Who wants our wheat?

WHEAT ACADEMY
DECEMBER 12, 2017

DR. CRAIG MORRIS

USDA-ARS WESTERN WHEAT QUALITY
LAB, PULLMAN, WA
World production of wheat (2013): 716 mmt – nearly all is converted into flour via roller milling
What’s inside the box?
§ 810.2202 Definition of other terms.


(1) Durum wheat. All varieties of white (amber) durum wheat. This class is divided into the following three subclasses:

(i) Hard Amber Durum wheat. Durum wheat with 75 percent or more of hard and vitreous kernels of amber color.

(ii) Amber Durum wheat. Durum wheat with 60 percent or more but less than 75 percent of hard and vitreous kernels of amber color.

(iii) Durum wheat. Durum wheat with less than 60 percent of hard and vitreous kernels of amber color.

(2) Hard Red Spring wheat. All varieties of Hard Red Spring wheat. This class shall be divided into the following three subclasses:

(i) Dark Northern Spring wheat. Hard Red Spring wheat with 75 percent or more of dark, hard, and vitreous kernels.

(ii) Northern Spring wheat. Hard Red Spring wheat with 25 percent or more but less than 75 percent of dark, hard, and vitreous kernels.

(iii) Red Spring wheat. Hard Red Spring wheat with less than 25 percent of dark, hard, and vitreous kernels.

(3) Hard Red Winter wheat. All varieties of Hard Red Winter wheat. There are no subclasses in this class.

(4) Soft Red Winter wheat. All varieties of Soft Red Winter wheat. There are no subclasses in this class.

(5) Hard White wheat. All hard endosperm white wheat varieties. There are no subclasses in this class.
(6) **Soft White wheat.** All soft endosperm white wheat varieties. This class is divided into the following three subclasses:

(i) **Soft White wheat.** Soft endosperm white wheat varieties which contain not more than 10 percent of white club wheat.

(ii) **White Club wheat.** Soft endosperm white club wheat varieties containing not more than 10 percent of other soft white wheats.

(iii) **Western White wheat.** Soft White wheat containing more than 10 percent of white club wheat and more than 10 percent of other soft white wheats.

(7) **Unclassed wheat.** Any variety of wheat that is not classifiable under other criteria provided in the wheat standards. There are no subclasses in this class. This class includes any wheat which is other than red or white in color.

(8) **Mixed wheat.** Any mixture of wheat that consists of less than 90 percent of one class and more than 10 percent of one other class, or a combination of classes that meet the definition of wheat.
Puroindoline
courtesy Prof. Peter Shewry
Hard wheat results from mutations in the *Puroindoline* genes: soft to hard

adapted from Greenwell and Day
### Grading factors

<table>
<thead>
<tr>
<th>Minimum pound limits of:</th>
<th>Grades U.S. Nos.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Test weight per bushel</td>
<td></td>
</tr>
<tr>
<td>Hard Red Spring wheat or White Club wheat</td>
<td>58.0</td>
</tr>
<tr>
<td>All other classes and subclasses</td>
<td>60.0</td>
</tr>
<tr>
<td>Maximum percent limits of:</td>
<td></td>
</tr>
<tr>
<td>Defects:</td>
<td></td>
</tr>
<tr>
<td>Damaged kernels</td>
<td></td>
</tr>
<tr>
<td>Heat (part of total)</td>
<td>0.2</td>
</tr>
<tr>
<td>Total</td>
<td>2.0</td>
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<tr>
<td>Foreign material</td>
<td>0.4</td>
</tr>
<tr>
<td>Shrunken and broken kernels</td>
<td>3.0</td>
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<tr>
<td>Total</td>
<td>6.0</td>
</tr>
<tr>
<td>Wheat of other classes:</td>
<td></td>
</tr>
<tr>
<td>Contrasting classes</td>
<td>1.0</td>
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<tr>
<td>Total</td>
<td>3.0</td>
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<tr>
<td>Stones</td>
<td>0.1</td>
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### Maximum count limits of:

<table>
<thead>
<tr>
<th>Other material in one kilogram:</th>
<th>1</th>
<th>1</th>
<th>1</th>
<th>1</th>
<th>1</th>
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<tbody>
<tr>
<td>Animal filth</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Castor beans</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Crotalaria seeds</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Glass</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Stones</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Unknown foreign substances</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Total</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
</tbody>
</table>

### Insect-damaged kernels in 100 grams

- 31
- 31
- 31
- 31
- 31

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U.S. Sample grade is Wheat that:

(a) Does not meet the requirements for U.S. Nos. 1, 2, 3, 4, or 5; or
(b) Has a musty, sour, or commercially objectionable foreign odor (except smut or garlic odor) or
(c) Is heating or of distinctly low quality.

