GRAIN HANDLING, MALTING, AND MALT ANALYSIS

BREWING + DISTILLING CENTER, INC.
INTRODUCTION OF CLASSMATES

• Your name.
• Where are you from?
• Have you ever brewed beer before? (details?)
• How did you become interested in brewing?
• What are your goals or objectives after completing this course?
• What is your favorite beer?
COURSE DESCRIPTION

This course seeks to establish understanding of the carbohydrate source of fermentation in quality beer production.

Topics include:

1. Barley breeding and selection for quality craft beer
2. Barley varieties
3. Proper techniques for malting of barley and the role of germination
4. Proper malt handling and proper milling
5. Proper techniques for malt kilning
6. Adjunct types and their uses
7. Barley structure and morphology
8. Proper procedures for barley intake and storage
9. Malt quality requirements
10. Barley changes during germination
11. Read a Malt Certificate Analysis and formulate grain bills using that information.
Barley was domesticated from a wild ancestor in the Fertile Crescent about 10,000 years ago...
Malt provides several key attributes that define beer as we know it, including:

- Color
- Flavor
- Body
- Alcohol

*Malt is as important to beer as HOPS! (Believe it or not, my YOUNG AMERICAN BREWERS)*
BARLEY FACTS

1. Short growing season, early maturing

2. Tolerant to drought, alkali, and saline soils.

3. Barley originally was selected for the brewing of beer
   It retains a husk on threshing, and this husk forms a porous filter bed from which the liquid wort is recovered.

4. Barley is self-pollinating, so varieties are relatively stable throughout successive generations
   Unless there is outside interference by growers
BARLEY FACTS

5. Raw barley is very hard and steely
   The starch is almost indigestible before the malting process modifies it.

6. Barley belongs to the grass family
   60-70% is used for animal feed; This barley is unsuitable for brewing.

7. 30-40% is used in malting to make beer & whiskey.
   Only 2-4% is directly consumed by humans.
BARLEY STANDARDS FOR MALTSTERS:

There are strict standards that barley must meet before being accepted by maltsters:

• High germination rate (at least 96%)
• Low moisture content (not exceeding 12%)
• Low protein/nitrogen content within an acceptable range (9-11% not higher than 13.5%).
  • More space for starch
• Free of disease, sprout damage, chemical damage, or insect damage.
BARLEY DISEASES (Fungal)

FUSARIUM HEAD BLIGHT
CAN CAUSE GUSHING IN PACKAGED BEER

ERGOT ON BARLEY
RUSSIAN WHEAT APHID

INFESTATION OF RUSSIAN WHEAT APHID

RUSSIAN WHEAT APHID
BARLEY GROWING AREAS IN U.S.
BARLEY GROWING AREAS OF THE WORLD

- <1,000 Metric Tonnes
- 1,000 - 99,999 Mt
- 100,000 - 999,999 Mt
- 1,000,000 - 9,999,999 Mt
- 10,000,000 - 49,999,999 Mt
- 50,000,000 - 100,000,000 Mt
2005 WORLD BARLEY PRODUCTION
BARLEY VARIETIES

Malts are in constant flux, with new varieties becoming popular and old varieties falling out of favor.

There are two general types of malting barley:
   6 row & 2 row
BARLEY VARIETIES

6 ROW ON LEFT  2 ROW ON RIGHT
BARLEY VARIETIES

Six Row Barley:

- **Preferred by large, mega-breweries** using unmalted adjuncts such as rice or corn.
- **Has thicker husk** than two row
  
  Thicker husk useful for making grain bed more porous.
- **Has greater concentration of enzymes** than two row, enabling it to convert starch from un-malted adjuncts in addition to its own starch.
- **Provides less extract** than two row variety.
BARLEY VARIETIES

Two Row Barley:

- Preferred by craft breweries and breweries making all-malt beers.
- Generally more plump than 6 row and with a thinner, tighter husk.
- Provides greater extract than 6 row.
- In the past had less enzymes than 6 row, but newer varieties now contain comparable levels of enzymes to the 6 row variety.
The endosperm is composed of starches in a matrix of protein and makes up to 80% of total weight.

