DUKES OF ALE **BJCP COURSE**
Craig Bias – Off Flavors **May 17, 2009**

ACETALDEHYDE (ALSO ACETYLALDEHYDE)

Characteristics:

- Aroma and flavor of green apples or freshly cut pumpkin.
- Some compare it to grass, green leaves and latex paint.
- Excess acetaldehyde produced in a high refined sugar wort can cause yeast to produce acetic acid with contributes to the cidery character.
- Acetaldehyde is typically inappropriate in any style, though Budweiser deliberately uses Beechwood chips to prematurely flocculate the yeast to give 6-8 ppm acetaldehyde in the beer.
- Salvator & EKU-28 also display acetaldehyde, though in lower amounts.

Causes:

1. Incomplete conversion of acetaldehyde to ethanol during fermentation resulting in green apple smell and flavor. Oxygen depletion, premature yeast flocculation, or prematurely racking the beer from the yeast will stop the fermentation reaction at acetaldehyde. Especially evident when weak yeast is used and the beers are young or have high alcohol content.
   Glucose -> pyruvic acid -> acetaldehyde -> ethanol
2. Oxidation of finished beer causes reverse oxidation of ethanol to acetaldehyde and acetic acid resulting in acetic-cider or rotten apple smell and taste.
3. Bacterial infection by *Zymomonas* or *Acetobacter* resulting in more vinegary and less pleasant rotten apple flavor. Typically occurs when racking or bottling.

Prevention:

1. Keep refined sugars (glucose and fructose) to <20% to avoid stuck fermentation where the yeast ferment the monosaccharides and quit. Excess acetaldehyde produced in a high refined sugar wort can cause yeast to produce acetic acid with contributes to the cidery character.
2. Use good quality yeast, especially in high alcohol beers to ensure proper attenuation.
3. Use lower pitching rate. (?)
4. Properly aerate to avoid oxygen depletion and ensure proper attenuation.
5. Use cooler fermentation temperature. (?)
6. Allow proper time for fermentation and aging.
7. Strict sanitation practices to avoid bacterial infection.

Remedy:

1. Use warmer lagering or conditioning temperature… I assume to prevent yeast flocculation. Cold storage for short durations promotes acetaldehyde in the final product, whereas longer cold storage would ultimately reduce acetaldehyde into ethanol.
2. Keep beer on the yeast (don't rack too soon).
3. Rouse the yeast to keep it suspended.
4. Use a less flocculent yeast strain.

SOUR/ACETIC (ACIDIC)

Characteristics:

- Perceived as sour aroma, tartness or vinegary flavor on the sides of the tongue towards the back of the mouth (such as with lemon juice).
- Also described as rubber (butyric acid), sour milk (lactic acid), or salty (pyruvic acid) flavors.
- At higher levels it can be felt all the way down the throat.
- Bacteria contamination sourness can also be perceived as spoilage or putrefaction.
- Though appropriate for lambic, oud bruin and Berliner weiss styles, and to a lesser extent, Belgian white beers, sour and acidic flavors are considered contaminants for other styles.
- Guinness stout undergoes a mild lactic fermentation (small portion of beer is soured and then blended back with rest of batch).

Causes:

1. Infection by lactic acid producing bacteria (*Lactobacillus* or *Pediococcus*), acetic acid producing bacteria (*Zymomonas* or *Acetobacter*), or acetic acid producing yeast (*Kloeckera* and *Brettanomyces* families). Bacterial growth can manifest from bad yeast strain; too much corn sugar; excessive amounts of citric or ascorbic acid (?); mashing too long (excessive acid rest); contamination from equipment; long lag times before pitching yeast; under-pitching yeast; excessive fermentation temperatures.

Prevention:

1. Strict sanitation practices.
2. Keep refined sugars (glucose and fructose) to <20% to avoid stuck fermentation where the yeast ferment the monosaccharides and quit. Excess acetaldehyde produced in a high refined sugar wort can cause yeast to produce acetic acid with contributes to the cidery character.
3. Proper fermentation temperature.
4. Avoid exposing wort to oxygen during fermentation and subsequent transfers since acetic acid bacteria require both oxygen and alcohol to metabolize.

Remedy:

1. If infected, none.

HUSKY/GRAINY

Characteristics:

- Dry, bitter, cardboardy, or harsh taste of raw grain husks.
- NOTE: Some references include astringency from grain husk tannins while others specifically caution confusion with tannins/astringency or oxidation off flavors.
- Cereal or grainy notes in the aroma may or may not be desirable, depending on the style, but the husky astringent tastes are undesired.

