



Dietary Fiber Update

34th National Nutrient Databank Conference

***Prairie to Plate: Exploring Food
and***

Nutrient Database Frontiers

12-14 July 12-14 2010

Grand Forks, North Dakota

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Dietary Fiber Update

The Story is Not Over on Dietary Fiber.

**AOAC International Official
AACC International Approved Methodology
for the
CODEX Alimentarius Definition of Dietary Fiber.**

**Jonathan DeVries, A. Christine Wold, Michael Marshak,
Rose Tobelmann, Brett Post**

July 13, 2010

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Dietary Fiber



History (brief) of Dietary Fiber Definitions/Methods

CODEX Definition of DF

AOACI/AACCI Methods for DF

Implications for Nutrient Databanking

Historical Ascendance Fiber Definition/Methods

Hipsley-Dietary Fiber (1953)



Health Relationship Research
(1950s and 1960s)



Variety of Dietary Fiber Methods



Dietary Fiber Hypothesis (1972)

Historical Ascendance (cont)

Hypothesized Disease Risk Reduction

(Trowell & Others, 1970's)

- **Constipation**
- **Diverticular Disease**
- **Hiatus Hernia**
- **Appendicitis**
- **Varicose Veins**
- **Piles (Hemorrhoids)**
- **Gallstone**
- **Obesity**
- **Cancer of the Large Bowel**
- **Coronary Heart Disease**
- **Diabetes**



Definition of Dietary Fiber

“Dietary fiber consists of the remnants of edible plant cells, polysaccharides, lignin, and associated substances resistant to (hydrolysis) digestion by the alimentary enzymes of humans.”

“This definition defines a macro constituent of foods which includes cellulose, hemicellulose, lignin, gums, modified celluloses, mucilages, oligosaccharides, and pectins and associated minor substances such as waxes, cutin, and suberin. ”

Trowell 1972-76

Prosky Survey 1979-80

Historical Ascendance (Cont)

Trowel Dietary Fiber Definition-1972 to 1976



Definition Relevant Methods Development (1970s)



AOAC Worldwide Surveys-Prosky-1979 to 1980
(Supports Trowell Definition and Physiological Method)



AOAC/AACC Official/Approved Methods 985.29/32-05



Soluble and Insoluble Dietary Fiber

1985-1994 Methods Development and Validation

- **AOAC,985.29/AACC 32-05**
-Total Dietary Fiber, Phosphate Buffer
- **AOAC 991.42/AACC 32-20**
-Insoluble Dietary Fiber, Phosphate Buffer
- **AOAC 993.19**
- Soluble Dietary Fiber, Phosphate Buffer
- **AOAC 991.43/AACC 32-07)**
-Total, Insoluble, and Soluble Dietary Fiber
(Equivalent results to 985.29/32-05)

Fiber Definitions

Traditional Dietary Fiber Methods-AOAC or AACC

- **All use the same principles and equipment with a slight variation in reagents (phosphate versus organic buffers) to quantitate total, insoluble and soluble dietary fiber respectively**
- **Designed for Food Labeling purposes**
- **Applicable and practical for all foods**
- **Gravimetric determination of dietary fiber quantity after an enzymatic digestion designed to simulate human digestion**

Historical Ascendance (cont)

AOAC Worldwide Surveys-1991 to 1993

-Non Digestible Oligosaccharides (NDOs)

-Resistant Starch(es) (RS)



AOAC Workshop-1995

-Component Definition-NDOs, RSs



Historical Ascendance (cont)

AOAC Official Methods/AACC Approved Methods

- **1990's- Early 2000s**
- **Very soluble fibers**
 - **Fructans (Inulin, FOS)-AOAC 997.08**
 - **Resistant Maltodextrins-AOAC 2001.03/AACC 32-41**
 - **Galactoligosaccharides-AOAC 2001.02/AACC 32-33**
 - **Polydextrose-AOAC 2000.11/AACC 32-28**
 - **Modified Celluloses-AOAC 2006.08**



