DIETARY FIBER PROFILE OF FOOD LEGUMES

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ABSTRACT

The dietary fiber profile of seven legume seeds was determined by enzymatic methods to assess their nutritional significance, at Post Graduate Research Lab of Department of Agricultural Chemistry, NWFP Agricultural University, Peshawar, during 2005. The total dietary fiber (TDF) content varied from 11.5% in lentil to 33.2% in guar. Guar was also found to be the richest source of soluble dietary fiber (SDF). The water insoluble to soluble fiber ratios reflected that all legumes contained higher proportion of insoluble fiber than the soluble fiber. The major fiber constituents in all legumes were cellulose and hemi-cellulose, while pectin and lignin were minor components. Guar seeds contained the highest amount of cellulose (12.5%), pectin (3.0%) and liginin (2.0%). Chickpea was found to be the best source of hemi-cellulose. The data indicated that guar, chickpea and field bean contained more soluble fiber than the other legume species, hence they are nutritionally better to be used in food menu.

INTRODUCTION

Dietary fiber has been recognized as a healthy food component (Walker, 1998). It consists of a mixture of polymeric non-starch substances, which resist enzymatic digestion in the human gastrointestinal tract. Most of these substances are complex carbohydrates like cellulose, hemi-cellulose and pectin (Toberfroid, 1993) Phenolic compound, lignin also constitutes a small portion of dietary fiber (Morenol and lopez, 1993). Health benefits associated with adequate intake of these substances include: lower blood cholesterol and sugar levels, reduced risk of constipation, obesity, dieabetics, heart complications, colon and rectal cancer, gallstone, piles and hernia. (ADA, 1997). These health benefits reflect the nutritional significance of dietary fiber, and have attracted the consumer to fiber rich foods. Public health organization (WHO, 1986 and NRC, 1989) also recommended an increase in the daily consumption of dietary fiber. For these reasons, the determination of the dietary fiber content of food has been receiving much attention for the last few years (Englst *et al,* 1988, and Palaami *et al.* 1992). A wide variety of food items have been analyzed for their total dietary fiber content (Lintas and Cappelloni, 1988, Mongean *et al,* 1989). Attention has been focused on the dietary fiber content of legumes (Sharma, 1986 and Vidal valverde *et al.* 1992) because of their effectiveness in lowering blood cholesterol, improving glucose tolerance and reducing insulin requirements (Anderson *et al.* 1984, Tappy *et al,* 1986 and Shulter *et al,* 1989). Although the total dietary fiber (TDF) content of certain legumes has been measured, but variations in the available data exist, these variations could be regional (soil and climatic) and genotypic. However, methodological differences could not be ignored with the recent development of the novel enzymatic techniques (Prosky *et al*. 1988). For dietary fiber determination in foods, increasing interest has been diverted to the soluble and insoluble components (Hughes, 1991). Legnin, cellulose and some hemi cellulose typically constitute the insoluble dietary fiber (IDF), whereas pectin, some hemi cellulose and other non-starch dietary fiber polysaccharides make up the soluble dietary fiber (SDF) (Roherfroid, 1993).

Legumes seeds typically contain more dietary fiber than cereals and are better sources of metabolically active SDF (Hughes and Swanson, 1989). The present work was undertaken to assess the dietary fiber profile of grain legumes commonly consumed in Pakistan, especially in the North-West Frontier Province (NWFP).

MATERIALS AND METHODS

Legume seeds (dehulled) were colleted from six different local markets of Peshawar in 2005 and mixed to make a composite sample. Air- dried seeds (0.5 kg) of each legume were powdered in a Wiley mill to pass 100mm sieve. Triplicate sub-sample (1g) was dried in a vacuum oven to constant weight for dry matter determination.

The fiber content as TDF, IDF and SDF was estimated in six oven dried sub-samples (0.1g) of each legume by the enzymatic method of the Association of Official Analytical Chemist, AOAC (Prosky *et al.* 1988) the cellulose, hemi-cellulose and lignin contents in triplicate sub-samples were determined by the procedures used by Valverde and Firas (1991). Pectin substances were estimated by a modified version of colorimetric method as adopted by Vidal-valverde *et al.* (1992). All of these analyses

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were carried at Department of Agricultural Chemistry, NWFP Agricultural University Peshawar, during the year 2005.

