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DIETARY FIBER: IT'S IMPORTANCE AND HEALTH BENEFITS

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ABSTRACT

Dietary fiber (DF) is gaining attention in studies since it is thought to have significant health advantages. Dietary fiber is a class of food ingredients that is mostly present in fruits, vegetables, and grains that is resistant to digestive enzymes. A special combination of bioactive ingredients, such as resistant starches, vitamins, minerals, phytochemicals, and antioxidants, can be found in dietary fiber and whole grains. Water-soluble and water-insoluble organic compounds are the two categories used to analyze dietary fiber that is indigestible in the human small intestine but fully or partially fermented in the large intestine. There are numerous components from dietary fiber that can be distinguished. Among these fractions are resistant starch, β-glucan, cellulose, pectin, inulin, and arabinoxylan. Dietary fibers make up the majority of low-energy items that have become more and more significant in recent years. In addition to their various health benefits, dietary fibers have technological and functional features that can be utilized in food production. The large intestine's functions are organized by dietary fiber components, which also have significant physiological impacts on mineral bioavailability, lipid metabolism, and glucose. Dietary fibers have a documented protective impact against a number of gastrointestinal conditions, including diverticulitis, duodenal ulcer, colon cancer, constipation, hemorrhoids, and gastroesophageal reflux disease. They also help prevent obesity, diabetes, stroke, hypertension, and cardiovascular illnesses. This review examines the biological and physicochemical characteristics of dietary fibers and their significant effects on human health.

Keywords: Dietary Fiber, Cardiovascular Health, Diabetes, Obesity, Gasto-Intestinal Health.

I. INTRODUCTION

Without a doubt, dietary fiber is a component of a healthy lifestyle. Eating a lot of highly processed food is not natural. Neither our gut flora nor we evolved to take on this nutritional maladaptive behavior. Ultra-processed foods were never consumed by our hominid ancestors or any of their ancient ancestors. In Olden days, people used to eat more fiber rich foods. The glaring absence of dietary fiber in our modern diet is especially troubling, even though many other features of it are also concerning, such as our high intake of fat and sugar. Hipsley was the first to discuss the idea and definition of the phrase "dietary fiber" (1953). Natural sources of dietary fiber include grains, fruits, vegetables, and nuts. Dietary fiber is defined as the edible portions of plants or comparable carbohydrates that, although partially or completely fermented in the large intestine, are resistant to digestion and absorption in the human small intestine. Dietary fiber is a common ingredient in plant-based diets and is made up of components with a variety of morphological and chemical structures that are resistant to the digestion enzymes in humans. Epidemiological evidence suggests that many chronic non-communicable diseases, including type 2 diabetes, cardiovascular disease, hypertension, chronic kidney disease, non-alcoholic fatty liver disease, and many types of cancer, can be prevented by eating a diet high in whole grains, legumes, fruits, and vegetables. In addition to lignin, non-digestible carbohydrates that withstand digestion by human digestive enzymes and enter the large intestine are known as dietary fibers (Anderson et al., 2009; Jones, 2014).

It has been demonstrated that consuming dietary fibers offers several health advantages to people, such as a decreased risk of stroke (Steffen et al., 2003), diabetes (Cummings et al., 2004), hypertension (Whelton et al., 2005), and coronary heart disease (Liu et al., 1999). Since the pre-industrial era, the amount of fiber in the average human diet has significantly reduced, with noticeable health repercussions.

II. DEFINITION OF DIETARY FIBER AND ITS CLASSIFICATION

Dietary fiber is defined as carbohydrate polymers with ten or more monomeric units that fall into one of the following groups and are not degraded by the body's own enzymes in the small intestine of humans:

- Naturally present edible carbohydrate polymers in the food when it is eaten.

- Carbohydrate polymers, which can be derived from food basic materials by physical, enzymatic, or chemical methods and which, when presented to appropriate authorities, have been established by widely acknowledged scientific research to have a positive physiological impact on health.
- Synthetic carbohydrate polymers that have been proven by widely acknowledged scientific data to appropriate authorities to have a physiological impact that is beneficial to health.

