

DIETARY FIBER CONTENT OF INDIAN DIETS

ARCHANA SINGH*, SOM NATH SINGH

Department of Nutrition, Defence Institute of Physiology and Allied Sciences, Defence Research and Development, Delhi, India.
Email singharchana14@gmail.com

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ABSTRACT

The fiber rich diets have a positive effect on health as their ingestion has been related to decreased prevalence of several diseases. It is speculated that Indian diets have the potential to reduce the prevalence of a variety of risk diseases; however there are limited studies available on the dietary fiber (DF) composition of foods available in India. High-fiber foods have a far lower energy density as compared with high-fat foods. Thus, high-fiber foods can displace energy (calories). The satiation and fullness of stomach are predominantly influenced by the bulking and viscosity properties of DF. Persons who consume generous amounts of DF, compared to those who have minimal fiber intake, are at lower risk for developing coronary artery diseases, stroke, hypertension, diabetes, obesity, and certain gastrointestinal diseases. Increasing the intake of high fiber foods or fiber supplements improves serum lipoprotein values, lowers blood pressure, improves blood glucose control for diabetic individuals, and aids weight loss. Emerging research indicates that intake of soluble fibers enhances immune function in humans.

Keywords: Dietary fiber, Glycemic index, Nutrient composition, Recommended allowance.

INTRODUCTION

The linkage between food and health has resulted in consumer's interest in knowing the nutritional and therapeutic value of the food they eat. The basic tendency of human beings has always been to procure and consume "natural foods" [1]. However, urbanization has increased the demand and intake of canned, packaged, ready to eat (RTE), processed foods. There is an increasing trend toward replacing traditionally cooked foods with readily available processed foods. Many of the consumers have become aware that they are being deprived of some food components, which may be of immense importance to health.

Different processing methods like milling of grain to yield refined flour, canning of fruits, and vegetables, etc., curtail the supply of fiber from the diet. Fiber not only increases the bulk of the food and movement through the gastrointestinal tract more rapidly, but also helps in preventing constipation and reducing the risk of colon and rectal cancer [2,3]. Traditionally, fiber was known as roughage, bulk or ballast and was measured as crude fiber. Fiber, now it is termed as dietary fiber (DF), has been accorded the scientific importance it deserves. Intake of fiber through various foods such as nuts, whole-grain flour, fruits, and vegetables is now associated with decreased low-density lipoprotein (LDL) - cholesterol, improving insulin sensitivity, increased stool bulk, softening of fecal contents, improved laxative properties [4-6], and body weight regulation [7]. Fiber increases mucin secretion for lubrication purposes and deficiency of fiber results in colonic mucosal fragility [8]. Epidemiological studies have correlated high consumption of DF with a lower incidence of certain diseases such as cardiovascular and cancer of colon and rectum. Such findings boosted searches for DF. Several conditions such as diabetes, atherosclerosis, breast cancer, diverticulitis, hemorrhoids have been connected to a low intake of fiber [9] and also the presence of obesity [10,11]. Fiber has now become the third most sought-after health information in supermarkets in our country India [12].

Indian diets have the potential to reduce the prevalence of a variety of risk diseases; however, there are limited studies available on the DF composition of foods available in India [13]. Earlier, the DF content of fifteen cereals and pulses by using the Southgate's method [14] of analysis was reported by researchers [15]. Using their values they have further calculated the fiber intakes from the balanced diets recommended for various age groups for Indians for a long period of time.

Diets with high energy density elevate energy intake in comparison to diets with lower energy density. Humans may consume a constant weight of food and, as such, a constant weight of lower energy (i.e., high-fiber) food per unit weight may promote a reduction in weight [16]. High-fiber foods have a far lower energy density as compared with high-fat foods. Thus, high-fiber foods can displace energy (calories). The satiation and fullness of stomach are predominantly influenced by the bulking and viscosity properties of DF. Fiber-rich foods usually are accompanied by increased efforts and/or time of mastication, which leads to increased satiety through a reduction in the rate of ingestion.

High-fiber foods are generally solid in nature. However, a number of newer functional fibers, like resistant starches and oligosaccharides are simply added to drinks without affecting their viscosity. The drinks supplemented with these soluble, non-viscous fibers may have satiating effects hereto unreported.

Intrinsic, secretion, and colonic effects of DF decrease food intake by promoting satiation and/or fullness [17]. Fullness or satiation is defined as the satisfaction of appetite that develops during the course of eating and eventually results in the cessation of eating. Satiety refers to the state in which further eating is inhibited and occurs as a consequence of having eaten. DF also decreases gastric emptying and/or slows energy and nutrient absorption, resulting in lower postprandial glucose and lipid levels. DF may also influence fat oxidation and fat storage.

