Health Benefits of Prebiotic Dietary Fiber

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Objectives

- Provide some background on dietary fiber
- To define the term "prebiotic dietary fiber"
- To discuss potential health effects of prebiotic dietary fibers
- To identify food sources of prebiotic dietary fibers

Dietary Fiber

- "Dietary fiber is the edible parts of plants or analogous carbohydrates that are resistant to digestion and absorption in the human small intestine… Dietary fiber includes polysaccharides, oligosaccharides, lignin, and associated plant substances." AACC

Dietary Fiber

Soluble
- Beta glucans
- Wheat dextrin
- Psyllium
- Inulin

Insoluble
- Cellulose
- Lignin

Dietary Fiber

Viscous
- Pectins
- B-glucans
- Psyllium

Non-viscous
- Polydextrose
- Wheat dextrin
- Inulin

Dietary Fiber

Fermentable
- Wheat dextrin
- Beta-glucans
- Guar gum
- Inulin

Non-Fermentable
- Cellulose
- Lignin

Health Benefits of Dietary Fiber

- 430 BC Hippocrates documented the effect of coarse wheat compared to refined wheat on regularity of bowel movements.

Health Benefits of Dietary Fiber

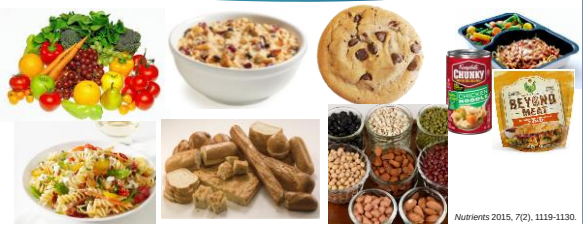
- Cardiovascular disease
- Glycemic control
- Laxation
- Appetite control/ Body weight
- Cancer
- Prebiotic effects

Consumption of fibers in US

- Fiber recommendations:
  - 14g/1000 calories
  - 25g/day for adult females
  - 38g/day for adult males
- Average intakes are approximately 17g/day
  - Only 5% of the population meets the Adequate Intake!

JAND. 2015;115:1861-1870.

Major Sources of Dietary Fiber



Nutrients 2015, 7(2), 1119-1130.

The new Nutrition Facts Panel will affect dietary fiber too

Nutrition Facts
Serving Size 2/3 cup (55g)
Servings Per Container About 8

Amount Per Serving
Calories 230 Calories from Fat 72
% Daily Value*
Total Fat 8g 12%
Saturated Fat 1g 5%
Trans Fat 0g
Cholesterol 0mg 0%
Sodium 160mg 7%
Total Carbohydrate 37g 12%
Dietary Fiber 4g 16%
Sugars 1g
Protein 3g
Vitamin A 10%
Vitamin C 8%
Calcium 20%
Iron 45%
* Percent Daily Values are based on a 2,000 calorie diet. Your daily value may be higher or lower depending on your calorie needs.

	Calories	2,000	2,500
Total Fat	Less than	65g	80g
Sat Fat	Less than	20g	25g
Cholesterol	Less than	300mg	300mg
Sodium	Less than	2,400mg	2,400mg
Total Carbohydrate		300g	375g
Dietary Fiber		25g	30g

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Sodium 160mg 7%
Total Carbohydrate 37g 13%
Dietary Fiber 4g 14%
Total Sugars 12g
Includes 10g Added Sugars 20%
Protein 3g
Vitamin D 2mcg 10%
Calcium 260mg 20%
Iron 8mg 45%
Potassium 235mg 6%
* The % Daily Value (DV) tells you how much a nutrient in a serving of food contributes to a daily diet. 2,000 calories a day is used for general nutrition advice.

Changing Fiber Regulations by the FDA

Changing Fiber Regulations by the FDA

- Fiber definition will now require each isolated and synthetic fibers to have a proven health benefit
  - Qualifying health benefits include:
    - Lowering blood glucose and cholesterol levels
    - Lowering blood pressure
    - Increase in frequency of bowel movements (improved laxation)
    - Increased mineral absorption in the intestinal tract
    - Reduced energy intake
  - Fermentability as indicated by the production of beneficial metabolites or specific changes GI taxa are not considered a direct health benefit

FDA approved isolated and synthetic fibers

Fibers not included on this list will need to be approved as a fiber by the FDA through a citizens petition process reviewing the health effects of the fiber.

