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Dietary fiber a natural barrier against alarmingly increasing metabolic disorders

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Abstract: Dietary fiber a poly saccharide having ten or more monomeric unit. Endogenous enzymes in small intestine are unable to hydrolyze the dietary fiber. Dietary fiber is partially fermented in colon. Alarmingly increasing chronic disorders needs the management strategies. Dietary fiber inclusion in daily intakes is the best option for management and prevention of these disorders. Dietary fiber has significant role in reduction of serum glucose level by increasing insulin sensitivity and delayed gastric emptying. Serum cholesterol level is also controlled by its fecal egestion and by preventing bile reabsorption. Dietary fiber also reduces hypertension. Ample intake of dietary fiber is dire need of the scenario to cope with metabolic disorders.
Key words: Dietary fiber, lipid profile, serum glucose level, hypertension

1. Introduction:

Dietary fiber a complex non digestible polymers having impact on e.g. gut microlora, immunity and gut endocrine regulation (El-Salhy, Ystad, Mazzawi, & Gundersen, 2017). Dietary fiber includes cellulose, hemicellulose, pectin, hydrocolloids and lignin. Hydrocolloids and pectin is among water soluble dietary fiber. Hemicelluloses, cellulose and lignin are among the insoluble dietary fiber and whole grain is their good source. Insoluble dietary fiber is those components that are insoluble in water and includes cellulose, hemicellulose and lignin. (McKEE & Latner, 2000). Short chain fatty acids are the fermentation product of dietary fiber by the intestinal micro biota, having host physiological impact such as digestion of complex macromolecules, Vitamin synthesis, and reduction elimination of pathogenicity and has immumo modulatory role. (Holscher, 2017; Koh, De Vadder, Kovatcheva-Datchary, & Bäckhed, 2016). Diet with high fiber contents has positive impact on the physiological functions of the body. Dietary fiber in whole grain considered to be effective in the prevention and management of diabetes (Kaline, Bornstein, Bergmann, Hauner, & Schwarz, 2007). Dietary fiber contributes to a number metabolic effects e.g. improvement in insulin sensitivity, modulation of gut hormones secretion and effects on metabolic and inflammatory markers that are associated with the metabolic syndrome (Weickert & Pfeiffer, 2008). High dietary fiber diet has tendency to reduce the serum lipid profile by minimizing absorption of cholesterol in intestinal area and increasing fecal elimination of cholesterol. LDL- Cholesterol level of the experimental group was decreased by 1 to 13 mg/100 mL (Guo, Shu, & Yang, 2016; Ramos et al., 2011). Diet with dietary fiber 11.5 g/d changed systolic and diastolic blood pressure by -1.13 mm Hg by -1.26 mm Hg respectively (Streppel, Arends, van't Veer, Grobbee, & Geleijnse, 2005). Dietary fiber may enhance the body's defenses against oxidative stress, reduce inflammatory markers and reduces level of C reactive protein a major contributory towards cardiovascular diseases (King, Mainous, Egan, Woolson, & Geesey, 2005). Dietary fiber intake has positive impact on the immune system. Dietary fiber Fibers produce the short chain fatty acid

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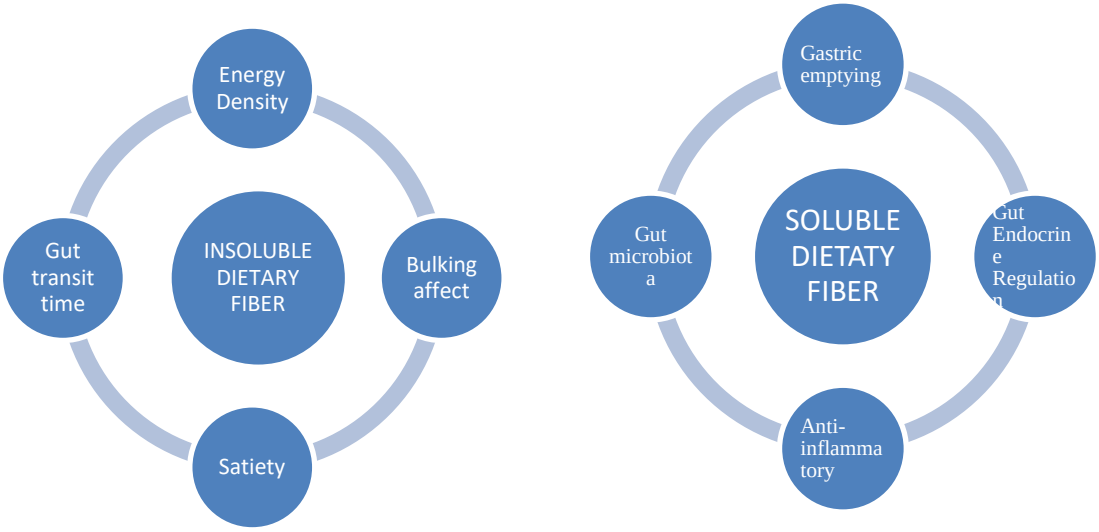
by fermentation of dietary fiber in colon by colonic micro biota and has immumo modulatory role. SCFA are produced in the fermentation process of dietary fibers in gastrointestinal track and have many physiological functions including maintenance of epithelial barrier, tumor suppression, reduction of oxidative DNA damage and cytokine regulation. Dietary fiber also has the anti-inflammatory affect, regulation of immune responses (Fernstrand, Bury, Garssen, & Verster, 2017).