The effects of DF on hunger, satiety, energy intake, and body weight were reviewed by researchers [7]. Most of the studies with controlled energy intake reported a rise in post-meal satiety and a decrease in subsequent hunger with increased DF.

CONSTITUENTS OF DF

Based on its solubility in the water total DF (TDF) can be classified into two types: Soluble and insoluble. Both types of fiber are composed of dense indigestible polysaccharide carbohydrates, which cannot be digested by humans.

Soluble DF (SDF)

It is the edible portion of plant foods, which is resistant to digestion and absorption in the small intestine. While passing through the large intestines (colon), partial or total fermentation occurs due to the action

of colonic bacteria. Soluble fiber is gummy and is primarily found in the pulp of fruits, legumes, greens, etc. [18]. The advantages of SDF are: (1) Lowers total and LDL cholesterol (bad cholesterol) therefore reduces the risk of heart diseases, (2) regulates blood sugar levels in diabetes.

Insoluble DF (IDF)

It is made up of the structural material of cell wall of plant foods. It adds bulk to the stool, softens the stool, and increases the transit time through the intestinal tract. Some insoluble fibers bind certain minerals, including calcium, magnesium, phosphorus, and iron. The advantages of IDF are: (1) Promotes regular bowel movement and prevents constipation, (2) removes toxic waste from the body, (3) prevents microbes from stagnating and producing cancerous substances.

Both insoluble and soluble fiber gives the feeling of fullness after a meal, which benefits obesity and weight management. Too much fiber can also cause abdominal discomfort, gas, and diarrhea. DF is not a single entity but consists of a wide range of complex polysaccharides such as cellulose, gums, mucilages, hemicellulose, and lignins with different chemical, physicochemical, and physiological properties (Table 1) [19].

DF: NUTRITIONAL AND HEALTH SIGNIFICANCE

Though fiber has been the most important component of the Indian diets, its benefits have been overlooked for a long time. There has been overwhelming evidence that fiber is essential to maintain body weight and composition, blood levels of sugar (low glycemic index [GI]), triglycerides, and cholesterol (binding by fiber components and increased excretion), and regulatory bodies like FDA have approved health claim label of many sources of good fiber, the soluble fiber [20-22]. Soluble fiber is derived from a range of sources and widely known ones are modified maltodextrins (reduces blood glucose, promotes growth of healthy bacteria), inulin (from wheat, onions, banana, and chicory or synthesized) a probiotic, and laxative in nature or oligofructose fructo-oligosaccharides, shown to be associated with inulin or is formed as a byproduct of bacterial or fungal action on inulin. Insoluble fiber is composed of structural components of plant cells. Cereals, seeds, beans, many fruits and vegetables, bran and whole grain are food sources of insoluble fiber [23,24]. These fibrous compounds may also help to facilitate weight loss [7], cut back the risk of carcinoma [25], and cardiovascular disease [26,27].

A decreased heart disease risk through better control of lipoprotein lipids with fiber supplementation was observed [28]. The concept of GI of foods as a method of ranking foods on the basis of the blood glucose response they produce was popularized [29]. This concept emerged as physiological basis for ranking carbohydrate foods according to the blood glucose response they produce on ingestion. The same weight of carbohydrate in different foods on the basis of the blood glucose response they produce. This concept emerged as a physiological basis for ranking carbohydrate foods according to the blood glucose response they produce on ingestion. The same weight of carbohydrate in different foods can produce widely different glucose responses. Some foods containing different fractions of soluble and insoluble fibers favor slow release of sugar into the small intestine and its absorption into blood (reduced peak and prolonged rate). Thus, these are termed lower GI foods as compared to higher glycemic foods with readily digestible and absorbable sugar, having practical utility in the management of diabetes and control of obesity shown in Table 2 [30, 31].

DF INTAKE IN INDIA

The recommended allowance of DF is 35-40 g/day for an adult and should be taken in small amounts but at regular intervals. In habitual Indian diets, being based predominantly on unrefined cereals and plant foods, this level of DF intake is easily achieved [13]. The DF contents of selected Indian foods are shown in Table 3 [32-35]. Portion size of foods (raw) to be used in balance diet and their DF content are depicted

Table 1: Components of DF [19]

Major class	Property	Chemical nature
Cellulose	Water insoluble	Linear 1-4 β -glycans
Non-cellulose polysaccharides		
Pectin	Water soluble	Galacturonic acid, neutral sugars
Hemicellulose	Water insoluble	Xylose, arabinose, galactose
Gums	Water soluble	Xylose, arabinose, rhaminose
Mucilages	Water soluble	Galactose, galacturonic acid, rhaminose
Lignin	Water insoluble	Polymer of hydroxyphenylpropane derivatives

