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ROLE OF DIETARY FIBER IN IMPROVING HUMAN PHYSIOLOGY AND IN CONTROLLING DISEASES

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ABSTRACT

Dietary fibers are usually indigestible part of the fruits and cereals, which play a crucial role in improving human physiology and in controlling and reducing certain diseases. Due to fast lifestyle in cities peoples are consuming less fiber and high calorie food products. In India, there is lot of gap between rural and urban population in consumption ratio of dietary fibers. Urban population in metros depends more on high calorie and low fiber based foods such as fast food, snacks and beverages etc. Dietary fibers are known to reduce risk of coronary heart disease, hypertension, obesity, diabetes, stroke, cancer and some gastrointestinal diseases. Sufficient intake of fibers maintains blood pressure, helps in adding bulk in fecal mass. The gastrointestinal diseases controlled by dietary fibers are gastroesophageal reflex, duodenal ulcer, diverticulitis, constipation and hemorrhoids. The dietary fibers are known to enhance immune system of body. The recommended intake of dietary fiber for children and adults is about 14g/1000 kcal. So it is great need to communicate and educate peoples for enhancing consumption of dietary fiber.

Keywords: Dietary Fiber, High Calorie Food Products, Hypertension, Diabetes, Immunity

INTRODUCTION

Dietary fibers, which are mostly indigestible parts of the plants, provide many health benefits if taken adequately **[1]**. Dietary fibers help in maintaining human physiology such as blood pressure **[2]**, weight loss **[3]**, maintains good appetite **[4]**, regulate fecal mass and its regularity **[5]**. Dietary fibers are known to reduce risk of many diseases such as diabetes **[6]**, coronary heart disease **[7]**, obesity **[8]**, hypertension **[9]**, hemorrhoids

[5], colorectal cancers **[10]**, breast cancer **[10]**, and prostate cancer **[10]**. Adequate intake of dietary fiber is known to enhance immune system of body also.

Dietary fibers are indigestible, non-calorific part of plants. Most of them are usually polysaccharides. These fibers are present in cell wall of plant cell and made up of cellulose. The definition of fiber has been extended to include oligosaccharides such as inulin and resistant starches **[1, 11]**. Scientist has classified fiber in number of ways by using their chemical and physical properties. Some scientist has classified fibers as dietary fibers like lignin, cellulose, betaglucans, hemicelluloses, pectins and functional fibers which include psyllium, chitin and chitosan, fructo-oligosaccharide, polydextrose etc. In other way fibers are classified as viscous and nonviscous, fermentable and nonfermentable and soluble and nonsoluble fiber.

Food habit of traditional India, regarding fiber intake is good; but in recent few decades with increasing urbanization food habit has been changed tremendously. In metros due to heavy work pressure and less time peoples are consuming high calorie and low fiber food materials, which are known as junk or fast food. Fast foods are energy rich and easily available or are very simple in cooking. Although fast food complete energy requirement of the body but they also creates several health related problems in body such as obesity, high blood pressure and gastrointestinal problems.

The review is written to make people aware about the positive impact of dietary fiber in human physiology and in reducing risk of several diseases. The average fiber intake for children as well as for adult is 14 g/ 1000kcal. There is need to let the people know about the benefit of intake of dietary fiber in their daily diet.

Dietary Fiber in Human Physiology

Dietary fibers play a crucial role in maintaining and functioning of many organs. Dietary fibers help in stool formation and its release. It also maintains blood pressure, stimulates insulin release, affects appetite and helps in release of bile salts. Dietary fibers are known to affect entire dietary tract. It is suggested that fiber behaves as a sponge with both fibrous and amorphous characteristics. The physiological actions of this sponge, as it passes along the gastrointestinal tract, are dictated by the physicochemical properties of its components **[12]**.

Dependent on the capacities of the fiber for gel formation and water adsorption, transit time may increase or decrease in different parts of the gastrointestinal tract (stomach, small intestine, colon) **[12]**. The indigestible

fibers help in movement of food materials and add bulk to the fecal mass and maintains it regularity in passing out **[1, 5, 12]**. Wheat bran **[13]**, fruits **[1]**, green vegetables [1], are rich in such fibers which are known to add bulk to **[12]**. In case of constipation cellulose and psyllium fibers are very effective **[14, 15]**. In India psyllium fibers are used since ancient time to add bulk and proper movement of stool. Soluble fibers such as pectin and mucilage are known to delay gastric emptying by slowing down movement of food material through the digestive tract **[1, 16]**.

Adequate consumption of dietary fiber may control constipation in both adult and children. Young children with milk feeding may often suffer from constipation. Increasing consumption of fiber in children may reduce constipation as well as it helps in reducing obesity, maintaining normal blood pressure and increasing immune response **[17, 18]**.

