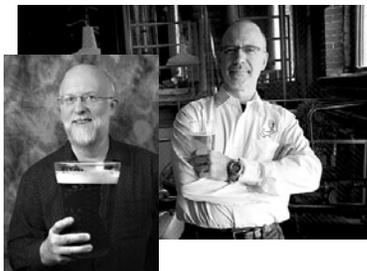


Randy Sez; Ray Sez



Advanced Topics

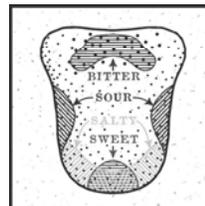
- Most of us brewing with 19th century technology
- We get the most important stuff, but brewing is all about the details
- Not a comprehensive survey, just some things we ran across

Sensory Topics

- Tasting incredibly important to brewing
- Lots of new sensory research
- We've been getting some very big things wrong...

Sensory Topics

- The tongue map



Sensory Topics

- The tongue map

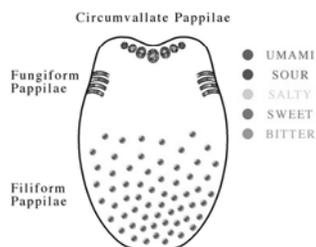


Sensory Topics

- Front half of tongue: all flavors
- Sides of tongue (way at back) a little more sensitive to sour
- Very back of tongue: a little more sensitive to bitter, umami
- Inside of cheeks, lips, soft palate all sensitive to all tastes

Sensory Topics

- **New tongue map**



Sensory Topics

- **Tongue tastes**

- Sweet
- Sour
- Salty
- Bitter

Sensory Topics

- **But wait, there's more:**

- Umami
 - Marker for protein
 - Glutamates, guanylates, inosinates
- Fat
 - Not just a mouthfeel

Sensory Topics

- **Now how much would you pay?**

- Probably:
 - Calcium
- And possibly:
 - Wet
 - Iron, zinc
 - Others?

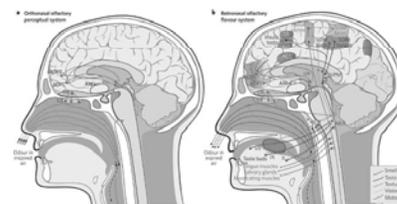
Sensory Topics

- **A bit about bitterness**

- A marker for poison (strychnine, cyanide, alkaloids, etc.)
- Evolutionarily, toxic compounds tossed into bitter category
- 30 separate pathways known
- Infants hate it
- For most, an acquired taste

Sensory Topics

- **Your two noses**



Sensory Topics

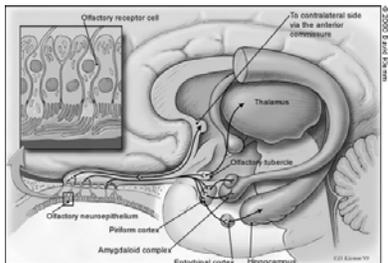
- **Orthonasal**
 - Top of your nose
 - Perceived as “smell”
 - Analytical
 - Responds to all olfactory stimuli

Sensory Topics

- **Retronasal**
 - Back of the nose, where nose connects to throat
 - Perceived as flavor, taste
 - Wired to the brain differently
 - Much more responsive to food odorants than non-food
 - Key to preference, familiarity

Sensory Topics

- **Smell and your lizard brain**



Malt Flavor Topics

- **Two types of caramelization**
 - Maillard
 - Requires presence of nitrogen (amines)
 - Plus, carbohydrates, moisture and heat
 - Familiar spectrum of bready, toasty, roasty, plus some caramelly aromas
 - Non-maillard (simple caramel)
 - Sugar + moisture, heat
 - Burnt sugar, dried fruit

Malt Flavor Topics

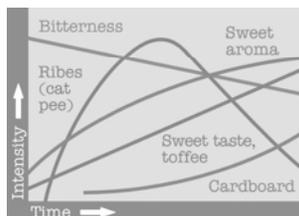
- **Crystal malt**
 - Conditions favor simple caramel
 - Responsible for toasted marshmallow
- **All other malt types**
 - Mostly Maillard browning

Bad news, good news

- **Oxidation and beer staling**
 - Very complex topic
 - Hot area of research
 - Most work done on pale lager
 - Had a European lager lately?
 - Working on fixes

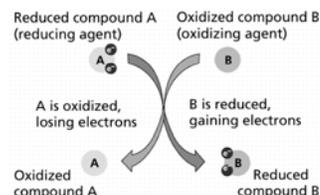
Bad news, good news

- **Beer staling**



Bad news, good news

- **Redox reactions**



Bad news, good news

- **Three sets of players**

- Oxidizing agents (electron acceptors)
- Reducing agents (electron donors)
- Substances reduced or oxidized

Bad news, good news

- **In beer, the players are:**

- Oxidizing agents (electron acceptors)
 - Oxygen
 - Peroxides, hydroxyl (free) radicals
- Reducing agents (electron donors)
 - Reductones (in dark malts, sulfites, others)
 - Yeast
- Substances reduced or oxidized
 - Lipids (fats), mainly linoleic acid
 - Higher Alcohols
- Oxidation: spontaneous or enzyme-driven

Bad news, good news

- **Main bad guy:** Trans-2-nonenal (cardboardy)
- Many others (carbonyls/aldehydes)
 - 2-furaldehyde
 - N-tert-butyl-a-phenylnitron
 - 5-hydroxymethylfurfural
 - Phenacetaldehyde
 - 1, 1 diphnyl-2-picrylhydrazyl
 - Thiobarbituric acid-reactive substances
- Scientists use as measures of staling, potential

