Dietary Fiber Definitions and Methods – A short history

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Julie Miller Jones, PhD, LN, CNS
jmjones@stkate.edu
St. Catherine University, St. Paul, MN
MEETING OBJECTIVES

• Educate branches on CCMAS activities on fiber and global implications.

• Outline a potential response address recent international issues related to carbohydrate science.

• Discuss other critical/emerging carbohydrate-related issues.
DIETARY FIBER

- Historical context of fiber
  Evolution from whole grains, nuts, etc, coining of the term “roughage”, etc. to dietary fiber early days
- Dietary Fiber Definitions
- Dietary Fiber Methods
  History
  Proposals for the upcoming session at CCMAS
  - Method Types I-IV CODEX
  - Proposed Decision Tree for CCMAS
Whole Grains - Ancient

- "Let thy food be thy medicine and thy medicine be thy food." Hippocrates

- Greek physician born in 460 BC

- He told his patients they should eat a moderate amount of food; not too much and not too little. A moderate amount of exercise was recommended. Patients were encouraged to walk for exercise.
Whole vs Refined Grains: Debated by the Great Philosophers

• 400 B.C. – Plato
  • Good health and longevity through eating locally grown whole grain breads
• Socrates
  • Plato’s whole grain “pig-food”!
• Plato lived longer than Socrates’
  • Whole grain vs hemlock
Galen 130 AD

- Food that excites the bowels to evacuate and food that prevents them.
- White bread is the stickiest and slowest to pass.
- Brown bread good for the bowels.
Fiber Studies - Pre the fiber hypothesis

- Mendel and Fine ('12) - increased metabolic fecal with diets high in indigestible material
- Mitchell ('24) consumption of filter paper increased N₂ the feces.
- Schneider ('34) - indigestible material increased N₂ the feces.

- Fewer calories available
History of the Definition of Dietary Fiber

1941 - The influence of dietary fibre on secretory activities of the alimentary tract: Observations on faecal phosphatase excretion and calcium and nitrogen balances of rats.

1953 - Hipsley - Published term “Dietary Fiber”
- Australian physician - Noted that toxemia was worse when fruits and vegetables were not in season and in lower income groups

1900s – 1970s - Initial Research – 8 papers
- Laxation and gut health
- Observations of human health states in less developed versus more developed countries

18 references on physiological effects;
only 1 on methods
Fiber and Cholesterol prior 1970
Note – data on isolated fibers


Fiber and Cholesterol prior to 1970
Note – data on isolated fibers

- **1966** Hypocholesterolemic activity of mucilaginous polysaccharides in White Leghorn cockerels.
  

- **1967** Effect of guar gum and pectin N. F. on serum and liver lipids of cholesterol fed rats.

Fiber / Constipation – Prior to 1970
Note – data on isolated fibers

• 1949 Cellulose esters in the treatment of constipation.

• 1949 Methyl cellulose therapy in chronic constipation with a brief summary of the etiology of this condition.

• 1952 A clinical evaluation of certain bulk and irritant laxatives.

• 1952 Modern therapy of constipation with cellulose derivatives.
Fiber and Constipation prior to 1970

• 1952  Treatment of constipation in infancy and childhood
  Burke RJ. Mo Med. 1953;50:343-4

• 1953  Treatment of chronic constipation in childhood.

• 1957  Treatment of chronic habitual constipation with methylcellulose (pasivon).
Dietary Fiber Hypothesis

1970-1976 – 41 articles
Trowell, Burkitt, Walker, Painter
Work in rural Africa – “Dietary fiber hypothesis”

• Painter. A call to Get on the Bran Wagon BMJ. 1976 1:1400
  • A call to turn off the tap, instead of mopping the floor!

• Trowell, H Why a new term for dietary fiber? AJCN. 1977; 30:1003-4

Studies with mostly bran
African Stool

African Hospital
US median Stool

US mega Hospital
Dietary Fiber Hypothesis
Disease Risk Reduction
(Trowell and Others, 1970s)

- Constipation
- Diverticular and other bowel diseases
- Hiatus Hernia
- Appendicitis
- Varicose Veins
- Hemorrhoids
- Cholesterol

- Implications in
  - Duodenal Ulcers
  - Breast Cancer
  - Blood Clotting
- Cancer
- 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 cellulosics, mucilages, oligosaccharides, and pectins and associated minor substances such as waxes, cutin, and suberin.”
Trowell 1972-76
Prosky Survey 1979-80