- Supplies the nutrients during growth of the embryo
- Source of sugars for FERMENTATION
MANUFACTURE OF MALT

MALTING:

“Malting is the controlled germination of barley during which enzymes are formed and the food reserves are sufficiently modified so they can be further hydrolyzed at mashing.”

**Malting Consists of Three Main Stages:**
1. Steeping
2. Germination
3. Kilning
MALTING: (STEP 1) STEEPING

- Barley that has been cleaned and graded is immersed in water. During steeping, the grain swells and increases in volume by about a quarter.

- 40 hour process involving three changes of water with an air rest between each change of water to provide embryo with access to oxygen.

- Introduction of air, adds O2 for germination; also to carry away carbon dioxide that has been generated by respiring barley.

- Barley moisture content will increase from 12% to 42-48% moisture level during the steeping phase. This amount of moisture is sufficient to support modification without allowing excessive growth.

“This steeping is the most important stage of malting, as it determines the subsequent rate and uniformity of barley germination and modification.”
MALTING: STEEPING

Steep Tank
MALTING: (STEP 2) GERMINATION

STEEPED GRAIN TRANSFER TO GERMINATION
MALTING: GERMINATION

Events of GERMINATION:
1. ‘Baby’ plant begins to grow
   - This breaks open the hull
2. Enzymes begin to convert insoluble starches to soluble starches
   - Proteins also broken down
MALTING: GERMINATION

“Malting is the controlled germination of barley during which enzymes are formed and the food reserves are sufficiently modified so they can be further hydrolyzed at mashing.”

Food reserves modified:
- **Convert insoluble starch chains to water soluble starches**
- **By using ENZYMES: Alpha & Beta Amylase, Cytase, Proteases**

2 starches:
- Amylose
- Amylopectin
MALTING: GERMINATION
MALTING: (STEP 3) KILNING

Main purpose of kilning: *remove moisture from the grain*... by heated air.

Kilning phases:
1. **Free drying (withering)**
   - Moisture removed easily by keeping temperature at a constant 120°-140°
   - Slower removal of moisture as air flow is reduced and temperature is gradually increased to 160° F

2. **Curing** – Applied air temperature is increased and the malt begins to develop color and aroma.
   - Decreasing air flow and increasing temperature to a range of 160° - 190°
   - Most of the malty flavors are developed via Maillard reactions and melanoidin development.
MALTING: KILNING

KILN DRYING OF GREEN MALT
BASE MALTS

The vast majority of base malt is made to supply essential elements needed to produce beer:

- Extract
- FAN (Free Amino Nitrogen)
- Basic malty flavor

Base Malt Examples:

- Pilsner
- American 2 row
- American 6 row
- Various pale ale malts
- Vienna
- Munich
SPECIALTY MALTS

Specialty malts are required to add diversity and complexity to beer.
SPECIALTY MALTS: ADDING DIVERSITY & COMPLEXITY TO BEER

SPECIALTY MALTS: Any malt that is not a standard base malt, which means that the category is really defined more by what it is not than by what it is.

5 categories:
1. High-Dried
2. Caramelized/Crystal
3. Roasted
4. Alternate Grains
5. Alternate Processes

*Characteristic flavors of specialty malts come mainly from Maillard reactions.*

Drum roasters are preferred for processing some specialty malts as well as coffee beans.
SPECIALTY MALTS

HIGH-DRIED MALTS

- Made in kilns by raising temperatures (or drum roasters)
- Higher temperatures during the final stages of kilning yield darker colors, and more malty/biscuit flavor.
- Munich malts are produced in this manner.
SPECIALTY MALTS

CARAMEL/CRYTALIZED MALTS

Examples:

- Cara-Pils
- Cara-Vienne
- Cara-Munich
- Special B
- Crystal Malts 1-180

Caramel malts are a broader class that also includes kiln made versions. Special malt kilns that produce caramel malts can reach maximum temperatures of 250-255°F (121-124°C).

