Overview of Fibersym® RW, a Resistant Wheat Starch

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Fibersym® RW and Dietary Fiber

• Definition of Resistant Starch
  – Resistant Starch is the sum of starch and products of starch degradation not absorbed in the small intestine of healthy individuals

• Resistant Starch is recognized as dietary fiber
  – American Association of Cereal Chemists International (AACC, 2000)
  – Institute of Medicine (IOM, 2001)
  – Codex (2009)
  – European Food Safety Authority (2007)
Fibersym® RW as a Dietary Fiber

• Measures as dietary fiber by both AOAC 991.43 and AOAC 985.29
  – Fibersym RW = 85% (minimum, dry basis) insoluble fiber
  – FiberRite RW = 75% (minimum, dry basis) insoluble fiber

• Labeled as “Modified Wheat Starch” and no use level limitations
  – Code of Federal Regulations Title 21, Part 172.892
## Four Types of Resistant Starches in Diet

<table>
<thead>
<tr>
<th>Types of RS</th>
<th>Occurrence</th>
</tr>
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<tbody>
<tr>
<td>RS1 - Physically inaccessible starch</td>
<td>Partially milled grains, seeds and legumes</td>
</tr>
<tr>
<td>RS2 - Granular starch</td>
<td>Native, uncooked banana starch and potato starch</td>
</tr>
<tr>
<td>RS3 - Nongranular, retrograded amylose</td>
<td>Cooked and cooled potato</td>
</tr>
<tr>
<td>RS4 - Chemically modified starch</td>
<td>Cross-linked or hydroxypropylated</td>
</tr>
</tbody>
</table>

*Slide Courtesy of Dr. Paul A. Seib*
Native Wheat vs. Resistant Wheat Starch

Native Wheat Starch

Resistant Wheat Starch Fibersym® RW

Pregelatinized RS Wheat FiberRite® RW

x1,000  x1,000  x1,000

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Benefits of Fibersym® RW in flour-containing products

- Low water-binding capacity
- Compatibility with wheat flour
- Bland/Neutral flavor profile
- Fine particle size with smooth texture
- White and “invisible” appearance
Key Function of Fibersym® RW in Bakery Products

- Low water holding capacity compared to conventional fiber sources. (0.7g water/g)
Physiological Benefits of Fibersym® RW

- Acts as a prebiotic
- Lower gas production than many other sources of fiber
- Beneficial short chain fatty acid production
- Glycemic response control
- Limited caloric contribution
Aim: To study the fermentation characteristics of Fibersym® RW

- Cooked Fibersym® RW was digested with pepsin and pancreatin-bile

- Indigestible residue was fermented using fresh human fecal microbiota as inoculum
Indigestible Residue from Fibersym® RW (after \textit{in vitro} digestion)

Boiling water bath
30 min.

Pepsin-HCl
37 °C
pH 2.0
3 hrs.

Pancreatin-Bile
37 °C
pH 7.5
12 hrs.

Digestion method by
Trinidad et al 1996
In Vitro Fermentation with Human Fecal Microbiota for 24 Hours

*Adapted from Van Hoeij et al 1997; **Adapted from McBurney et al 1989.

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The high level of dietary fiber residue in resistant wheat starch was fermented by human feces (colonic bacteria) to short-chain fatty acids for 24 hours (Fermentation by the method of McBurney et al 1987).
20g of RS2 and RS4 were mixed in equal amounts of water and capillary glucose were measured over 2 hours with standard GI method.

Al-Tamimi et al. Unpublished data 2007
Resistant Starch on Glycemia

• Three groups
  – Glucose beverage (control)
  – Fibersym® RW (RS4 bar)
  – Puffed wheat bar (PWB bar)
    • Bars had identical ingredients except for RS or puffed wheat

Source: Haub 2009
Nutrient Composition of Each Meal Per Dose
(GLU = 198ml; PWB = 65g; RS4 = 80g)

<table>
<thead>
<tr>
<th></th>
<th>GLU</th>
<th>WB</th>
<th>RS4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Energy (kcal)</td>
<td>200</td>
<td>261</td>
<td>326</td>
</tr>
<tr>
<td>Carbohydrate (g)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>50</td>
<td>56</td>
<td>71</td>
</tr>
<tr>
<td>Available</td>
<td>50</td>
<td>51</td>
<td>51</td>
</tr>
<tr>
<td>Total Dietary Fiber (g)</td>
<td></td>
<td>5</td>
<td>20</td>
</tr>
<tr>
<td>Fat (g)</td>
<td>--</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Protein (g)</td>
<td>--</td>
<td>7</td>
<td>6</td>
</tr>
</tbody>
</table>

Source: Haub 2009
MEAN±SEM blood glucose response for 13 healthy younger adults after consumption of Glucose Drink (♦Glu), Puffed Wheat Bar (■ WB), and Resistant Wheat Starch (▲RSB). Means of blood glucose at the same time with different letters differ significantly (p<0.05).

Al-Tamimi, Ph.D. Dissertation 2007, Kansas State University

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MEAN±SEM blood insulin response for 13 healthy younger adults after consumption of Glucose Drink (♦ GLUC), Puffed Wheat Bar (■ WB), and Resistant Wheat Starch (▲ RSB). Means of blood insulin at the same time with different letters differ significantly (p<0.05).

Al-Tamimi, Ph.D. Dissertation 2007, Kansas State University

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Glycemic Response of Fibersym® RW and FiberRite® RW in Type 2 Diabetics

Source: Haub 2008
Fibersym® RW has great potential as a functional ingredient to improve digestive health; can be classified as a prebiotic fiber.

Fibersym® RW creates no significant differences in appearance, texture, flavor and overall sensory properties of snack crackers.

In total, snack crackers formulated with Fibersym® RW were more bifidogenic than crackers formulated with a high-amylose resistant corn starch.

30 grams of dietary fiber from Fibersym® RW are well tolerated by human subjects based on results related to bowel movement, stool consistency, discomfort, flatulence, abdominal pain and bloating.

Gut microbiota was modified by Fibersym® RW in 5 out of 10 subjects.

On average, Fibersym® RW increased Bifidobacteria by 350% in 10 human subjects tested.
Results: Symptoms

No statistically significant differences.