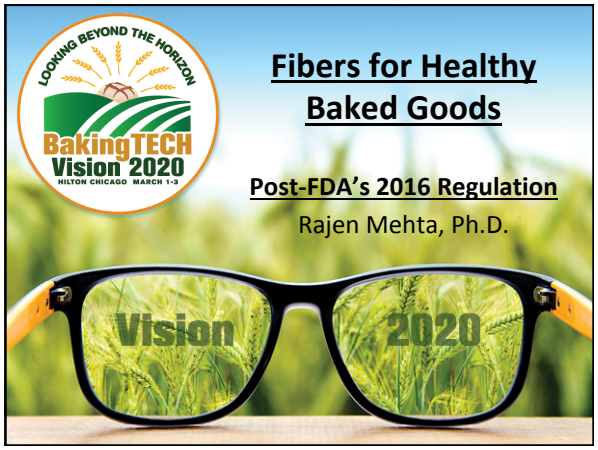


Fiber Topics

- FDA Regs – Simplified
- Improve Texture & Optimize Costs
- Microbiome & Consumer Trends

*Please check with your Legal Counsel to validate statements in this presentation
Slides adapted from: Mehta publications/presentations

FDA Dietary Fiber Definition

- Dietary fiber is defined as non-digestible soluble and insoluble carbohydrates (with 3 or more monomeric units),* and lignin that are
  - intrinsic and intact in plants;
  - isolated or synthetic non-digestible carbohydrates (with 3 or more monomeric units) → determined by FDA to have physiological effects* that are beneficial to human health.
- *Physiological Benefits:
  - Lower blood glucose/cholesterol/blood pressure
  - Improve laxation/bowel function
  - Increase mineral absorption
  - Reduced energy intake

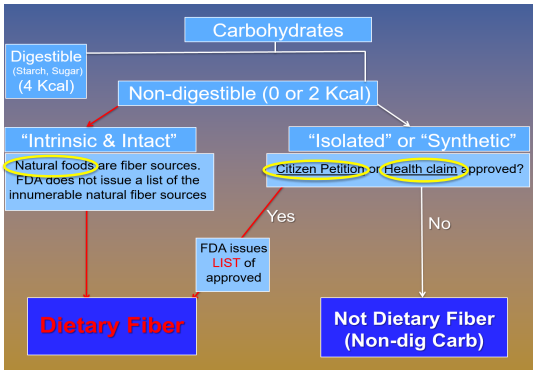
Why is FDA Differentiating Fiber Types?

	Intrinsic & Intact	Isolated or Synthetic
FDA Position	A "true" fiber with physiological benefits	A Carb that is not digested. No proven physiological benefits. Thus not a fiber.
Why?	Fiber & other natural nutrients could provide physiological efficacy	Analytical methods – makes it "non-digestible" Processes may eliminate physiological benefits
Examples	-Whole grains, Corn, Bran -Pulses/legumes/fruits/Veg -I&I oat/pea hull	17 proven/approved to date (on the "list")
FDA list of "approved"?	No. Impossible. Too many	Yes
Nutrients lost?	Almost none. Only heat-labile	Minerals, water soluble, phyto-nutrients, phenolic, antioxidants, anti-inflamatory
Nutrients added?	None	Sodium (typical). Misc process dependent

FDA: Fiber Nutritional Label

- Fiber Definition added:
  - "Intrinsic & Intact" vs. "Isolated" or "synthetic"
  - Dietary fiber vs. non-digestible Carbohydrates
  - Insoluble (0 Kcal/g) vs. soluble (2 Kcal/g), Polydex (1 Kcal/g)
- FDA Fiber Definition = Adapted from Codex 2009 + IOM 2001 (I&I + Added/Functional)
- **Compliance: Jan 1, 2020** (Sales >$10M)
- **Record keeping requirements added**
- Daily Value – increased from 25 to 28 g/day
- Citizens petition/Physiological efficacy –
  (Scientific agreement, Human study, Control, P<0.05, healthy population)
- Any AOAC method for "DF" content acceptable
- Intrinsic & intact fibers approved but not listed
- Isolated & synthetic fibers. Most approved. Exceptions:
  - Soluble: Pullulan, XOS, IMO
  - Insoluble, mixture: RS3
  - Hydrocolloids: Acacia, CMC, karaya, xanthan (6 approved)