RESULTS AND DISCUSSION

The results on the dietary fiber content of grain legumes are presented in Table I. It is evident that the total dietary fiber (TDF) content of legume seeds varied from 11.5 to 33.2%. Guar was the richest source of fiber, followed by chickpea, pigeon pea, green pea and lentil. Guar seeds also contained the highest amount of soluble fiber (12.5 %) among the other legumes. Chickpea and field bean were good sources of soluble fiber as both contained more than 5 % SDF.

The TDF content of bean as found in this study fairly agrees to that of Hughes and Swanson (1989) who reported that beans contained 14 to 19% TDF. However, Sharma (1986) found 17 to 23.4 % TDF in beans. He also recorded higher TDF content in Chickpea (26 %) and Guar (35.2%) than the present study.

The water insoluble to soluble fiber ratios (Table I) indicates that all the legumes contained higher proportion of insoluble fiber than fiber. This ratio was higher in both cowpea and lentil, indicated that the fiber of these legumes was mainly composed of cellulose, hemi cellulose and lignin, which are the major constituents of insoluble fiber. The fiber profile, indicating cellulose, hemi-cellulose, pectin and lignin contents of seven legumes seeds is presented in Table II; it is evident that the major fiber constituents in all legumes were cellulose and hemi-cellulose, while lignin and pectin were minor components. Pectin and some hemi-celluloses constitute soluble fiber. Guar and chickpea contained the maximum amount of these constituents (Table II), and thus were the richest source of soluble fiber. These observations are in line with the soluble fiber data given in Table I. Although field bean contained lower amount of pectin the chickpea (Table II), both were comparable with respect to their soluble fiber content, shown in Table I. The cellulose and lignin contents of chickpea, bean and guar as found in this study fairly fall within the range of values of these constituents reported by Sharma (1986) for the same legumes species. Likewise, the cellulose content of lentil corresponds to that of Vidal-valverde *et al.* (1992). However, they observed less lignin (1.14%) and pectin (1.2%) contents as compared to this study.

Cellulose molecules are linear, un-branched, polymer of glucose joined by β,1-4 linkages in contrast to the α, 1-4 linkages found in starch (Sonthgate, 1990). This difference renders cellulose inert to starch-digesting enzyme, amylase. In the plant cell wall cellulose is present in the form of fibrils surrounded by matrix of hemi-celluloses and pectic substances (Trowel et al 1985).

Most hemi-celluloses are linear xylose polymer with arabinose, glucose, glucuronic acid side chains (Southgate,1990). Some hemicelluloses particularly in guar like galactomanans are in the form of gums which are water soluble and consist of about 63 % mannose and 35% galactose. They are found in seed endosperm particularly in guar (Alen and Alan, 1981).

Pectin substances are a mixture of arabinogalactans (branched Polymers with a galactouronic acid). Lignins, which represent only a small fraction of the dietary fiber, are complex molecules of polyphenylpropane units. These non-starch polymers collectively constitute the dietary fiber of plant food. Most of these substances are fermented by anaerobic bacteria in the large intestine, producing certain gases (Hydrogen, carbon dioxide, and methane), and the so-called short chain fatty acids butyrate, propionate and acetate. Some of these acids enter the portal system and mediate the lipid metabolism. The insoluble components (cellulose, lignin and some hemi-celluloses) absorb toxins and extra bile acids and facilitate their elimination from the body. This aids to prevent health complications.

The soluble fiber (pectin and few other non-starch polysaccharied es) being viscous gels liner along the walls of the intestine and thus reduces glucose and cholesterol absorption into the blood stream (Anderson *et al.,* 1984 and Toppy *et al*., 1986). This helps in dipping low blood sugar and cholesterol levels which is most beneficial for diabetic and heart patients (Kritchevsky,1986). Since legumes are better source of soluble fiber than cereals (Hughes and Swanson, 1989), they are particularly recommended in the diets of both diabetic and heart patients. Public health organizations (ADA,1997) recommended that adults should take 25 to 35 g dietary fiber per day with adequate fluid intake.