In addition to noncarbohydrate substances including polyphenols, waxes, saponins, cutin, and phytates, dietary fiber also consists of a combination of oligosaccharides and polysaccharides such cellulose, hemicelluloses, gums, resistant starch, and inulin (Rodríguez et al., 2006; Yangilar, 2013). Meyer (2004) distinguished between soluble and insoluble dietary fibers based on how well they dissolve in the stomach. Soluble fibers include pectins, beta-glucans, galactomannans, and a wide range of non-digestible oligosaccharides, such as inulin. Insoluble fibers include lignin, cellulose, and hemicellulose. Although the majority of dietary fiber components are indigestible, some may be subject to partial enzymatic breakdown by bacteria (Heredia et al., 2002). The type of bacteria, the length of time the colon takes to pass, and the components of the dietary fiber all affect this enzymatic breakdown (Kay, 1982; Meyer, 2004). In summary, breakdown proceeds as follows: intracellular anaerobic glycolysis releases butyrate, propionate, and acetate; extracellular hydrolysis breaks down polysaccharides into mono- and disaccharides (Saura-Calixto and Goñi, 1993). While insoluble dietary fiber has little to no impact in the small intestine, viscous polysaccharides like gums and pectins have a major effect by reducing the absorption of nutrients. The low water-holding fermentable chemicals are what cause increased fecal bulk, while the high fermentable substances create the bacterial mass (Madar and Odes, 1990). Fruits and vegetables are the main suppliers of pectin, gums, and mucilage, but cereals are the main source of cellulose, lignin, and hemicelluloses (Elleuch et al., 2011). Carbohydrates can be categorized into two primary types according to how easily they are absorbed by the gastrointestinal (GI) tract. Enzymatic processes readily hydrolyze the first group, which includes starch, simple sugars, and fructans, and allow for absorption in the small intestine. These substances are also known as simple carbohydrates, non-structural carbohydrates, or non-fibrous polysaccharides (NFC). The second group, which includes beta-glucans, cellulose, hemicellulose, lignin, and pectin, cannot be broken down in the small intestine and must instead be fermented by bacteria in the large intestine. Referred to as structural carbohydrates, non-starch polysaccharides (NSP), or complex carbohydrates, these substances exhibit reflection in both acid and neutral detergent fiber (ADF) and neutral detergent fiber (NDF) analyses. NSP can be separated further into the two broad categories of soluble and insoluble substances. Based on chemical, physical, and functional characteristics, this category was created. When soluble fiber dissolves in water, viscous gels are created. They are quickly fermented by the large intestine's bacteria, avoiding the small intestine's digestive process. They include certain hemicelluloses, pectins, gums, and fructans of the inulin type. Insoluble fibers are not soluble in water in the human GI tract. Because they are insoluble in water and have a restricted capacity for fermentation, they do not gel. Examples of insoluble fiber include cellulose, lignin, and some hemicelluloses.

Classification of Dietary Fibre according to water solubility properties	
Soluble Fibres	Insoluble Fibres
Oligosaccharides Fructo oligosaccharides Fructans Inulins Chitins β-Glucans Pectins	Cellulose Hemicellulose Lignan

III. IMPORTANCE OF DIETARY FIBER

It has long been known that dietary fiber, a complex carbohydrate that is only present in plant-based diets, is essential to human nutrition. Dietary fiber, although indigestible, is essential for gastrointestinal health maintenance, metabolic regulation, and risk reduction for a number of chronic diseases.

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Physiological Effects of Dietary Fiber:

The diverse range of molecules that make up dietary fiber includes cellulose, hemicellulose, pectins, gums, and lignin, each of which has unique biological activity and physicochemical characteristics. While insoluble fibers like cellulose and hemicellulose stay intact throughout the digestive tract, contributing bulk to stool and encouraging regularity, soluble fibers like pectins and gums breakdown in water to form viscous gels. Due to their ability to delay stomach emptying and alter hormones that control hunger, both forms of fiber can promote fullness and aid in managing weight.

Additionally, dietary fiber acts as a substrate for the fermentation of the colon, producing short-chain fatty acids (SCFAs), which have anti-inflammatory properties and supply colonic epithelial cells with energy. Butyrate in particular, one of the SCFAs, is essential for preserving the integrity of the gut barrier, regulating immunological responses, and warding off inflammatory bowel illnesses and colon cancer. Furthermore, dietary fiber affects the gut microbiota's makeup and metabolic activity, promoting a symbiotic connection that improves immunity, nutrient absorption, and general health.

Health Implications and Disease Prevention:

Consumption of dietary fiber is inversely correlated with the risk of developing chronic conditions such as cardiovascular disease, type 2 diabetes, and several malignancies, according to epidemiological research. Diets rich in fibre have been demonstrated to reduce systemic inflammation, enhance glycemic management, and lower blood cholesterol levels, all of which help to mitigate the pathophysiology of cardiometabolic illnesses. Furthermore, dietary fiber's proven capacity to reduce carcinogens, support bowel regularity, and alter the composition of the gut microbiota has been linked to its preventive effects against colorectal cancer.

A nutritious diet must include dietary fiber since it has a variety of physiological effects that promote general health and the prevention of disease. Dietary fiber is essential for maintaining human health over the long term because it supports gastrointestinal health, regulates metabolic processes, and strengthens the immune system. As a result, initiatives to boost fiber intake through dietary changes and supplementation options have great potential to improve public health outcomes and lessen the prevalence of chronic illness worldwide.