Fiber Decision Tree



FDA Fiber "Approval" Timeline

- May 27, 2016
  - Intrinsic & Intact
  - Heart Health Claim (CFR 101.81)
  - 5 others fibers
- June 14, 2018
  - 8 new fibers (including "mixed plant cell wall")
- March 27, 2019 & January 10, 2020
  - 2 more fibers

FDA Approved Fibers

	Approved (May 27, 2016)	Allowed (Enforcement Discretion) (June 14, 2018)
1	β-glucan soluble fiber (CFR 101.81) Oat & Barley	Mixed plant cell wall fibers. At least 2 of: Cellulose, pectin, lignin, β-glucan, arabinoxylan
2	Psyllium husk (CFR 101.81)	Arabinoxylan
3	Cellulose	Alginate
4	Guar gum	Inulin & inulin-type fructans
5	Pectin	High amylose starch (RS2)
6	Locust bean gum	Galactooligosaccharide
7	Hydroxypropylmethylcellulose	Polydextrose
8		Resistant maltodextrin/dextrin
9		Cross-linked phosphorylated RS4 (*March 27, 2019*)
10		Glucomannan (*January 10, 2020*)

FDA Status – Insoluble Fibers

(Commercially Important)

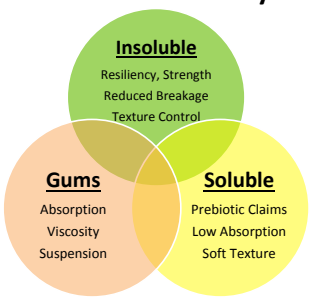
	Approved/Allowed	Not Approved
1	Cellulose	
2	Mixed plant cell wall – 2 of: Cellulose, pectin, lignin, β-glucan, arabinoxylan	Efforts ongoing by many manufacturers
	Bamboo Soy Isolated Oat Isolated Pea Wheat Cotton seed Sugarcane Sugar beet Corn hull Potato Apple	
3	RS2 resistant starch RS4 resistant starch - cross-linked phosphorylated = recently approved	RS3 resistant starch
4	Arabinoxylan	

FDA Status – Soluble Fibers

(Commercially Important)

	Approved/Allowed	Not Approved
1	Inulin & fructans	Pullulan
2	Resistant maltodextrin/ dextrin	XOS
3	Soluble corn fiber	IMO
4	Galactooligosaccharide	
5	Polydextrose	
A	β-glucan (Oat & Barley) Psyllium husk	Acacia, CMC, Karaya, xanthan
B	Gums: Guar, Pectin, LBG, HPMC, Alginate	None others of commercial importance
C	Gum: Glucomannan	