Figure 1. Soluble and insoluble dietary fiber role



1.1 Health Benefits of Dietary fiber:

1.2 Effect of Dietary Fiber on Serum Glucose Level

Dietary fiber intake can reduce fasting glucose level 0.85 mmol. Type 2 diabetes can be managed by dietary fiber intake (Post, Mainous, King, & Simpson, 2012). Dietary fiber plays a therapeutic role. Dietary fiber incorporation in daily intake can reduce incidence of disease and can save millions lives and economic losses incurred on mediation (Ismaiel, Yang, & Min, 2016). Higher proportion of fiber in daily intake soluble dietary fiber decreases hyperinsulinemia and has hypolipidemia effect in diabetic patients (Chandalia et al., 2000; Tiberius, Carmen, & Evelin, 2017). Cereals grains are the economical and the richest source of insoluble dietary fibers and has potential role in prevention and management of diabetes (Kaline *et al*., 2007). Dietary fiber was efficient in decreasing glucose levels of diabetic patients. Consistent intake in daily diet has significant efficacy against these metabolic disorders (Andrade *et al.*, 2015). Type 2 diabetes is one of the metabolic syndrome having highest economic and social impact, also has detrimental effect on the quality of life. Prevention and management of this metabolic disorders should be focused rather than cure. High dietary fiber affect satiety level and delays gastric emptying hence promote blood glucose control (Velázquez-López *et al*., 2016). Dietary fiber when taken as dietary supplement improves various physiological functions including absorption, guts viscosity and regulates endocrine hormones.

Due to change in dietary behavior of masses dietary fiber should be incorporated in diet to fetch its physiological merits. This will not only improve the individual life but also will contribute towards decreasing health treatment burden of the developing countries (Lattimer & Haub, 2010). Diabetes increases mortality by almost 2-fold and increases mortality by cardiovascular disease by 2-to 3-fold. The diet rich in fiber reduces glycemic index of the food and is used as nutritional therapy against diabetes mellitus (Post *et al.*, 2012). Dietary fiber has no significant impact on the physiological function of pancreatic islets of Langerhans (C. Chen et al., 2016). High fiber diets having soluble fiber has impact in weight management, carbohydrate metabolism, total cholesterol and LDL. It also plays important role in improvement of insulin sensitivity, modulation of the secretion of certain gut hormones, improvement of various metabolic and inflammatory markers associated

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with the metabolic syndrome, thus reducing the risk of cardio-metabolic diseases (Mogoş, Dondoi, & Iacobini, 2017). Among the dietary fiber water soluble dietary fiber has potential to reduce postprandial blood glucose and insulin than insoluble fiber (Tabatabai & Li, 2000).

