Chapter

Suitability of Fruits and Vegetables for Provision of Daily Requirement of Dietary Fiber Targets

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Abstract

The risk factors associated with low dietary fiber intake and the synergy with its role in colon prebiotic activity has stimulated a re-awakening in the scientific research. Dietary fiber intake has reduced all over the world, and so it has been labelled as a major shortfall nutrient of important in public health. Changes in lifestyle and improved standard of living have affected the diet of consumers in so many ways. Observation of these facts have spurred a special interest in the search for functional foods that contains essential nutrients like dietary fiber whose nutritional value improves the health of the consumer, enhances their physical and mental state and prevent lifestyle diseases. Fruits and vegetables are a modest source of total dietary fiber with nutrients such as vitamins, minerals, and phytochemicals, including polyphenols, which provide support for their biological plausibility and enhance their health benefits. This chapter therefore reviews existing literature on the utilization of fruits and vegetables as rich sources of fiber; their fiber concentration, their appropriateness in meeting the adequate fiber intake for daily consumption and their overlapping roles as a fiber source and as nutraceuticals.

Keywords: Dietary fiber, chronic diseases, fruits, vegetables, functional fiber, adequate intake

1. Introduction

Diets of most industrialized nations have become sophisticated, transiting from the nutritious traditional diet to high-energy density and low nutrient diversity diet. This is largely reinforced by changes in lifestyle and improved standard of living, which in turn has resulted into an upsurge in lifestyle diseases such as diabetes [1], obesity, hypertension [2], intestinal cancer [3], obstructive sleep apnea and cardiovascular disease, caused by imbalanced diet [4]. In addition to the premature-mortality cases recorded for these diseases, they are also known to have a great impact on psycho-social functioning [5], work productivity [6], and global healthcare expenditure [7, 8]. These concerns have stimulated a special interest in the search for functional foods which benefits the consumer's physical and mental

state; and with the ability to prevent lifestyle diseases. Research in this regard has occurred primarily in western societies where a high prevalence of these chronic diseases has been observed and ultimately address the more frequent and severe malnutrition among lower-income countries [9].

Significant advances have been made recent years regarding the search for functional foods for metabolic regulations and medical therapeutic approaches to various chronic diseases. However, regardless of therapeutic choice for the management of most of these diseases, ultimately, the solution stems from behavioral change at an individual level [4]. One of the important factors that can guarantee an overall healthy lifestyle of an individual, is the consumption of adequate, but not excessive, levels of nutrient. While daily nutritional requirements for every individual varies depending on sex, size, age, and activity levels [10, 11]. An individual's exact requirement for a specific nutrient is generally unknown, with multiple confounding factors such as variations in genetic, metabolic, and gut microbial factors. All these factors combine to create much uncertainty regarding the optimal dietary needs for the individual [4]. Therefore, assessment of dietary adequacy for an individual can be a cumbersome task, due to the ambiguities associated with estimating an individual's usual intake and the lack of knowledge of an individual's actual nutrient requirements [11].

In this chapter, current knowledge on:

1. Dietary fiber definition

2. Dietary fiber intake among western population

3. Recommended adequate intake for total fiber.

4. Dietary fiber food sources: fruits and vegetables for daily fiber target provision.

5. Health promoting properties of dietary fiber.

2. Dietary fiber

Since the mid-twentieth century, when the term "dietary fiber" was coined by Hipsley [12], there has been concern about accurate and meaningful definition of this macronutrient component of the human diet. Due to the complexity of its varying composition in different food, it was formerly referred to as the non-digestible component of plant cell wall that resist digestion by secretions of the human alimentary tract (cellulose, hemicelluloses, pectin, and lignin) [12]. In 1998, 1998 American Association of Cereal Chemists International (AACCI) referred to Dietary fiber as the edible parts of plants or analogous carbohydrates that are resistant to digestion and absorption in the human small intestine with complete or partial fermentation in the large intestine. Like the AACCI definition, Codex Committee on Nutrition and Foods for Special Dietary defined dietary fiber as carbohydrate polymers with a degree of polymerization not lower than 3 which are neither digested nor absorbed in the small intestine [13]. Its definition was further stretched to include indigestible plant material that are not cell-wall components such as gums, algal polysaccharides, mucilage, and carrageenan were also included as dietary fiber [14]. Analytically, dietary fiber is a non-starch polysaccharide with three or more monomeric units and lignin from plants. Lignin, being a complex polymer of phenylpropane residues; the remaining dietary fiber components are polysaccharides. These polysaccharides resist digestion because they are

