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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**

**Cytoplasmic or metabolic proteins**

- **Albumins**
- **Globulins**
- **Gliadins** (35%)
- **Glutenins** (45%)
  - solubles
  - insolubles

**Gluten**

- **Viscosity**
- **Elasticity**

**Quality**
Gluten (wheat) Related Pathogenesis

- **Autoimmunes**
  - Coeliac disease
  - Dermatitis herpetiformis
  - Gluten ataxia
- **Allergic**
  - Wheat allergy
  - Mediated by anti-α 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

**Prevalence**:
- Coeliac disease: 0.7-1.5%
- Dermatitis herpetiformis: < 1%
- Gluten ataxia: 6-8%

**Symptoms**:
1. Abdominal pains (68 %)
2. Epigastric burns (15 %)
3. Nausea and vomiting (15 %)
4. Borborygmus (10 %)
5. Bloating, flatulences (25 %)
6. Constipation (20 %)
7. Diarrhoea (33 %)
8. Eczema /erythema (40 %)
9. Headache (35 %)
10. Disturbance in attention (34 %)
11. Chronic tiredness (35 %)
12. Neuromuscular troubles
13. Comportemental troubles
Global Social Media Hype: Eating wheat makes you fat and sick

![Wheat Belly](image1)
![Paleo Diet](image2)
![Grain Brain](image3)

**REASONS FOR PURCHASING ‘GLUTEN-FREE’ FOODS**

<table>
<thead>
<tr>
<th>Reason</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>No reason</td>
<td>35%</td>
</tr>
<tr>
<td>Healthier option</td>
<td>26%</td>
</tr>
<tr>
<td>Digestive health</td>
<td>19%</td>
</tr>
<tr>
<td>Weight loss</td>
<td>13%</td>
</tr>
<tr>
<td>Enjoy the taste</td>
<td>13%</td>
</tr>
<tr>
<td>Someone in my family has a gluten sensitivity</td>
<td>10%</td>
</tr>
<tr>
<td>Inflammation</td>
<td>9%</td>
</tr>
<tr>
<td>Diet cleanse</td>
<td>9%</td>
</tr>
<tr>
<td>Trendy</td>
<td>0%</td>
</tr>
<tr>
<td>Some other reason</td>
<td>0%</td>
</tr>
<tr>
<td>I have a gluten sensitivity</td>
<td>0%</td>
</tr>
</tbody>
</table>

The biggest reason for purchasing gluten-free foods is “No reason at all.”

Gluten-Free is healthy!
How to Prepare Gluten Free Pasta?

• Gluten Free pasta should have the same sensorial attributes as traditional 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>Egg</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>Whey</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></td>
<td>Legume (flour)</td>
<td>Inulin</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Aroma, cane sugar syrup, salt</td>
<td></td>
</tr>
</tbody>
</table>

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

- Rice pasta
- Durum Pasta
- Buckwheat Pasta
- Lentil 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>Minerals (mg/100 g)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Ca</td>
</tr>
<tr>
<td>GF pasta</td>
<td>19</td>
</tr>
<tr>
<td>Durum pasta</td>
<td>25</td>
</tr>
</tbody>
</table>

*Source: http://ndb.nal.usda.gov/ndb/foods*
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 (mg/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>

Source: http://ndb.nal.usda.gov/ndb/foods
## 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>
</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>

*Note: The price differentials are calculated based on the price of traditional pasta compared to gluten-free (GF) pasta.*
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 hypotese 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.