Journal of Life Science and Biomedicine

JLSB ISSN 2251-9939

Volume 13, Issue 1: 12-16; March 25, 2023

DOI: https://dx.doi.org/10.54203/jlsb.2023.2

Therapeutic aspects of dietary fibre and glycemic index: a brief review

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REVIEW ARTICLE

PII: S225199392300002-13

Received: February 12, 2023

Revised: March 24, 2023

Accepted: March24, 2023

ABSTRACT: **Simple sugars, complex polysaccharides, and dietary fibres are all examples of dietary carbohydrates. A healthy diet should consist of more complex and less added carbohydrates. Dietary fibre is a non-digestible carbohydrate that is not digested and absorbed by the body but is required for satiety and bowel motility. Dietary fibre contains cellulose, hemicellulose, pectins, gums, mucilages, and lignin, which are resistant to enzymatic digestion. Various components of dietary fibre include arabinoxylan, inulin, β-glucan, pectin, bran, and resistant starches. Dietary fibre is a carbohydrate that resists digestion and absorption in the large intestine and may or may not be fermented by bacteria. Short chain fatty acids (SCFAs) are produced in the gut by the breakdown of fibre by intestinal microorganisms and offer energy calories (2 kcal/g). Dietary guidelines recommend increasing the dietary fibre intake since a high fibre intake provides health benefits and prevents dietary and life-style diseases. The aim of the present review article is to understand and suggest better dietary carbohydrates containing high fibre with low glycemic index for the prevention of diabetes, obesity and lifestyle diseases. The different types of carbohydrates in the diet need further recommendation to elucidate its function in health and diseases.**

KEYWORDS: **Carbohydrates; Fibre; Glucose; Glycemic Index; Short Chain Fatty Acids; Energy; Nutrition; Sugars**

INTRODUCTION

Simple sugars and complex polysaccharides are examples of dietary carbohydrates, which represent a broad range of natural chemicals. Carbohydrates are the most common source of macronutrients in the diet, and they are required for energy production and a variety of metabolic functions in the body. Carbohydrates are the main dietary source of energy for the human diet and accounts for about 50-65 percent of total calorie intake. There are three forms of carbohydrates: sugars, starches, and dietary fibres (Table 1). Polysaccharides, or complex carbohydrates, are the bigger carbohydrate polymers. Polysaccharides are divided into two categories in terms of nutrition: starches and non-starches. Starch is made up of glucose polymers that are either straight chain (amylose) or branched (xylose) (amylopectin). Non-starch polysaccharides are a diverse category of chemicals that aren't broken down by human digestive enzymes [1]. Starches found in potatoes, rice, and bread, as well as dietary fibres, are examples of complex carbohydrates. Whole grains, fruits and vegetables, as well as dietary fibre, provide the majority of the carbohydrate in the diet. Carbohydrates are mostly found in vegetables, fruits, whole grains, milk, and milk products. The dietary guidelines recommend the inclusion of foods such as cereals, vegetables, fruits, legumes, nuts, seeds, dairy products, and fibre which are rich in carbohydrates such as starch (grains, corn, potatoes), sucrose (sweet potatoes, table sugar), dietary fibre (fruits and vegetables) [2]. Foods high in dietary fibre, such as whole grains, cereals, legumes, vegetables, and fruits, are recommended. Therefore, dietary guidelines recommend the consumption of fruits, vegetables, whole grains, and nonfat dairy products in the diet for the requirement of carbohydrates [3].

Carbohydrates can also be divided into two categories based on how easily they digest in the intestine. Non-structural carbohydrates, also known as non-fibrous polysaccharides (NFC) or simple carbohydrates are the first type (i.e., starch, simple sugars, and fructans). Enzymatic processes easily hydrolyze it, allowing it to be absorbed in the small intestine. Complex carbohydrates, non-starch polysaccharide (NSP), or structural carbohydrates are included in the Neutral Detergent Fiber (NDF) and Acid Detergent Fiber (ADF) group (i.e., cellulose, hemicellulose,

lignin, pectin and beta-glucans). Dietary fibre is the carbohydrate polymers that are neither digested nor absorbed in the small intestine [4]. Dietary fibre is a polysaccharide that cannot be digested in the small intestine by endogenous enzymes [4-7].