IV. HEALTH BENEFITS OF DIETARY FIBER

Cardiovascular Health:

Cardiovascular disorders account for the majority of morbidity and mortality in the United States, affecting over 80 million individuals and including hypertension, stroke, and coronary heart disease (CHD). Strokes were the third most common cause of mortality in the US in 2005, while congestive heart failure was the top reason [American... 2008]. Although heart disease (CHD) is the leading cause of mortality, it is also the most preventable; according to studies, lifestyle factors like diet, exercise, and cigarette smoking account for 82% of CHD cases [Stampfer et al. 2000] and eating habits for 60% of cases [Kris-Etherton et al. 2002]. Significantly lower prevalence rates of coronary heart disease, stroke, and peripheral vascular disease are linked to high dietary fiber intake (Merchant et al. 2003); major risk factors, including obesity, diabetes, dyslipidemia, and hypertension, are also less common in those who consume the most fiber (Lairon et al. 2005).

According to seven cohort studies with observations for over 158,000 people, the prevalence of CHD illness is significantly lower (29%) in those who consume the most dietary fiber than in those who consume the least (Table 3). Particularly, for people in the highest quintile for dietary fiber intake compared to those in the lowest quintile, the relative risk, calculated by variance weighting (fixed effect meta analysis), is 0.71 [Anderson et al. 2009].

The unfavorable link between dietary fiber and CHD risk is supported by numerous studies. More recent research, however, has produced some intriguing findings showing that the mortality risk of coronary heart disease (CHD) dropped by 17–35% for every 10 g of extra fiber given to a diet. Obesity, type 2 diabetes, high blood pressure, and high cholesterol are risk factors for coronary heart disease (CHD). It is hypothesized that the processes underlying the prevention of CHD and DF are related to the control and treatment of these risk factors. First, it has been demonstrated that soluble fibers speed up bile excretion, which lowers LDL and total cholesterol levels in the blood. Second, it has been demonstrated that the creation of propionate, a short chain fatty acid, inhibits the synthesis of cholesterol. Third, dietary fiber shows promise in controlling energy intake, which can help with weight loss or maintaining a healthy body weight. Fourth, dietary fiber has been demonstrated to minimize the incidence of type 2 diabetes through glycemic management or reduced energy intake. Fifth, it has been demonstrated that DF reduces pro-inflammatory cytokines including interleukin-18, which could impact the stability of plaque. Sixth, consuming more DF has been demonstrated to lower blood levels of C-Reactive protein (CRP), an inflammatory marker and CHD predictor [James and Mark 2010]. An increased daily consumption of bran dramatically reduced the incidence of coronary heart disease in healthy adult men, according to a long-term clinical trial by Jensen et al. [2004]. This is most likely because of research done in 2002 by Qureshi et al., who discovered that consuming 10 g of rice bran for eight weeks could lower triglycerides, LDL cholesterol, and total cholesterol in the blood. These effects could be caused by two different methods. An increase in the synthesis of bile acid is probably the cause of the decrease in cholesterol levels. Oat bran increased the serum content of 7α-hydroxy-4-cholesten-3-one (α-HC), an oxidized form of 7α-hydroxycholesterol that is a metabolite in the formation of bile acids, according to research by Andersson et al. [2002]. The drop in fat absorption from the small intestine could be the cause of the drop in blood triglyceride levels. According to Theuwissen and Mensink's [2008] research, numerous carefully monitored intervention trials have demonstrated that the four main types of water-soluble fiber—psyllium, guar gum, pectin, and β-glucan—effectively reduce serum levels of low-density lipoprotein (LDL) cholesterol while having no effect on triacylglycerol or HDL cholesterol. Furthermore, a diet rich in water-soluble fiber may protect against CVD, according to epidemiological research. Current dietary recommendations to further increase intake of water-soluble fiber are supported by these findings.

Obesity:

Approximately one-third of the world's population is overweight or obese, which raises their risk of developing diabetes, cardiovascular disease (CVD), and several types of cancer. While there are several potential causes of obesity, a rise in the ratio of energy expenditure to absorption is the main culprit. Therefore, when treating obesity, restricting energy absorption is essential. Researchers have gone one step further and examined the impact of additional dietary components, such as dietary fiber, that may help regulate weight. By reducing the amount of energy available in a meal while preserving other vital nutrients, increasing dietary fiber consumption may reduce the absorption of energy [Lattimer and Haub 2010]. A large amount of research has been done to assess the relationship between body weight and dietary fiber, and the majority of the findings indicate that there is an inverse relationship between dietary fiber consumption and changes in body weight. This claim was corroborated by Tucker and Thomas's [2009] study, which included 252 middle-aged women. They found that individuals shed 4.4 pounds on average over a 20-month period when their dietary fiber intake increased by 8 grams per 1000 calories.

