Wheat Sensitivities: Sorting Fact from Fiction

Lisa Kissing Kucek, PhD
Research Geneticist
USDA-ARS-DFRC
Poll:

How many people in your close circle of friends and family avoid wheat in their diet?
“Wheat gluten isn’t bad”

-National Association of Wheat Growers
Figure from Kissing Kucek et al. (2015), based on Diepenbrock and Gore (2015)
## Sensitivities to Wheat

<table>
<thead>
<tr>
<th>Condition</th>
<th>Prevalence</th>
<th>Commonly potent reactive compounds in wheat</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>Celiac Disease</td>
<td>0.5-2%</td>
<td>α- and ω-gliadins, ATIs</td>
<td>(Rewers 2005; Tye-Din et al. 2010)</td>
</tr>
<tr>
<td>Wheat Allergy</td>
<td>0.2-0.5%</td>
<td>ATIs, LTPs, serpins, α- and ω-gliadins</td>
<td>(Zuidmeer et al. 2008; Vu et al. 2014)</td>
</tr>
<tr>
<td>Baker's Asthma</td>
<td></td>
<td></td>
<td>(Sanchez-Monge et al. 1997; Sandiford et al. 1997)</td>
</tr>
<tr>
<td>Atopic Dermatitis</td>
<td></td>
<td>ATIs, LTPs, gliadins and glutenins</td>
<td>(Kusaba-Nakayama et al. 2000; Battais, Courcoux, et al. 2005)</td>
</tr>
<tr>
<td>Urticaria</td>
<td></td>
<td>ω-5 gliadin</td>
<td>(Battais, Courcoux, et al. 2005)</td>
</tr>
<tr>
<td>Non-celiac Wheat Sensitivity</td>
<td>0.55%1</td>
<td></td>
<td>(Biesiekierski et al. 2013; Digiacomo et al. 2013; Skodje et al. 2018)</td>
</tr>
<tr>
<td>Fructose Malabsorption</td>
<td>11-38%1</td>
<td></td>
<td>(Truswell et al. 1988; Born et al. 1995; Ladas et al. 2000; Barrett et al. 2009)</td>
</tr>
<tr>
<td>Irritable Bowel Syndrome</td>
<td>11.5-14.1%</td>
<td></td>
<td>(Roberfroid 1993; Brighenti et al. 1995; Rumessen &amp; Gudmand-Høyer 1998; Hungin et al. 2005)</td>
</tr>
</tbody>
</table>

ATIs: amylase-trypsin inhibitors
LTPs: lipid transfer proteins

1A large scale epidemiological study has not been conducted

### The Suspects

- **Celiac-like**
- **ATIs**
- **Fructans**

http://www.ebi.ac.uk/Celiac-like-Hypersensitivity

---

**90 kDa**

- Not wheat

**60 kDa**

- Hypersensitivity

**30 kDa**

- Celiac-like

**10 kDa**

- ATIs

**Fructans**
Celiac Immunoreactivity

Meta-analysis of eight studies (Molberg et al. 2005; Pilloli et al. 2018; Pizzuti et al. 2006; Vincentini et al. 2007; Vincentini et al. 2009; van den Broeck, de Jong, et al. 2010; van den Broeck, Hongbing, et al. 2010). Max, min, and mean values (dark linkes) are presented. Labels “n=” refer to the number of unique varieties evaluated. Values were were standardized by converting means for modern wheat in each study to 1.
Specificity of Reaction Varies by Patient

Figure adapted from Molberg et al., 2005
Allergenicity

Meta-analysis of eight studies (Weiss, Vogelmeier, and Gorg 1993; Sánchez-Monge et al. 1996; Klockenbring et al. 2001; Nakamura et al. 2005; Larré et al. 2011; Vu et al., 2014; Wieser et al. 1994; Wieser et al. 1998). Max, min, and mean values (black lines) are presented. Labels “n=” refer to the number of unique varieties evaluated. Values for IgE were normalized to a relative scale by converting reported average values for modern wheat in each study to a common value.
Amylase-Trypsin Inhibitors
(Celiac Disease, Wheat Allergy, and NCWS)

Meta-analysis of five studies (Bedetti et al. 1974; Vittozzi and Silano 1976; Sánchez-Monge et al. 1996; Wang et al. 2007; Zoccatelli et al. 2012). Max, min, and mean (black lines) values presented. Labels “n=” refer to the number of unique varieties evaluated. Values for ATIs were normalized to a relative scale by converting reported average values for modern wheat in each study to a common value.
Meta-analysis of nine studies (De Gara et al. 2003; Fretzdorff and Welge (2003); Gelinas et al. (2015); Huynh et al. 2008; Brandolini et al. 2011; Hammed 2014; Veenstra 2014; Verspreet et al. (2012); Ziegler et al. 2016). Max, min, and mean (black lines) values presented. Labels “n=” refer to the number of unique varieties evaluated. Values for ATIs were normalized to a relative scale by converting reported average values for modern wheat in each study to a common value.
From Varieties to Flour

<table>
<thead>
<tr>
<th>ω-5 gliadins</th>
<th>ATIs</th>
<th>Fructans?</th>
</tr>
</thead>
</table>

DOI 10.1007/s10681-013-0984-1

Development and characteristics of ω-gliadin-free wheat genotypes

Photo by: pink hats, red shoes
Field performance: Einkorn less than half the yield

Milling standards: Einkorn must be dehulled

Taste, flavor, texture: Will consumers accept the texture quality of einkorn?

Baking quality: Einkorn does not have the glutenin composition for bread baking
Processing Method

Impacts on Wheat Sensitivity
Germination and Fermentation

Germination/Fermentation Time (hours)

Relative Amount of Compound (%)

100
0
50
24
12
18
6

Prolamins after germination

GMP after fermentation

Prolamins after fermentation

Germination and Fermentation Time (hours)
Food Additives and Supplements

Grocery Survey: % Products in a Category Containing Wheat

Data from Atchison et al., 2010
Conclusions

• Understand what is causing sensitivities first.

• No wheat is safe for celiac disease.

• To reduce accidental exposure and delay disease epidemiology:
  • Select wheat genotypes with low reactivity for specific conditions (get tested first);
  • Use germination and fermentation processes;
  • Avoid Vital Wheat Gluten, isolated wheat protein, and/or inulin.