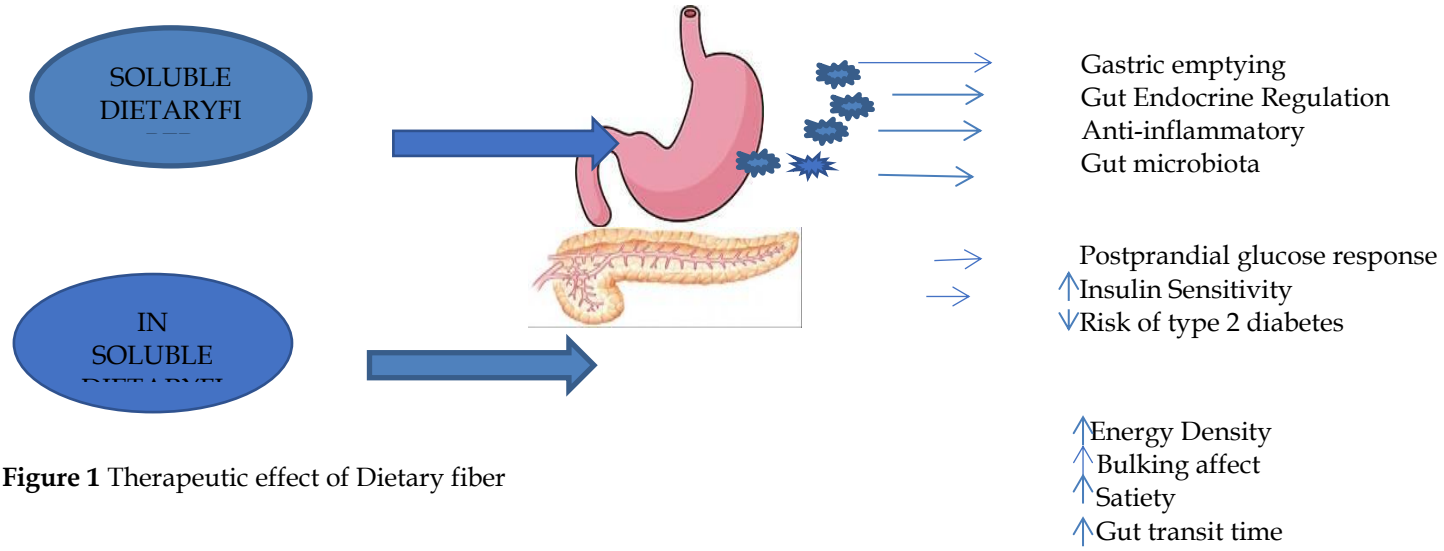

Figure 1 Therapeutic effect of Dietary fiber

Dietary fiber reduces prevalence of abdominal obesity, hypertension and metabolic syndrome. Dietary fiber intake lower occurrence of albuminuria, lower the glomerulous filtration rate and uremia (Fujii *et al.*, 2013). Primarily dietary fiber was considered due to its gastrointestinal affects but presently it is also known as having effect on glycaemia and lipidemia. Dietary fiber is s associated with substantial improvements in glycemic control and reductions in the use of oral medication and insulin doses (Anderson *et al.*, 2009). Functional role of dietary fiber is well documented in prevention and management of diabetes, attenuates insulin sensitivity, decreasing weight gain and reducing CVD,s (Li & Uppal, 2010). Apricot pulp SDF was investigated on diabetic rat. SDF fiber from apricot significantly ($p < 0.01$) changed blood glucose level and body weight after intragastric administration for 28 days (Cui, Gu, Zhang, Ou, & Wang, 2015).
(Kimmel, Michel, Hess, & Ward, 2000) investigated the effect of low fiber, high insoluble fiber diet and high soluble fiber diet diabetic dogs concluded that the blood glucose level of the dogs is affected significantly by the high insoluble dietary fiber intake.

Table 1. Mechanism of serum glucose lowering

Mechanism	Reference
Inhibit macronutrient absorption, reduce postprandial glucose response, Improvement of glucose sensitivity, modulation of gut hormones and by affecting metabolic and inflammatory markers	(Weickert & Pfeiffer, 2008)
Prolonged feeling of satiety	(de Leeuw, Jongbloed, & Verstegen, 2004)
Attenuates glycemic index, alters insulin sensitivity and has hypolipidemia affect	(Chandalia et al., 2000)
Alter small intestine juice viscosity Binding of available glucose Inhibitory effect on α amylase	(Ou, Kwok, Li, & Fu, 2001)
Increase insulin concentration	(Díez et al., 2013)

Body weight Management	(Rohajatien, Estiasih, & Sriwahyuni, 2018; Russell et al., 2016)
Regulating insulin level and body weight management	(Jiang et al., 2012)
Production of SCFA Regulation of pancreatic insulin release Regulation of glycogen breakdown	(Slavin et al., 2009(Zhao et al., 2018)
Venous and capillary postprandial blood glucose reduction Reduction in postprandial insulin concentration	(Stewart & Zimmer, 2018)
Reduction of micro inflammation Intestinal flora improvement	(Cai, Wang, Wang, & Liu, 2017)
Delayed gastric emptying, reduction of PH of digestion medium	(Alexander, 2012; Asif, 2011; Hyman, 2010; Scazzina, Siebenhandl-Ehn, & Pellegrini, 2013)
Abrogation of obesity	(Han et al., 2015; McRorie Jr, 2015)
Mediating glucose metabolism(Costa, Guimarães, & Sampaio, 2012)	(Costa et al., 2012(Abutair, Naser, & Hamed, 2016)
Obesity Management , insulin resistance, altering endocrine and cytokines production by the adipose tissue	(Galisteo, Duarte, & Zarzuelo, 2008)
Fermentation and altering viscosity of GI	(Dahl & Stewart, 2015)