The main cause of this weight loss was a reduction in body fat. It should be noted that there was no significant relationship between baseline intakes of fat and fiber, age, activity level, or baseline calorie intake and the association between dietary fiber and weight change. In addition to supporting the aforementioned findings, Koh-Banerjee et al. [2004] propose a dose-response association. According to their findings, weight gain decreased by 1.1 pounds for every 40 g/d increase in whole grain intake. Furthermore, it appeared that bran was a significant factor in the 0.8 lb weight gain reduction with 20 g/d ingestion. There are a number of reasons why dietary fiber can either reduce body weight or moderate weight increase. First, soluble fiber ferments in the large intestine to create peptide YY (PYY) and glucagon-like peptide (GLP-1). These two gut hormones contribute to the feeling of fullness. Second, eating dietary fiber may considerably reduce the amount of energy used [Tucker and Thomas 2009].

Increased fiber consumption was associated with lower dietary fat consumption in women. Third, dietary fiber may decrease a diet metabolizable energy (ME), which is gross energy minus the energy lost in the feces, urine and combustible gases. Baer et al. [1997] observed that an increased consumption of dietary fiber resulted in a decrease in the ME of the diet This could be explained by the fact that when dietary fiber levels rose, fat digestion dropped. Additionally, the consumption of simple carbs tends to decline when dietary fiber intake rises. Dietary fiber is still included in the total number of calories in a diet, but it is much more difficult for the small intestine to digest and even partially resistant in the large intestine. Loss of weight is possible with both soluble and insoluble fiber. Nonetheless, there appears to be a connection between the kind of fiber ingested and the diet type—high or low fat. When consuming a high-fat diet, insoluble fiber can be more crucial for weight loss. Comparing resistant starch and insoluble fiber can help us better understand how dietary fiber can be utilized to treat and prevent obesity because both are components of dietary fiber and are digested similarly. Dietary resistant starch dilutes ME, but not as much as insoluble fiber does. The same unfavorable connection between dietary fiber and weight increase has been shown in another research [Koh-Banerjee et al. 2004, Du et al. 2010].

Diabetes:

Over the past few years, the prevalence of type 2 diabetes has skyrocketed. Self-reported diabetes has increased by 61% since 1990 [Mokdad et al. 2003]. Dietary variables appear to be a significant component in the condition, even though other risk factors like smoking, obesity, and inactivity also play a role. Hyperglycemia and reduced insulin sensitivity are the causes of type 2 diabetes. Because of this, the consumption of carbohydrates is a major dietary element that should be especially monitored [Lattimer and Haub 2010].

Total carbohydrates were found to have no effect on the risk of diabetes by Meyer et al. in 2000. Nonetheless, there was a significant correlation between the kind of carbohydrate—dietary fiber and non-structural carbs. Consequently, it's critical to comprehend the glycemic index or load of a food. The glucose index uses a reference group, such as glucose or white bread, to determine how much total carbohydrate intake is related to the immediate postprandial glucose response. Glycemic index-lower carbohydrates produce a reduced glucose/insulin response. Since simple small chain carbohydrates raise blood glucose levels, they are said to have a higher glycemic index.

Hu et al. [2001] discovered that while inadequate diet played a significant role, high body fat was the single most significant driver of type 2 diabetes. In addition, women who ate a poor diet had a far higher chance of getting type 2 diabetes. A poor diet was defined as having a high content of non-structural carbs, low dietary fiber, and saturated fat. With a larger intake of quickly absorbed and readily digested carbs, this diet would be consistent with a high glycaemic load [Hu et al. 2001]. A favourable relationship between glycaemic index and type 2 diabetes risk was discovered by Schulze et al. [2004] in a long-term, supported investigation including over 90,000 female nurses that lasted eight years. Even after controlling for age, body mass index (BMI), and family history, there was still a substantial connection. A number of methods have been put out to comprehend the physiology underlying the correlation between diabetes and glycemic index. First, blood glucose levels are raised by carbohydrates with a higher glycemic index. It is hypothesized that this persistent hyperglycemia causes the pancreatic beta cells to malfunction, reducing the amount of insulin released. Second, overabundance of energy (high glycemic load) causes tissues like adipose, liver, and skeletal muscle to lose their ability to metabolize insulin. It is significant to remember that age and body weight had no bearing on the inverse connection between dietary fiber and diabetes that Meyer et al. [2000] and Schulze et al. [2004] found. After accounting for age, fat intake, smoking, alcohol consumption, family history, exercise, and body weight, Hu et al. [2001] confirmed these results. Thus, it appears that dietary fiber, even in the absence of additional aggravating variables, is linked to type 2 diabetes. Using middle-aged, healthy women, Meyer et al. [2000] found no correlation and a high ($P = 0.0012$) inverse association between the risk of type 2 diabetes and insoluble fiber. The same outcomes were observed by Montonen et al. [2003] in middle-aged, healthy men and women who consumed more whole rye bread. It's interesting to note that fiber from fruits and vegetables had no impact on the likelihood of type 2 diabetes. These results are consistent with previous research. According to a comprehensive epidemiological study including 42,000 males, dietary fiber from fruits and vegetables had no impact on the risk of developing diabetes. On the other hand, dietary fiber derived from whole cereal grains significantly reduced the incidence of diabetes. Every group's daily fiber consumption was comparable. [Salmeron et al. 1997].