The definition was done trying to emulate the human digestive tract and account for the various physiological functions.
From a Working Definition to Working, Agreed Upon Method

• AOAC Ottawa, Ontario-1981
  • International Collaboration (few months)
  • 43 Laboratories; 29 Countries
• By 1982 - method used worldwide
• AOAC Official Method 985.29
  AACC Approved Method 32.05
  • Definition became practical, workable and measurable

• Some believed that the method defined dietary fiber, but the method was really based on the definition.
985.29 (32-05) Met Criteria for a Dietary Fiber Method

- Accurately emulate what happens to the CHO in the **human digestive gut** as designated in the definition
- Rugged
- Reproducible in competent laboratories
- Applicable to foods as likely to be eaten
- Solidified the flurry of worldwide dietary fiber research activity
- Expanded arenas of dietary fiber nutrition research
- Served (serves) as the **basis for establishing relationship between dietary fiber and health**
“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 COMMITTEE ON FOODS FOR SPECIAL NUTRITION AND DIETARY USES (CCNFSDU) Dietary Fiber Definition

- Started deliberations on the 8 step process for an international definition - 1990s (18 year process)
- By 2005/2006 reached Step 7 of an 8 Step process.
Dietary fiber means carbohydrate polymers** with a degree of polymerization (DP) not lower than 3, which are neither digested nor absorbed in the small intestine.

A degree of polymerization not lower than 3 is intended to exclude mono- and disaccharides. It is not intended to reflect the average DP of a mixture.
Dietary fibre (CODEX 2006) consists of one or more of:

• 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, or of synthetic carbohydrate polymers.
• Synthetic carbohydrate polymers.
Dietary fibre (CODEX 2006) generally has properties such as:

1. Decrease intestinal transit time and increase stools bulk
2. Fermentable by colonic microflora
3. Reduce blood total and/or LDL cholesterol levels
4. Reduce post-prandial blood glucose and/or insulin levels.

• Material considered as dietary fibre should have at least one of these properties.

(Note – these were not included in the final iteration.)
Proposed Change to the 16 years of CODEX deliberations

- **Small group at CCNDFSU Thailand, Nov 2006**
  - proposed a change
  - Very unusual to alter steps in the protocol

- **Dietary fiber consists of intrinsic plant cell wall polysaccharides only.**
  - This definition does not include carbohydrate polymers that have been obtained from plant products by physical, chemical or enzymic means.
  - It also does not include oligosaccharides or resistant starch
No Scientific Basis to Separate Intrinsic and Extrinsic

  - Recommends against intrinsic and extrinsic
  - Body cannot distinguish physiologically
2007 Codex Germany

Bad Neuenahr-Ahrweiler, Germany

• NSP reintroduced by several proponents

• Codex process of 17 years stalled and sent back one level.

• 2008 – CODEX Geneva Switzerland
• Definition passed; became official July 2009
Codex Definition Dietary Fibre

Dietary fibre means carbohydrate polymers\(^1\) with 10 or more monomeric units\(^2\), which are not hydrolysed by the endogenous enzymes in the small intestine of humans and belong to the following categories:

1. Edible polymers naturally occurring in the food
2. Polymers, which have been obtained from food raw material by physical, enzymatic or chemical means*
3. Synthetic polymers*

*must have a *physiological effect of benefit to health* as demonstrated by generally accepted scientific evidence to competent authorities.
“Dietary fibre means carbohydrate polymers$^1$ with 10 or more monomeric units$^2$ ....

**FOOT NOTE 2:**

“$^2$Decision on whether to include carbohydrates from 3 to 9 monomeric units, i.e. DP 3-9, should be left to national authorities.”
Codex Definition – Issues remaining

• Countries not accepting the footnote
• Methods of measurement for fiber.
• Specified health benefits were not included in the final document.
Acceptance DP3-9 Codex Defn

- European Food Safety Authority (2007)
- American Association of Cereal Chemists (2001)
- FSANZ - Australia / New Zealand (2001)
- International Life Science Institute – ILSI 2006
- Association Official Analytical Chemists AOAC (1997)
- Brazil
- Chile - for labeling but not health claims
- Mexico: NOM 051 (2010)
- Thailand, Singapore, Malaysia and Indonesia
- Rejected South Africa
AOAC Official Methods
AACC Approved Methods
Total, Insoluble, and Soluble Dietary Fiber
AOAC 991.43, AACC 32-07

• Method a slightly modified 985.29 (32-07)
• Enzymatic-gravimetric using organic buffers (MES-Tris)
• Results equivalent to AOAC 985.29.
CODEX Methods Issues

