Health-Promoting Starch Fractions in Parboiled Rice

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Parboiling
- Rice subjected to soaking, steam, and/or high pressure prior to drying and milling
- Improved milling yield and nutritional value
- Parboiled rice accounting for as much as a fifth of the world’s rice production
- More suitable for canning and frozen food applications

Starch Fractions
- Rapidly Digestible Starch (RDS)
  - Hydrolyzed by amylolytic enzymes in 20 min
- Slowly Digestible Starch (SDS)
  - Hydrolyzed by amylolytic enzymes between 20 and 120 min
- Resistant Starch (RS)
  - Not hydrolyzed by amylolytic enzymes in 120 min

Health Benefits of SDS
- Improved metabolic profile
- Reduced insulin requirement
- Mental performance
- Satiety

Resistant Starch
- Starch that resistant digestion in the small intestine
- Fermented to short-chain fatty acids
- Similar function to dietary fiber

Health Benefits of RS
- Improved colonic function:
  - Reduced transit time
  - Increased fecal weight and output
  - Lower pH from increased short chain fatty acid (SCFA) production
- Energy Management
- Weight Management
**Health Claims**

- “Reduction of post-prandial glycaemic and insulinaemic responses by RS” confirmed when replacing digestible starches in high carbohydrate baked goods by at least 14%.
  - April 8, 2011 by EFSA (European Food Safety Authority)
- “Digestive health benefits” and “favors a normal colon metabolism” not confirmed.

**Types of Resistant Starch**

<table>
<thead>
<tr>
<th>RS1</th>
<th>RS2</th>
<th>RS3</th>
<th>RS4</th>
<th>RS5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physically inaccessible starch</td>
<td>Granular resistant starch</td>
<td>Retrograded starch</td>
<td>Chemically modified starch</td>
<td>Amylose-lipid complex</td>
</tr>
</tbody>
</table>

**Laboratory-scale Parboiling**

- Soaking at 65°C for varying time periods
- Autoclaving
- Drain soaking water
- Drying
  - Cycle 1: Immediate drying
  - Cycle 2: Ambient for 24 hr prior to drying
  - Cycle 3: Ambient for 24 hr, re-autoclaved, stored at ambient for 24 hr, dried

**Water Absorption during Soaking**

<table>
<thead>
<tr>
<th>Rough Rice</th>
<th>Brown Rice</th>
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</table>

**Thermal Properties**

- Differential scanning calorimetry

Retrograded amylopectin

Amylose-lipid complex
### Amylose-Lipid Complex Peak Enthalpy

- **Pasting Profile of Native Flours**
  - **Temperature (°C)**: 0, 10, 20, 30, 40
  - **Viscosity (cP)**: 0, 500, 1000, 1500, 2000
  - **Time (sec)**: 0, 200, 400, 600, 800, 1000, 1200, 1400

### Wells - RVA Pasting Profile

- **Rough rice Cycle 1**: RDS (%): 88.8
  - SDS (%): 5.5
  - RS (%): 5.7
- **Brown rice Cycle 1**: RDS (%): 83.8
  - SDS (%): 10.1
  - RS (%): 6.1
- **Cycle 3**: RDS (%): 83.7
  - SDS (%): 10.3
  - RS (%): 6.0
Correlations

<table>
<thead>
<tr>
<th></th>
<th>RDS</th>
<th>SDS</th>
<th>RS</th>
</tr>
</thead>
<tbody>
<tr>
<td>SDS</td>
<td>-0.72*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>RS</td>
<td>-0.35*</td>
<td>-0.39*</td>
<td></td>
</tr>
<tr>
<td>Retrograded Amylopectin Enthalpy</td>
<td>-0.41*</td>
<td>0.4*</td>
<td>0</td>
</tr>
<tr>
<td>Amylose-lipid Complex Enthalpy</td>
<td>-0.26*</td>
<td>0.14</td>
<td>0.18*</td>
</tr>
</tbody>
</table>

Summary

• Cultivar and parboiling process and their interactions affected the amounts of starch fractions in parboiled rice.
• The storage treatment increased SDS and decreased RDS in parboiled rice.
• It is possible to increase the health benefits of parboiled rice by encouraging the formation of retrograded amylopectin and amylose-lipid complex and the interactions among rice components.
• Parboiled rice with different SDS and RS contents can be produced by varying rice cultivar and parboiling conditions.

Research In Progress

• Human study
  • to evaluate the effectiveness of our rice product in reducing the blood glucose level
  • 30 subjects
  • blood glucose level from subjects at 15 min before, 0, 15, 30, 45, 60, 75, 90, 120, and 180 min after ingestion of the rice products

Acknowledgements

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