non-α-linked-glucan-polysaccharides, whereas the human digestive tract appears to secrete only α-glucosidases [15]. The European Food Safety Authority (EFSA) defined dietary fiber as non-digestible carbohydrate plus lignin. An extensive list of substances that constitute dietary fiber, such as hydrocolloids, non-starch polysaccharides, cellulose, fructo-oligosaccharides (FOS), and other resistant oligosaccharides were provided by EFSA [16].

Furthermore, dietary fiber is known to be the combination of "dietary" and "functional" fiber. It is classified into two basic categories based on water solubility: soluble fiber (pectins, gums and mucilage) and insoluble fiber (cellulose, hemicellulose, and lignin). This is because their physiological benefit differs based on their sources. However, most dietary sources of naturally occurring fiber contain both soluble and insoluble fiber, but in varying amounts [17]. Soluble fibers are known to be an active compound in the regulation of digestion and absorption in the gut and are known to be present in fruits, vegetables, legumes, sugar beet, potato, seed plants and seaweed extracts. In contrast, insoluble fibers are less fermented and will primarily act in the large intestine where it effectively increases fecal weight and volume, dilutes colonic contents, and decreases intestinal transit time. Its main food sources are vegetables, sugar beet, various bran, cereal grains, and wood plants [18–20]. Functional fiber refers to fiber sources (nondigestible carbohydrates) that are either synthesized, extracted, or isolated and manufactured from natural sources and been reported to show health benefits. They include β-glucans, cellulose, chitins, and chitosan, fructans, gums, lignin, pectin, polydextrose and polyols, psyllium, resistant dextrin, and resistant starches [21, 22]. Consumption of total fiber is considered as the sum of dietary fiber and functional fiber.

2.1 Dietary fiber intake among western population

The beneficial health effects associated with dietary fiber consumption and its synergy with the role of human intestinal microbiota has caused a re-awakening in the scientific research of its prebiotic properties [17]. Food composition tables from many countries now contain values for the dietary fiber content of foods. Several observational studies have established the link between fiber intake and the risk reduction of coronary heart disease, stroke, hypertension, diabetes, and diverticular diseases [23–25]. Low fiber intake is perhaps the most studied dietary risk factor responsible for the development of most cardiovascular diseases and other diverticular diseases [26].

In 2014, the Food Survey Research Group Dietary (FSRG), recorded the mean dietary fiber intake of all individuals two years and older, in US population, to be 15 grams per day (excluding breastfed children). While intakes of males and females were reported to be18 and 15 grams per day, respectively. The 2015–2020 Dietary Guidelines for Americans named fiber as a major shortfall nutrient of important public health concern [27, 28]. Despite the efforts in the past years to promote sufficient fiber consumption through fruit, vegetable, whole-grain, and other fiber sources, fiber intake has remained low when compared to the adequate recommended amount. Blacks had significantly lower dietary fiber intake (13 gm) compared to Whites (16 gm) and Hispanics (17gm) [29]. The National Health and Nutrition Examination Survey of 2009–2010 (NHANES), recorded vegetables and fruits as the highest contributors to the dietary fiber intake of the US population. They both accounted for the over one-quarter (28%) of the population intake (**Table 1**) [29].