Resistant Starch(es)

- Majority included in AOAC 985.29 or 991.43
- Properties extensively studied in EU early 1990's EURISTA project
- Behaves as dietary fiber-resists digestion in small intestine, ferments in large intestine, and physiological benefits of fiber.
- Processing properties and flavor similar to regular starches.
- AOAC Resistant Starch Method 2002.02

Resistant Starch- 4 Types

RS-1

Physically inaccessible starch: Partially milled grains and legumes

RS-2

Granular starches: Green bananas, raw potatoes, high amylose corn, (other) starches

Resistant Starch- 4 Types

RS-3

Gelatinized and retrograded starch: Cooled potato starch, enzyme debranched starches, cooled starches in cooked products

RS-4

Chemically modified starch: Usually done by cross linking for high DF (RS) levels. Often produced in small quantities during processing.

Definitions After AOAC 985.29

- Strange Phenomenon occurred post Ottawa 1981 Basis definition (Trowell et al) quickly forgotten
- AOAC 985.29 Method used almost universally
- Defacto, the method became the definition



Fiber Definitions

AACC Dietary Fiber Definition

American Association of Cereal Chemists

June, 2000

“Dietary fiber is 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. Dietary fiber includes polysaccharides, oligosaccharides, lignin, and associated plant substances. Dietary fiber promotes beneficial physiological effects including laxation, and/or blood cholesterol attenuation, and/or blood glucose attenuation.”



CODEX Dietary Fiber Definition Alinorm 9/32/26 and Alinorm 9/32/Rep

CODEX Dietary Fiber Definition 1993-2009

CODEX Alimentarius Commission

**CCNFSDU-CODEX Committee on Nutrition and
Foods for Special Dietary Use**

CODEX Alimentarius Commission

- **United Nations- 1963 (FAO) (WHO)**
- **Protect consumer health**
- **Ensure fair trade**
- **Recognized WTO**
- **Each UN member votes (up to 192)**
- **Committees develop standards**
- **CCNFSDU is handling dietary fiber**

The 8-Step Codex Decision Process

Step 1: Approves a new standard for debate

Step 2: New standard is drafted

Step 3: Circulated to member governments for comment.

Step 4: Comments incorporated into the draft standard

Step 5: The Executive Committee adopts the draft standard

Step 6: Draft text is circulated for another round of comment

Step 7: Amendments are made and the proposed standard is referred to the Commission for adoption

Step 8: A last opportunity to debate the proposed standard

Source: <http://www.foodsafetycentre.com.au/fsh/fshbull37a.htm>



CODEX COMMITTEE on NUTRITION and FOODS for SPECIAL DIETARY USES (CCNFSDU)

- **DF Effort started in 1993**
- **Bottom Up Definition Development**
- **Driven in Recent Years**
 - **Sweden**
 - **France**
- **Definition adopted by CCNFSDU in November 2008**
- **Definition adopted by CAC in July, 2009**



Fiber Definitions

CODEX Dietary Fiber Definition

CODEX defines dietary fiber as carbohydrate polymers^a with ten or more monomeric units^b, which are not hydrolyzed by the endogenous enzymes in the small intestine of humans and belong to the following categories:

- **Edible Carbohydrate polymers naturally occurring in the food as consumed,**
- **Carbohydrate polymers, which have been obtained from food raw material by physical, enzymatic or chemical means and which have been shown to have a physiological effect of benefit to health as demonstrated by generally accepted scientific evidence to competent authorities,**
- **Synthetic carbohydrate polymers which have been shown to have a physiological effect of benefit to health as demonstrated by generally accepted scientific evidence to competent authorities**