The glassy, crystallized interior characteristic of "true" crystal malts requires the use of a drum roaster. Drum roasters are capable of surpassing the point of spontaneous combustion of malt - about 460°F (238°C).
SPECIALTY MALTS

ROASTED MALTS

Examples:

• Chocolate malt
• Black Malt
• Roasted Barley
SPECIALTY MALTS

CHOCOLATE ROASTED MALTS

Examples:
- Chocolate Wheat
- [brand] Chocolate Malt
- Pale Chocolate
- Chocolate Rye
- Carafa 1
- Carafa 2 (almost considered black malt)
- Coffee Mal

There are a number of different varieties of chocolate malt that act to produce a dark color within beer while also providing a chocolaty flavor. This chocolate flavor is similar to the taste of non-sweet, slightly burnt chocolate, or cocoa. There are significant differences across varieties of chocolate malts, with some producing a more toast and biscuit-like flavor, while others produces flavors that are more reminiscent of actual chocolate.
SPECIALTY MALTS

ALTERNATE PROCESSES-- SMOKED MALTS
Examples:
- Beechwood Smoked – Weyermann Malting
- Cherrywood Smoked – Briess Malting
- Mesquite Smoked – Briess Malting
- Alderwood Smoked – Alaskan Brewing Company

ALTERNATE PROCESSES-- ACIDULATED MALTS
Lactic acid bacteria is allowed to grow in the malt during the malting process. will assist in adjusting the mash pH
Dehusked/Debittered Malts:
Husks have been removed from these very dark roasted grains to reduce astringency caused by tannins in the husk. Weyermann produces these dark roasted malts in three color ranges:

- Weyermann® CARAFA® Type 1 - 300-375° Lovibond
- Weyermann® CARAFA® Type 2 - 413-450° Lovibond
- Weyermann® CARAFA® Type 3 - 488-563° Lovibond
When “Special” is added before the Type (as in, CARAFA® Special Type 1) the malt has been dehusked.

Roasted Unmaltered Grains:
Unmalterted roasted grains include Barley, Wheat, and Rye.
OTHER SPECIALTY MALTS

**Biscuit Malts**
- Lightly kilned and creates a taste and aroma that is similar to toast.
- Can create a nutty quality within the beer
- Typical Styles: bitters, milds, and brown ales.

**Light Malts**
- Light colored and create a fuller flavor and aroma of malt
- Kilned at higher temps and have more malt flavor

**Aromatic Malts**
- Gives more aroma to beer
- Amber color
- Typical Styles: Oktoberfest, Vienna lagers, and Marzen beers
ADJUNCTS

NON-BARLEY SUGAR-SOURCE
1. Grain Adjunct
2. Non-grain Adjunct

GRAIN ADJUNCT
3 processes used to expand starches in unmalted adjuncts:

1. Gelatinization by boiling in water until starch granules swell (like cooking rice or grits).
2. Torrefaction – The whole grain is exposed to an intense heat source, such as infrared, which causes an increase in volume and reconfigures the starch. Puffed wheat and puffed rice are examples of this.
3. Pre-Gelatinized Adjunct Flakes – Grain is steamed and then passed through heated rollers to produce flakes that can be added directly to the mash tun. Flaked maize, flaked wheat, flaked rice, flaked barley, etc.
ADJUNCTS

NON-BARLEY SUGAR-SOURCE
1. Grain Adjunct
2. Non-grain Adjunct

NON-GRAIN ADJUNCT
1. Malt extracts can be added to a strong beer wort to augment the sugars when insufficient malt sugars were extracted from the mash and an all-malt beer is desired.
2. Syrups and sugars
   Example: Belgian Candi-sugar and Candi-syrups are used in many Belgian beer styles to lighten the body and increase the alcohol without increasing the heavy maltiness that would be in an all-malt high alcohol beer.
The Weyermann® Malt Aroma Wheel® was developed empirically through sensory analysis and is based on the following categories:

- **Roasted Aromas:** Coffee, Cacao, Dark Chocolate, Roasted Almond, Dried Fruit, Bready
- **Smoky Aromas:** Wood Smoke (Beech, Oak), Clove
- **Fruity/Nutty Aromas:** Almond, Hazelnut, Raisin, Vanilla
- **Malty Aromas:** Honey, Biscuit, Marmalade, Malty-Sweet
- **Caramel Aromas:** Toffee, Light Caramel, Dark Caramel
- **Taste:** Sour, Sweet, Bitter