The World Health Report of 2016 acknowledged high intake of saturated fatty acids, high total fat intake and inadequate consumption of dietary fiber as being among the world's most serious health risk factors [30]. In Australia, Dietary

Food categories	Individuals reporting (%)‡	Contribution to dietary fiber (%)
Vegetables: fresh, frozen, and canned vegetables, including potatoes	67	16
Fruits: fresh, frozen and canned fruit	48	12
Breads, rolls, tortillas: yeast breads and rolls, flour and corn tortillas, bagels, English muffins	66	12
Grain-based mixed dishes: pasta dishes, macaroni and cheese, burritos, tacos, tamales, fried rice,	33	9
Cereals: cooked and ready to eat cereals	33	8
Plant-based protein foods: beans, peas, legumes, nuts and seeds, processed soy products	28	8
Sweet bakery products, candy, other desserts: cakes, pies, cookies, snack/meal bars, ice cream	65	7
Savory snacks and crackers: potato chips, tortilla and corn chips, popcorn	46	6
Pizza: fast food/restaurant and frozen pizza	14	4

Data are from National Health and Nutrition Examination Survey (NHANES) 2009–2010 "What We Eat in America" (Fiber intake of the U.S population).
‡Percentage of individuals reporting the foods in the category at least once on the reporting day.
†Food categories not listed including soups, milk and dairy, burgers, and meat, poultry, seafood mixed dishes, contributed 3% or less to fiber intake.
†SOURCE: Hoy and Goldman [29].

Table 1.
The 2011–2012 National Nutrition and physical activity survey, showing vegetables as the food category with the highest contribution to dietary fiber consumption.

fiber is regarded as a nutrient of concern in diets, especially among adolescents, young adults and generally among the lower socio-economic status individuals falling short of recommendations. From the 2011–2012 National Nutrition and Physical Activity Survey, only 28.2% of children met the adequate fiber intake and less than 20% of adults met the suggested dietary target to reduce the risk of chronic disease [31]. The survey also showed that fruits and vegetables contributed greatly to dietary fiber intake (**Table 1**), as they accounted for 28% of population intake.

2.2 Recommendation for adequate intake (AI) level for dietary fiber

The compelling evidence of the health benefits associated with the consumption of dietary fiber has led to the emphasis on the increment of its inclusion in daily diet. According to the Institute of Medicine "the recommended Dietary Reference Intake (DRI) daily allowance for individuals aged 50 years and younger is 25 to 38 g/day (14g/1,000 kcal/day). For men aged 19–50 years the daily recommendation is 38 g/day and women 25 g/days, and for men ages > 51 is 31 g/day and women ages > 51 is 21 g/day. The recommendation for children ages 1–3 is 19 g/day and ages 4–8 is 25 g/day. For boys, ages 9–13, the DRI recommendations are 31 g/day, and 38 g/days for ages 14–18. For girls ages 9–18, the DRI recommendations is 26 g/day and 25 g of dietary fiber is the recommended amount in a 2000-kcal diet [32, 33]. Manufacturers are allowed to call a food a "good source of fiber" if it contains 10% of the recommended amount (2.5 g/serving) and an "excellent source of fiber" if the food contains 20% of the recommended amount (5 g/serving). It is assumed that once the lay public knows of the benefits of a given functional food then they

	Recommended intake (g/MJ)		Recommended intake (g/d)	
Country	**Children**	**Adults**	**Children**	**Adults**
Belgium				F: 30 M 15–18 years: 40 M 19–≥75 years: 30
Estonia			5+ age	25–35
Europe		3		>25
France			5+ age	30
Germany/Austria		F:3		≥ 30
Switzerland		M:2.4		
Greece				EC 1993 recommendations
Hungary				25[1]
Ireland				25–35
Italy	Developmental age (≥ 1 year):2	3–4 (RI)		
Latvia				No recommendation
Lithuania				No recommendation
Luxembourg				No recommendation
The Netherlands	13 years: 2.8		3.4	32–45 g/d
	4–8 years: 3.0			
	9–13 years: 3.2			
	14–18 years: 3.4			
Nordic countries	1–17 years: 2–3, from school age (6 years) increasing to level recommended for adults	3	≥6 years (school age): 10,	F:25
			Increasing gradually to adult recommended level	M:35
Poland			1–3 years:0	19–30 years:25
			4–6 years: 19	31–50 years:25
			7–9 years: 19	51–65 years:25
			10–12 years:16	66–75 years:20
			13–15 years:19	>75 years:20
			16–18 years:21	
Portugal				27–40
Romania				25–35[2]
Solvakia			0–6 months: 1	F 19–54 years:22–26[3]
			7–12 months:3	M 19–34 months 26–32[3]
			1–3 years: 10	M 35–59 years: 24–30[3]