Fiber Definitions

CODEX Dietary Fiber Definition Footnotes

- a. When derived from a plant origin, dietary fiber may include fractions of lignin and/or other compounds when associated with polysaccharides in the plant cell walls and if these compounds are quantified by the AOAC gravimetric analytical method for dietary fibre analysis : Fractions of lignin and the other compounds (proteic fractions, phenolic compounds, waxes, saponins, phytates, cutin, phytosterols, etc.) intimately “associated” with plant polysaccharides in the AOAC 991.43 method. These substances are included in the definition of fibre insofar as they are actually associated with the poly- or oligo-saccharidic fraction of fibre. However when extracted or even re-introduced in to a food containing non digestible polysaccharides, then cannot be defined as dietary fibre. When combined with polysaccharides, these associated substances may provide additional beneficial effects (pending adoption of Section on Methods of Analysis and Sampling).
- b. Decision on whether to include carbohydrates of 3 to 9 monomeric units should be left up to national authorities.



Criterion for a Codex Definition Comprehensive Method

- Apply to foods as they will be consumed
- Leave all digestion resistant species intact
- Optimize enzyme systems for relevancy
- Quantitate all relevant carbohydrate polymers to $dp = 3$ or greater
- Collaboratively study on a wide variety of matrices

Water Insoluble and Alcohol Insoluble Dietary Fiber by Gravimetry, Highly Soluble Dietary Fiber by HPLC



Flow Chart of Official Method

Flow Chart of Method

**Homogenize Sample-
Grind to 0.3-0.5 mm mesh**
(Defat as necessary)
(Desugar as necessary)



**Weigh duplicate 1 g samples &
Disperse with alcohol**

pH adjust to 6.0



Pancreatic Alpha Amylase
and Amyloglucosidase

Digest @ 37 C
for 16 hours



pH adjust to 8.2

Inactivate @ 100 C for
20 minutes, cool





Protease



Digest @ 60 C for 30 minutes



Adjust pH to 4.3



Proceed to Total Dietary Fiber or
Insoluble and Soluble Fiber



Total Dietary Fiber

Add EtOH,
(Precipitate
Alcohol
Insoluble
Fiber)



FILTER & WASH

**DRY, WEIGH FOR WATER and
ALCOHOL INSOLUBLE FIBER**

**CONCENTRATE,
FILTRATE & DESALT**

**CORRECT
for
PROTEIN**

**CORRECT
For
ASH**

**HPLC for Alcohol
Soluble Fiber**

**TOTAL= RESIDUE plus
HPLC DF**



Insoluble & Soluble Fiber

Add EtOH,
Precipitate Alcohol
Insoluble Fiber

FILTER and WASH

FILTER and WASH

**DRY, WEIGH
FOR IDF**

**DRY, WEIGH
FOR AISDF**

**CORRECT
For PROTEIN**

**CORRECT
For ASH**

**CORRECT
For PROTEIN**

**CORRECT
For ASH**



(to Alcohol Soluble by HPLC)

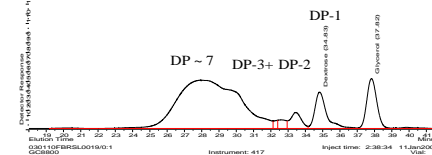
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Insoluble & Soluble Fiber

**CONCENTRATE
FILTRATE and
DESALT**



Soluble DF Analysis Standard
500mg/mL



HPLC for Alcohol Soluble

Soluble Fiber (SDF) = AISDF + ASDF

Total Dietary Fiber (TDF) = IDF + SDF

Interlaboratory Process

- **Organized international study Team**
 - **McCleary-Ireland**
 - **DeVries, Rader, Prosky, Cohen-US**
 - **Mugford-Australia**
 - **Champ-France**
 - **Okuma-Japan**
- **Precollaborative Ruggedness Study-15 labs**
- **Full Collaborative Study on TDF-18 labs**

Conclusions of Collaborative Work

- **The method quantitates the food components of the CODEX definition**
- **Method performance on par with current Official and Approved methods**

CODEX Dietary Fiber Method

- **AOAC 2009.01, Adopted as Official October 7th, 2009**
- **AACC-Approved as AACC 32-45**