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1. Includes damaged kernels (total), foreign material, shrunken and broken kernels.
2. Unclassed wheat of any grade may contain not more than 10.0 percent of wheat of other classes.
3. Includes contrasting classes.
4. Includes any combination of animal filth, castor beans, crotalaria seeds, glass, stones, or unknown foreign substance.
So what gets put in the box? And is it something our customers want?
Wheat Protein

Gliadin

Glutenin

Gluten (gliadin + glutenin)
Gliadins: Extensibility

Glutenins: Elasticity
Bread:
--Hard kernel texture
--Strong gluten
--Elasticity and extensibility

Cookies, cakes, delicate pastries:
--Soft kernel texture
--Weak gluten
--More extensibility than elasticity
Same Protein Content
Flour Milling

Why is it important to quality?
Goal: Milling Trifecta

- Fine Particle Size
- Clean Bran-Endosperm Separation
- Low Starch Damage

All milling decisions are driven by these factors
Bake Products

Are complex systems of polymer interactions

- Starch
- Protein
- Arabinoxylan
- Fats
Flour Milling

- Directly impacts the availability of these components to the bake product
Why is the Trifecta Important?

Particle Size

- Mean flour particle size about 70 microns
- Clusters of a few starch granules embedded in protein matrix
- Bake products are chemical reactions
- All components of the reaction in close proximity
Why is the Trifecta Important?

Bran-Endosperm Separation

- Bran is fiber & non-functional in forming product, 20% dead weight plus germ
- Bran interferes with gluten development
- True of any introduced fiber source
- A good quality flour can carry 10% dead weight and still make a reasonable product
- Also provides avenues for CO$_2$ loss
Why is the Trifecta Important?

Starch Damage

- Normal levels calculated into baking formulas,
  3-5% soft, 6-10% hard
- Broken starch behaves differently than intact granules
- Hydrolysis happens in mixing bowl instead of oven, sticky dough
- Gelatinization happens at different times during baking, rough crumb grain
- High water absorption dough, bad news for soft wheat
Milling Technology

- 2 Rocks- Saddle & Rubbing Stone

- Stone Quern
  - Rubbed or Rolled
  - Mechanization of Process

- Stone Mill
  - Top Stone Suspended
  - Flutes Direct Meal to Edge
Milling Technology

Steel Roller Mill

- Developed ~1850, fine metal work possible
- Rolls Mounted Vertically on Edge
- 2:1 Speed Ratio Between rolls
- Rolls Move in Opposite Directions
Fundamental Change

Instead of Crushing Action
Grain is Sheared or Exploded Apart

The Trifecta is Improved
- More fine particles
- Cleaner Bran-Endosperm separation
- Less Starch Damage
Milling Technology

- **Break Rolls are Ribbed**
  - Break wheat kernel apart
  - Scrape endosperm off of bran

- **Reduction Rolls are Smooth**
  - Gently reduce sandy size particles to flour
**Western Wheat Quality Laboratory, MIAG MULTOMAT**

**Break Roll Speed**
- Fast Rolls: 340rpm
- Slow Rolls: 145rpm
- Differential: 2.34 : 1

**Reduction Roll Speed**
- Fast Rolls: 340rpm
- Slow Rolls: 250rpm
- Differential: 1.36 : 1

**Temper**
- 14% Soft Wheat
- 16% Hard Wheat
- 0.5% Pre-Temper

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<table>
<thead>
<tr>
<th>Break</th>
<th># of Teeth</th>
<th>α</th>
<th>β</th>
<th>Land</th>
<th>Radius</th>
<th>Spiral</th>
<th>Break Setting Targets</th>
<th>Targets</th>
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</thead>
<tbody>
<tr>
<td>1st Break</td>
<td>14</td>
<td>40</td>
<td>70</td>
<td>0.004”</td>
<td>0.024”</td>
<td>8% = 1”</td>
<td>43% Through 707 micron</td>
<td>707 micron</td>
</tr>
<tr>
<td>2nd Break</td>
<td>20</td>
<td>40</td>
<td>75</td>
<td>0.002”</td>
<td>0.012”</td>
<td>10% = 1¼”</td>
<td>64% Through 707 micron</td>
<td>707 micron</td>
</tr>
<tr>
<td>3rd Break</td>
<td>24</td>
<td>35</td>
<td>75</td>
<td>0.002”</td>
<td>0.008”</td>
<td>10% = 1¼”</td>
<td>Bran Appearance</td>
<td>707 micron</td>
</tr>
</tbody>
</table>
Scale of Modern Milling is Huge

WWQL Miag mill will produce 16 100# bags of flour in 16 hours
During 1950’s milling industry changed to fewer & larger mills
Today an average mill will produce 15,000 100# bags of flour 16 hours
This is 1.5 million pounds per day
Use 35,000 bushels of wheat
WWQL Milling Systems

- **Micro** 15 grams
- **Quadruplet** 500 grams
- **Buhler** 2000 grams
- **Miag Multomat** 125#/hour
Milling Technology
Other Methods

Various Kinds of Impact Mills
– Pin, Knife, Turbine, Sonic Disruption

Roller Milling has Stuck Around
– Energy Efficient, developed in wind & water power age
– Does a Good Job in Achieving the Trifecta
The Quest of the Miller

Choosing wheat lots and mill streams to use to make the best quality product for the least amount of $$

Achieve the Trifecta in the best way possible
The Value of US Wheat Shipments

US Wheat Associates estimates that it costs Asian millers ~$1.50 per bushel more to source US wheat than India, Black Sea or Australia.

US wheat shipments are viewed by overseas mills as providing value and are used to “blend up” poorer quality wheat.
Thank You