According to Weickert and Pfeifer's [2008] research, consuming more cereal fiber greatly enhanced the body's ability to eliminate glucose, which in turn led to an 8% rise in insulin sensitivity. This implies that the mechanisms underlying insoluble fiber are not confined to nutrient absorption, but rather are more peripheral in nature. First, after consuming an insoluble fiber, healthy women showed an increased release of glucose-dependent insulin tropic polypeptide (GIP). An incretin hormone called GIP increases the release of insulin after meals. Second, insoluble fiber may cause a person to feel less hungry and consume less food [Samra and

Anderson 2007]. This could result in a reduction in caloric intake and body mass index. Third, it has been demonstrated that short chain fatty acids can lessen the postprandial glucose response by fermentation [Ostman et al. 2002]. Early studies showed that oral acetate could reduce blood levels of free fatty acids (FFA) and that lipid infusions hampered glucose utilization. Increases in FFA in the blood can block glucose metabolism by blocking the GLUT 4 transporters, claim Kelley and Mandarino (2000). Thus, through competition in insulin-sensitive organs, short chain fatty acids may lower blood glucose levels by lowering serum free fatty acid levels. Magnesium intake may possibly be the cause of the inverse association between cereal grains and diabetes. It has been demonstrated that consuming more magnesium lowers the incidence of type 2 diabetes [Meyer et al. 2000]. Diabetes patients frequently have hypomagnesemia, which has been linked to a decrease in tyrosine kinase at the insulin receptor. Insulin resistance may result from this, which could affect how well insulin functions [Paolisso and Barbagallo 1997].

Gastrointestinal Health:

From the mouth to the anus, the entire gastrointestinal tract is impacted by dietary fibers. Foods high in fiber typically require more time to consume and have a lower calorie density [Haber et al. 1977]. In most cases, soluble fibers slow down stomach emptying. While insoluble fibers typically cause "intestinal hurry," soluble fibers may serve to impede the passage of dietary materials through the small intestine [Cummings 2001]. Dietary fibers have the ability to detect reactions of a broad range of gastrointestinal hormones in the small intestine, which act as incretins to trigger insulin release and influence hunger [Anderson 2008]. Certain fibers increase the amount of bile acids and cholesterol excreted in the feces by binding to bile acids and preventing micelle formation [Kirby et al. 1981]. Fermentable fibers boost the number of bacteria in the colon, and some of them serve as prebiotics to support the growth of bacteria that are good for you, such Lactobacilli and Bifidobacteria [Roberfroid 2005]. Particularly useful for boosting regularity and fecal bulk are insoluble fibers [Cummings 2001]. Drzikova et al. (2005) discovered that when the amount of oat bran, total and insoluble dietary fiber, and b-glucan in pre-digested oat-based extrudates increased, so did the in vitro binding of bile acids. The study's findings demonstrate that dietary fiber preparations' chemical makeup, source, and pre-treatment all have a significant impact on how well they interact with bile acids. Diets high in resistant starch and b-glucan have a number of positive physiological advantages. Therefore, in healthy individuals, b-glucan reduces postprandial blood glucose and insulin responses. B-glucans from barley and oats, as well as cereal products, can lower serum cholesterol and lipoprotein concentrations in both humans and animals. Increased excretion of bile acids could be one factor contributing to the cholesterol-lowering benefits of diets high in b-glucan [Drzikova etal. 2005].

According to Burkitt and Trowell (1975), early observers hypothesized that dietary fiber intake reduced the incidence of hiatal hernias, GERD, peptic ulcer disease, gallbladder disease, appendicitis, diverticular disease, colorectal cancer, and hemorrhoids. A thorough analysis of the prevalence of these illnesses reveals that the following conditions may be less common in people who consume high amounts of dietary fiber than those who consume low amounts: diverticular disease [Aldoori et al. 1997], esophageal cancer [Wu et al. 2007], GERD [El-Serag et al. 2005], gastric cancer [Wu et al. 2007], peptic ulcer disease [Aldoori et al. 1997], gallbladder disease [Tsai et al. 2004], constipation and hemorrrhoids [Cummings 2001].