• CCMAS Codex Committee on Methods of Analysis and Sampling
  • Meeting in Budapest in March 2012
  Certain CCMAS members have created a Decision Tree Document around the methods with the following:
  • 1. the inclusion of the NSP method (a type IV CODEX Method) - labeled it empirical method portion of the decision tree.
  • 2. the AOAC method (used by most and is a Type III CODEX method) –labeled it as the rational method portion of the decision tree
CODEX Methods Classifications

• **Defining Methods (Type I)** - A method which determines a value that can only be arrived at in terms of the method per se and serves by definition as the only method for establishing the accepted value of the item measured.

• Examples: Loss on drying, salt in brine by density.

• **Reference Methods (Type II)** - A Type II method is the one designated Reference Method where Type I methods do not apply. It should be selected from Type III methods (as defined below). It should be recommended for use in cases of dispute and for calibration purposes.

• Example: Potentiometric method for halides.

http://www.fao.org/docrep/w5975e/w5975e09.htm
CODEX Methods Classifications

- **Alternative Approved Methods (Type III)** - is one which meets the criteria required by the Codex Committee on Methods of Analysis and Sampling for methods that may be used for control, inspection or regulatory purposes.
- **Example:** Volhard Method or Mohr Method for chlorides

- **Tentative Method (Type IV)** - is a method which has been used traditionally or else has been recently introduced but for which the criteria required for acceptance by the Codex Committee on Methods of Analysis and Sampling have not yet been determined.
- **Examples:** chlorine by X ray fluorescence, estimation of synthetic colours in foods.

http://www.fao.org/docrep/w5975e/w5975e09.htm
CCMAS Decision Tree for Methods

- Has two Fibre Decision Trees – one so-called ‘empirical’ and one called ‘rational.’

**Empirical** approach AOAC methods that have undergone co-labs and are reproducible and rugged.

**Rational** uses a combination of proven methods (AOAC) and unproven methods (e.g. Type IV-Englyst methods for NSP etc), which are neither reproducible nor rugged.
Definition of Terms
May not Fit Usage

• **EMPIRICAL**
  
  • a. Relying on or derived from observation or experiment: empirical results that supported the hypothesis.
  
  • b. Verifiable or provable by means of observation or experiment: empirical laws.

• **RATIONAL**
  
  • Having or exercising the ability to reason.
  
  • Consistent with or based on reason or good judgment; logical or sensible: *rational decisions*.

• American Heritage Dictionary of the English Language
ISSUE

• The AOAC Methods under “Empirical” fit the Empirical Definitions
  • Proven to support the hypothesis (CODEX Definition)
  • Verified and proven by experimentation
• “Rational” approach no more logical than the “Empirical”
  • Methods not necessarily proven (Type IV methods—see above)
  • Based on reason and good judgment, but not necessarily validated nor agreed as applicable.

• The Type IV method does not include all the parts of the CODEX definition and is not reproducible)
Role of ILSI Branches

• Continue to advocate for the inclusion of the footnote enfranchising DP 3-9 (in your region and in other venues to enable international harmonization)

• Help with arguments to support the CODEX Type I, II, III methods
  • Nearly all regulatory agencies and company labels use AOAC methods (type III), not NSP, a type IV method.

• Alert member companies with special focus on colleagues who have method expertise and conduct analysis for food labeling and research.

• Be ready to provide, if necessary, commentary to ILSI and country representatives to CCMAS about the need for unified, agreed upon methods that are reproducible and the importance of selecting methods that are not Type IV.
Other Issues - Physiological Functions

• Physiological effects – listed in the earlier iteration and in verbage accompanying the definition

1. Decrease intestinal transit time and increase stools bulk
2. Fermentable by colonic microflora
3. Reduce blood total and/or LDL cholesterol levels
4. Reduce post-prandial blood glucose and/or insulin levels.

• Which ones and what methods to prove them?
Issues for ILSI

- Physiological effects – listed in the earlier iteration and in verbage accompanying the definition

- **Which physiological effect to focus on first?**
  - Will this vary by country/region or should this be a unified effort? Amount of data? Which fibers? How will the fibers need to be characterized, eg particle size, etc.
  - Use ILSI Vahouny paper as starting point

- What degree of change is needed for physiological impact?

- What measure can prove the positive impact?
Charge to ILSI CHO Groups

• Strategy to tackle the issue
• By region or as a coalition.

• Other issues