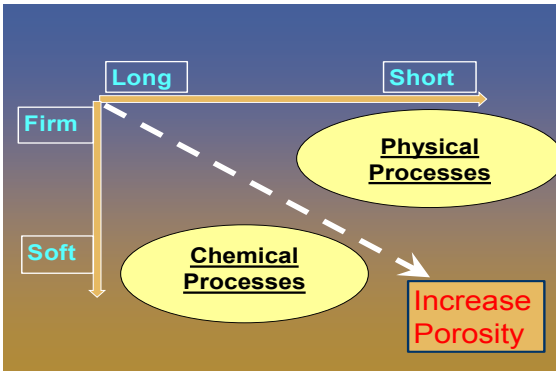
Fiber Functionality



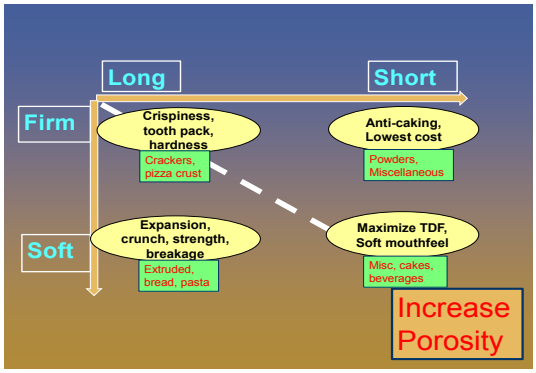
Processes for Insoluble Fiber

Physical	Chemical
Traditional Milling/Cooking: No Effluents="Intrinsic/Intact"	Functionality with Chemicals: Effluents = "Isolated"
Phytonutrients Preserved	Phytonutrients + Fiber Fractions Discarded
Natural/Sustainable	Not Sustainable
Porosity Increased	Water Absorption ALSO Increased

Insoluble Fiber Modification for Functionality



Insoluble Fiber Functionality



Fiber for Non-Traditional Foods

(e.g. Gluten Free, High Protein, Whole Grain, Clean Label)

Issue/defect	Fiber characteristic	Fiber effect	Typical foods
Gummy, hard, Dense	Soft/Flexible Long and/or short	Open up structure, slightly reduce free water (if any), fluffy, soft	Soft baked goods, bread, snacks, cereals
Doughy, soft	Long. Firm or flexible	Rigidity, crunch/chewy	Crusts, bars, bread
Not resilient	Long/soft (flexible)	Flexibility, strength, springiness	Bread, fine bakery
Dry, not cohesive	Long/soft + Hydrocolloid	Absorbs water/oil - released on chewing, binding, adds fat-like mouthfeel	Bars, crusts
Powdery	Long/soft + slight Hydrocolloid	Provide structure during leavening, moistness	Fine bakery, bars
Shape control	Long: Firm or soft Or soft/short.	Long for more spread/dome shape. Soft short to prevent spread.	Cookies, bars
Stiff dough	Short	Relaxes dough	All doughs
Caking, not free-flowing	Firm/fine	Powder separation with fine fiber	Mixes. Blends in processing.

Adapted from: Mehta 2014. Food texture design & optimization. Pg 245-280. John Wiley & Sons.

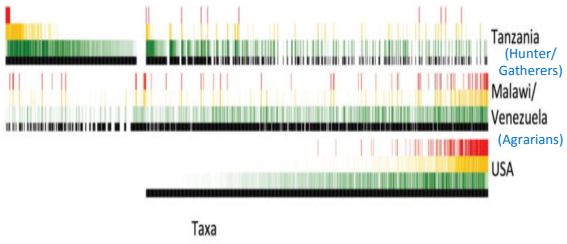
Cost Savings – by Optimization

Ingredients
Fibers (soluble, insoluble),
Gums, brans, starches

Quality
Breakage, fines, rework
Staling, returns, waste

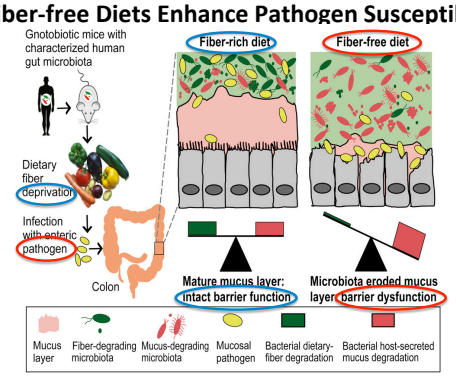
Add Air/Water
Bulk density, fluffiness
Cheese, filling, meat yields

Western Populations have Depleted Diversity of Microbiota vs. Traditional Groups*



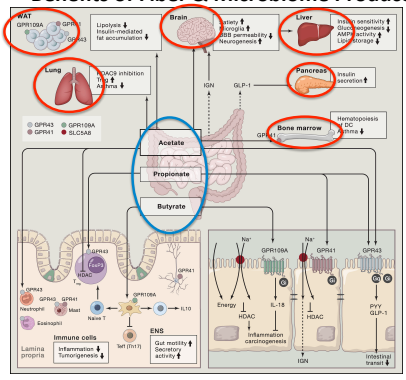
*From: Sonneburg et al. Nature 529: 212-215. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4850918/figure/F4/?report=objectonly

