**Fibers for Healthy Baked Goods**

Post-FDA's 2016 Regulation

Rajen Mehta, Ph.D.

---

**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?**

<table>
<thead>
<tr>
<th>Intrinsic &amp; Intact</th>
<th>Isolated or Synthetic</th>
</tr>
</thead>
<tbody>
<tr>
<td>FDA Position</td>
<td>A &quot;true&quot; fiber with physiological benefits</td>
</tr>
<tr>
<td></td>
<td>A Carb that is not digested, no proven physiological benefits, not a fiber.</td>
</tr>
<tr>
<td>Why?</td>
<td>Fiber &amp; other natural nutrients could provide physiological efficacy</td>
</tr>
<tr>
<td></td>
<td>Analytical methods makes it &quot;non-digestible.&quot; Processes may eliminate physiological benefits</td>
</tr>
<tr>
<td>Examples</td>
<td>Whole grains, Corn, Bran, Pulses/legumes/fruit/Veg</td>
</tr>
<tr>
<td></td>
<td><em>soy hull</em></td>
</tr>
<tr>
<td>FDA list of &quot;approved&quot;?</td>
<td>Not impossible</td>
</tr>
<tr>
<td></td>
<td>No to many</td>
</tr>
<tr>
<td>Nutrients lost?</td>
<td>Almost none, only heat-labile</td>
</tr>
<tr>
<td></td>
<td>Minerals, water soluble, phyto-nutrients, phenolic, antioxidants, anti-inflammatory</td>
</tr>
<tr>
<td>Nutrients added?</td>
<td>None</td>
</tr>
<tr>
<td></td>
<td>Sodium (typical) Misc process dependent</td>
</tr>
</tbody>
</table>
**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 (II & I + Added/Functional)
- Compliance: Jan 1, 2020 (Sales >$10M)
- Daily Value – increased from 25 to 28 g/day
- Compliant petition/Physiological efficacy
  - Scientific agreement, Human study, Control, PolSAS, 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)

**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**

<table>
<thead>
<tr>
<th>Fiber Type</th>
<th>Approved (May 27, 2016)</th>
<th>Allowed (Enforcement Discretion) (June 14, 2018)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>β-glucan soluble fiber (CFR 101.81)</td>
<td>Mixed plant cell wall fibers: At least 2 of: Cellulose, pectin, hemicellulose, arabinoxylan</td>
</tr>
<tr>
<td>2</td>
<td>Psyllium husk (CFR 101.81)</td>
<td>Arabinogalactan</td>
</tr>
<tr>
<td>3</td>
<td>Cellulose</td>
<td>Alginate</td>
</tr>
<tr>
<td>4</td>
<td>Guar gum</td>
<td>Inulin &amp; inulin-type fructans</td>
</tr>
<tr>
<td>5</td>
<td>Pectin</td>
<td>High amylose starch (RS2)</td>
</tr>
<tr>
<td>6</td>
<td>Locust bean gum</td>
<td>Galacto-oligosaccharide</td>
</tr>
<tr>
<td>7</td>
<td>Hydroxypropylmethylcellulose</td>
<td>Polydextrose</td>
</tr>
<tr>
<td>8</td>
<td>Resistant maltodextrin/dextrin</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Cross-linked phosphorylated RS4 (March 27, 2020)</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Glucomannan</td>
<td>January 10, 2020</td>
</tr>
</tbody>
</table>
## FDA Status – Insoluble Fibers
(Commercially Important)

<table>
<thead>
<tr>
<th>No.</th>
<th>Fiber Source</th>
<th>FDA Status</th>
<th>Approved/Allowed</th>
<th>Not Approved</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Cellulose</td>
<td></td>
<td>Approved/Allowed</td>
<td>Not Approved</td>
</tr>
<tr>
<td>2</td>
<td>Mixed plant cell wall – 2 of: Cellulose, pectin, lignin, β-glucan, arabinoxylan</td>
<td></td>
<td>Efforts ongoing by many manufacturers</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Bamboo</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Isolated Oat</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Wheat</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sugarcane</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Corn hull</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Apple</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>RS2 resistant starch</td>
<td></td>
<td>RS3 resistant starch</td>
<td>Recently approved</td>
</tr>
<tr>
<td>4</td>
<td>Arabinoxylan</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## Fiber Functionality

**Insoluble**
- Resiliency, Strength
- Reduced Breakage
- Texture Control

**Soluble**
- Prebiotic Claims
- Low Absorption
- Soft Texture

**Gums**
- Absorption
- Viscosity
- Suspension

## Processes for Insoluble Fiber

<table>
<thead>
<tr>
<th>Physical</th>
<th>Chemical</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traditional Milling/Cooking:</td>
<td>Functionality with Chemicals:</td>
</tr>
<tr>
<td>No Effluents=&quot;Intrinsic/Intact&quot;</td>
<td>Effluents = &quot;Isolated&quot;</td>
</tr>
<tr>
<td>Phytonutrients Preserved</td>
<td>Phytonutrients + Fiber Fractions Discarded</td>
</tr>
<tr>
<td>Natural/Sustainable</td>
<td>Not Sustainable</td>
</tr>
<tr>
<td>Porosity Increased</td>
<td>Water Absorption ALSO Increased</td>
</tr>
</tbody>
</table>
**Insoluble Fiber Modification for Functionality**