DF: Dietary fiber

Table 2: Classification of foods depending on their GI

Classification	GI range	Examples
Low GI	55 or less	Most fruit and vegetables (except potatoes, watermelon, and sweet corn), whole grains, pasta foods, beans, lentils
Medium GI	56-69	Sucrose, basmati rice, brown rice
High GI	70 or more	Corn flakes, baked potato, some white rice varieties (e.g. jasmine), white bread, candy bar, and syrupy foods

GI: Glycemic index

Table 3: DF content in selected Indian raw foods [32-35]

Food group	Food item	Fiber content g/100 g edible portion		
		Crude fiber	TDF	Soluble fiber
Cereals	Rice	0.2	4.11	0.92
	Wheat	0.3	12.48	2.84
	Bajra	1.2	11.33	2.19
	Maize	2.7	11.54	1.65
	Jowar	1.6	9.67	1.64
	Ragi	3.6	11.85	0.89
Pulses, dhals	Lentil	0.7	10.31	2.04
	Chick pea	1.2	15.3	2.56
	Pigeon pea	0.9	9.14	2.33
	Green gram	0.8	8.23	1.69
Vegetables	Cluster beans	3.2	5.7	1.6
	Brinjal	1.3	6.3	1.7
	Cabbage		2.8	0.8
	Cauliflower	1.2	3.7	1.1
	Bhendi	1.2	3.6	1
Roots and tubers	Potato	0.4	1.7	0.6
	Carrot	1.2	4.4	1.4
	Onion	0.6	2.5	0.8
Green leafy vegetables	Spinach	0.6	2.5	0.7
	Amaranth	1	4	0.9
Fruits	Orange	0.3	1.1	0.5
	Banana	0.4	1.8	0.7
	Apple	1	3.2	0.9
	Tomato	0.8	1.7	0.5

DF: Dietary fiber

in Table 4. It shows the number of carbohydrate servings prescribed covered 40-42% of TDFs.

Table 5 shows the DF intake in India by different socioeconomic groups varies from 15 to 41 g/day, depending upon the type of food consumed [36]. The fiber intake is lower in women (15-30 g/day) and is much lesser in tribal population (15-19 g/day). DF intakes in

Table 4: Portion size of foods (raw) to be used in balance diet and their DF content

Food Item	Portion	g/portion	Energy (Kcal)	Protein (g)	Carbohydrate (g)	Fat (g)	Fiber content		
							Crude DF (g)	TDF	Soluble
Cereals and millets	1	30	100	3	20	0.8	0.564	3.411	0.552
Pulses	1	30	100	6	15	0.7	0.27	3.222	0.648
Egg	1	50	85	7	0	7	0	0	0
Meat/chicken/fish	1	50	100	9	0	7	0	0	0
Toned milk (ml) and milk products	1	100	70	3	5	3	0	0	0
Roots and tubers	1	100	80	1.3	18	0	0.73	2.86	0.93
Green leafy vegetables	1	100	46	3.6	0	0.4	0.8	3.25	0.8
Other vegetables	1	100	28	1.7	0	0.2	1.72	4.42	1.24
Fruits	1	100	40	0	10	0	0.625	1.95	0.65
Sugar	1	5	20	0	5	0	0	0	0
Fat and oils (visible)	1	5	45	0	0	5	0	0	0

DF: Dietary fiber, TDF: Total dietary fiber

Table 5: Intake of DF by different income groups in India [36]

Group	Fiber intake (g/day)	
	Male	Female
Rural	39	30
Tribal	19	15
Industrial	41	31
HIG	31	21
MIG	43	22
LIG	24	20

Average intake per consumption unit. DF: Dietary fiber, LIG: Lower income group, HIG: Higher-income group, MIG: Middle-income group

Table 6: Reported DF content in selected Indian processed foods [33]

Processed foods/rations	DF (g/kg DW)		
	Soluble	Insoluble	Total
PD khichdi	8.22 (10)	70.66 (90)	78.88
PD vegetable pulav	6.18 (8)	70.35 (92)	76.53
PD green gram da1 curry	18.44 (19)	80.43 (81)	98.87
Instant halwa mix	8.82 (26)	24.69 (74)	33.51
Instant upma mix	26.54 (31)	59.92 (69)	86.46
Flavored chapathy	22.56 (26)	63.79 (74)	86.35
Spiced potato chapathy	22.78 (42)	31.59 (58)	54.37
Chikki (peanut candy)	15.27 (27)	42.40 (73)	57.67
Pickle mixed	2144 (22)	77.43 (78)	98.87