- Beta-glucan soluble fiber
- Psyllium husk
- Cellulose
- Guar gum
- Pectin
- Locust bean gum
- Hydroxypropylmethylcellulose

Health Canada's Fiber Definition

- "Dietary fibre consists of:
  - Carbohydrates with a DP1 of 3 or more that naturally occur in foods of plant origin and that are not digested and absorbed by the small intestine; and
  - Accepted novel fibres."

*Accepted novel fibres have at least one physiological effect demonstrated by generally accepted scientific evidence

Health Canada

Accepted Physiologic Effects for Health Canada

- Improves laxation or regularity by increasing stool bulk
- Reduces blood total and/or low-density lipoprotein cholesterol levels
- Reduces post-prandial blood glucose and/or insulin levels
- Provides energy-yielding metabolites through colonic fermentation

Health Canada

List of dietary fibers accepted by Health Canada

- Barley beta-glucan concentrate
- Barley bran
- Corn bran
- Oat bran
- Wheat bran
- **Fructooligosaccharides**
- **Inulin**
- **Galactooligosaccharides**
- **Isomaltooligosaccharides**
- Oat beta-glucan concentrate
- Oat hull fibre
- Partially hydrolyzed guar gum
- Pea hull fibre
- **Polydextrose**
- Psyllium seed husk
- Resistant starches
- **Resistant maltodextrins**

Health Canada

Prebiotic Dietary Fibers

Why are we seeing this increasing interest in Prebiotics?

- The gut microbiome!

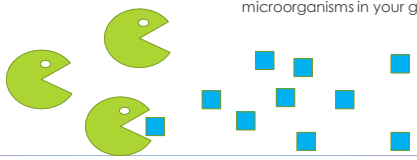
Probiotics vs Prebiotics

Probiotics

- Live microorganisms

Prebiotics

- Fuel source for the microorganisms in your gut



Prebiotic Dietary Fibers

- Specific, microbiota-shaping compounds that function as a carbon source for growth of beneficial taxa, thus delivering a specific or selective change that influences host health related to its metabolism.

EFSA J. 2010

A prebiotic must:

- Resist digestion
- Be fermentable by the microflora
- Promote the production of beneficial bacteria

Physiologic Effects of Prebiotic Dietary Fiber

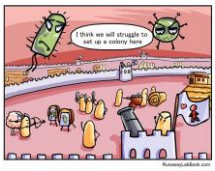
- Gas production
- SCFA production
- Lower pH
- **Depends largely on sources for fermentation**

Potential Health Effects of Prebiotic Dietary Fibers

1. Effects on Hind Gut Bacteria Composition
2. Change in Pathogenic Bacteria Populations
3. Metabolite Production
4. Effect on Mineral Absorption
5. Effect on Protein Fermentation
6. Effect on Allergy Risk
7. Effects on Gut Barrier Permeability
8. Effects on Immune System Defense

Effect on Gut Microbiota

- Promotion of beneficial bacteria
  - *Lactobacilli* and *Bifidobacteria*
- Reduction in pathogenic bacteria populations
  - Lower colonic pH
  - Competition
  - Inhibitory peptides
  - Improved immune function



Allergy Risk

- Decreased *Bifidobacteria* and *Lactobacilli* associated with development of allergies
- Supplementation of oligosaccharides may have allergy protective effects
  - Reduced eczema in infants
- Mechanism unknown

Cochrane Database Syst Rev. 2013 Mar 28;(3) Clin Exp Allergy. 2009 Apr;39(4):518-26.

Metabolite Production

- Short chain fatty acids
  - Acetate, propionate, butyrate
  - Source of metabolizable energy
  - Negatively correlated with presence of GI disorders, cancers and obesity
  - High degree of individual variation

Front Microbiol. 2016; 7: 185.