Cause:

1. Torn, shredded, or over-crushed grain husks resulting in husk flavors extracted during sparge.
2. Sparge temperature in excess of 170˚F.
3. Excessive sparging.
4. High pH during sparging (above 5.8 per Noonan, 6.0 others).
5. Boiling grains.
6. Improper decoction mashing.
7. Improper wetting of grist during mash-in
8. Direct-firing of mash tun without proper stirring (burning the mash).
9. Old beer.
10. Too many salts in water (sodium, magnesium, sulfate, chloride).
11. Iron in water.
12. Harsh aromatic compounds from freshly prepared toasted malts.

Prevention:

1. Proper crush.
2. Slow mash-in.
3. Lautering temperatures between 164-170˚F.
4. Monitoring pH of runoff and adding gypsum to keep pH below 6.
5. Proper sparge amounts.
6. Temperature controlled or infusion mash.
7. Steeping adjunct grains (such as crystal malt added to extract brews) below 170˚F instead of bringing to boil.
8. Water appropriate to style.
9. Iron-free water.
10. Let freshly toasted malts age for two weeks after crushing to dissipate harsh aromatics.

Remedy:

1. Cold conditioning for 1-2 months will allow harsh aromatics to settle out with yeast.
2. Call it a breakfast beer.

DMS

Characteristics:

- Cooked creamed corn, sweet canned corn, celery, cabbage or parsnip aroma and flavor in pale beers; tomato-like or tomato juice character in dark beers.
- In extreme cases, it may even be reminiscent of shellfish, oysters, or water in which shrimp has been boiled.
- Can be rancid with a cooked broccoli, cauliflower or cabbage character if from bacterial infection.
- Lager malts produce more SMM and therefore will result in higher DMS levels.
- Low levels of DMS are appropriate in most lagers, particularly American light lagers and pre-prohibition pilsners, but are not desirable in any ale style.

Cause:

1. Produced during reduction in hot wort (>158˚F or 70˚C) of S-methyl methionine (SMM), a resulting product of malt germination. SMM is significantly reduced in toasted and roasted malts hence DMS is less pronounced in darker beers.
2. High moisture malt.
3. Bacterial infections by *Zymomonas*, *Obesumbacterium,* or *Hafnia*. Coliform bacteria strains can also give a strong cooked-vegetable note.
4. Infected yeast that is repitched.
5. Underpitching.
6. Long lag time before fermentation.
7. Chilling fermentation too soon.
8. Too high initial fermentation temperature.
9. Over-sparging with water below 160˚F.

Prevention:

1. Good supplier of malt that ensures proper germination length and temperature to limit SMM production.
2. Full boils of at least one hour with lid partially open to evaporate DMS.
3. Prevent boil condensation on the lid from dripping back into the wort.
4. Rapidly cool wort following boil to stop reduction of SMM to DMS.
5. Use strong yeast, proper aeration, and proper fermentation temperature to vigorously produce CO_2 during fermentation to scrub out residual DMS. This is why lagers and cold-conditioned ales may have slightly higher levels than warm-fermented ales.
6. Good sanitation.
7. Do not re-pitch yeast from an infected batch of beer.

Remedy: Tell everyone it's a lager.

VEGETAL

- Characteristics:
- Cooked corn, cabbage, broccoli, or other vegetables.
- Not to be confused with the smells or tastes of rotten vegetables (oxidation) or raw vegetables (desired quality of some hops).
- Combination of the off flavors sulfurlike/rotten eggs/burning match and DMS.
- Hydrogen sulfide (rotten egg) and DMS combine to produce a sour/sweet flavor reminiscent of cooked vegetables.

Cause:

1. Sulfur-based compounds in malt or malt extract.
2. Bacterial infection (See DMS).

Prevention: See DMS.

Remedy: Serve with kielbasa.

GRASSY

Characteristics:

- Musty smell of freshly cut grass or green leaves.
- Can also be the flavor of chlorophyll.

Cause:

1. Improperly stored malts can absorb moisture and bacterial metabolism of barley produces aldehydes (hexanal, and heptanal) that smell like green grass.
2. Improperly dried or stored hops will exhibit their chlorophyll flavors in the beer.
3. Oxidation of finished beer produces aldehydes, hexanal, and heptanal which smell like green grass.

Prevention:

1. Store malts in cool, dry place.
2. Buy quality hops in proper packaging. Store unopened in cool/cold, dry place.
3. Prevent oxidation in finished beer, especially during racking and bottling.

Remedy: None.

REFERENCES

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