Figures in parentheses indicate values expressed as a percent of TDF. PD: Precooked and dehydrated, TDF: Total dietary fiber, DF: Dietary fiber

Table 7: Reported DF content in selected RTE foods [38,39]

Product	DF (g/100 g dry weight)		
	Soluble	Insoluble	Total
Pongal	2.11	6.12	8.23
Khara bhath	2.64	6.7	9.3
Dal fry	3.7	6.9	10.6
Bise bele bhath	3.36	9.97	13.33
Rajmah masala	6.46	12.4	18.86
Kesari bhath	6	8.8	14.8
Vegetable khichdi	12.3	5.9	18.2
Vegetable pulav	12.3	1.1	13.4
Chicken pulav	12.2	1	13.2
Mutton pulav	18.8	1.2	20
Sooji halwa	10.3	2.5	12.8
Upma	17.2	1.1	18.3
Potato peas curry	10.1	3	13.1
Cauliflower peas curry	5.1	0.4	5.5

DF: Dietary fiber, RTE: Ready to eat

Table 8: Reported DF content (g/100 g FW) in selected Indian processed foods [40]

Product	Carbohydrates g/100 g FW	Fiber g/100 g FW
RET foods		
IPS Sooji halwaa	58	0.9
IPS Aloo cholay	12.4	1.1
IPS potato peas curry	16.8	1.9
IPS baked beans	25.9	1.5
Canned vegetable pulav	23.8	1.1
Canned upma	23.8	1.1
Canned vegetable curry	10.2	0.8
Mango bar	82.4	1.2
Canned mutton curry	3.5	1
Canned chicken curry	3.9	0.6
Easy-to-reconstituted foods		
P.D. Arhar Dal curry	51.5	12.5
Insta Nutro cereal mix	47.7	2.3
Instant spiced arhar dal	47.8	4.4
Instant spiced urad dal	48	1.9
Instant spiced channa dal	46.2	2.4
Freeze-dried products		
Lemon rice	67.8	0.8
Peas pulav	61.9	4.7
Peas paneer	23.4	5.5
Chicken pulav	45.7	2
Chicken masala	9.9	1.2
Pineapple juice powder	96.3	0.7
Mango juice powder	95.8	1.4
Grape juice powder	96.5	0.7

FW: Fresh weight, DF: Dietary fiber, RET: Ready to eat

Table 9: DF digestibility

Fiber component	Intake g/day	Digestibility (%)
Cellulose	18.2	30.0
Hemicellulose	12.8	53.4
Lignin	6.7	8.1
Neutral detergent fiber (total)	37.7	34.1

DF: Dietary fiber

wheat- or millet-based diets are generally higher than in a rice-based diet. Particularly among the low-income group, about 80% of the fiber content of the diets, consumed in India, is contributed by cereals. Diets of high income groups mainly include fruits, vegetables and legumes, and, therefore, contain more soluble non-starch polysaccharides (NSP) than diets of the poor, although the total NSP content of the diets of the two groups may be the same.

Several Indian foods have been analyzed [37-40] and are shown in Tables 6-8. The DF content of the various foods rank as follows: Mutton

Pulav > Rajmah > Upma > Vegetable khichdi > Kesari bhath > Vegetable pulao > Bisi bele bhath > Chicken pulao > Khara bhath > Pongal > Cauliflower pea curry > Dal fry.

A study estimated the digestibility of neutral detergent fiber of diets with wheat and rice as predominant cereals (Table 9) [41]. The overall fiber (intake 38 g/day) digestibility was about 35%, in which lignin digestion was only 8%, hemicellulose was 53%, and cellulose 30%. This 35% digestibility of fiber adds to the calorie content (about 13 g of digested fiber adds approximately 50 kcal/day to the daily calorie intake).

CONCLUSION

This article provides information on the DF content of different sources of fiber. A high level of fiber intake has health-protective effects and disease-reversal benefits. The fiber intake is lower in women and is much less in the low-income group and tribal populations in our country. Persons who consume generous amounts of DF, compared to those who have minimal fiber intake, are at lower risk for developing chronic heart diseases, stroke, hypertension, diabetes, obesity, and certain gastrointestinal diseases. Increasing the intake of high fiber foods or fiber supplements improves serum lipoprotein values, lowers blood pressure, improves blood glucose control for diabetic individuals, aids weight loss, and improves regularity. Emerging research indicates that intake of soluble fibers enhances immune function in humans.

It was observed that different processed foods, RTE foods contain appreciable amounts of DFs. Thus, have different physiological implications, it is suggested to be beneficial in the management of obesity and diabetes. DF undergoes fermentation in the large bowel, producing short-chain fatty acids, which are implicated to exert a protective effect against the development of colon cancer [42-44].

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