Cardiovascular Disease

High intakes of Fiber-rich foods are associated with significant reductions in coronary heart disease (CHD) risk **[19]**. The studies of dietary fiber intake in the US and Europe has found that each 10 g/d increase in total dietary fiber intake was associated with a 14% decrease in the risk of coronary events, such as myocardial infarction (MI), and a 24% decrease in deaths from CHD **[20, 21, 22, 23, 24]** Beneficial effects of fiber consumption on blood glucose and insulin responses may also contribute to observed reductions in CHD risk. Diets that are rich in fiber may also help lower blood pressure, another important risk factor for cardiovascular disease. In many studies it was found that adquate consumption of dietary fiber helps in reduction of systolic and diastolic blood pressure **[25, 26]** Oat fibers along with other fibers are known to reduce blood pressure from less to moderate **[2, 27, 28]**. Some observational studies have found inverse associations between dietary fiber intake and blood pressure or hypertension **[25, 26, 29, 30]**.

Numerous controlled clinical trials have found that increasing intake of viscous dietary fibers, particularly from legumes (dry beans, peas and lentils) and oat products decreases total serum LDL cholesterol and increases HDL cholesterol **[31, 32, 33]**. Soluble fiber from foods such as oat bran, as part of a diet low in saturated fat and cholesterol, may reduce the risk of heart disease. It was also found that if viscous fibers, such as pectin, guar gum and psyllium are increased in diet, has also been found to decrease total and LDL cholesterol levels **[20, 21, 22, 23, 24]**. Over

consumption of zero-fiber foods such as meat and dairy products and processed carbohydrates lead to a build-up of fat and cholesterol in blood leading to thickening and narrowing of arteries which lead to atherosclerosis.

Diabetes

Diabetes is disease in which degradation of glucose stops in body either due to no production of insulin hormone or due to insensitivity of cells towards insulin hormone. In the first condition where insulin production stops, is due to destruction of beta cells of islets of langerhans present in pancreas is called Type I diabetes. In second condition body makes sufficient amount of insulin but it does not bind to the receptor or receptor does not correctly transmit the second messenger. Diabetes is increasing at alarming rate all over the world **[34]**. The main causes of increasing diabetes are obesity **[35, 36]** less fiber and more fat based diet **[4]** and increasing stress.

High level of dietary fiber intake reduces diabetes significantly **[1]**. Studies have shown that high intake of dietary fiber have protective role in diabetes independent of other dietary factor **[1]**. Recent studies in Finland have shown that highest level of fiber consumption had 62% reduction in progression of prediabetes to diabetes in compared to those with lowest fiber intake **[1, 37]**. A separate study clearly indicated that high dose of fiber intake have substantial improvement in glycemic control and reduction in the use of oral medication and insulin doses. **[1, 38, 39]** both in type I and type II diabetes. The metabolic syndrome, which is a cluster of abnormalities including insulin resistance, dyslipidemia, visceral adiposity, and hypertension, can be ameliorated and, perhaps, reversed by high levels of dietary fiber or whole grain intake.64 Short-term studies indicate that dietary fiber intake decreases postprandial glycemia and insulinemia and enhances insulin sensitivity **[1, 40, 41]**.

Dietary Fiber and Gastrointestinal Diseases

Gastrointestinal system constitutes whole digestive tract from mouth to anus. Unhealthy and unbalanced diets are main cause of several gastrointestinal diseases such as gastroesophageal reflux disease (GERD), peptic ulcer, gall bladder disorders, appendicitis, diverticular diseases, hemorrhoids and colorectal cancer. It is found that balanced diet along with prebiotics and sufficient dietary fiber intake decreased prevalence of above mentioned diseases **[1, 42]**. High level of dietary fiber in diet is more effective in controlling diseases like GERD **[43]**, gastric cancer **[44]**, peptic ulcer **[45]**,

gall bladder **[46]**, diverticular diseases **[45]**, constipation and hemorrhoids **[4]**.

Studies have shown that higher fiber intake lowers the risk of GERD **[44]**. It is found that Guar gum and other soluble fibers lower the gastric acid production, which in turn protects GERD and reduce the risk of duodenal ulcer disease **[14, 47]**. Irritable bowel syndrome is another common worldwide gastrointestinal functional disorder. It is complex disorder in which many factors are involved. The symptoms involve abdominal pain, bloating, diarrhea or constipation **[1]**. High intake of dietary fiber such as methyl cellulose **[14]** partially hydrolyzed guar gum **[48]** and psyllium **[15]** have been reported to alleviate symptoms. Inflammatory bowel disease (IBD) including Crohns disease and ulcerative colitis are another very common problem of gastrointestinal tract. These diseases can be controlled and reduced by proper use soluble and non soluble fiber **[49]**.

Constipation

Increasing intakes of dietary fibers and fiber supplements can prevent constipation or hemorrhoids by softening and adding bulk to stool and speeding its passage through the colon **[5]**. Wheat bran and fruits and vegetables are the fiber sources that have been most consistently found to increase stool bulk and shorten transit time **[5]**. Fiber supplements that have been found to be effective in treating constipation include cellulose **[14]** and psyllium **[14, 15]**. Irritable bowel syndrome, sometimes called spastic colon or IBS, is one of the most common disorders of the lower digestive tract. The symptoms of IBS are constipation, diarrhoea (or both alternately), abdominal pain, cramps and spasms. Increased amounts of fiber in the diet can help relieve symptoms of irritable bowel syndrome and if not treated it may lead to diverticulosis of the colon **[1, 5, 42, 45]**.