The aim of the present review article is to understand and suggest better dietary carbohydrates containing high fibre with low glycemic index for the prevention of diabetes, obesity and lifestyle diseases.

Table 1. Nutritional classification of dietary carbohydrates [6, 7].

Carbohydrates	Nutrients	Pathophysiology
Sugars	Lactose, fructose, sucrose, glucose	Largely metabolized by liver. Malabsorbed by those with lactase deficiency
Starch	Maltodextrins, starch	Glucose release from foods reflects the rate of glucose availability in blood (glycemic index)
Non-starch	Dietary fibre	Plant foods rich in micronutrients and are beneficial to health.

Dietary fibre

Dietary fibre refers to non-digestible carbohydrates and some non-carbohydrate compounds such as cellulose, hemicelluloses, pectin, lignin, etc. Intracellular storage oligosaccharides, such as fructans, are also sources of fibre [8]. Dietary fibre is made up of non-digestible carbohydrates and lignin found naturally in plants [9]. Dietary fibre is made up of a wide range of macromolecules with a wide range of physicochemical properties. Cellulose, hemicelluloses, pectins, lignin, resistant starch, and non-digestible oligosaccharides are the primary components of fibre. The modification of intestinal function is one of the most well-known benefits of dietary fibre [9]. Meals high in dietary fibre increase satiety and are typically lower in calories [10-12] and may also help in the prevention of diseases [9]. Whole grains, fruits, and vegetables are all considered high-fiber foods [13, 14]. Fruits and vegetables typically have a fibre level of 1-3 percent. Fiber content is higher in nuts, legumes, and dried fruits than in fruits and vegetables (Table 2). Pectin is found in fruits, vegetables, legumes, and nuts while hemicelluloses are present in grains, etc. In most foods, cellulose accounts for one-third or less of the total fibre content [15-18].

Table 2. Amount of dietary fibre in some food items [19].

Foods	Fibre %
Rice	01
Potato	07
Onion	17
Chickpea	18
Beans	36
Wheat	44
Peach	67
Apricot	71
Soybean	72
Apple	74
Corn/Maize	88

Although vegetables and fruits may not contain the highest concentration of fibre, they are significant diets because they provide critical micronutrients. Cereals, particularly wholegrain meals, are high in nutritional fibre and typically contain 10-15% non-digestible substance. Insoluble polysaccharides such as cellulose and hemicelluloses are abundant in wheat and maize, while soluble gums such as beta-glucans are abundant in oats and barley, and soluble pentoses are abundant in rye [20]. Cellulose contains 30-40% of the non-starch and non-cellulosic polysaccharides such as uronic acids and arabinogalactans. Non-starch polysaccharides are found in seed legumes such as beans and peas (e.g., guar gum, locust gum and galacto-oligosaccharides). Other non-digestible plant substances that contribute to dietary fibre include cutin and suberin (leaves and fruits), lignin (seeds), chitin (fungi, an amino sugar) [4, 20].

Fibre consumption for people should be between 20 and 35 grams per day, based on the 14 g/1000 kcal/day recommendation. Adults in the United States consume less than half of the recommended fibre intake [13]. The dietary fibre consumption in developed countries is about 25 to 38 grams per day, which is half of what is recommended for adults. For a two-year-old child, the recommended fibre intake for infants and children is 19 g. These guidelines were developed using the age plus 5 rule (i.e., a 2-year-old should ingest 7 g of fibre per day). For

a 2000 kcal/day diet, people should consume 25 g of dietary fibre. A diet is said to be a good source of fibre if it contains 10% (2.5 g/serve) to 20% (5 g/serve) of the daily intake. Dietary fibre lowers the risk of chronic diseases such as coronary heart disease (CHD), type 2 diabetes mellitus (T2DM) and obesity [21]. If a food has 10% of the recommended quantity (2.5 g/serve), it is labelled as a "good source of fibre," and if it contains 20% of the recommended amount (5 g/serve), it is labelled as a "excellent source of fibre", which is about 25 g/d for women and 38 g/d for males based on the daily energy intake [14].