1.3 Effect on Serum Lipid Profile

Diet with high fiber supplementation decreased the serum cholesterol level. It was observed there was a decrease of 1 to 15 mg/100 ml in the experimental group. The change in the LDL- Cholesterol value was significant at both 5 percent and 1 percent level of supplementation (Khogare, 2012). Soluble fiber and soy protein improved the serum lipid profile of the hypercholesteromic subjects significantly low-density lipoprotein (LDL) cholesterol fraction was significantly reduced (8.5% ± 3.3%, P = .020). Cholesterol rich diets are responsible for Hypercholesterolemia and hypertriglyceridemia. Cocoa fiber showed significant affect in hypercholesterolemia animals. The hypocholesterolemic effect was also patent, reducing LDL and total cholesterol (Guo et al., 2016; Lecumberri et al., 2007). Dietary fiber increased the fecal discharge of cholesterol by binding cholesterol through gastrointestinal track. Dietary fiber has lipid-binding ability and the inhibition of lipid peroxidation. Dietary fiber from has potential role in prevention and management of CVD,s. A higher content of dietary fiber in the diet reduces HbA1c, triglycerides and improves HDL levels. Higher fiber consumption ensures lowering calorie consumption and manage body weight to maintain healthy serum lipid profile.(Velázquez-López *et al*., 2016). Greater dietary fiber intake lower risk of both cardiovascular disease and coronary heart disease. It is recommended to increase fiber intake (Threapleton *et al*., 2013).

Table 2. Mechanism of serum cholesterol lowering effect of dietary fiber

Mechanism	References
Reduced glycemic response Prevention of bile salt re-absorption Excess fecal bile salt excretion Fiber binds bile salt micelles	(Gunness & Gidley, 2010)
Reduction in endogenous cholesterol synthesis	(Ramos et al., 2011)
Regulation of alpha-hydroxylase activity Reduction in cholesterol absorption	(Babio, Balanza, Basulto, Bulló, & Salas-Salvadó, 2010; Fernandez, 1995)
Production of SCFA	(Queenan et al., 2007)
Reduction in hepatic cholesterol synthesis Deconjugating bile salts	(Gallaher et al., 2002; Pereira & Gibson, 2002)
Secretion of 7-α-hydroxy-4-cholesten-3-one (Bile acid)increases	(Bazzano, 2008; Moreyra, Wilson, & Koraym, 2005)

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Depleting cholesterol from liver	
Lipid emulsification	(Sánchez-Muniz, 2012)
Lipolysis	
Postprandial lipemia	
inhibition of bile acid reabsorption	(Moreyra et al., 2005)
Glucose oxidation	(Zunft et al., 2003)
Insulin clearance	
Free fatty acids	
Cholesterol homeostasis	(Z.-Y. Chen, Ma, Liang, Peng, & Zuo, 2011)