**Total Dietary Fiber in Foods
Enzymatic–Gravimetric–Liquid Chromatographic
Method Collaborative Study**



The Scientific Association Dedicated to Analytical Excellence®

October 7, 2009

Dr. Barry McCleary
Megazyme International
Bray Business Park
Bray, Co.
Wicklow, Ireland

Dr. Jonathan W. DeVries
Medallion Laboratories/General Mills
2000 Plymouth Ave. N.
Golden Valley, MN 55427

Dear Dr. McCleary and Dr. DeVries:

We are pleased to inform you that the Methods Committee on Food Nutrition adopted the method **Determination of Total Dietary Fiber (CODEX Definition) by Enzymatic-Gravimetric Method and Liquid Chromatography: Collaborative Study** as Official First Action on October 07, 2009. The method was assigned *Official Methods*SM number **2009.01**. A notice of the adopted method will be published in the *AOAC* magazine, *Inside Laboratory Management*, and in "For Your Information" in the *AOAC Journal*. AOAC staff editors will prepare the manuscript for publication in the *Journal*. The method will be published as part of the collaborative study and will be included in the *Official Methods of Analysis* online at <http://eoma.aoac.org/> and in the next printed edition.

AOAC would like to take this opportunity to thank you for all your contributions in the development of this method.

Sincerely,

Robert Rathbone
Senior Director of Publications,
*Official Methods*SM and *Peer-Verified Methods*SM Programs
AOAC INTERNATIONAL

Cc: Committee E Chair: Shang-Jing Pan
General Referee: David Woollard

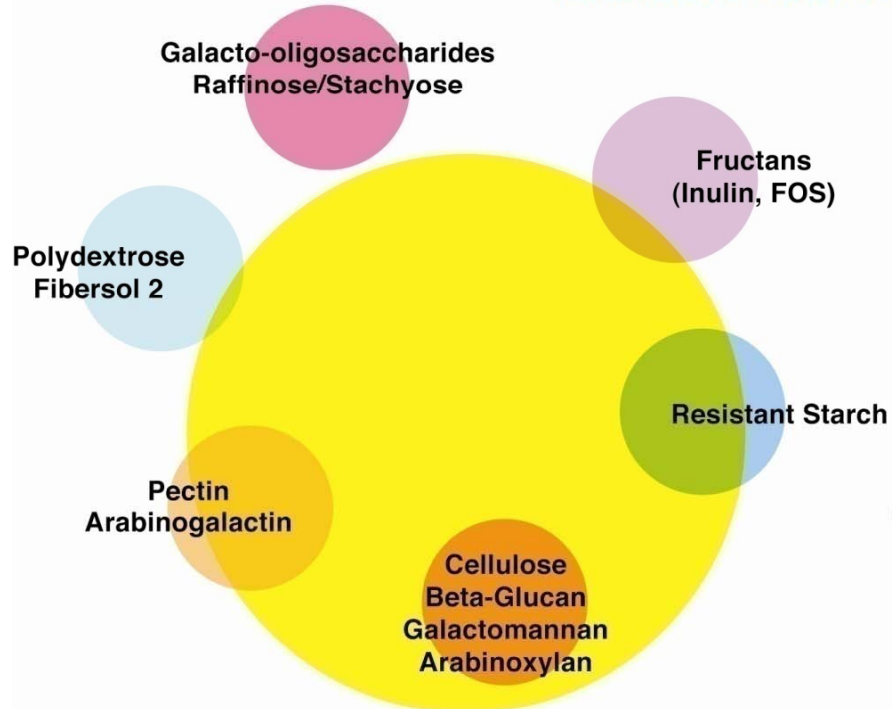
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• Dr. DeVries
received notification
from AOAC on Oct.
7th, 2009

