Pasta and Gluten: Facts and Fakes

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This presentation was prepared at the initiative of the French Pasta Manufacturers Association (SIFPAF) but the content of this presentation is on the sole responsibility of the authors.
How Traditional Pasta are made?

- Only one raw material: Durum wheat
- Primary processing: Extraction of the starchy endosperm in form of semolina
- Pasta processing:
  - Hydration
  - Mixing
  - Forming: sheeting or cold extrusion (< 55°C)
  - Drying
- Sensorial attributes
  - Yellow color
  - High capacity to hold water during cooking with low amount of solid losses
  - Texture: firm and elastic
  - Surface condition: no stickiness, no disintegration
Physicochemical Basis of Pasta Quality

Pasta processing consists in developing a protein network able to entrap starch granules during cooking.

- Starch Swelling and Gelatinisation
- Protein Network forming and denaturation

Native starch

Swelling

Leaching and Pasting

Disulfid bond (elasticity)
Non Covalent bond (viscosity)
Proteins and Gluten

Semolina

Water

Salted Solution

Ethanol solution

Diluted Acid ± detergents

ALBUMINS

GLOBULINS

GLIADINS (35 %)

GLUTENINS (45 %)

- solubles
- insolubles

GLUTEN

Viscosity

Elasticity

QUALITY
Gluten (wheat) Related Pathogenesis

Autoimmunes
- Coeliac disease
- Dermatitis herpetiformis
- Gluten ataxia
  - Genetic background: HLA DQ2 and DQ8
  - Atrophy of duodenal villi
  - Anti-transglutaminase 2 Ac
  - Anti-class A endomysium Ac
  - Anti deamidated gliadin IgG
  Dermatological form
  Neurological form

Allergic
- Mediated by anti-ω gliadin IgE
  - Respiratory symptoms (baker asthma)
  - Induced by physical effort
  - Skin and digestive symptoms

Non autoimmune
- Non allergic

Non coeliac gluten sensitivity NCGS
- Gluten intolerance (?) with:
  - No serological markers
  - No IgE
  - No atrophy of intestinal mucosis

1. Abdominal pains (68 %)
2. Epigastric burns (15 %)
3. Nausea and vomiting (15 %)
4. Borborygmus (10 %)
5. Bloating, flatulences (25 %)
6. Constipation (20 %)
7. Diarrohea (33 %)
8. Eczema /erythema(40 %)
9. Headache (35 %)
10. Disturbance in attention(34 %)
11. Chronic tiredness (35 %)
12. Neuromuscular troubles
13. Comportemental troubles

Prevalence: 0.7-1.5%  < 1%  6-8%
Global Social Media Hype: Eating wheat makes you fat and sick.

- Wheat Belly: Lose the wheat, lose the weight, and find your path back to health.
- The Paleo Diet: Lose weight and get healthy by eating the food you were designed to eat.
- Grain Brain: The surprising truth about wheat, carbs, and sugar - your brain's silent killers.

**Reasons for purchasing 'Gluten-Free' foods:**

- 35%: No reason
- 26%: Healthier option
- 19%: Digestive health
- 13%: Weight loss
- 13%: Enjoy the taste
- 10%: Someone in my family has a gluten sensitivity
- 9%: Inflammation
- 9%: Diet cleanse
- 0%: Trendy
- 0%: Some other reason
- 0%: I have a gluten sensitivity

The biggest reason for purchasing gluten-free foods is 'No reason at all'.
How to Prepare Gluten Free Pasta?

• Gluten Free pasta should have the same sensorial attributes as traditionnal pasta:
  – Color
  – Cooking Quality

• Mixing different raw material: Flour and/or starch products without gluten content

• Adding or not additives for color

• Adapting pasta processing
  – Modifying starch properties
  – Additives for cooking quality
How to Replace Gluten Functionality?

Modifying the starch components in order to:

1. Create a new organised structure to give a form to pasta during extrusion (binding properties)
   - Heat-treated flours and starches
   - Extrusion cooking

2. Limit starch swelling and solubilisation during cooking
   - High-amylose content (starch)
   - Additives to complex amylose: Emulsifiers (mono and diglycerides)
   - Other texturing ingredients: hydrocolloids (guar, Xanthan, CMC, etc.)
### Commercial GF Pasta Ingredients

<table>
<thead>
<tr>
<th>Starch sources</th>
<th>Protein sources</th>
<th>Additives</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rice (flours and starches)</td>
<td>Protein isolates from pea or lupin</td>
<td>Hydrocolloids and gums</td>
</tr>
<tr>
<td>Corn (flours and starches)</td>
<td></td>
<td>• Xanthan</td>
</tr>
<tr>
<td>Pseudocereals : (flours)</td>
<td></td>
<td>• Guar</td>
</tr>
<tr>
<td>• Buckwheat,</td>
<td></td>
<td>• ...</td>
</tr>
<tr>
<td>• Quinoa</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• ...</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Potato and tubers (starch)</td>
<td>Egg</td>
<td>Emulsifiers</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Mono-glycerides</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Di-glycerides</td>
</tr>
<tr>
<td>Legume (flour)</td>
<td>Whey</td>
<td>Inulin</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Sources:
- Web sites of different French supermarkets and health food stores
Some Examples of GF Pasta