	Recommended intake (g/MJ)		Recommended intake (g/d)	
Country	**Children**	**Adults**	**Children**	**Adults**
			4–6 years: 14	M 35–39 years: 20
			7–10 years:17	M 60–74 years: 22
			F 11–14 years:18	F > 75 years: 18
			M 11–14 years: 20	M > 75 years: 20
			F 15–18 years: 18–22	Pregnant F: 26
			M 15–18 years: 22–25	Lactating F: 28
Solvenia	2.4	F:3		30
		M2.4		
UK				18 (range 12–24)[4]
USA	All ages ≥1 years: 3·4	All ages ≥1	1–3 years:19	F 19–50 years**:** 25
		Years: 3–4	4–8 years: 25	M 19–50 years: 38
			F 9–13 years: 26	F > 51 years:21
			M 9–13 years:31	M > 51 years: 30
			F 14–18 years:26	
			M 14–18 years: 38	
			1–3 years:14	F:25
Australia/New Zealand			4–8 years: 18	M: 30
			F 9–13 years: 20	
			M9–13 years: 24	
			F14–18 years: 22	
			M14–18 years: 28	
WHO				>25

F, female; M, male; RI, recommended intake.; 1-Insoluble fiber: soluble fiber ratio 3:1; 2–75% insoluble, 25% soluble; 3- Depending on physical activity; 4 NSP.
Source: Stephen et al. [23].

Table 2.
Recommendations (adequate intake) for average population total fiber intake in different age groups in Europe.

will embrace the dietary change. **Table 2** provides recommendations for adequate intake for dietary fiber in different countries for different age groups.

Despite the beneficial health effects of dietary fiber, its intake is far below recommendations globally. Although there is no known deficient state of dietary fiber reported worldwide, trends in recent studies of adherence to healthy lifestyle habits have strongly influence food choice, which in turn affect daily total fiber intake. This trend is common among the young adults, for their preference in the consumption of soft drinks, snacks, prepared and pre-cooked meals and other ready-to-eat products, most of which are rich in sugars and fats, and deficient in fiber [34, 35]. This has

Food sources	TDF(g/100 g)	Solube fiber (%TDF)	Insolube fiber (%TDF)	Cellulose	Pectic polysaccharide	Hemicellulose	β-Glucans	RS	RO
Vegetable (Excluding potatotes)	<0.5–6: median: 2.2	37	63	+	+	++	-	-	-
Raw, steamed and baked vegetables				+	+	++	-	-	-
Soups	0.3–1.8; median: 0.9	39	6	+	+	++	—	—	—
Fruits									
Fresh fruit	0.4–10-4; median: 2.3	43	57	+ mostly skin	++	+	—	+(banana) (most fruits)	—
Processed fruit	0.4–2.0; median: 1.3			+	++	+	—	—	—
Dried fruit	0.1–11-14	53	47	+	++	+	—	—	—
Fruit Juices and nectar	Traces-0.65; median:0.4	90 (orange juice)	10	+	+++	—	—	—	—
Nuts and seeds	1.3–14; median:4.2	32	66	+	+	++	—	—	—
Legumes	4.2–10.6: median:4.5	25	75	+	—	++	—	++	++
Potatoes and other starchy tubers	0.5–8, median: 2.25	48 (potato without skin	52		+	+	—	+	—
Cereal products					—				
Leavened breads					+				—
White flour	3.0–3.4	50	50	+	—	++	—	+	—
Whole flour	5.6–7.2	20	80	+	—	++	+	+	+

Food sources	TDF(g/100 g)	Solube fiber (%TDF)	Insolube fiber (%TDF)	Cellulose	Pectic polysaccharide	Hemicellulose	β-Glucans	RS	RO
Breakfast cereals and cereal bars(excluding oat porridge, cereals)	1.2–15; median: 3–4	27	73	+	—	++	+	+	+
Oat porridge	1.7	52	48	+	—	++	++	+	+
Rye-based products	3.9–5-9	44	56	+	—	++	++	+	+
Rice									
White	0.82- < 1.1	≈0	≈100	+	+	+		+	
Whole	2.1–4; median 3–4	13	87	++	—	++		+	

TDF-total dietary fiber; RS- resistant starch; RO- resistant oligosaccharide; – means absent; + means present; ++ represent the level of abundance. Source [23].