- **Long**
  - Firm
  - Soft
  - **Physical Processes**
    - Increase Porosity

- **Short**
  - Firm
  - Soft
  - **Chemical Processes**

**Insoluble Fiber Functionality**

- **Long**
  - Firm
  - Soft
  - **Physical Processes**
    - Increase Porosity

- **Short**
  - Firm
  - Soft
  - **Chemical Processes**

---

**Fiber for Non-Traditional Foods**

*E.g., Gluten Free, High Protein, Whole Grain, Clean Label*

<table>
<thead>
<tr>
<th>Issue/defect</th>
<th>Fiber characteristic</th>
<th>Fiber effect</th>
<th>Typical foods</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gummy, hard, dense</td>
<td>Soft/Flexible</td>
<td>Open up structure, slightly reduce free water (if any), fluffy, soft</td>
<td>Soft baked goods, bread, snacks, cereals</td>
</tr>
<tr>
<td>Doughy, soft</td>
<td>Firm or flexible</td>
<td>Rigidity, crunch/chewy</td>
<td>Crumbs, bars, bread</td>
</tr>
<tr>
<td>Not resilient</td>
<td>Long (flexible)</td>
<td>Flexibility, strength, springiness</td>
<td>Bread, fine bakery</td>
</tr>
<tr>
<td>Dry, not cohesive</td>
<td>Long/soft + hydrocolloid</td>
<td>Absorbs water/oil - released on chewing, binding, adds fat-like mouthfeel</td>
<td>Bars, crusts</td>
</tr>
<tr>
<td>Powdery</td>
<td>Long/soft + slight hydration</td>
<td>Provide structure during leavening, moisture</td>
<td>Fine bakery, bars</td>
</tr>
<tr>
<td>Shape control</td>
<td>Long/Firm or short</td>
<td>Long for more spread/dome shape. Soft</td>
<td>Cookies, bars</td>
</tr>
<tr>
<td>Soft dough</td>
<td>Short</td>
<td>Relaxes dough</td>
<td>All doughs</td>
</tr>
<tr>
<td>Caking, not free-flowing</td>
<td>Firm/fine</td>
<td>Powder separation with fine fiber</td>
<td>Mixes. Binds in processing</td>
</tr>
</tbody>
</table>


---

**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*


Fiber-free Diets Enhance Pathogen Susceptibility


Benefits of Fiber & Microbiome Produced SCFAs in Gut


<table>
<thead>
<tr>
<th>SCFAs Decrease</th>
<th>SCFAs Increase</th>
</tr>
</thead>
<tbody>
<tr>
<td>WAT (White Adipose tissue) Fat accumulation</td>
<td></td>
</tr>
<tr>
<td>Brain Inflammation Satiety, Immunity, Neurogenesis (Communication)</td>
<td></td>
</tr>
<tr>
<td>Liver Lipid storage Gluconeogenesis (glucose from proteins, lipids, etc.) Insulin sensitivity Energy generation</td>
<td></td>
</tr>
<tr>
<td>Lung Prevent autoimmune disease, Asthma Cancer inhibition</td>
<td></td>
</tr>
<tr>
<td>Bone Marrow Asthma Immune system growth</td>
<td></td>
</tr>
</tbody>
</table>


SCFAs (Acetate Propionate Butyrate)
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

Microbiome for Consumers

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 gut 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

Microbiome for Consumers

MicroBiome Bar

Prebiotic

Probiotic

Fiber

Microbiome Benefits

Claim Level

Company

Product

Approach

Very Conservative

Kellogg

Happy Inside Cereal

Prebiotics + Probiotics + Fiber

= Digestive Wellness

Conservative

Solaray

Microbiome Supplement (future=bar)

PROBIOTICS + Prebiotics + Insoluble fibers

= Healthy Microbiome

Progressive

ProBiotin

Microbiome Bar

Fibers + Prebiotics + Probiotics + Misc ingredients

= Gut + prevent diseases

Ingredients Impacting Food Healthfulness

**Top Trends - Fiber**

High consumer demand for fiber, industry responds

Fiber matters to consumers

Science and package with culinary truth

Top Trends 2019 - Fiber

Trend 7: A Fresh Look at Fiber

New research offers an essential new ingredient

A growing interest for fiber

44% of consumers interested in increasing their consumption of fiber

33% of consumers interested in increasing their consumption of fiber

**Top Trends 2019 - Fiber**

Newly discovered health benefits are driving fiber applications

Food and potato innovation in sports drinks

Dietary fiber

Nutritional benefits which are associated with gut health and overall health

Dietary fiber

100% of consumers agreed that the fiber health claims were "very convincing"
Let Food be thy Medicine & Medicine be thy Food

Thanks – Questions?

Rajen Mehta, Ph.D.  617-803-3938
Rajen.Mehta@grainmillers.com