One of the most prevalent gastrointestinal functional diseases in the world is irritable bowel syndrome. The symptoms of this complex disorder include bloating, diarrhea, and/or constipation, as well as abdominal pain or discomfort. Other fiber supplements including methylcellulose, partially hydrolyzed guar gum, and psyllium have been shown to reduce symptoms, even though wheat bran frequently makes them worse [Anderson et al. 2009]. Clinical trials frequently show statistically significant and dramatic decreases in symptoms in both the fiber and placebo groups. This complicates the evaluation of the treatment intervention. Reducing symptoms can frequently be achieved with the sympathetic support of the primary care physician in conjunction with highly targeted treatment approaches involving dietary fiber in meals or supplements [Giannini et al. 2006]. People with ulcerative colitis who are in remission may benefit from the prudent use of soluble fibers [Seidner et al. 2005]. One of the classical fiber-deficiency disorders, diverticular disease is the fifth most frequent gastrointestinal ailment in Western countries. According to Frieri et al. (2006), a high dietary fiber intake protects against, ameliorates, and prevents recurrences. Increasing dietary fiber consumption is a frequent strategy for managing and preventing hemorrhoids or constipation. Consumers frequently utilize wheat bran, high-fiber cereals, and fiber supplements, indicating that they are aware of their health benefits [Anderson et al. 2009]. As a prebiotic, inulin has shown promise in supporting the well-being of the human large intestine.

They showed that inulin inhibited the growth of potentially harmful bacteria like Salmonella, Listeria, and E. coli, while it promoted the growth of Bifidobacteria. This may prove beneficial in conditions like C. difficile infections and ulcerative colitis. These results were confirmed by Rafter et al. (2007), who proposed that these were the underlying mechanisms for the finding that inulin reduced biological compounds linked to colonic cancer, such as decreased interleukin-2 release, decreased exposure to genotoxins, and decreased colorectal cell proliferation and water-induced necrosis.

Oral pectin supplementation significantly slowed diarrhea and decreased acute intestinal infections in children and newborns, according to a number of recent clinical investigations. It is believed that fewer harmful bacteria, including Shigella, Salmonella, Klebsiella, Enterobacter, Proteus, and Citrobacter, are present. Olano-Martin et al.'s [2002] observation that pectin promoted the in vitro growth of specific strains of Lactobacillus and Bifidobacteria lends credence to this. The concentrations of these bacteria indicate a healthy microbiota population, and they are thought to be directly related to the well-being of the large intestine. Rats fed high-fiber diets had significantly higher wet and dry fecal weights than those fed low-fiber diets, according to research by Kahlon et al. [2001]. Compared to cellulose diets, stomach weights were significantly higher after following a wheat bran diet. In contrast to cellulose diets, bran diets produced longer cecal lengths and heavier stomachs; nevertheless, a high-cellulose diet also increased colon weight. Bran particle size did not significantly affect anything, with the exception of coarse bran's better fiber digestibility. The shape and function of the gastrointestinal tract may be related to the health benefits of wheat bran. In addition to preventing constipation, fecal bulking and a shorter intestinal transit time may dilute or lessen the absorption of harmful or cancer-causing chemicals, enhancing gastrointestinal health and reducing the risk of tumor growth and cancer. Ferguson and Harris [1996] discovered that two categories of mechanisms have been put forth to explain how dietary fibers may prevent colorectal cancer: those that involve direct action from the fiber and those that involve an indirect effect from the fiber's breakdown by colonic bacterial enzymes and fermentation of the by products.

Cancer:

One of the most common health concerns among people worldwide is still cancer. Increased fruit and vegetable consumption along with a high fiber intake have long been linked to a protective association between dietary fiber intake and the risk of colon cancer, according to historical observational and epidemiological studies conducted worldwide. Dietary fiber offers potent protection against colon and rectal cancers, according to preliminary findings from the European Prospective Investigation of Cancer (EPIC), a European study including over 500,000 participants across ten European nations. Inadequately fermented fiber, such that found in cereal brans, causes laxation, shortens the time it takes for transit, and binds things like carcinogens and bile acids. Nevertheless, there isn't enough data available to say whether a lower risk of colon cancer is a benefit of this kind of fiber. The use of fermentable fiber by the colonic microbiota is of special interest because it can alter the composition and abundance of bacteria as well as their metabolic processes, which in turn can alter the production of genotoxins, carcinogens, and tumor promoters. Certain prebiotic fiber sources, like inulin, resistant starches, and certain oligosaccharides, can lower the pH of the digestive tract by acting as a selective substrate for bacteria that make particular short-chain fatty acids (SCFA). It has been demonstrated that in human colonic carcinoma cell lines, SCFA butyrate increases apoptosis. Apoptosis is a process that helps maintain regulated tissue size throughout development by eliminating extra or superfluous cells. Thus, a natural cell defense mechanism against the development of cancer is apoptosis. Certain prebiotic fiber sources, like inulin, resistant starches, and certain oligosaccharides, can lower the pH of the digestive tract by acting as a selective substrate for bacteria that make particular short-chain fatty acids (SCFA). It has been demonstrated that in human colonic carcinoma cell lines, SCFA butyrate increases apoptosis. Apoptosis is a process that helps maintain regulated tissue size throughout development by eliminating extra or superfluous cells. Thus, a natural cell defense mechanism against the development of cancer is apoptosis. There is evidence that lower gut pH and more Bifi dobacteria in the colon have a direct effect on the development of large intestine cancer. More research is necessary as the mechanisms underlying the anticarcinogenic and antitumorigenic effects of

