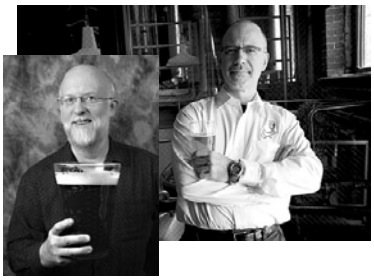
Randy Sez; Ray Sez



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

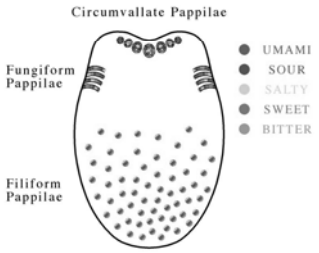
- **The tongue map**

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

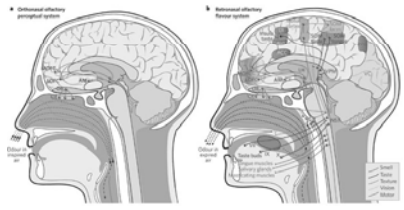
- **Now how much would you pay?**
- Probably:
  - Calcium
- And possibly:
  - Wet
  - Iron, zinc
  - Others?

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

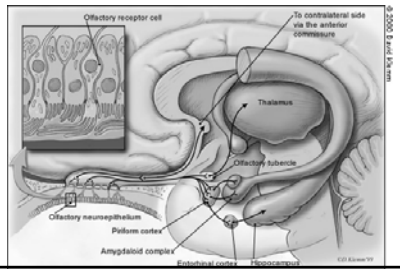
- **Orthonasal**
  - Top of your nose
  - Perceived as “smell”
  - Analytical
  - Responds to all olfactory stimuli

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

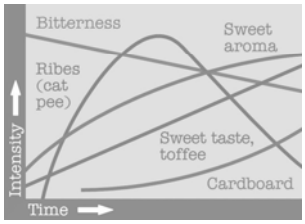
- **Crystal malt**
  - Conditions favor simple caramel
  - Responsible for toasted marshmallow
- **All other malt types**
  - Mostly Maillard browning

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

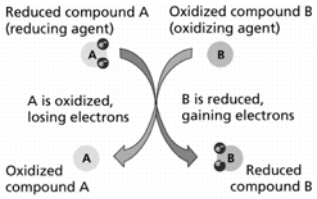
Bad news, good news

- **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-phenylnitrone
  - 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

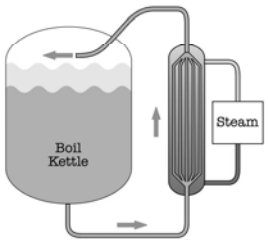
- **The bad news**
  - Oxidation/staling is real
  - Hot side aeration can be a real problem
  - Batch sparging not helpful (O_2 contact w/grain)
  - Sparging w/o spraying is best
  - High heat density very bad, esp. in pale beers
  - Iron, copper exacerbate problem
  - Commercial brewers have not fixed the problem

Bad news, good news

- **The good news**
  - Yeast in package scavenges O_2 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

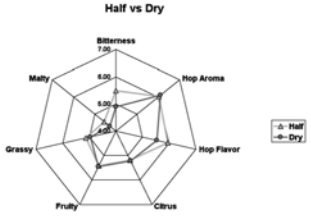
Four approaches to finishing hops
  - 1 lb/bbl total per trail
- Short – 50 mins stand in hot wort
- Long – 80 mins stand in hot wort
- Dry – all dry hopped
- Half – half dry, half long stand

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 exceed "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
  - Beta Acids
  - Essential Oils
    - >300 compounds
    - 70% hydrocarbons
    - 30% oxygenated components
    - <1% sulfur compounds

Bitterness

Lost

Low levels

"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 CO_2
- 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