Diverticular Disease

High fiber intakes are associated with decreased risk of diverticulosis, a relatively common condition that is characterized by the formation of small pouches (diverticula) in the colon **[50]**. These pockets usually cause no problem, but sometimes they can become infected (diverticulitis) or even break open, causing abscess or peritonitis. A high-fiber diet increases the bulk in the stool, which reduces pressure within the colon. By so doing, diverticula formation may be reduced or even stopped **[1, 5, 42, 45]**. Inulin type soluble fibers have great role in reducing recurrent inflammation of colon diverticuli **[51]**.

Colorectal Cancer

Colorectal cancer remains second most commonly diagnosed cancer in humans,

which leads to death **[52]**. Colorectal adenomatous polyps are considered as precursor to colorectal cancer **[53]**. The actual causes of colorectal cancer are mutagens and luminal irritants that damage colonic epithelial cell **[54, 55]**. This damage triggers epithelial hyperproliferation, which increases risk of colon cancer **[54, 56]**. Dietary habbits of a person are responsible for increase or decrease in colorectal cancer **[54]**. High intake of red meat with low green vegetables increases chance of colorectal cancer **[54]**. The red meat contains haem which acts as irritant **[54]**. Sesink *et al,* **[57]** hypothesized that haem the iron porphyrin pigment is important dietary risk factor. It is also thought that heterocyclic amines associated with high intake of meat are also important mutagens **[54, 58]**. Many other irritants such as high intake of spices also enhance proliferation of colonic epithelial cells.

The majority of case control studies conducted found that incidence of colorectal cancer was lower in people with high fiber intake. The green vegetables were found to be more effective than others fiber rich food products **[54]**. In countries where grains are less processed and contain high fiber and green vegetables are preferred in diet have lower incidence of colorectal cancer **[54]**. A large number of epidemiological studies indicate that diets high in fiber and low in fat protects colon cancer, especially green and raw vegetables **[59, 60]**. Vogel *et al,* **[54]** found that protective effect of green vegetables is due to inhibition of haem induced colonic cytotoxicity and hyperproliferation of epithelial cells.

Breast Cancer

A number of studies have found significant inverse associations between dietary fiber intake and breast cancer incidence, the majority of studies have not found dietary fiber intake to be associated with significant reductions in breast cancer risk. In Sweden, it was found that women with the highest fiber intakes (averaging about 26 g/d) had a risk of breast cancer that was 40% lower than women with the lowest fiber intakes (averaging about 13 g/d). Those women with the highest fiber intake and lowest fat intakes had the very lowest risk of breast cancer. In premenopausal and postmenopausal women, suggest that low-fat (10-25% of energy), high-fiber (25-40 g/d) diets could decrease circulating estrogen levels by increasing the excretion of estrogens and promoting the metabolism of estrogens. However, it is not known whether fiber-associated effects on endogenous estrogen levels have a clinically significant impact on breast cancer risk. At present, the available evidence does not support the idea that high

fiber intakes significantly decrease the risk of breast cancer in women **[61, 62, 63, 64, 65, 66, 67]**.

Dietary Fiber and Immune System of Body

The dietary fibers are known to improve the immunity of body. The immune system is defined as host's defense system against antigens. This is usually of two type; innate ie inborn component of the immune system and acquired; that body develops from exposure to environment. The innate immune system includes physical barriers such as skin and mucous membrane and cell mediated barriers such as phagocytic cells, inflammatory cells, dendritic cells, killer cells, cytokines and complements **[68, 69]**. The acquired immune system includes antigen antibody interaction, which develops throughout life time **[70]**.

Mucosal immune system which includes both innate and acquired immune system is placed in the areas where external pathogens and antigens may gain access to the body. It includes mucosal associated lymphoid tissue, which protects respiratory, urinary and reproductive tracts and GALT responsible for the protection of intestine **[69]**.

It is found in many studies that the addition of fermentable fiber in diet increases the immune response of the GALT and alters production of gut hormones **[69, 71, 72]**. Schley and Field, **[69]** found that in rats number of CD4+T-cells increased in mesenteric lymph nodes when they were fed with a diet containing 5% w/w pectin compared to cellulose. Similarly increased proportion CD8+ IEL when fed with sugar beet fiber than fiber free diet **[69, 73]**. Increased intake of fiber based diet has improved many other immune functions such as increase in serum, mesenteric lymph node and immunoglobulin production **[74, 75, 76]**, an increase in Peyers patches, more cytokine production in mesenteric lymph node **[69, 74, 75]**, and increase in intestinal mucosa **[69, 77, 78]**.

CONCLUSIONS

Increase in dietary fiber in daily diet is beneficial for healthy person as well as the patients. If taken adequately fiber can maintain body physiology and as well as could prevent from many diseases such as obesity, diabetes, stroke, cancer and some gastrointestinal diseases. The gastrointestinal diseases controlled by dietary fibers are gastroesophageal reflex, duodenal ulcer, diverticulitis, constipation and hemorrhoids. So it is urgent need for us to increase daily consumption of fiber for living a good healthy life.

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