Bad news, good news

- All malting and brewing stages play a role in potential for oxidation/aging
 - Malting
 - Recipe formulation
 - Milling
 - Mashing
 - Boiling
 - Fermentation
 - Packaging

Bad news, good news

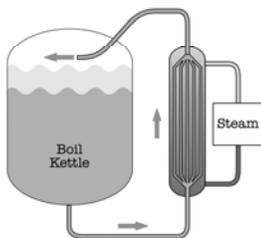
- **The bad news**
 - Oxidation/staling is real
 - Hot side aeration can be a real problem
 - Batch sparging not helpful (O₂ contact w/grain)
 - Sparging w/o spraying is best
 - High heat density very bad, esp. in pale beers
 - Iron, copper exacerbate problem
 - Commercial brewers have not fixed the problem

Bad news, good news

- **The good news**
 - Yeast in package scavenges O₂ problem
 - Dark malt protects and masks
 - Un-isomerized hop Xanthohumol is protective (use lots of aroma hops at end of boil)
 - Gallotannin (Tannox) may be helpful in pale beers (add 0.5 g/5 gallons brewing liquor)
 - Be wary of iron, copper pickup
 - Flame-tamer under kettle should help

Extreme Measures

- Thermosyphon/external calandria



Extreme Measures

- Homebrew setup
 - Direct fired
 - Redwood Avenue Picobrewery



Extreme Measures

- Steinecker Merlin
 - Thin-film evaporator
 - Low energy use
 - High evap. Rate
 - Speed



Brewing Science Review

- Hops
- Hops
- Hot Side Aeration Revisited

Stretching Your Hops

- Shortage of hops in 2007-2008
- Prices up 400% in some cases
- Impossible to get aroma varieties sometimes

Stretching Your Hops

- Aroma/Flavor Hop Utilization Experiment
- Rock Bottom Breweries (22 sites)
- American IPA w/ Amarillo finishing hops
 - 15° P OG
 - 1 lb/bbl
- Four approaches to finishing hops

Stretching Your Hops

Four approaches to finishing hops

- 1 lb/bbl total per trail
- Short – 50 mins stand in hot wort
- Long – 80 mins stand in hot wort
- Dry – all dry hopped
- Half – half dry, half long stand

Stretching Your Hops

- Short – 50 mins stand
- Long – 80 mins stand
- Longer hot wort stand increases hop flavor and aroma



Stretching Your Hops

- Dry – all dry hopped
- Half – half dry, half long stand
- Half equals or exceeds “dry” on all measures!



Stretching Your Hops

- Dry – all dry hopped
- Half – ½ dry, ½ long stand
- Long – 80 min hot stand
- “Half” equals or exceeds “Long” on all but “grassy”



Stretching Your Hops

Conclusion:

- Dry hop gives best aroma
- Long steep increases hop character
 - Caution: long wort stand OK if you have a strong, vigorous 90 min boil
- For a given amount of finishing hops:
 - Best results if you split them btw steep and dry

Frontiers in Hop Chemistry

- 1999 David Ryder Paper at CBC
 - Hop glycosides
 - Possible explanation for “first wort hopping”
- *Hop Flavor & Aroma*
 - *Proceedings of Aug 2007 Conference*

Frontiers in Hop Chemistry

- Hop Lupulin Gland Contains:
 - Alpha acids  Bitterness
 - Beta Acids
 - Essential Oils
 - >300 compounds
 - 70% hydrocarbons  Lost
 - 30% oxygenated components  Low levels
 - <1% sulfur compounds

“No component of the essential oil fragment has been shown unequivocally to be present in kettle hopped beers.”

Frontiers in Hop Chemistry

- “We have identified a number of β -glycosides present in the water-soluble fraction of hops that may play a significant role in the kettle hop flavor of beer.”
- *Glucose bound compounds*
- *Odorless in this form*
- *Non-volatile*
- *Water soluble*

Frontiers in Hop Chemistry

- *During fermentation:*
- Yeast liberates the glucose from the glycoside
- Yields a volatile, flavor-active hydrocarbon
- “When this glycoside-containing fraction is subjected to the brewing process, it is bio-transformed to produce the kettle hop flavor by yeast.”

Hot Side Aeration

- Trans-2-nonenal used as only measure
- Primary staling odor only in very pale beers
- Many other staling odors/flavors
 - Bready, sweet, toffee
 - Honey, earthy, straw, hay, woody
 - Waxy, fatty
 - Winey, sherry-like

Hot Side Aeration

- Bamforth:
 - "...acute shortage of good sensory data to support many of the claims that have been made."
 - Lack of statistical treatment
- Heroic measures give little payback
 - Total isolation: 15% "improvement"
 - But the beer was still stale!

Beer Dispense

When I pour my beer from a bottle, it seems flat with no head. But when I keg it, all I seem to get is foam!

Beer Dispense

- Beer Clean: free of residue
- No bubbles cling to sides!
- Non-petroleum-based detergent
- Don't wash beer glasses with your regular dishes!



Beer Dispense

- Testing for Beer Clean
- Water sheets off, does not spot
- Salt test:
 - Wet and shake
 - Salt should adhere everywhere



Beer Dispense

- Draft beer foams when it is out of balance
 - Temperature
 - Pressure
 - Resistance



Beer Dispense

System Balance

- 12-15 psi to maintain CO₂
- Draft system must provide an equal resistance



Beer Dispense

For 12 psi resistance:

- 3/16" vinyl tubing
 - Need 4 feet of hose
- 1/4" vinyl tubing
 - Need 14 feet of hose
- 3/8" vinyl tubing
 - Need 60 feet of hose



Beer Dispense

Actually *is* a science!

- System design
- Operation & troubleshooting
- Maintenance
- www.draughtquality.org

