefore little amount of food portion will be consumed only.
- Eat balanced diet every day and make last meal 3 hours before bed time. This will make the stomach empty therefore metabolism of foods will be reduced during night bed rest.

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