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highly fermentable fibers are not well known. But for the inhibitory effect to happen, it's likely that some or all are a part of a metabolic chain reaction. The main hypothesized mechanisms for these effects include: reducing the number of pathogenic bacteria in the colon, which reduces the production of carcinogenic substances; lowering the colon's pH to affect pH-dependent enzymatic reactions, such as the formation of secondary bile acid [Rowland et al. 1998]; and/or reducing the amount of carcinogenic substances available to the colonic mucosa by adsorption of the substances to the microbiota's cell wall, which speeds up the intestinal transit time and dilutes all components; and/or exerting inhibitory effects on the initiation and promotion stages of colon cancer formation, in which SCFA, specifically butyric acid, may play a key role [Tungland and Meyer 2006].

Immune System Health:

The dietary fibers that have been investigated the most are inulin and other oligofructoses. They function to promote the colon's bifidobacterium proliferation. Beneficial bacteria that increase immunity and create short-chain fatty acids include lactobacilli and bifidobacteria. The beneficial effects of inulin on the immune system have been well-documented by very large animal studies, and early research in humans supports the theories produced by these studies. Since pancreatic enzymes cannot break down inulin and oligofructoses, they pass through the colon essentially undigested. Bifidobacteria thrive in the colon because inulin is entirely fermented by microbacteria there. Through this fermentation process, short-chain fatty acids (SCFA) are produced. Although other fibers are fermented to produce SCFA, the effects of non-oligofructose fibers on bacteria are not as well understood. Among the alleged health advantages of bifidobacteria are the following:

- Defense against gastrointestinal infections; decrease of potentially hazardous bacteria; generation of vitamins and antioxidants; lowering of gut ph to allow for the synthesis of acids following the assimilation of carbs;
- Bolstering activity to prevent and treat constipation;
- Immune response stimulation;
- May lower risk of colon cancer;
- Stimulation of intestinal function and aid in digestion and absorption, particularly of calcium.

Human investigations that have been limited have shown that inulin supplementation has a positive impact on the types and quantities of circulating lymphocytes as well as an increase in bifidobacteria in the feces. Though oat b-glucan, gum Arabic, and other soluble fibers have been shown to benefit from fermentable soluble fibers, inulin and oligo-fructoses have received the greatest research attention. There is a lot of interest in the function prebiotic fibers play in the nutrition and health of newborns, particularly those who are not breastfed. According to the studies, taking a prebiotic fiber mixture supplement can help with bowel function, reduce respiratory infections and atopic dermatitis, and support postnatal immunological development. Prebiotic fibers are being researched for their possible therapeutic use in the management of inflammatory bowel disease. Prebiotic fibers have been shown in animal research to decrease gastrointestinal inflammation in several animal experimental models. Prebiotic fibers significantly lower the risk of infection in liver transplant recipients, according to preliminary research. According to Anderson et al. (2009), preliminary human studies have demonstrated positive outcomes for patients suffering from pouchitis, Crohn's disease, or ulcerative colitis.

Gut Mobility:

Among all the advantages of eating dietary fiber, its impact on gastrointestinal motility and ability to avoid constipation may be the most well-known and valued. This impact is well-supported by numerous research, and the evidence that is now available seems to be indisputable. Compared to the control group, those who received "vege-powder," which is made up of chicory, broccoli, and whole grains, experienced significant improvements in symptoms of constipation, such as stool hardness, frequency of defecation, and straining to pass gas at two and four weeks in one randomised controlled double-blind trial on the effects of the product on alleviating constipation in over ninety participants [Woo, H.I.; Kwak 2015]. A comprehensive review by Rao et al. provides more proof for the clinical usefulness of dietary fiber as an efficient constipation therapy. In order to address chronic constipation and irritable bowel syndrome (IBS), evidence supporting dietary fiber intake and limits in fermentable oligosaccharide, disaccharide, monosaccharide, and polyol (FODMAP-restricted diet) was sought [Rao, S.S. et al ; 2015]. Dietary fiber was helpful for chronic constipation in five out of the seven trials that were looked at, as well as in all three of the studies that looked at constipation linked to IBS. Overall IBS symptoms also seemed to improve with the FODMAP-restricted diet. Based on available data, dietary fiber appears to have positive effects on gastrointestinal motility and to be a useful management strategy for treating and preventing constipation.