Fiber-free Diets Enhance Pathogen Susceptibility



From: Patel et al. 2016. Cell 167: 1339-1353. https://ars.els-cdn.com/content/image/1-s2.0-S0092867416314647-fx1_lrg.jpg

Benefits of Fiber & Microbiome Produced SCFAs in Gut



From: Koh et al. (2016). 165:1332-1345 https://www.sciencedirect.com/science/article/pii/S009286741630592X

Benefits of Fiber & Microbiome Produced SCFAs in Gut

Fiber → Gut Microbiota → SCFA (Acetate Propionate Butyrate) → Physiology (Benefit) → Health + Disease

	SCFAs Decrease	SCFAs Increase
WAT (White Adipose tissue)	Fat accumulation	
Brain	Inflammation	Satiety, immunity, Neurogenesis (communication)
Liver	Lipid storage Gluconeogenesis (glucose from proteins, lipids, etc.)	Insulin sensitivity Energy generation
Lung	Prevent autoimmune disease, Asthma	Cancer inhibition
Bone Marrow	Asthma	Immune system growth

Koh et al. (2016). Cell 165:1332-1345 https://www.sciencedirect.com/science/article/pii/S009286741630592X

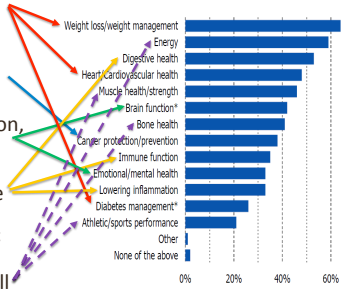
Fiber/Gut Microbiome Effects Vs. Consumer Needs

Microbiome Effects

- Obesity, heart disease, hypertension, high cholesterol, diabetes
- Cancer, kidney/liver disease, pathogen inhibition
- Brain function, cognition, depression, anxiety, Parkinson's
- Inflammation, immune function, asthma, digestive health, celiac disease, IBS
- Health & Energy overall

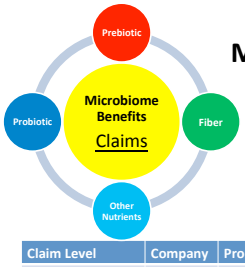
Top Sought After Health Benefits

(Of those who seek health benefits from foods)



K. Madsen. 2018. Dietary Fiber Conf Amsterdam. A. Jefferson & K. Adolphus. 2019. Frontiers in Nutrition 6:33. Koh, A. et al. 2016. Cell:165:1332. IFIC. 2019. https://foodinsight.org/wp-content/uploads/2019/05/IFIC-Foundation-2019-Food-and-Health-Report-FINAL.pdf

Microbiome for Consumers



Claim Level	Company	Product	Approach
Very Conservative	Kellogg	Happy Inside Cereal	Prebiotics + Probotics + Fiber =Digestive Wellness
Conservative	Solaray	Microbiome Supplement (future=bar)	PROBIOTICS + Prebiotics + Insoluble fibers = Healthy Microbiome
Progressive	ProBiotin	MycroBiome Bar	Fibers + Prebiotics + Probiotics + Misc ingredients = Gut + prevent diseases

Microbiome for Consumers

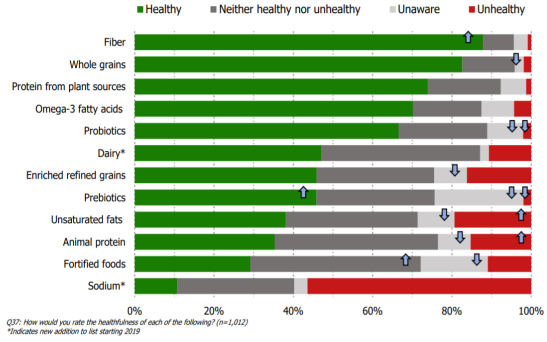
- Kellogg's Happy Inside "3-in-1" cereal with combination of **prebiotics, probiotics and fiber** to support digestive wellness
  - 5 g soluble + 4 g insoluble fibers
- Mycrobiome Probiotic Supplement
  - Probiotics (30+ billion organisms)
  - Prebiotic (inulin)
  - Additional insoluble fibers (rice bran, cellulose, cellulose capsule)