Figure 2. Mechanism of cholesterol removal from gastrointestinal track

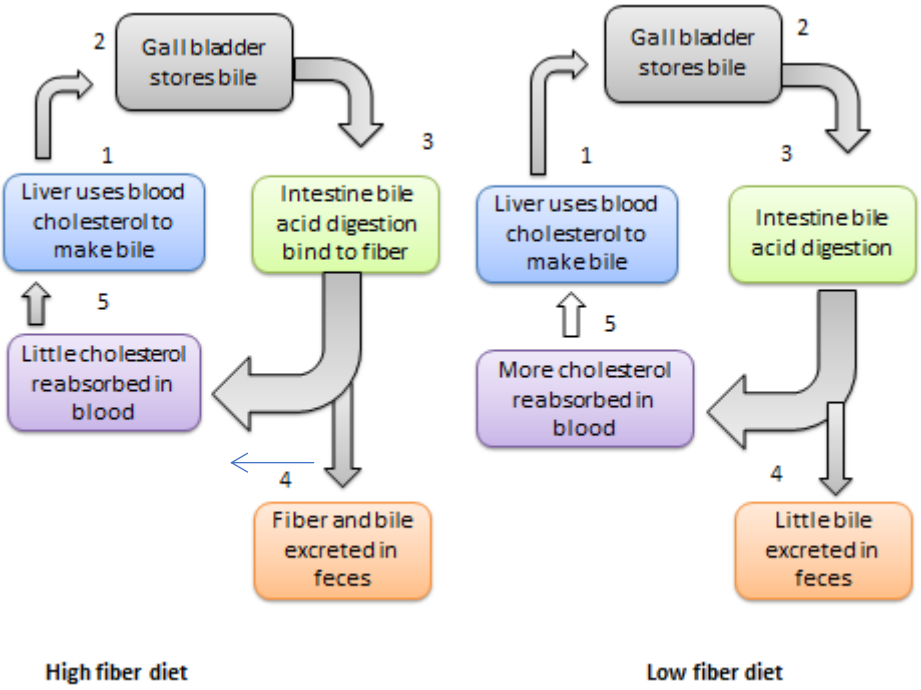

Figure 2.cholesterol reabsorption pathway

1.3.1 Dietary fiber Role in Hypertension

Dietary fiber is the natural mediator of metabolic disorders (Whelton et al., 2005).Studies revealed that oral intake of dietary fiber plays potential role in the reduction of systolic and diastolic blood pressure(Aleixandre & Miguel, 2016) by 1.13 mm Hg and 1.26 mm Hg respectively (Streppel et al., 2005). Dietary fiber intake reduced systolic blood pressure by 2.9 mmHg and diastolic by 1.5mmHg (Evans et al., 2015). Studies revealed that linear polysaccharide present in oat have significant effect on blood pressure reduction among the hypertensive patients. These mainly contribute towards the arterial blood pressure reduction (Aleixandre & Miguel, 2008; Daou & Zhang, 2012). Study revealed that dietary fiber lowered the systolic pressure by −5.95 mmHg and diastolic blood pressure and lowered systolic pressure −4.20 mmHg respectively by eight weeks intervention (Whelton et al., 2005).11.5 g /day dietary fiber intake systolic BP by –1.13 mm Hg and diastolic BP by –1.26

respectively. The reduction was more significantly observed among the hypertensive patients above the 40 years old (Streppel et al., 2005).Dietary fiber has significant effect in reduction of hypertension (Ötles & Ozgoz, 2014).

1.3.2 Immuno Modulatory Role of Dietary Fiber

Soluble fiber from oat has stimulates macrophages and monocytes thus increasing immunoglobin quantity, NK cells and killer T-cells. Immunomodulation provides natural barrier against parasitic infection and infectious cancerous cells (Daou & Zhang, 2012). Fermentable dietary fiber has immune modulatory effect. Mechanism by which this effect is modulation of gut-associated lymphoid tissues, secondary lymphoid tissues and peripheral circulation (Schley & Field, 2002), Mechanism of immunomodulation includes effects on f lactic acid-producing bacteria , bacterial constituents on immune cells, production of short chain fatty acids and binding of these fatty acid receptor on leucocytes (Kelly-Quagliana, Nelson, & Buddington, 2003; Seifert & Watzl, 2007; Watzl, Girrbach, & Roller, 2005). Studies revealed that dietary fiber has immunomodulatory role in both animals and plants (Delgado, Tamashiro, & Pastore, 2010). Immuno modulatory role of cereal beta glucan is due to its physical structure. Polymer ratio affects its solubility and aggregation. Fiber having low solubility and more aggregation property increase Immuno response (Mikkelsen, Jespersen, Mehlsen, Engelsen, & Frøkiær, 2014).

2. Conclusion

Chronic disorders are not only affecting the individuals but also threat to the developing economies. These increasing disorders can only be wiped out by preventive and management strategies. Dietary fiber is natural barrier against these disorders. Unfortunately, we are not consuming the recommended intake that's why are not fetching its benefits. Massive public awareness can play a vital role in introduction of health effect of dietary fiber at gross root level especially illiterate population of developing countries. This can be only the way to reduce the public health burden round the globe.

Abbreviation:

SCFA: Short Chain Fatty acid
HDL: High density lipo protein
IDF: insoluble dietary fiber
LDL: Low density lipo protein
SDF: Soluble dietary fiber
CVD,s : Cardio vascular diseases

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