Dietary Fiber Content in Dry Bean: Report to the BeanCAP

Mark A. Brick, Henry Thompson,
Dimas Echeverria, and Leslie Brick

Colorado State University

USDA

United States Department of Agriculture
National Institute of Food and Agriculture

Recommended Daily Consumption of Fiber in Human Diet

- Recommended adult DF daily intake:
  - Range from 21 – 40 g/day in countries that have developed guidelines
  - World Health Organization (WHO) recommends 25 g/day of total dietary fiber
- Actual consumption ranges from 14 g/day to 29 g/day
  - Most countries are below the WHO recommendation

Health Benefits of Fiber in the Diet

- Physiological effects in the human alimentary canal have demonstrated positive health benefits, primarily: (AACC, 2001)
  - Laxation
  - Blood cholesterol attenuation
  - Blood glucose attenuation
- Fiber may also play a role in disorders such as colorectal cancer, diabetes, and diverticular diesase
  -

Historical Background

- In 1953 Eben Hipsley used the term "dietary fiber" to describe a component of human diet containing:
  - "lignin, cellulose, and the hemicelluloses" (Hipsley, 1953)

- This was one of the first attempts to relate fiber to human physiology and health

Historical Background

- Since Hipsley's rough definition, a concrete definition of dietary fiber has been the subject of debate
  - Few proposed definitions have been accepted without stipulations

- In 1998, the Codex Committee on Nutrition and Foods for Special Dietary Uses began developing a definition of dietary fiber (CCNFSDU, 2006)

Components of Dietary Fiber

Table 2-Dietary fiber constituents

Fiber Constituent	Principal groupings	Fiber components/sources
Nonstarch polysaccharides & oligosaccharides	Celluose	Cellulose-Plants (vegetables, sugar beet, various brans)
	Hemicellulose	Arabinogalactans, β-glucans, arabinoxylans, glucuronoxylans, xyloglucans, galactomannans, pectic substances.
	Polyfructoses	Inulin, oligofructans
	Gums & Mucilages	Seed extracts (galactomannans –guar and locust bean gum), tree exudates (gum acacia, gum karaya, gum tragacanth), algal polysaccharides (alginates, agar, carrageenan), psyllium
	Pectins	Fruits, vegetables, legumes, potato, sugar beets
Carbohydrate analogues	Resistant starches and maltodextrins	Various plants, such as maize, pea, potato
	Chemical synthesis	Polydextrose, lactulose, cellulose derviatives (MC, HPMC)
	Enzymatic synthesis	Neosugar or short chain fructooligosaccharides (FOS), transgalactooligosaccharides (TOS), levan, xanthan gum, oligofructose, xylooligosaccharides (XOS), guar hydrolyzate, curdlan.
Lignin	Lignin	Woody plants
Substances associated with nonstarch polysaccharides	Waxes,cutin, Suberin	Plant fibers
Animal origin fibers	Chitin, chitosan, collagen, chondroitin	Fungi, yeasts, invertebrates

Tungland & Meyer, 2002

Recent Significant Changes to the AOAC/AACC Dietary Fiber Methodology

AOAC Method 985.29 (1999):

-Did not measure non-digestible oligosaccharides (NDO).

-Resistant starch (RS) is not completely measured.

An international survey of scientists in 1993 showed that:

-65%of the respondents favored the inclusion of NDO, and

-80%favoured inclusion of RS.

This led to the development of new methods to better represent indigestible fractions of food products, especially for the nondigestible oligiosaccharides.

Most recently (2009), the development of a new method to measure dietary fiber in food was approved by the AOAC.

- Method 2009.01 termed the "Integrated Total Dietary Fiber Method".

Our Procedure Utilized the AOAC 2009. 01

- Sample preparation:
  - Soak ~1 g dried bean seed in tubes containing 8 mL distilled water for 14 hrs
  - Transfer tubes to autoclave and cook 65 minutes
  - Homogenize cooked sample in tube

- Integrated Total Dietary Fiber (Megazyme Assay Kit)
  - Enzymatic Digestion and precipitation
  - Gravimetric Filtration
  - Weigh precipitate for IDF and HMWSDF (SDF)
  - Determine N and ash content to subtract from the weight of the precipitate

- Sample preparation:
  - Soak ~1 g dried bean seed in 8 ml water for 14 hrs
  - Transfer tubes to autoclave and autoclave for 65 minutes
  - Homogenize cooked bean and water in tube (retain soak and cooking water)
  - Samples were frozen at -80 °C until fiber analysis

Integrated Total Dietary Fiber (Megazyme Assay Kit)

Enzymatic Digestion with Pancreatic α amylase and amyloglucosidase.

Incubate at 37 C for 16 hours.