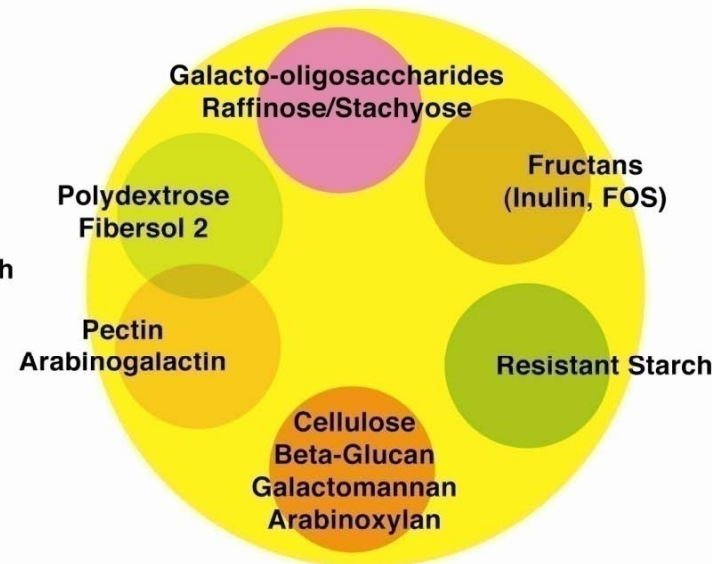
• AOAC Official
Method 2009.01

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ANALYSIS OF FIBER COMPONENTS TM



Total Dietary Fiber
(AOAC Method 985.29)
(AOAC Method 991.43)



Total Dietary Fiber
CODEX Definition Method
(AOAC Method 2009.01)

Benefits of CODEX Fiber Method

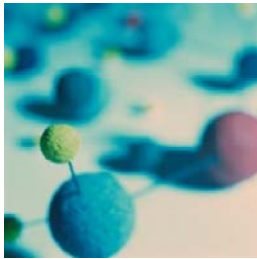


New Method Simulates the Human Digestive System

- Traditional Method digests enzyme at temps near boiling point of water
- New Method digests samples by a mammalian pancreatic alpha-amylase near human body temp

Impact: Small amount of resistant starches & other fibers that were degraded/lost in old method are now recovered in 2009.01

Benefits of CODEX Fiber Method



New Method quantifies low-molecular weight soluble dietary fibers

- Traditional Method only recovers soluble fibers that precipitate with ethanol
- New Method recovers all soluble fibers (not just those that precipitate with ethanol) & reports everything with three plus carbohydrate units as dietary fiber

Impact: Total dietary fiber reported by New Method includes resistant oligosaccharides not included in Traditional Method.

Benefits of CODEX Fiber Method

AOAC 2009.01 Method Lessens the Need to Run Traditional DF and RO Methods



Including:

- **Traditional Dietary Fiber (AOAC 991.43)**
- **Resistant Maltodextrin Method (AOAC 2001.03)**
- **Fructans (Inulin & FOS) Method (AOAC 997.08)**
- **Polydextrose Method (AOAC 2000.11)**
- **Galactooligosaccharides (GOS) Method (AOAC 2001.02)**

Practical inclusion of resistant oligosaccharides as dietary fiber to meet the definition.

Continued Uses for Traditional Methods

- **Methods can still be run to track formulations**
- **Resistant starch method (AOAC 2002.02) for resistant starch ingredients.**
- **Determine individual components of Total Dietary Fiber**

Implications for Nutrient Databanking

- **Current Data typically understates TDF**
 - Small amounts of resistant starch captured
 - Small amounts of resistant Oligosaccharides captured
e.g. wheat has 1-4% inulin
- **AOAC 2009.01/AACC 32-45 will capture all TDF**
 - As defined
 - As ready to be eaten
- **Relative Impact (0-10%)**

Why Focus On Issues

Issues →

Why Focus On Issues

Issues → **Emotional**

Why Focus On Issues

Issues → **Emotional**

Solutions →

Why Focus On Issues

Issues → **Emotional**

Solutions → **Technical**

Why Focus On Issues

Issues → **Emotional**

Solutions → **Technical**

Decisions →

Why Focus On Issues

Issues → **Emotional**

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We Welcome Your Questions

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