- Rice pasta
- Corn Pasta
- Lentil Pasta
- Durum Pasta
- Buckwheat Pasta
- Quinoa Pasta
# Macronutrients of Traditional and GF Pasta

<table>
<thead>
<tr>
<th>Pasta</th>
<th>Protein (%)</th>
<th>Total Carbohydrates (%)</th>
<th>Total Lipids (%)</th>
<th>Fiber (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>GF pasta</td>
<td>11.2</td>
<td>80.8</td>
<td>5.5</td>
<td>2.4</td>
</tr>
<tr>
<td>Durum pasta</td>
<td>13.8</td>
<td>78.4</td>
<td>2.6</td>
<td>5.3</td>
</tr>
</tbody>
</table>

Means based on 15 GF products and 38 non GF pasta
Micronutrients of Traditional and GF Pasta Minerals

<table>
<thead>
<tr>
<th>Products</th>
<th>Ca</th>
<th>Fe</th>
<th>Mg</th>
<th>P</th>
<th>K</th>
<th>Na</th>
<th>Zn</th>
</tr>
</thead>
<tbody>
<tr>
<td>GF pasta</td>
<td>19</td>
<td>1.46</td>
<td>77</td>
<td>224</td>
<td>197</td>
<td>326</td>
<td>1.44</td>
</tr>
<tr>
<td>Durum pasta</td>
<td>25</td>
<td>2.46</td>
<td>90</td>
<td>266</td>
<td>328</td>
<td>6</td>
<td>2.19</td>
</tr>
</tbody>
</table>

## Micronutrients of Traditional and GF Pasta Vitamins

<table>
<thead>
<tr>
<th>Products</th>
<th>Thiamin (mg/100 g)</th>
<th>Riboflavin (mg/100 g)</th>
<th>Niacin (mg/100 g)</th>
<th>B6 (mg/100 g)</th>
<th>E (µg/100 g)</th>
<th>Folate (µg/100 g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>GF pasta</td>
<td>0.25</td>
<td>0.08</td>
<td>1.99</td>
<td>0.16</td>
<td>0.11</td>
<td>30</td>
</tr>
<tr>
<td>Durum pasta</td>
<td>0.25</td>
<td>0.14</td>
<td>5.19</td>
<td>0.21</td>
<td>0.28</td>
<td>43</td>
</tr>
</tbody>
</table>

Sensorial Properties of GF Pasta

<table>
<thead>
<tr>
<th>Composition</th>
<th>Colour</th>
<th>Cooking Quality</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Brightness</td>
<td>Yellowness</td>
</tr>
<tr>
<td>Rice Flour</td>
<td>↗</td>
<td>↘ ↘</td>
</tr>
<tr>
<td>Yellow Corn Flour</td>
<td>↘</td>
<td>↗</td>
</tr>
<tr>
<td>Corn Starch</td>
<td>↘</td>
<td>→</td>
</tr>
<tr>
<td>Rice + Corn flours + additives</td>
<td>→</td>
<td>→</td>
</tr>
</tbody>
</table>

# Glycemic Index of Traditional and GF Pasta

<table>
<thead>
<tr>
<th>Pasta content</th>
<th>GI</th>
<th>Sources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Whole wheat</td>
<td>46</td>
<td></td>
</tr>
<tr>
<td>Corn</td>
<td>64</td>
<td>Bacchetti et al. (2014) Food Funct. 5:3014-3017</td>
</tr>
<tr>
<td>(pea, millet, protein isolates)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## Price Differential between GF and Traditional Pasta

<table>
<thead>
<tr>
<th>Country</th>
<th>Year</th>
<th>Price differential</th>
<th>Sources</th>
</tr>
</thead>
<tbody>
<tr>
<td>France</td>
<td>2015</td>
<td>x 5.0</td>
<td>prices recorded on web sites of different French supermarkets and health food shops (based on 36 durum wheat pasta formats and 36 GF equivalent products + 1 pasta made with legumes)</td>
</tr>
</tbody>
</table>
Conclusions

1. Durum wheat remains the most suited raw material to reach pasta quality attributes expected by consumer with a very high reliability.

2. GF pasta can be elaborated from a large diversity of raw materials. It results as a “non well-defined” product exhibiting large variability.

3. Except celiac patients and other gluten proven pathologies, eviction of gluten in pasta is not justified neither for sensorial properties nor for nutritional aspects.

4. For non-celiac sensitivity, not only gluten has to be considered but other hypothese should be explored (fodmaps, ATI, etc). It is suggested to organise a vast study through an international consortium.

5. In a longer term vision, pasta stakeholders should be able to separate trends from fads with the aim not to demonize traditional pasta which is a pillar of the Mediterranean diet.