Table 3.
Dietary fiber in different food sources – Quantitative and qualitative aspects.

led to the creation of strategies, such as the formulation of dietary guidelines model to increase fiber intake to improve American people's health [24, 29, 35, 36]. Low fiber intake has also been reported for other countries like Tunisia [37], Spain [38] and Australia [39] where only 29.5% of women reported to meet the recommended Adequate Intake (AI) of dietary fiber during pregnancy of 28 g/day. In terms of tolerance level for fiber intake, there is no upper tolerable level, but it varies by individual, and overconsumption can lead to common side effects such as bloating and abdominal discomfort.

2.3 Dietary fiber food sources: fruits and vegetables for daily fiber target provision

Dietary fiber food sources are characterized with high total fiber, low in moisture and lipid content, low caloric value, and neutral flavor [40]. With dietary fiber being undoubtedly an essential part of a healthy diet, numerous studies in food science field and human nutrition have constantly encouraged that the public should include adequate amount of food rich in dietary fiber into the diet. Fruits, and vegetables, grains, legumes, nuts, bread, pasta, cereals, and seeds contribute significant amounts of fiber to the diet. These food groups account for more than 70% of dietary fiber in the food supply [41, 42]. Other fiber sources include over-the-counter laxatives containing fiber, fiber supplements, and fiber-fortified foods. Several surveys have reported the contribution from these major sources of dietary fiber in the diet [23, 29, 43]. However, the contribution of fiber proportion from each food source varies for different nations of the world. Although Some uniformity exists and hence some general statements, like "grain products provide the largest proportion of fiber in the diet" were reported in most reports, with bread being the largest grain source, with smaller contributions from cereals, pasta, biscuits, and pastries [29, 44]. White flour and potatoes have also been reported to be the major fiber sources in American diets because they are widely consumed in the United States [45]. **Table 3** gives information on the main dietary fiber food sources, components of dietary fiber found in different fiber food sources and their total fiber in gram per 100 g. Apart from nuts and seeds, dried fruits and vegetables are seen at the top of the chart with total dietary fiber of 0.1–11.4 and 0.5–8 g/100 g, respectively.

3. Fruit and vegetables for daily target provision

Fruits and vegetables have historically held a place in dietary guidance as most countries have dietary recommendations that include fruits and vegetables. Compared with grains products and other fiber sources, fruits and vegetables are a very good and cheap source of dietary fiber mainly because of their availability, relatively higher soluble/insoluble fiber ratio, higher fat retention capacity, enhanced colonic fermentability, and improved functionality [40–42]. The nutritional assessment of fruits and vegetables in terms of dietary fiber was calculated using The Harvard University food composition database, derived from the US Department of Agriculture (USDA) data, and were categorized as "high in fiber" [46]. Dietary guidelines for Americans (2010) recommend that one-half of the food plate should be fruit and vegetables because commonly consumed vegetables provide about 1 to 3 g dietary fiber per 100 g and supply vitamins and minerals to the diet. Additionally, fruit and vegetables are sources of phytochemicals that functions as phytoestrogens, anti-inflammatory agents, and other protective mechanisms [43].

Recent focus on fruit and vegetables as a promising source of dietary fiber resides not only in their important role of lowering the risk of chronic diseases, but also as rich sources of carbohydrates, fats, proteins, energy, vitamins A, B1, B2, B3, B6, B9, B12, C, folic acid, and minerals [45]. The energy and fiber content (soluble and insoluble) of 10 commonly consumed fruits and vegetables are presented in **Table 4**. Most fruits and vegetables are not only consumed raw, some are consumed in the cooked form, and sometimes fried or prepared with other ingredients prior to consumption form. Potato is known to be one of the nutrient dense vegetable with high fiber content. Cooking methods, including frying, do not diminish dietary fiber content of potato. Fried and oven-baked potato with skin is reported to have fiber concentration ranging from 0.6 to 5.1 and may contribute a great amount of sodium and fat to the diet (**Table 3**). Similarly, cooked broccoli, green beans, spinach, and corn contains 3.3 g, 3.2 g, 2.4 g, 2.4 g respectively [45]. Regardless of the variation in the nutritional composition of fruits and vegetables varies widely, but they are known to be good sources of fiber and potassium [47].