Integrated Total Dietary Fiber (Megazyme Assay Kit)

1. First gravimetric filtration provides high molecular weight insoluble dietary fiber (HMWIDF)
2. Second gravimetric filtration provides high molecular weight soluble dietary fiber (HMWSDF)

Integrated Total Dietary Fiber (Megazyme Assay Kit)

- The filtrate after the second gravimetric filtration include the low molecular weight soluble dietary fibers (LMWSDF= non digestible oligosaccharides)

Fiber Residues Dried and Weighed

Residues Adjusted for Ash and Protein Content to Calculate Fiber

g Fiber = DW residue – {Protein + Ash + Blank}

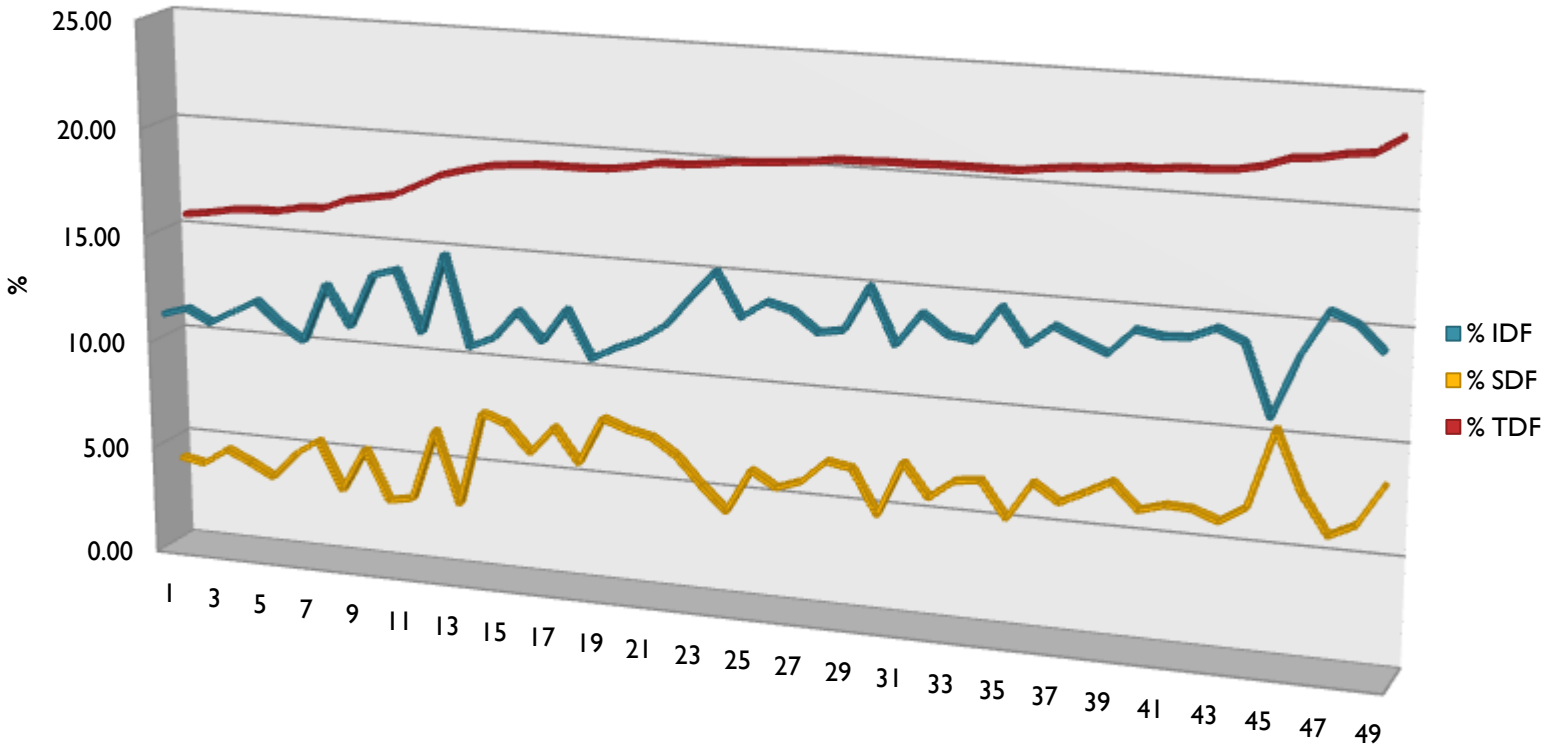
Bean Samples Measured for IDF, SDF, and TDF

- 32 dry bean entries (lines from BeanCAP)
- Grown in Michigan and Idaho
- Represented 5 races of Common bean CODs

Results

Variety	Class	Location	% IDF	% SDF	% TDF
Highest TDF					
Big Bend	Small Red	Michigan	14.61	8.57	23.18
Merlot	Small Red	Michigan	15.72	6.71	22.43
A801	Carioca	Michigan	16.17	6.13	22.30
CDC Rosalee	Pink	Idaho	14.19	7.86	22.05
Lowest TDF					
Crestwood	Navy	Idaho	11.72	4.26	15.98
Midland	Navy	Idaho	11.12	4.76	15.88
Black Knight	Black	Idaho	11.68	3.98	15.66
Avalanche	Navy	Idaho	11.33	4.17	15.50

Bean Dietary Fiber



1. Large variation among lines for IDF, SDF and TDF.

2. IDF and SDF were somewhat inversely proportional.

Final Thoughts

1. Fiber content varies by about 45% among lines.

2. We are in the process of developing methods to estimate oligosaccharide content.

3. We plan to resample a subset of lines grown in the field in 2011.

Acknowledgements:

Hannah Walters
Sarah Dominick
Leslie Brick
Dimas Echeverria
Colton Heeney
Bryan Fischer
Jordon Leone
Barry Ogg