Gut Barrier Permeability

- Leaky Gut
- When tight junctions between the intestinal epithelial cells are compromised due to inflammation

"I'm still thirsty. Maybe I've got leaky gut syndrome."

Curr Opin Gastroenterol. 2016 Mar;32(2):74-9

Gut Barrier Permeability

- Addition of SCFA the the walls of rat intestines can improve intestinal barrier function
- Mice fed fiber supplemented diets had reduced paracellular permeability in the distal colon
- Supplementation of prebiotics promotes *Bifidobacteria* growth and increases in GLP-2 production in mice

Gut 1999;44:394-399.
Br J Nutr. 2008 Aug;100(2):297-305. Gut 2009; 58 1044-1045

Immune System

- Prebiotic fermentation influences many immune cells including TREG, T cells, B cells and natural killer cells
  - Exact mechanism not known
  - Butyrate has been shown to effect number if macrophages, T cells and dendritic cells

Cur Op in Gastro , 2015,.31(2), p.153-158

Mineral Absorption

- Distal intestine is a primary site for mineral absorption
  - Calcium, magnesium and zinc
  - Improved absorption of calcium and magnesium have been observed
  - Overall results are mixed in human studies

J Nutr. 2007 Mar;137(3 Suppl 2):838S-46S

Protein Fermentation

- Without sources of fermentable carbohydrates, the gut bacteria will ferment protein
  - Production of harmful metabolites
- Supplementation of prebiotic dietary fibers shown to reduce fecal and/or urinary ammonia levels and p-crestol levels

Br J Nutr 2006;96(6):1078–86

Common Sources of Prebiotic Dietary Fibers

Beta-glucan

- Soluble fiber found in the cell walls of grain endosperm
- Oats and barley are the two largest sources of beta-glucans
  - Other foods like mushrooms and algae also contain beta-glucan

Oligosaccharides

- Fructooligosaccharieds, galactooligosaccarides, xylooligosaccharides and isomaltooligosaccharides
  - Non digestable carbohydrates with chain lengths of 2-20 monomers
  - Strong bifidogenic effects
  - Chain length influences its prebiotic effects
- Common food sources: wheat and rye, legumes, onions, garlic, asparagus, broccoli, etc.

Resistant starches and maltodextrins

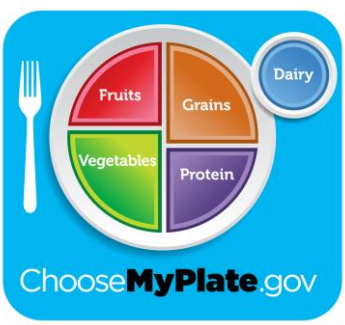
- Starches that are not digestible by enzymes in the small intestine and are fermented in the colon by microbiota

Type of Resistant Starch	Description	Food Sources
RS_1	Starch that is physically inaccessible due to cell walls	Whole grains, seeds, legumes
RS_2	Starch with highly crystalline structure	Raw potatoes, green bananas
RS_3	Retrograded nongranular starch	Cooked and retrograded starchy foods
RS_4	Chemically modified starches	Functional foods with added RS_4

Starch. 2013; 66(1-2), 102-144

Prebiotic Consumption

- Consumption of prebiotics is difficult to quantify
  - No analytic test
  - Found in a wide range of foods
  - No universal definition or list of accepted ingredients



Dietary trends limited in prebiotic dietary fibers

- Restrictive carbohydrate diets like low FODMAP, ketogenic diet, Atkins, etc.
- Important to encourage individuals following restrictive diets to ensure that they are consuming adequate fiber.
- Variety is important for a healthy gut microbiota

Summary

- Prebiotic dietary fiber is an evolving area of research in nutrition
- Current evidence indicates various health impacts associated with the consumption of prebiotic dietary fiber
- Each prebiotic source provides a unique carbon source for fermentation
- A varied diet, rich in fiber is recommended to achieve these health benefits

Thank you!