Several studies have endorsed fruits and vegetables as a suitable and healthy source for adequate fiber intake. World Health Survey (2002–2003) report gotten from the interviews of 196,373 adults from 52 countries with mainly small and middle income showed that about 78% of the men and women consumed ≤5 portions

Common fruit /vegetable	Serving	Kcal	Total dietary fiber	Insoluble dietary fiber	Soluble dietary fiber
Potato, boiled	1 med, 167 g	144	3.0	1.6	1.4
Iceberg lettuce	1 cup, 57 g	8	0.7	0.6	0.1
Tomato	NLEA, 148 g	27	1.8	1.6	0.2
Onion	NLEA, 148 g	47	1.3	0.8	0.5
Carrot	NLEA, 85 g	30	2.5	2.1	0.4
Celery	NLEA, 110 g	18	1.8	1.7	0.1
Sweet corn	1 ear, 77 g	74	1.8	1.7	0.1
Broccoli	NLEA, 148 g	50	3.8	3.0	0.8
Green cabbage	1 cup, 89 g	22	2.2	1.7	0.1
Cucumber with peel	1 cup, slices	16	0.6	0.5	0.1
Banana	1 med, 118 g	105	3.1	2.1	1.0
Apple with skin	1 med, 182 g	95	4.4	3.1	1.3
Watermelon	NLEA, 280 g	84	1.1	0.8	0.3
Orange	NLEA, 154 g	75	3.4	1.4	2.0
Cantaloupe	NLEA, 134 g	46	1.2	0.9	0.3
Green grapes	NLEA, 126 g	87	1.1	0.6	0.5
Grapefruit	NLEA, 154 g	65	2.5	0.9	1.6
Strawberry	NLEA 147 g,	47	2.9	2.2	0.7
Peach	NLEA, 147 g	57	2.2	1.2	1.0
Pear	NLEA, 166 g	96	5.1	3.6	1.5

Source: [43].

Table 4.
Ten commonly consumed fruits and vegetables in.

of vegetables and fruit daily as recommended by the World Health Organization (WHO, according to the WHO: 400 g/day) [48]. In a 24-year study, Bertoia et al. [46] found that the consumption of all fruits and most vegetables contributed substantially to meet the daily adequate fiber intake by combining an increase of one-to-two servings of vegetables and one-to-two servings of fruits daily.

To meet the recommended (DRI) daily allowance of 25 to 38 g/day, Hornick and Weiss [49] found that a diet with mean fruits and vegetables of 2 daily servings intakes (servings/d) of 5.16 servings 3.5 portions (men); and 4.7 servings, 3.8 portions (women) will help an individual to meet the daily target. About 10% of the western population have been found to achieve the recommended adequate fiber intake by consuming whole fruits like apples/pears and prunes during mealtimes [50]. Fruits and vegetables are modest for synthetizing functional fiber. By-products from processing of fruits and vegetables like orange, apple and peach, carrot, potato, green pea, pepper, artichoke, onion, and asparagus that contains both soluble and insoluble fiber compounds have been reported to have a great potential for enrichment of foods or for providing techno-functional properties to food [51].