MicroBiome Bar* Literature

- Prebiotic fiber and gut health bar. 4 prebiotic fibers (AXOS, FOS, MOS and XOS), ω-3 fatty acids, β-glucans & fermented protein from grains (wheat, oats, barley, flax) that support microbiome.
- Immune Response 70% of body's immune system response is in gut which is main organ in battle against illnesses, pathogens, avoiding colds, flu, preventing diseases.
- Antioxidants, ω-3, β-glucans. maintain healthy heart, reduce harmful cholesterol, resist type 2 diabetes, rheumatoid arthritis & strokes.
- Beneficial bacteria create SCFA, maintain intestinal villi, intestinal wall permeability. SCFA affect brain, liver, large intestine wall. Increase mineral absorption, provide anti-inflammatory benefits, stabilize gl cholesterol synthesis, keep levels of immune system agent
- Pathogens reduced by good bacteria & can reduce harmful gut antigens and inflammation.
- 40g Serving: 7g – 9g of Functional Fiber, 0.2 – 0.5g ω-3 Fatty Acids, 0.3g β-glucans

*Condensed comments from (refer to brand website for legal/complete comments)
https://www.probiotein.com/_assets/pdf/ProBiotein-Brochure-12pages.pdf
https://www.probiotein.com/products/microbiome-bar/
https://connect.naturalproductsexpo.com/product/prebiotic-fiber-gut-health-microbiome-bar

Ingredients Impacting Food Healthfulness

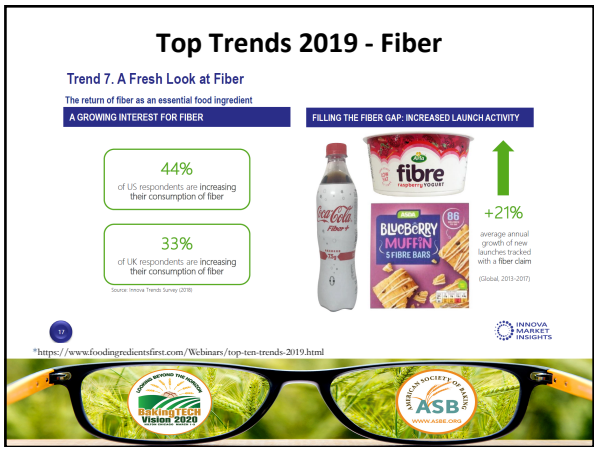


Q37: How would you rate the healthfulness of each of the following? (n=1,012)
**Indicates new addition to list starting 2019*

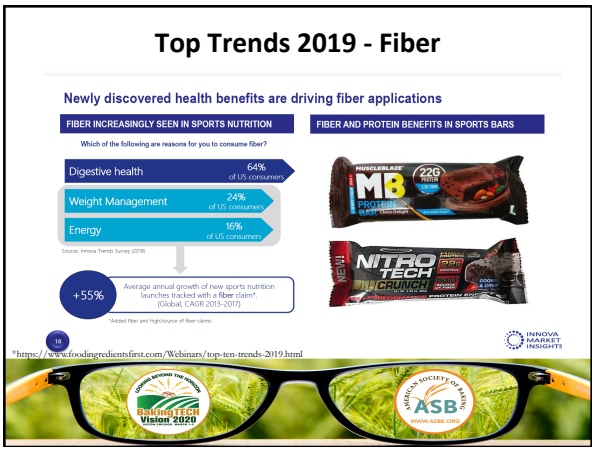
IFIC. 2019. https://foodinsight.org/wp-content/uploads/2019/05/IFIC-Foundation-2019-Food-and-Health-Report-FINAL.pdf

Top Trends - Fiber

Top Trends 2019 - Fiber



Top Trends 2019 - Fiber



(Fiber) *(Fiber)*

Let Food be thy Medicine & Medicine be thy Food

Thanks – Questions?

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