Depression:

Consumption of dietary fiber seems to be linked to a lower chance of developing depression. It has been suggested that inflammation may mediate the relationship between dietary fiber and depression, and that the correlation between a high-fibre diet and a decrease in inflammatory compounds may change the concentrations of specific neurotransmitters that may lower the risk of developing depression [Swann, O.G. et al; 2020]. The underlying mechanisms behind these theories are still not fully understood. According to Liu et al. (2019), a meta-analysis of controlled clinical studies revealed a marginally significant impact of probiotics on anxiety and depression. This finding is consistent with the gut microbiota's potential role in mediating the effects of fiber on mental health. The SMILES trial, which involved adult patients with poor quality diets and major depressive disorders, provided evidence that a healthy diet improves depressive symptoms. Specifically, the modified Mediterranean diet, which included nutrition counseling sessions, was associated with improvements in depressive symptoms when compared to the control group [Opie, R.S.; 2018]. Future research should provide light on the mechanisms connecting our food—including dietary fiber—and mental health, given the correlation between depression and other mental health issues and poor diet and obesity. A high-fibre diet might potentially be recommended in future guidelines for managing and preventing depression and other mental health conditions.

V. DISCUSSION

In this view there is a need for development of more fiber supplements. In this need, GVSK pharma Pvt Ltd (Nutraceutical Division) is working on development of fiber rich supplements which help consumers in India. It is offering wide range of products that help to support consumer to meet his daily fiber requirement.

VI. CONCLUSION

Dietary fiber can be defined as a carbohydrate that is resistant to absorption and digestion, and it may or may not be fermented by microbes in the large intestine. This description serves as the foundation for the relationship between consumption levels and potential health advantages. There are many different components that make up dietary fiber, but some are especially important, such as arabinoxylan, inulin, β-glucan, pectin, bran, and resistant starches. It has been demonstrated that each of these dietary fiber's unique components significantly contributes to enhancing human health. While more study is required to fully comprehend specific health claims and the mechanisms underlying them, current research is particularly focused on these components. Consuming large amounts of fiber can help prevent disease and reverse its consequences. Individuals with high dietary fiber intakes are less likely to acquire cardiovascular disease, hypertension, diabetes, obesity, and several gastrointestinal disorders than people with low fiber intakes. Increasing the consumption of foods high in fiber or fiber supplements improves blood pressure, blood glucose control in diabetics, serum lipoprotein levels, aids in weight loss, and promotes regularity.

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VII. REFERENCES

[1] Slavin JL. Position of the American Dietetic Association: health implications of dietary fiber. J Am Diet Assoc. 2008;108:1716-1731.

[2] Zaloga GP. Parenteral nutrition in adult inpatients with functioning gastrointestinal tracts: assessment of outcomes. Lancet. 2006;367:1101-1111.

[3] Kelly TW, Patrick MR, Hillman KM. Study of diarrhea in critically ill patients. Crit Care Med. 1983;11:7-9.

[4] Shankardass K, Chuchmach S, Chelswick K, et al. Bowel function of long-term tube-fed patients consuming formulae with and without dietary fiber. JPEN J Parenter Enteral Nutr. 1990;14:508-512.

[5] Green CJ. Fiber in enteral nutrition. Clin Nutr. 2001;20(suppl1):23-39.

[6] Hijova E, Chmelarova A. Short chain fatty acids and colonic health. Bratisl Lek Listy. 2007;108:354-358.

[7] Bowling TE, Raimundo AH, Grimble GK, Silk DB. Reversal by short-chain fatty acids of colonic fluid secretion induced by enteral feeding. Lancet. 1993;342:1266-1268.

[8] Backhed F, Ley RE, Sonnenburg JL, Peterson DA, Gordon JI. Host-bacterial mutualism in the human intestine. Science. 2005;307:1915-1920.

[9] Gibson GR, Probert HM, Loo JV, Rastall RA, Roberfroid MB. Dietary modulation of the human colonic microbiota: updating the concept of prebiotics. Nutr Res Rev. 2004;17:259-275.

[10] Pineiro M, Asp NG, Reid G, et al. FAO technical meeting on prebiotics. J Clin Gastroenterol. 2008;42(suppl 3, pt 2):S156-S159.

[11] Institute of Medicine, National Academy of Sciences. Dietary reference intakes: proposed definition of dietary fiber. Washington, DC: National Academy Press; 2001.

[12] Ötles S., Ozgoz S., (2014). Health effects of dietary fiber. Acta Sci.Pol. Technol. Aliment. 13 (2), 191-202 https://doi.org/10.17306/J.AFS.2014.2.8

[13] Barber TM, Kabisch S, Pfeiffer AFH, Weickert MO. The Health Benefits of Dietary Fibre. Nutrients. 2020 Oct 21;12(10):3209. doi: 10.3390/nu12103209. PMID: 33096647; PMCID: PMC7589116.

[14] Barber TM, Kabisch S, Pfeiffer AFH, Weickert MO. The Health Benefits of Dietary Fibre. *Nutrients*. 2020; 12(10):3209. https://doi.org/10.3390/nu12103209