Table I ***Dietary fiber content of grain legumes***

Legume	Dry matter %	Dietary fiber % of dry matter			IDF / SDF ratio
		IDF	SDF	TDF	
Chickpea	90 a	17.2 ab	5.5 b	22.7 b	3.1 ab
Cowpea	88 ab	14.8 b	3.3 bc	18.2 bc	4.5 a
Field bean	86 b	12.5 bc	5.2 b	17.7 bc	2.4 bc
Guar	89 a	20.7 a	12.5 a	33.2 a	1.7 c
Lentil	87 ab	9.5 c	2.0 c	11.5 c	4.6 a
Pea (green)	85 c	10.2 c	3.2 bc	13.4 c	3.2 ab
Pigeon pea	90 a	12.2 bc	3.5 bc	15.5 c	3.4 ab

a. Chickpea or Bengal gram (*Cicer arietinum* L); cowpea, black-eyed pea or wonder pea (*Vigna unguiculata* (L) Walp); Field bean (*Phaseolus vulgaris* L); Guar, cluster bean (*Cyamopsis tertagonoloba* (L) Taub); Lentil or massor (*Lens esculenta*); Pea, Green pea or Field pea (*Pisum sativum* L) ; Pigeon pea, red gram or arhar (*Cajanus cajan* (L) Mill SP)

b. IDF = Insoluble dietary fiber, SDF = Soluble dietary fiber, TDF = Total dietary fiber

Table II ***Dietary fiber components of grain legumes as % of dry matter of legume seeds***

Legume	**Cellulose**	**Hemi-cellulose**	**Pectin**	**Lignin**	**Total NSP**
Chickpea	6.5 b	5.5 a	2.7 ab	2.1 b	16.8 b
Cowpea	6.0 b	3.9 b	1.8 c	2.0 b	13.7 b
Field bean	5.9 b	2.0 bc	2.3 b	1.4 c	11.6 bc
Guar	12.5 a	3.0 b	3.0 a	2.0 b	20.5 a
Lentil	2.9 c	1.0 c	1.5 c	1.8 bc	7.2 c
Pea (green)	2.4 c	1.0 c	1.7 c	2.5 ab	7.6 c
Pigeon pea	3.8 bc	0.2 c	2.0 b	3.2 a	9.2 bc

a botanical name of legumes are the same as given in Table I

b total non-starch polysaccharides (or dietary fiber)

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The dietary fiber intake influences the different methods in which nutrients are absorbed. The increase in the total fiber content of the diet may delay the glycemic response. Soluble fiber decreased blood glucose content whereas purified insoluble fiber has a little or no effect on the blood glucose levels after a meal. Dietary fiber and prebiotics influence the host animal well-being by regulating blood glucose or insulin levels, stool bulking effects, increasing the acidity of the gut, constructive synthesis of short chain fatty acids (SCFAs), decreasing intestinal transit time, stimulating the growth of intestinal microbes, and increasing blood parameters. Previous studies suggest that fiber affects the bioavailability of nutrients, and maintains the host wellness. Food-Based Dietary Guidelines for South Africa: â€œEat dry beans, split peas, lentils and soya regularlyâ€: a food-based dietary guideline. to other high carbohydrate-containing foods, because of. Nutrient profile of legumes. their high fibre and high resistant starch content. This may be a contributing factor in the prevention or treatment of these health problems.10 It has been proposed that several non-nutritive phytochemicals, such as phytates, saponins, isoflavones and oligosaccharides, may also have a role to play in cancer prevention.11. Dietary fibre has been shown to have important health implications in the prevention of risks of chronic diseases. The objective of the present study was to determine the potential health benefits of legumes as a good source of dietary fibre. Six to ten local legumes were studied as follows: cowpeas â€¦Â 1 Department of Science and Technology, Food and Nutrition Research Institute, Gen Santos Avenue, Bicutan, Taguig City, Metro Manila 1631, Philippines. tpt@fnri.dost.gov.ph.Â The above studies can be a scientific basis for considering legumes as functional foods. Dietary fiber or "roughage" is an essential nutrient required for proper digestion of foods and helping you feel full. (1). Health benefits of fiber include reduced blood pressure, lower cholesterol, and a decreased risk for stroke, diabetes, and various gastrointestinal diseases. (1). High fiber foods include beans, lentils, avocados, chia seeds, acorn squash, green peas, collard greens, broccoli, oranges, and sweet potato. (2) The current daily value (DV) for dietary fiber is 28 grams. (3).Â Top 10 Foods High in Fiber. #1: Navy (Haricot) Beans. Fiber per Cup.Â More Beans and Legumes High in Fiber. 19g (66% DV) in 1 cup of white beans. 16g (56% DV) in 1 cup of lentils.