Glycemic Index

The essential micronutrients (e.g., micronutrients, polyphenols, phytosterols, and phytoestrogens) may have health benefits associated with dietary fibre consumption [8]. Increased consumption of high dietary fibre is related to the lower risk of cardiovascular disease, hypertension, diabetes, obesity [19]. Jenkins et al. [22] coined the term "glycemic index" to describe the rapid influence of carbohydrates on blood glucose levels. For persons with diabetes, the GI was used as a reference to help them choose low-GI foods [23]. Lower GI diets were thought to provide benefits due to their lower glycemic reaction after ingestion as compared to high GI foods (Table 3). The idea of GI has been expanded to include the impact of total carbohydrate consumption. As a result, the glycemic load (GL), which is a combination of the GI and the amount of carbohydrate consumed, indicates the amount of glucose accessible after a carbohydrate-rich meal [24-26] in addition to their function in the treatment of diabetes. The relationship between the test food/incremental meal's area under the Blood Glucose Response Curve (IAUC) and the reference food's IAUC determines GI (glucose). After consuming a portion of the test or reference food, which typically contains 25 or 50 g of accessible carbohydrate, blood glucose levels are measured [27].

GI: Carbohydrate (g) = Total carbohydrate (g) - Dietary fibers (g)

Relative GI of food = available CHO (g) X GI of the food/available CHO of the meal (g).

The foods with a high GI rapidly increase boost blood glucose levels as compared to low GI foods resulting in increased insulin demand and secretion. The GI system classifies carbohydrates as low (less than 55), medium (55-70), or high (higher than 70). Both the quantity and quality (i.e. nature or source) of carbohydrate influence the glycaemic response, the higher the GL, the bigger the predicted rise in blood glucose [26-30]. Hence, high fibre and low glycemic index carbohydrate intake is the key to human health and wellbeing [31, 32].

Table 3. Classification of foods according to glycemic index [27].

Low GI	Medium GI	High GI
Banana	Apricot	Breakfast corn cereal
Cashewnut	Banana	Energy drinks
Chickpea	Bread	Glucose
Lentils	Fresh orange juice	Potato
Mango	Honey	Watermelon
Milk	Pineapple	
Orange	Sweet potato	
Papaya	Sugar/Sucrose	
Pea		
Peanut		
Pear		
Strawberry		

CONCLUSION

Sugars, starches, and fibre are among the chemical constituents found in dietary carbohydrates. A healthy diet should consist of a high carbohydrate and fibre intake, as well as a low intake of added or free sugars. Non-glycemic carbohydrates and their derivatives are dietary fibres that are not absorbed by the body. If a person is diabetic, obese, and trying to reduce weight, free and added sugars are generally not suggested. Consuming complex carbs and dietary fibres on a daily basis is a good idea. People should be encouraged to choose lower GI foods and prepare them in such a way that their blood glucose levels do not spike. High GI meals should be eaten in conjunction with foods that are high in nutritional value, such as lean protein and olive oil, which can help lower

blood glucose levels. More research is needed to determine the impact of complex carbohydrates, dietary fibre, prebiotics, and processed foods on the potential health benefits of nutrients in food.

DECLARATIONS

Acknowledgments

This review article is dedicated to the memory of my late beloved father, one of the noblest human beings who lived and passed this side of the world. I also wish to acknowledge and appreciate the contribution of my family and friends for their prayers, encouragement and support in health and wellbeing.

Conflict of interest

The author declares no conflicts of interest, financial or otherwise.

Funding support

None.

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