Likewise, dietary fiber content of fruits and vegetables have been implicated with several health-promoting properties. Prentice and Jebb [52] reported dietary fiber from fruits and vegetables to be involved in the regulation of hunger and saturation and hence prevented obesity. In a meta-analysis of cohort studies, Kan et al. [53] showed that dietary fiber from fruits and vegetables reduce the risk of diabetes. Dietary fiber from Fruits was also found to be associated with a reduced risk of chronic obstructive pulmonary disease [54]. Boeing et al. [55] reported that the dietary approaches to stop hypertension consists of a high proportion of vegetables and fruit in the diet. Some types of dietary fiber which are not present in most fiber food sources, are found in some fruits. For example, resistant starch that is only present in starchy foods is also present in fruits like green banana. Likewise, pectic substances are found in most fruits and vegetables but absent in major fiber sources (**Table 3**). The Los Angeles Atherosclerosis Study observed that a higher intake of pectin significantly slowed intima-media thickness IMT progression which appears to be the leading cause of cardiovascular disease [56].

It is a known fact that dietary fibers obtained from different sources, vary in fiber content and in composition of other nutrients that may impact their health benefits. For example, fiber from different food sources behave differently during their transit through the gastrointestinal tract, depending on their chemical composition and physicochemical characteristics [33, 57, 58]. Higher intake of dietary fibers from fruits like red apples, pears and prunes were reported to be associated with a lower the risk of diverticulitis [59]. Recent research found that dietary fiber from white potatoes plays a role in the production of fecal short-chain fatty acids concentration, which is important for immune regulation and maintaining gut health [45]. Studies have also established that most vegetable fiber, especially potato fiber has antiproliferative functions that may act as chemo preventive agents and protect the small intestinal wall against ingested compounds formed during cooking, such as melanoidins and acrylamide [60].

3.1 Health promoting properties of dietary fiber

The physiological functionalities and health benefits of dietary fiber has been extensively studied. Deficiency of dietary fiber in the diet may lead to several diseases such as gastrointestinal disorder [58], metabolic syndrome [61], appendicitis [62], inflammatory bowel syndrome [63], diabetes [64], obesity [65], cardiovascular disease [24], gallstones [66], etc. **Table 5** summarizes the functional health effect of dietary fiber.

Source	Isolated dietary fiber	Functions	Effects
Potato, lentils, peas	Somalto-oligosaccharides	Reduction of LDL and total cholesterol	Reduced risk of heart disease and cholesterolaemia
Apples, carrots, oranges, grapefruits, and lemons	Pectin	Blood lipid lowering; attenuates blood glucose	May reduce onset risk or symptoms of metabolic syndrome and diabetes
Treated vegetable cellulose	Methylcellulose,	Adds bulk to stool	Alleviates constipation.
artichokes, asparagus, bananas, chicory root, garlic, onions	Inulin, fructooligosacchaides	Balances intestinal pH and stimulates intestinal fermentation. production of short-chain fatty acids	May reduce the risk of colorectal cancer
Konjac roots	Glucomannan	Speeds the passage of foods through the digestive system	Facilitates regularity
Corn	Resistant starch, beta-glucan	Adds bulk to the diet, making feel full faster	May reduce appetite
Apples, oats, and Barley	Psyllium, β-glucans, and pectin	Increases gut transit rate and reduces the amount of time available for colonic bacterial fermentation of non-digested foodstuff	Lowers variance in blood sugar levels
Green banana	Cellulose	Delayed colonic transit time	Prolonged post-meal satiety and satiation
Beans		Induction of cholecystokinin	Balances intestinal pH and stimulates intestinal fermentation
Psyllium husk	Psyllium	Reduction of the glycaemic response	Lower the risk of diabetes

Sources: [19, 51, 67].

Table 5.
Source, types of fiber, functions, and health benefits of dietary fiber.

4. Conclusion

Dietary fiber is an active component of fruits and vegetables. They have been recognized nutritionists and public health as the cheapest and most commonly available fiber source all over the world. Apart from their dietary fiber composition, fruits and vegetables contain nutrients such as vitamins, minerals, and phytochemicals, including polyphenols, which provide support for their biological plausibility and enhance their health benefits. Increase in the consumption of fruit and vegetable fiber increases post-meal satiety and a decrease in subsequent hunger. Addition of fruits and vegetables servings to the diet can provide the daily recommended adequate fiber intake, therefore public health recommendations and nutritional guidelines should emphasize adequate consumption of specific fruits and vegetables and provide practical dietary guidance that maximizes the potentials their dietary fiber content and composition.

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Conflict of interest

The authors declare no conflict of interest.

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